



CCS Consulting Limited on
behalf of Makki Masjid

**Makki Masjid,
Beresford Road,
Longsight,
Manchester**
*Geotechnical
Interpretative Report*

April, 2010

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EXECUTIVE SUMMARY

Makki Masjid is proposing to redevelop the existing mosque site and two adjacent semi-detached residential properties to form a new mosque building incorporating a basement, with associated car parking, and with limited soft landscaping. The site is located off Beresford Road in Longsight, approximately 4km to the south east of Manchester City Centre.

Card Geotechnics Limited (CARD) has been commissioned by CCS Consulting Limited acting on behalf of Makki Masjid to conduct an intrusive investigation in external areas of the site in order to obtain information on the ground conditions, primarily to allow for geotechnical analysis and to install soil gas monitoring wells for subsequent monitoring.

The site comprised open fields from the mid 1900s with a small pond shown on the northern portion of the site on the 1893 historical map. The northern portion of the site was developed by 1934 as a *depot* whilst the two semi-detached residential properties located in the southern portion of the site had been constructed by 1957. The *depot* was later converted for use as a mosque, however, the layout of the site did not alter.

Available geological records indicate that the site is underlain by superficial deposits of Glacial Till overlying bedrock of Manchester Marl, which is described as a 'Secondary B' groundwater aquifer.

The CARD investigation comprised four window sample probeholes incorporating standard penetration testing (SPTs) at 1.0m intervals to 5mbgl and three dynamic probes (DPTs) to a maximum depth of 8mbgl. One gas / groundwater monitoring visit was conducted following the completion of site works.

Exploratory holes WS1, WS3 and WS4 generally encountered up to 1.1m of Made Ground / topsoil comprising tarmac/concrete/turf overlying soft clay with fragments of brick and ceramic, overlying undetermined depths of Glacial Till comprising a firm locally soft becoming very stiff sandy clay with depth.

The ground conditions in WS2 comprised 1m of Made Ground, overlying 2m of soft to firm sandy clay including plant matter thought to be infilled reworked natural ground associated with the former historic pond noted to previously occupy a section of the northern site boundary. Glacial Till comprising medium dense clayey sand was recorded beneath the pond infill and proven to 5.0m depth.

As the development will comprise a basement with a finished floor level of 2.3m below existing ground level, foundations should be founded within the underlying very stiff Glacial Clays or medium dense sands. Monitoring has shown the groundwater level is above the basement floor slab and therefore the slab should be designed to resist the hydrostatic forces. The floor slab may be designed as ground bearing and should also be designed to accommodate limited heave forces which may develop on the underside of the slab.

It is understood that a maximum structural column load for the development of 1400kN is envisaged. In order that the foundations are located on competent material it is considered that the foundation level should be at a minimum depth of 4mbgl. It is considered that an allowable bearing capacity of the soils at 4mbgl of 200kN/m² is adopted for design purposes in order to limit the potential effects of differential settlement between foundations located on differing material.

A CBR value of less than 2% should be adopted for road design within the Made Ground at or near to ground level. The pH and sulphate concentrations, recorded in the soil, indicate that buried concrete can be designed to Design Sulphate Class DS-1 and ACEC Class AC-1.

Based on the limited monitoring, the soil gas regime beneath the site can be classified as *Characteristic Situation 1*. On this basis no gas protection is likely for the development, although it should be noted that additional gas monitoring may be required by the Local Authority due to the limited monitoring undertaken. Furthermore, given the basement incorporates a car park it is likely to be well ventilated and of watertight construction, and therefore the risk of residual gas ingress is likely to be very low.

1. INTRODUCTION

Makki Masjid is proposing to redevelop the existing mosque site and two adjacent semi-detached residential properties to form a new mosque building incorporating a basement, with car parking, and with limited soft landscaping.

Plans showing the proposed site layout and basement cross sections are presented in Appendix A.

The mosque is located off Beresford Road in Longsight, approximately 4km to the south east of Manchester City Centre.

Card Geotechnics Limited (CARD) has been commissioned by CCS Consulting, structural engineers for the project, acting on behalf of Makki Masjid, to conduct a limited desk study and an intrusive investigation to obtain information on the ground conditions including bearing capacity and design criteria for buried concrete, road pavements and to undertake a round of gas / groundwater monitoring.

Environmental issues associated with the site are beyond the brief of this investigation and have therefore not been addressed.

This report presents the results of the intrusive investigation and laboratory testing and provides recommendations for geotechnical aspects of the proposed development along with recommendations for gas protection, where appropriate.

2. SITE CONTEXT

2.1 Site location

The site is located off Beresford Road between Buller Road and Campbell Road in Longsight, approximately 4km to the south east of Manchester City Centre. The approximate National Grid Reference for the site is 386710, 394880. A site location plan is presented in Figure 1.

2.2 Site description

The site comprises an operational mosque in the north along with a pair of semi-detached residential properties with front and rear gardens in the south. It is rectangular in shape, relatively level and has an area of 1,307m². It is bounded by Buller Road to the north west, Beresford Road to the south west, Campbell Road to the south east and a track to the north east.

The northern portion of the site is covered in hardstanding comprising tarmac surfacing in the north west corner with concrete in all other external areas. The surfacing in the southern portion of the site, however, mainly comprises soft landscaping with hardstanding comprising tarmac limited to a driveway and a pathway leading to the residential properties.

Photographs of the site are provided in Appendix B and a site layout is provided in Figure 2.

2.3 Site history

The historical development of the site has been traced using old Ordnance Survey maps dating from 1848. The historical maps are presented in Appendix C.

2.3.1 *Summary of development*

The earliest available record, dated 1848, indicates that the site and surrounding area was undeveloped and shown as open fields. The 1893 and 1894 maps show a small pond feature which extends onto the northern portion of the site.

The pond is no longer identified on the 1907 map which shows that the site remains undeveloped, however Campbell Road with residential / commercial properties beyond has been constructed adjacent to the south east boundary. In addition, land to the west is shown as a golf course.

The 1922 map shows that further residential / commercial properties have been constructed to the north east of the site whilst Beresford Road is now identified adjacent to the south west of the site.

An unidentified rectangular building has been constructed on the northern portion of the site on the 1934 map whilst the southern portion remains undeveloped. In addition, the surrounding areas to the north west and south west have been developed for residential / commercial use.

The 1957 map identifies the rectangular building as a *depot* whilst two semi-detached residential properties have been constructed on the southern portion of the site.

The historical maps do not show any significant change to the site or the surrounding area following the 1957 map. The date of when the depot was converted to a mosque is unknown.

2.4 Geology

2.4.1 Published geology

The geological records for the area¹ indicate the site to be underlain by drift deposits of Glacial Till and solid strata comprising the Manchester Marl Formation.

2.4.2 Unpublished geology

The BGS borehole log, referenced SJ89NE488, located approximately 170m to the north west of the site is in general agreement with the published geology. It identifies the following geological sequence:

¹ British Geological Survey. Manchester. England and Wales. Sheet 85. Solid and Drift Edition. 1:50,000 Series. 1975.

Table 1: Summary of unpublished geology

Thickness (m)	Depth (mbgl)	Description
1.8	0.0 – 1.8	Clayey ash and brick fill
1.5	1.8 – 3.3	Firm and soft grey brown silty CLAY with a little fine to medium gravel
0.4	3.3 – 3.7	Soft grey brown sandy silty CLAY with a little fine and medium gravel
6.3	3.7 – 10.0	Very stiff becoming stiff brown slightly sandy silty CLAY with a little fine and medium gravel

The groundwater level is recorded at 2.00mbgl rising to 1.70mbgl after 20 minutes.
The borehole record and a plan showing its location is presented in Appendix D.

2.5 Hydrology and Hydrogeology

The Environment Agency has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology, and are based on the importance of aquifers for potable water supply and their role in supporting surface water bodies and wetland ecosystems.

According to the Environment Agency² the superficial deposits beneath the site (i.e. Glacial Till) have not yet been classified whilst the Manchester Marl Formation is classified as a Secondary B aquifer. These deposits comprise predominantly lower permeability layers which may store limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.

The nearest surface water feature is a pond located approximately 230m to the south east whilst the nearest watercourse is the Gore Brook approximately 600m to the north west of the site.

² www.environment-agency.gov.uk

3. GROUND INVESTIGATION

3.1 Fieldwork

An intrusive investigation was conducted by CARD on 22nd February 2010. The investigation comprised 4No. window sampler holes formed to 5mbgl incorporating standard penetration testing (SPTs) at 1.0m intervals. In addition, 3No. dynamic probes, were advanced using a superheavy rig with a 63.5kg drop weight to 7mbgl in WS1 and to 8mbgl in WS2 and WS3. Gas and groundwater monitoring wells were installed in WS1, WS3 and WS4 with response zones formed in the Glacial Till.

All positions were CAT scanned in advance and hand inspection pits dug to 1.2mbgl prior to drilling. Sampling was undertaken at every change in lithology or every 1m if homogenous.

The exploratory hole positions are presented in Figure 3 and the logs are presented in Appendix E.

3.2 Gas and groundwater monitoring

Gas monitoring was undertaken within the monitoring wells located in WS1, WS3 and WS4 on 5th March 2010. During the visit, records were taken for percentage of volume in air of carbon dioxide, methane and oxygen, as well as flow rates, atmospheric pressure and differential pressures. The depth to groundwater was also noted during the visit. The monitoring record is presented in Appendix F.

3.3 Laboratory testing

Representative soil samples were sent to a UKAS accredited laboratory, Professional Soils Laboratory (PSL), for geotechnical analysis. Samples were analysed for the following:

- pH, water soluble sulphate
- Moisture content

- Index properties (liquid and plastic limit)
- Particle size distribution (hydrometer)

Laboratory test results are presented in Appendix G.

4. GROUND AND GROUNDWATER CONDITIONS

4.1 General

The ground conditions encountered during the CARD investigation are consistent with those expected from published geological records. Table 1 below provides a summary of the ground conditions based on the CARD exploratory holes and these are further discussed in the following sections.

Table 1: Summary of ground conditions

<i>Description</i>	<i>Depth to top of stratum (mbgl)</i>	<i>Thickness (m)</i>
TURF over dark brown topsoil comprising soft clay with rootlets and occasional brick. (WS3, WS4) [TOPSOIL]	0.0	0.45-0.9
TARMAC/CONCRETE over soft to firm brown grey clay with occasional gravel of flint with fragments of brick, ceramic and concrete. (WS1, WS2) [MADE GROUND]	0.0	1.0-1.1
Soft to firm dark brown grey sandy CLAY with occasional gravel of medium to coarse subrounded flint. Plant matter was noted at 1.8mbgl. (WS2 only) [POSSIBLE REWORKED INFILLED GROUND]	1.0	2.5
Firm locally soft becoming very stiff with depth grey brown sandy CLAY with gravels of flint. (WS1, WS3, WS4) Medium dense dark brown slightly gravelly clayey SAND (WS 2 only) [GLACIAL TILL]	0.5-1.1 3.5	Proven to 5.0m depth

4.2 Made Ground / Topsoil / Reworked Infilled Ground

The northern portion of the site is covered with either concrete or tarmac which is generally 100mm to 200mm thick whilst the southern portion of the site is covered in turf forming the gardens to the two residential properties.

In the southern portion of the site, topsoil is encountered beneath the turf to depths of 0.45m to 0.9m comprising dark brown soft clay with rootlets and occasional brick.

A layer of Made Ground, present to depths of between 1.0m to 1.1m, is encountered beneath the concrete or tarmac covering in the northern portion of the site. The Made Ground generally comprises soft dark brown clay with fragments of brick and ceramic as well as rootlets and wood fragments in the southern portion of the site.

In addition, due to the soft strength of the clay and the plant matter noted at 1.8mbgl in WS2, it is likely that materials present at this location constitutes reworked infilled ground associated with the former pond located on the site in the late 1900s. The reworked material within WS2 was encountered between 1m and 3mbgl.

Testing of a Made Ground sample of cohesive material from WS2 at 0.5mbgl indicates a liquid limit of 37% and a plasticity index of 20% indicating a clay of intermediate plasticity. In-situ shear strength testing with a hand shear vane indicated a shear strength of 18kN/m².

A sample from the Made Ground tested for aggressive ground conditions indicated a pH value of 9.9 and a sulphate concentration of 0.05 g/l.

4.3 Glacial Till

Beneath the Made Ground, superficial deposits of Glacial Till are encountered generally comprising a cohesive firm, locally soft becoming very stiff with depth sandy clay with occasional gravel of subrounded to subangular black flint. The Glacial Till becomes very stiff from approximately 4mbgl.

Testing of the cohesive material indicated a liquid limit of 58% and plastic limit of 20% at 0.9m to 1.2mbgl indicating a high plasticity clay whilst a liquid limit of 38% and plastic limit of 17% indicated an intermediate plasticity clay at 1.8m to 2mbgl. In addition, a liquid limit of 32% and a plastic limit of 15% indicates a low plasticity clay at 2.8 to 2.9mbgl.

The particle size distribution test undertaken at 1.5m to 2.0mbgl indicates a silty sandy clay.

SPTs were conducted in the window sampler holes up to 5mbgl with blow counts, generally increasing with depth, ranging from 10 to 35. These blow counts equate to an equivalent shear strength³ (c_u) between 55 kN/m² and 192.5 kN/m² indicating a firm clay which becomes increasingly stiff with depth. In-situ shear strength results from a hand shear vane indicated a shear strength within this stratum between 80 kN/m² and 140 kN/m².

Dynamic probe testing (DPT) undertaken within the cohesive stratum within WS1 and WS3 indicated blow counts of 2 at 2mbgl equating to an equivalent SPT 'N' value⁴ of 4, whilst DPT blow counts of between 2 and 6 were recorded between 3-4mbgl equating to an equivalent SPT 'N' value of between 4 and 12. DPT blow counts increased with depth to a maximum of 15 equating to an equivalent SPT 'N' value of 30 at 7mbgl.

The Glacial Till in WS2, however, was noted to comprise a non cohesive medium dense clayey sand with occasional gravel of flint from approximately 3mbgl to the base of the window sampler hole.

SPTs were conducted on this non cohesive clayey sand within WS2 with blow counts ranging from 12 to 26 indicating a medium dense sand. DPTs within this stratum indicated blow counts of 1 at 3mbgl which equates to an equivalent SPT 'N' value of 2, whilst blow counts of 5 were recorded at 4mbgl equating to an equivalent SPT 'N' value of 10. DPT blow counts increased with depth to a maximum of 20 equating to an equivalent SPT 'N' value of 40 at 8mbgl. The DPT results are very conservative and SPT values have been used for the purposes of design.

Graphs showing DPT results v depth, Equivalent SPT N values v depth and Correlated shear strength v depth are presented as Figures 4, 5 and 6 respectively.

³ $c_u = f_1 N$ where $f_1 = 5.5$ for Glacial Till: Stroud, M.A., 'The standard penetration test in insensitive clays and soft rocks', Proceedings of the Symposium on Penetration Testing, 2, 367-375 (1975)

⁴ Card G.B. and Roche D.P. *The use of continuous dynamic probing in ground investigation*. Penetrating testing in the UK. Thomas Telford, London, 1988. ($SPT'N'_{300} = 2 \times DPN_{100}$).

Samples from the Glacial Till tested for aggressive ground conditions indicate pH values of 9.3 to 9.5 and sulphate concentrations of 0.02 g/l to 0.3 g/l.

4.4 Groundwater

During window sampling and probing, perched groundwater was encountered at WS2 in the Made Ground at approximately 0.25mbgl and the Made Ground arisings were moist from approximately 0.5mbgl within WS1.

No evidence of groundwater was noted in the remaining window samples during formation of the holes.

4.5 Monitoring

A gas monitoring visit was undertaken on Friday 5th March 2010 and was conducted during an atmospheric pressure of 1026mb. During monitoring a maximum carbon dioxide concentration of 0.5% by volume in air was encountered along with a maximum flow rate of 0.1l/hr whilst 0.0% methane was recorded at the site. A minimum oxygen concentration of 20.1% by volume was recorded along with a maximum differential pressure of 0.3Pa.

Groundwater was encountered during monitoring at depths of 0.6mbgl at WS1, 0.64mbgl at WS3 and 0.67mbgl at WS4. It is likely that pockets of groundwater are present due to the sandy nature of the clay.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 General

It is understood that the existing mosque is to be redeveloped to form a new mosque building incorporating a basement with finished floor level at 2.3mbgl, with an associated car park, and limited soft landscaping. The intrusive investigation was conducted to provide information on bearing capacity for foundations and the design of buried concrete, substructures, floor slabs and road pavements, along with gas protection requirements. These are further discussed in the following sections.

5.2 Foundations

It is understood that the proposed development will comprise a basement with a finished floor level of 2.3m below existing ground level. In addition, a maximum structural column load of 1400kN is proposed for the development. From the intrusive investigation, it should be noted that the Made Ground, reworked infilled ground and soft clay identified up to a maximum of 3mbgl in WS2 is not suitable founding strata.

Accordingly, taking account of the need to accommodate the thickness of the floor slab and the foundations, it is considered that the foundation level should be at a minimum of 4mbgl. It is also noted that there is some variation within the Glacial Till at this depth. Hence, in order to minimise the potential effects of differential settlement, it is considered that the allowable bearing capacity of the soils at 4mbgl is restricted to 200 kN/m² for design purposes.

5.3 Basement wall

Based on in-situ information and recognised published data⁵ the following parameters are recommended for the design of the basement wall:

- Made Ground - $c_u = 20 \text{ kN/m}^2$; $c' = 0$; kN/m^2 ; $\phi' = 25^\circ$; $\gamma = 19 \text{ kN/m}^3$

- Glacial Till - c_u = typically 100 kN/m² (between 55 kN/m² and 66 kN/m² within top 1.5m); $c' = 0$; kN/m²; $\phi' = 27^\circ$; $\gamma = 20$ kN/m³
- Assume ground water level at 0.6mbgl.

5.4 Basement floor slab

The basement floor slab may be designed as ground bearing provided it is founded upon the underlying very stiff clays/medium dense sands.

During the monitoring visit, groundwater was recorded at 0.60mbgl to 0.67mbgl within all three of the monitoring wells, i.e. above the base of the basement slab; therefore the basement floor slab will need to be designed to resist hydrostatic forces.

Due to the presence of groundwater it may be necessary to undertake some dewatering during the excavation of the basement structure.

5.5 Roads/pavements

Based on the results of classification testing, it is recommended that a CBR value of <2% be adopted for road design within the Made Ground. All formations should be proof rolled. If pockets of weak material are encountered during excavation at the road formation level these should be removed and replaced with well compacted granular fill.

5.6 Buried concrete

The soil pH and sulphate concentrations indicate that buried concrete can be designed to Design Sulphate Class DS-1 and ACEC Class AC-1 based on current guidance⁶.

⁵ CIRIA (2003). Embedded retaining wells - guidance for economic design. CIRIA Report C580.

⁶ BRE. Special Digest 1:2005. Third Edition. *Concrete in aggressive ground*. BRE Construction Division.

5.7 Gas protection

The limited results obtained during monitoring indicate the soil gas regime at the site can be classified as *Characteristic Situation 1* based on current guidance⁷. This indicates that the soil gas beneath the site poses a low risk to users and no special gas protection measures are required.

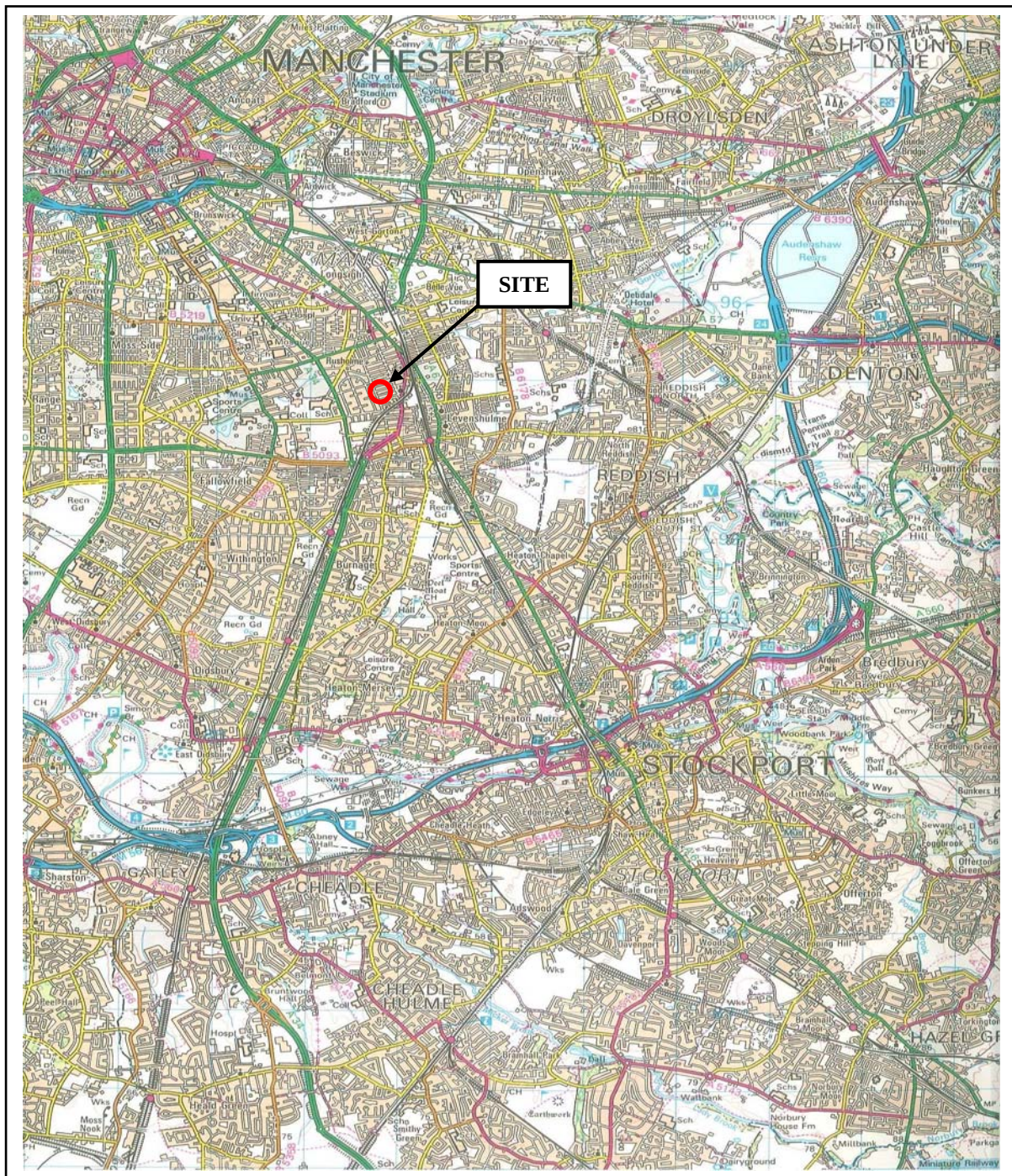
This conclusion is based solely on one gas monitoring visit and current guidance stipulates that four visits may be required over a period of one month. However, ventilation will be required for the basement construction, as it incorporates car parking, which is likely to be sufficient to deal with the potential of soil gas at the site. In addition, the Made Ground, which is the likely source of any soil gas, will be removed during the construction of the basement. The basement will also be tanked with a membrane for water proofing purposes. This membrane will also act as a barrier should soil gas be generated.

Should the basement be tanked, the gas pathway will be broken and the risk to the site will be negligible.

⁷ CIRIA (2007). *Assessing risks posed by hazardous ground gases to buildings*, CIRIA Report C665, CIRIA, London

FIGURES



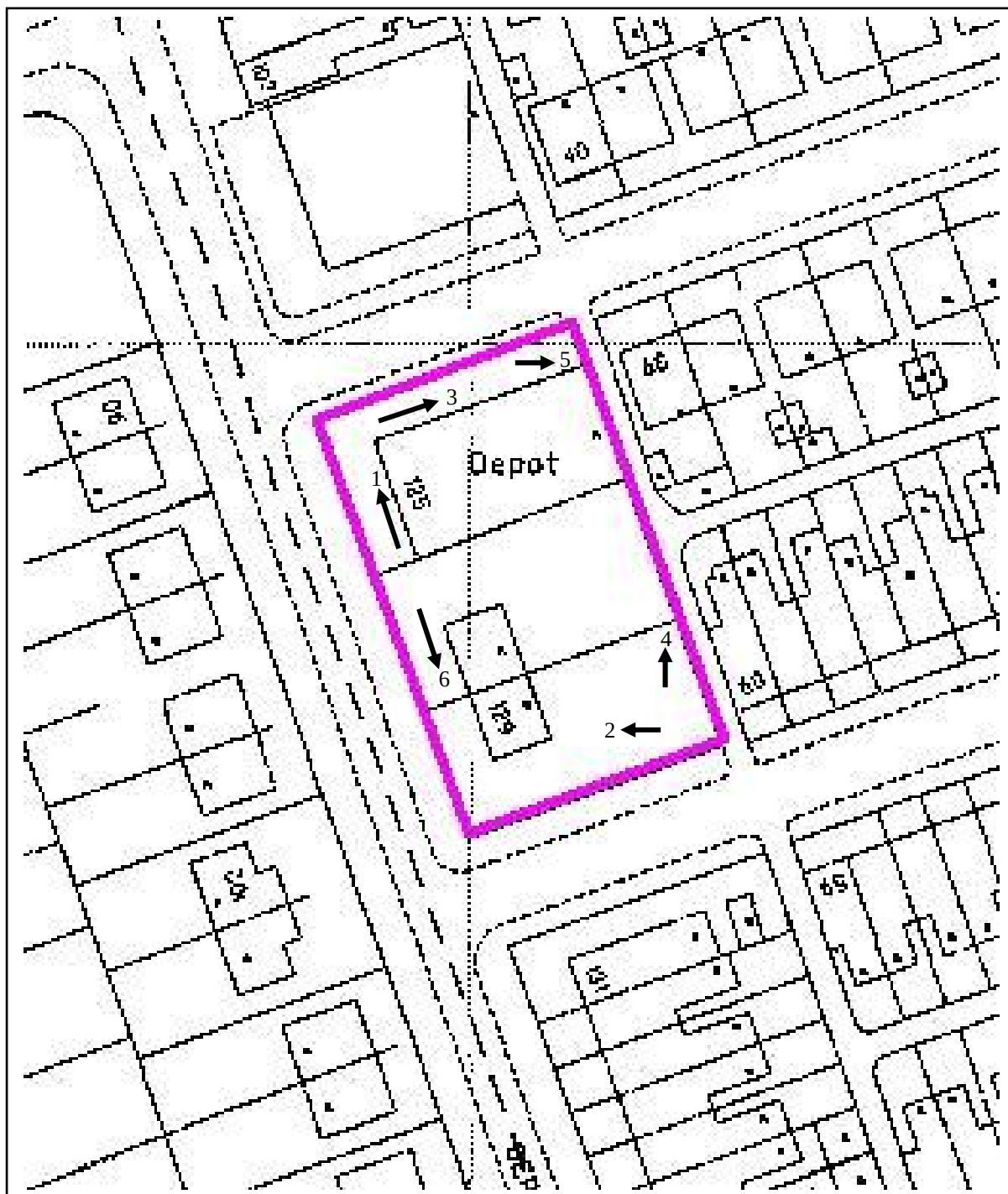


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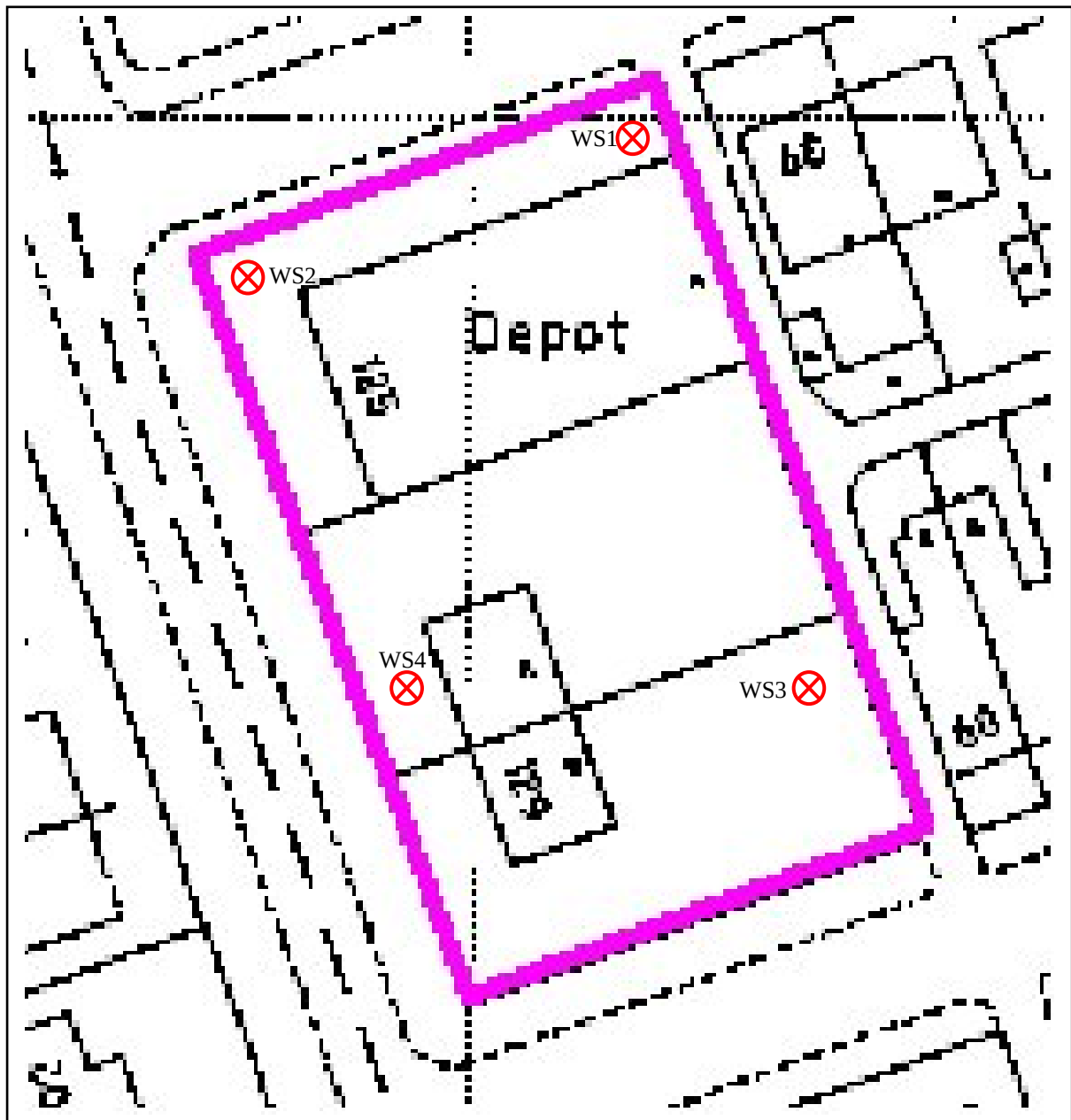


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	Title Site location plan	Figure 1



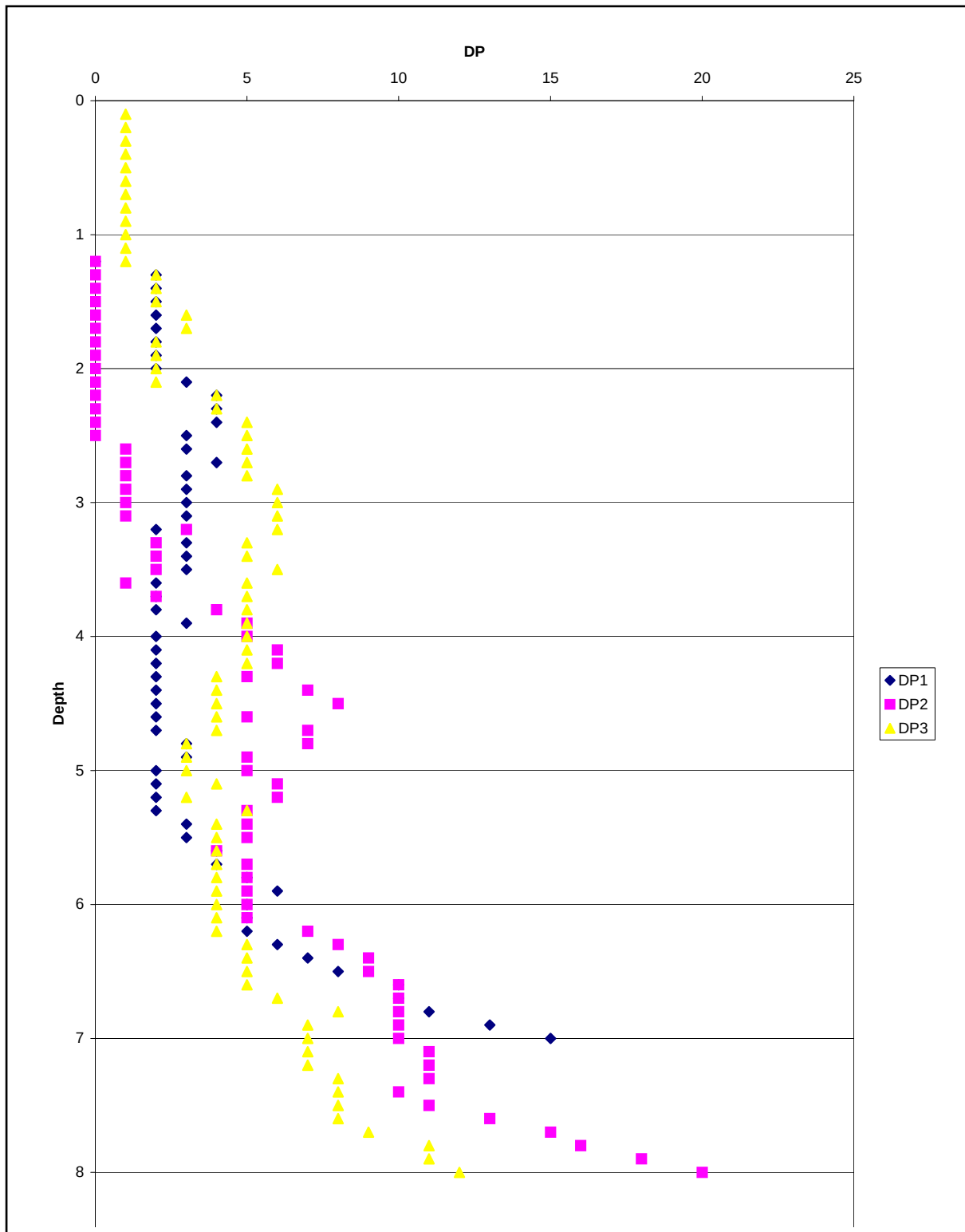
→ 1-6 - Location of photos

Client CCS Consulting Ltd c/o Makki Masjid	Project Makki Masjid, Beresford Road, Longsight, Manchester	Job No CGN/2638
CARD GEOTECHNICS	Title Site layout plan	Figure 2




 Approximate window
sample locations

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	Title Exploratory hole location plan	Figure 3



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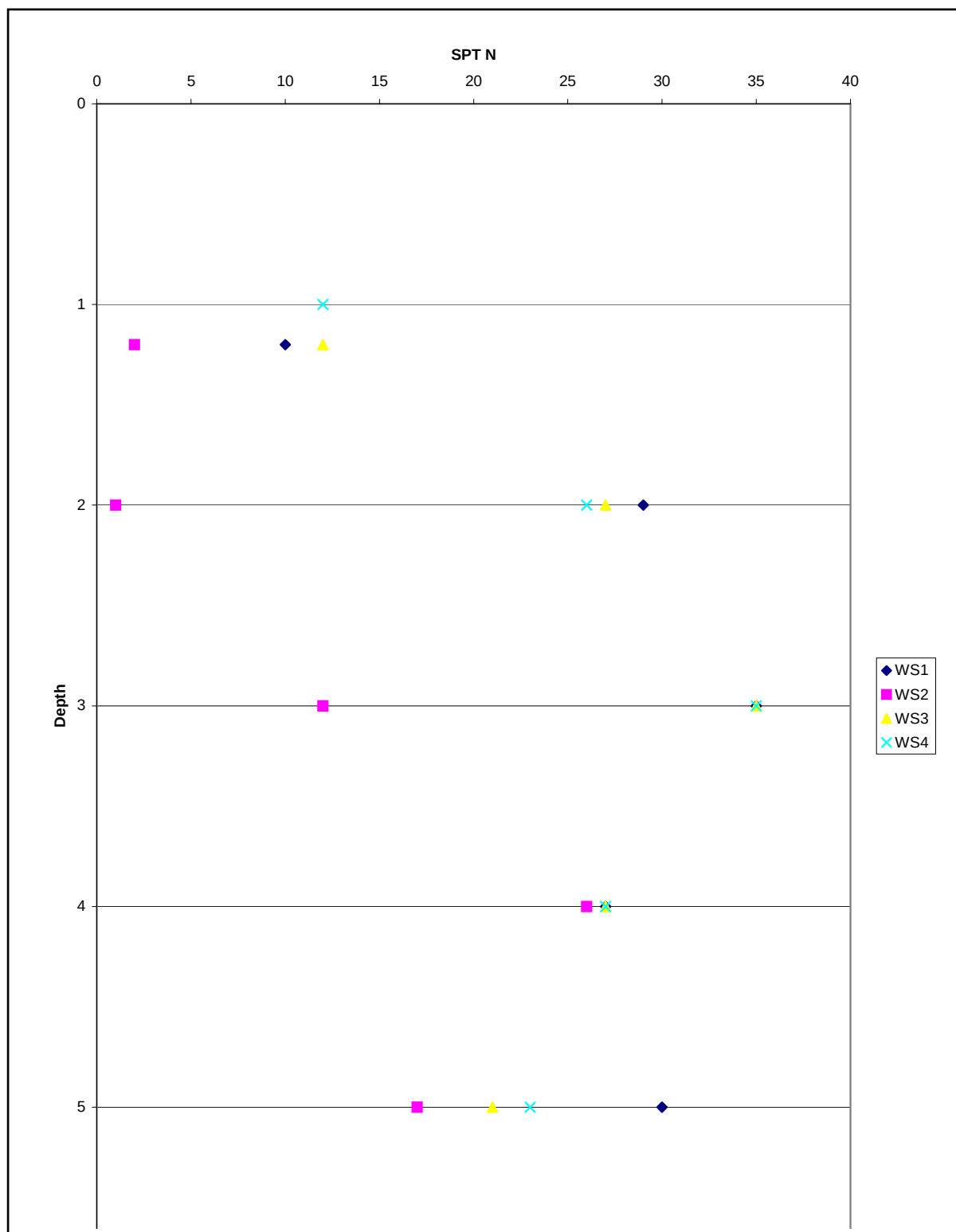
Project
**Makki Masjid, Beresford
 Road, Longsight, Manchester**

Job No
CGN/2638

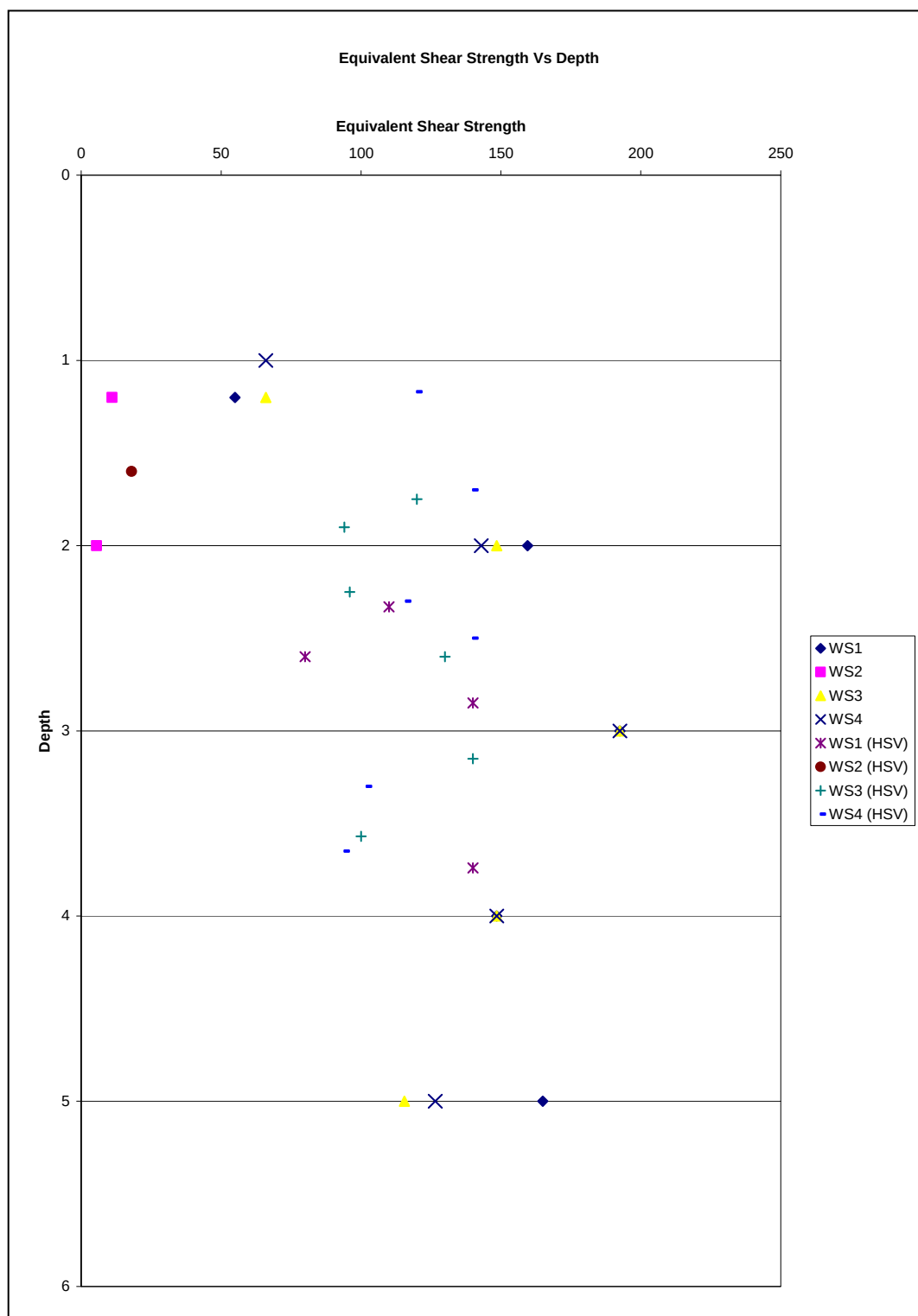
CARD
 GEOTECHNICS

Title
**Dynamic probe test results v
 depth**

Figure 4



Client CCS Consulting Ltd c/o Makki Masjid	Project Makki Masjid, Beresford Road, Longsight, Manchester	Job No CGN/2638
CARD GEOTECHNICS	Title Equivalent SPT N values v depth	Figure 5



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CARD GEOTECHNICS	Title Correlated undrained shear strength v depth	Figure 6