UNIVERSITY OF MANCHESTER

UNIVERSITY OF MANCHESTER CHEMISTRY BUILDING, MANCHESTER, M13 9PL

REPORT ON GROUND INVESTIGATION

Contract: 41887v1

Date: June 2016

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REPORT ON GROUND INVESTIGATION

carried out at

UNIVERSITY OF MANCHESTER CHEMISTRY BUILDING, MANCHESTER,

M13 9PL

Prepared for

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c/o Curtins Consulting
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EXECUTIVE SUMMARY

On the instructions of Curtins Consulting, on behalf of University of Manchester, a ground investigation was undertaken to determine ground conditions for the proposed construction of new nitrogen generation facility, N_2 solvent store and waste, dispensing and receiving storage.

The site is situated adjacent to University of Manchester Chemistry Building, approximately 1.85km to the southeast of the city centre of Manchester.

The geological map indicates the site to be underlain by superficial deposits comprised of glacial till. Subsequently underlain by bedrock of Sandstone part of the Chester Pebble Beds Formation of Triassic age.

The site work was carried out between 18th and 19th April 2016 with a second visit between the 30th April and 1st May 2016.

The sequence encountered generally comprises of made ground overlaying clay, subsequently overlaying sandstone bedrock.

The investigation has proved made ground to depths of about between 0.60m to 2.30m.

The deepest made ground (2.30m) was encountered within vicinity of BH01 and WS03B located to the northern and southern edges of the site.

Foundation options for the support of structural loads include the following:

- Ground improvement
- Deep trench fill
- Piles

Overall design purposes a Design Sulphate Class of DS-1 should be adopted. An ACEC class for the site of AC-1 would be appropriate.

The elevated concentration of PAH is present the made ground (WS02 at 0.50m) where ash has been noted. The remaining of the results are below the relevant guideline values for a commercial end use. Asbestos was not detected.

The risks relating to the development of the site are therefore considered to be very low as the site will be covered by hardstanding. The only risk present will be during the construction phase.

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1.0 INTRODUCTION

1.1 It is understood that the proposed development comprises the construction of a new nitrogen generation facility, N_2 solvent store and waste, dispensing and receiving storage.

1.2 On the instructions of Curtins Consulting, acting on behalf of University of Manchester, a ground investigation was undertaken to determine ground conditions for the proposed development.

1.3 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.

1.4 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.5 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.6 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated adjacent to the existing University of Manchester Chemistry Building, approximately 1.85km to the southeast of the city centre of Manchester.

2.1.2 The site may be located by Grid Reference SJ 847 965.

2.1.3 A site location plan is included in Appendix 1, Figures A1.1.

2.2 Site Description

2.1.1 The site was located in a service yard to the west of the existing six storey red brick University of Manchester Chemistry Building.

2.1.2 The site was rectangular in shape with approximate dimensions of 30m by 15m.

2.1.3 The site comprised of two levels. The upper level, which is the existing ground level, comprises grey block paving. The lower level, which is the basement level of the existing building, comprised an open lightwell which extended southward covered by a concrete slab forming a tunnel. A concrete slab was encountered at surface level.

2.1.4 A square lightwell surround by 1m high metal railings was located adjacent to the building.

2.1.5 The lightwell was approximately 2.5 to 3.0m below ground level. The north, south and west walls of the lighwell are red brick retaining walls with the eastern wall comprising part of the existing building. South of the lightwell on the lower level a covered passage was located, extending towards Dover Street. The roof of the passage was concrete.

2.1.6 A cylindrical liquid nitrogen tank is located in the northwest corner of the site. A feeder pipe runs into the chemistry building. The pipe follows the edge of the lightwell.

2.1.7 The site was accessed via an automatic barrier from Dover Street to the south.

2.1.8 The site was bound to the north by a car park, to the east by the existing red brick chemistry building, to the south by Dover Street and to the west by the Zochonis Building.

2.2 Geological Setting

2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No. 85, 'Manchester', solid and drift edition, 1:50,000 scale, published 2011.

2.2.2 The geological map indicates the site to be underlain by superficial deposits of Glacial Till.

2.2.3 The superficial deposits are underlain by bedrock of sandstone; part of the Chester Pebble Beds Formation of Triassic age.

2.2.4 The site is within an urban area and, although not indicated as present on the site from the geological maps, the possibility that Made Ground exists on site cannot be discounted.

2.2.5 One historical borehole (SJ89NW250) was located 0.18km west of the site extending to 7.77m. Made ground was encountered up to depth of 4.88m. Clay was encountered between 4.88m and 5.49m. Sandstone bedrock was encountered at 7.77m.

3.0 SITE WORK

3.1 The site work was carried out between 18th and 19th April 2016 with a second visit between the 30th April and 1st May 2016.

3.2 The locations of exploratory holes were indicated on drawings provided by Curtins Consulting.

3.3 The site work was carried out on the basis of the practices set out in BS 10175:2011+A1:2013, ref. 9.2, BS 5930:2015 ref. 9.2 and ISO 1997:2007, ref 9.4.

3.4 The locations of the exploratory holes were restricted by existing buildings and services.

3.5 The site work comprised the following:

- BH01: Cable percussion borehole
- WS01 (WS03A and WS03B) to WS04: Window sampler borehole
- TP01 to TP06: Hand excavated trial pit
- Core01 to 03: Wall Cores

3.6 The positions of the exploratory holes are shown on Figure A1.2 in Appendix 1.

3.7 The depths of boreholes and trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the borehole and trial pit records in Appendix 2.

3.8 Representative disturbed and undisturbed samples were taken at the depths shown on the borehole and trial pit records and despatched to the laboratory. Standard penetration tests, ref. 9.4 were carried out in the boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records.

3.9 Samples were collected for environmental purposes in amber glass jars and kept in a cool box.

3.10 Photographic records of the trial pits are presented in Appendix 7

3.11 Three horizontal wall cores (Core 01 to Core 03) were undertaken along the lightwell west wall. Photographic records of the wall cores are presented in Appendix 7.

3.12 Perforated standpipes, surrounded by pea shingle and protected by a stopcock cover were installed in borehole BH01, as detailed in the borehole record.

3.13 The ground levels at the borehole and trial pit locations were not determined.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing

4.1.1 All soil samples were prepared in accordance with BS1377: Part One: 1990 ref. 9.9 and representative sub-samples were taken for testing. The following tests were carried out:

- 4 No. Moisture contents
- 4 No. Plasticity indices
- 2 No. Particle size distribution by wet sieving
- 1 No Undrained shear strength
- 1 No. Oedometer consolidation
- 9 No. Water soluble sulphate
- 9 No pH value

4.1.2 The results of the soil tests are presented in Appendix 3, Test Report 41887/1

4.1.3 The results of the sulphate and pH tests are presented in Appendix 3, Test Report 16-64699.

4.2 Chemical Testing

4.2.1 The chemical analyses were carried out on seven samples of soil. The nature of the analyses is detailed below:

- 7 No. Metal Screen - arsenic, cadmium (III and VI), chromium, lead, mercury, selenium, boron (water soluble), copper, nickel and zinc
- Inorganics Screen – 4 no. cyanide (total), 7 no. sulphate (water soluble), sulphide
- Organic Screen – 7 no. polyaromatic hydrocarbons (PAH) – USEPA 16 suite, 7 no. monohydric phenols, 2 no. TPH (CWG) and 2 no. BTEX
- 7 No. pH values
- 4 No. Asbestos identification
- 7 No. Total Organic Carbon
- 4 No. Volatile Organic Compounds
- 1 No. Waste Acceptance Criteria (WAC)
- 2 No. Solvent suite – VOC, TPH(CWG), sulphate, chloride, nitrate, target alcohols, sulphate (total & water soluble) and pH

4.2.2 The results of these tests are shown in Appendix 4, test reports 565188-1, 565352-1, 565383-2 and 576477-1.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Sequence

5.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

5.1.2 The sequence encountered generally comprises of made ground overlaying clay, subsequently overlaying sandstone bedrock.

5.1.3 The general sequence of strata is shown on the nominal sections; Figures A1.3A and A1.3B.

5.2 Made Ground

5.2.1 Made ground was encountered at all locations from ground level to depths between 0.15m and 2.30m.

5.2.2 Block paving and bedding sand was encountered within BH01, WS01, WS02, TP01, TP02, TP03 and TP04 up to depths between 0.10m and 0.15m.

5.2.3 Paving slab and bedding sand was encountered within WS03, WS03A, WS03Band WS04 at depths up to 0.15m.

5.2.4 Concrete was encountered within TP05, TP06 and TP07 between surface and 0.15m to 0.60m. Rebar was encountered at 0.15m and 0.25m within TP06 and TP07.

5.2.5 WS01, WS02, BH01, TP01, TP02, TP03 and TP04A encountered a tarmacadam layer at depths in range of 0.10m and 0.35m.

5.2.6 Limestone gravel was encountered beneath the tarmacadam within TP04 depth between 0.35m and 0.50m.

5.2.7 Beneath the surface covering varying made ground was encountered comprising coarse soils, predominantly gravel with localised clay.

5.2.8 Coarse soil comprised gravel with localised sand, was encountered at all locations apart from TP01, TP03, TP05, TP06, TP07 and WS01 at depths from 0.15m to 0.50m. The material generally comprised brown, slightly clayey, very sandy, angular to subangular gravel.

5.2.9 Made ground of sand was encountered within BH01 at depths between 0.30m and 2.30m. The material comprised light brown, gravelly fine to coarse sand.

5.2.10 The base of the coarse soils was encountered between 0.60m and 1.70m.

5.2.11 Made ground of clay was encountered in WS01 and WS03B at depths of 0.40m and 0.80m respectively. The material comprised firm, brown, slightly

mottled grey, slightly sandy, slightly gravelly clay. The base of the clay was encountered between 0.60m and 2.30m.

5.2.12 Low cobble content was noted throughout made ground.

5.2.13 Anthropogenic fragments included brick, concrete, ash, rebar and wood fragments.

5.2.14 A black armoured cable was encountered at 0.60m within WS03 and WS03A.

5.2.15 An obstruction was encountered at 1.70m in WS02 and 3.50m in WS04, assumed toe of the retaining wall.

5.2.16 One SPT 'N' value of 18 was obtained within the made ground of coarse soils. This value indicates medium dense material.

5.2.17 Laboratory analysis of made ground has indicated pH values in the range 8.2 to 10.4 and soluble SO_4 contents in the range 19 to 260mg/l.

5.2.18 One particle size distribution test (BH01 at 1.20m and TP04 at 0.70m) indicated predominantly fine to coarse gravel with secondary sand content of 26 to 29%. Fine constituents (silt and clay) of 7 to 22% were recorded.

5.2.19 The base of the made ground was proven in BH01, WS01 and WS03B, at depths from 0.45m to 2.30m. the remaining locations were terminated within made ground at depths in the range of 0.15m to 1.70m.

5.3 Clay

5.3.1 Clay was encountered directly beneath made ground within BH01, WS01 and WS03B at depths in the range of 0.60m to 2.30m.

5.3.2 The material comprised brown, slightly sandy, slightly gravelly clay considered to represent the reordered Glacial Till. Consistence were generally recorded as stiff.

5.3.3 A sand band was encountered between 4.10m to 4.40m within BH01.

5.3.4 Atterberg limits on four samples of clay recorded plastic limits in range of 17% and 22% and plastic index values in the range of 16% to 27% with 87% and 99% passing 425µm sieve. Moisture contents in range of 14% to 22% were also obtained.

5.3.5 On the basis of these results the material may be classified low plasticity clay (one sample) and intermediate clay (three samples).

5.3.6 Based on the measured plastic index values the material may be classified as medium volume change potential as defined by the National House Building Council, ref 9.13 and other published data, refs 7.14, 7.15.

5.3.7 One triaxial test on clay recorded an undrained shear strength (Cu) of 146kN/m^2 at a depth of 3.00m (BH01) respectively. This value indicates stiff material.

5.3.8 One consolidation test recorded a coefficient of compressibility, m_v, of 0.16m^2/MN at the pressure stages rising from overburden. The values recorded generally indicate medium compressibility.

5.3.9 Five SPT 'N' values were obtained within clay with values in the range of 21 to 35.

5.3.10 The SPT 'N' values do not appear to systemically vary with depth although this is based on a limited data set.

5.3.11 SPT 'N' values may be used to provide an approximation of Cu values in clay (see Appendix 4).

5.3.12 The Cu values in the range of 105kN/m^2 to 175kN/m^2 may be derived from SPT 'N' values where full penetration was achieved. These have been based on an f_1 value about 5.

5.3.13 The consistencies of the clay determined by logging, laboratory tests and derivation from in-situ tests are in general accordance.

5.3.14 Laboratory analysis of clay has indicated pH value of 8.2 and soluble SO_4 contents of 29mg/l to 48mg/l.

5.3.15 WS03B was terminated at a depth of 5.00m within the clay.

5.3.16 The base of the clay was proven in BH01 and WS01, at depths of 5.60m and 5.40m respectively.

5.4 Bedrock

5.4.1 Bedrock of sandstone was encountered in BH01 and WS01 at depths of 5.60m and 5.40m respectively.

5.4.2 Sandstone was in part weathered and recovered as brown, orange and yellow, slightly gravelly sand (WS01) and sand and gravel (BH01).

5.4.3 One SPT 'N' value in bedrock recorded greater than 50 blows with penetration of 175mm.

5.4.4 The base of the bedrock was not proved.

5.4.5 BH01 and WS01 were terminated at depths of 6.33m and 5.45m within sandstone.

5.2 Wall cores

5.4.1 Three wall cores (core 01 to core 03) were undertaken along the existing lightwell western retaining wall.

5.4.2 The wall generally comprised 1 course of red brick to depths of 0.10m to 0.12m, with concrete between 0.41m and 0.45m along axis.

5.4.3 Core 02 encountered mudstone at 0.45m.

5.4.4 Core 01 and core 02 terminated at 0.41m and 0.44m within concrete.

5.4.5 Core 03 terminated at 0.51m within mudstone.

5.4.6 The length of the cores varied from 0.41m to 0.51m.

5.4.7 Wall core photographs are presented in Appendix 7.

5.3 Concrete Slab / Retaining wall

5.4.1 TP01 to TP04 were excavated to locate the top of the concrete slab and top of the retaining wall.

5.4.2 Concrete slab was encountered within TP01 and TP03 as depths of 0.42m and 0.35m respectively. the concrete extended 0.70m (TP01) and 0.85m (TP03).

5.4.3 A 50mm diameter core hole was drilled to determine the thickness of the slab. The slab thickness was recorded as 255mm.

5.4.4 A concrete step out extending 0.20m and 0.22m were within TP02 and TP04 at depths 0.65m and 0.62m respectively.

5.4.5 The base of the retaining was not encountered in TP01 to TP04.

5.4.6 An obstruction was encountered at 1.70m in WS02 and 3.50m in WS04, assumed toe of the retaining wall.

5.4.7 Trial pit sketches and photographs are presented in Appendix 7.

5.5 Existing Foundations

5.5.1 TP05, TP06 and TP07 were undertaken to investigate the concrete thickness, the location of the footing of the existing building and the retaining wall within the lightwell.

5.5.2 No footings were encountered due to the thickness of the concrete.

5.5.3 Trial Pit photographs are presented in Appendix 7.

5.6 Groundwater

5.6.1 Groundwater was not encountered in any of the exploratory holes.

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

6.1 Structural Details

6.1.1 It is understood that the proposed development comprises the construction of new nitrogen generation facility, N_2 solvent store and waste, dispensing and receiving storage.

6.1.2 The proposed site development plan is presented on Figure A1.4.

6.1.3 The principal developments generally relate to exploratory hole position as follows:

- Concrete service yard – BH01.
- Waste processing, dispensing and receiving store building – WS01, WS02 and TP04.
- Proposed new Stairwell – WS03, 03A, 03B and WS04.

6.1.4 The comments and discussion below do not fall within the requirements of EC7 (ref. 9.4) and are offered for guidance. The comments and recommendations below should be reviewed as development details become available.

6.2 Foundations

6.2.1 The investigation has proved made ground to depths of about between 0.60m to 2.30m.

6.2.2 The deepest made ground (2.30m) was encountered within the vicinity of BH01 and WS03B located to the northern and southern edges of the site.

6.2.3 Suitable consistent natural founding strata of stiff clay was encountered at depths from 0.60m to 2.30m in the vicinity of the proposed waste, dispensing and receiving store. The remaining proposed structures onsite may therefore be underlain by made ground predominantly comprised of coarse soils with localised fine soils.

6.2.4 Whilst WS01 encountered stiff clay at a depth of 0.60m, BH01 and WS02 encountered made ground to depth of 1.70m to 2.30m indicating that foundation excavation may be increased in depth towards the north and south of the proposed store.

6.2.5 Foundation options for the support of structural loads include the following:

- Ground improvement
- Deep trench fill
- Piles

6.2.6 Ground improvement may be carried out either by the re-compaction of the existing granular made ground material or the use of an in-situ improvement system such as vibro-compaction.

6.2.7 If shallow pad or strip foundations are subsequently emplaced upon improved ground, nominal reinforcement may be required to reduce the risk from differential settlement.

6.2.8 The allowable bearing capacity subsequent to ground improvement will vary with the method used. Generally allowable bearing capacities in the region of 100 to 200kN/m^2 are achievable. Specialist contractors should be consulted to determine anticipated bearing capacity for various proprietary methods.

6.2.9 Deep trench fill may be considered to transfer foundation loads through made ground to competent bearing strata. Trench excavations may be backfilled with mass concrete.

6.2.10 Consideration may also be given to the use of piled foundations. Guidelines for the design of piles are given in Appendix 5.

6.2.11 The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art methods are often employed before they reach the public domain, perhaps several years down the line. It is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

6.3 Ground Floor Slabs

6.3.1 The design of the ground floor slab will be dependent on anticipated floor loads and foundation method adopted.

6.3.2 Lightly loaded floors may be placed on formation prepared in the granular made ground.

6.3.3 Ground improvement may be extended across the ground floor area to provide a suitable bearing capacity for the design of floor slabs.

6.3.4 If piled foundations are anticipated then the use of floor slabs bearing on the pile caps by a network of beams will minimise any differential settlement between the floor and the piled structure.

6.3.5 Alternatively a combined system may be considered with a piled perimeter to support principal structural loads and ground improvement across the ground floor slab.

6.4 Excavations

6.4.1 On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to less than 1.00m should stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations.

6.4.2 Groundwater should be expected in shallow excavations for foundations or services. However, it is possible that perched groundwater could be present in the Made Ground overlying the clay. It is considered that this could be dealt with by localised pumping.

6.5 Chemical Attack on Buried Concrete

6.5.1 The site has been classified in accordance with BRE Special Digest 1, ref. 9.19, as greenfield without the presence of pyrite and laboratory testing undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 9.19, be adopted.

6.5.2 It is recommended that the groundwater should be regarded as mobile.

Made ground

6.5.3 The result of chemical testing indicate sulphate concentration in the made ground of 19mg/l to 260mg/l as 2:1 water/soil extract, with pH values of 8.2 to 11.3. For classification purposes a characteristic value of 250 mg/l soluble sulphate may utilised.

6.5.4 On the basis of the laboratory test results it is considered that a Design Sulphate Class for the made ground may be taken as DS-1. On this basis an ACEC class for the site of AC- would be appropriate.

Natural Strata

6.5.5 The results of chemical testing indicate sulphate concentrations in the natural strata of 29 and 48mg/l as 2:1 water/soil extract, with pH values of 8.2.

6.5.6 On the basis of the laboratory test results it is considered that a Design Sulphate Class for the made ground may be taken as DS-1. On this basis an ACEC class for the site of AC-1 would be appropriate.

Bedrock

6.5.7 The results of chemical testing indicate sulphate concentrations in the bedrock of 17mg/l as 2:1 water/soil extract, with pH value of 8.4.

6.5.8 On the basis of the laboratory test results it is considered that a Design Sulphate Class for the made ground may be taken as DS-1. On this basis an ACEC class for the site of AC-1 would be appropriate.

Design

6.5.9 For overall design purposes a Design Sulphate Class of DS-1 should be adopted. An ACEC class for the site of AC-1 would be appropriate.

7.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

7.1 Contaminated Land

7.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 9.21, which was introduced by the Environment Act 1995, ref 9.22, as;

- 'Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –
- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

7.2 Risk Assessment

7.2.1 The definition of contaminated land is based on the principles of risk assessment. Risk is defined as a combination of:

- The probability, or frequency of exposure to a substance with the potential to cause harm, and:
- The seriousness of the consequence.

7.3 Pollutant Linkage

7.3.1 The basis of an environmental risk assessment involves identifying a 'source' of contamination, a 'pathway' along which the contamination may migrate and a 'receptor' at risk from the contamination.

7.3.2 Current legislation defines the various elements of the pollution linkage as:

- A contaminant is a substance which is in or under the ground and which has the potential to cause harm or to cause pollution of controlled waters.
- A pathway is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected.
- A receptor is either a living organism, an ecological system, a piece of land or property, or controlled water.

7.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 7.1 above.

7.3.4 The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification
- Hazard Assessment
- Risk Assessment
- Risk Evaluation

7.4 Risk Assessment – Human Health

7.4.1 The proposed development consists of the construction of new nitrogen generation facility, N_2 solvent store and waste, dispensing and receiving storage. The risk assessment has therefore been based on guidelines for a commercial / industrial end use. Should the proposed development be changed in the future then further risk assessment may be required, particularly should a more sensitive end-use be envisaged.

7.4.2 The results of the soil analyses from the current investigation have been compared to CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, ref 9.24 and SC050021, ref 9.25, where available, Generic Assessment Criteria (GAC), determined by LQM and CIEH, ref 9.26, DEFRA C4SL, ref. 9.27 as well as Assessment Criteria (AC) derived in-house using the CLEA Software Version 1.06, ref 9.27. The CLEA AC have been derived by Ian Farmer Associates in accordance with current legislation and guidance.

7.4.3 The guidance values used within this contamination assessment have been tabulated and are detailed within Appendix 6.

7.4.4 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 9.29. Where the concentrations determined on site are at or below the respective Guidance Level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated. Those contaminants with observed concentrations above the Guidance Level are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
WS02	0.50	Benzo(a)Anthracene	440	97
		Chrysene	390	140
		Benzo(b)fluoranthene	380	100
		Benzo(k)fluoranthene	200	140
		Benzo(a)Pyrene	310	14
		Indeno(123-cd)Pyrene	160	62
		Dibenzo(ah)Anthracene	45	13

7.4.5 Asbestos was not detected.

7.4.6 On this basis the results indicate a potential risk from a number of PAH compounds within the made ground in WS02 at 0.50m.

7.4.7 The material in WS02 at 0.50m comprised made ground including concrete, ash and brick.

7.4.8 The number of samples is too small to undertake statistical analysis.

7.4.9 As the site will be covered with buildings and hardstanding the recorded concentrations of contaminants in soil are considered to represent only a low risk to end users of the development.

7.5 Risk Evaluation

7.5.1 The conceptual model formed based upon the finding of the site investigation, detailing the relevant pollutant linkages, is tabulated below:

Source	Potential Pathways	Receptor Group
PAH Compounds	• Entry of contaminants by skin or eye contact with contaminated soils or dust. • Inhalation of contaminated dust. • Inhalation or migration of toxic / explosives gases	Humans • Construction workers[2] • Maintenance workers[1]
[1] – Assumes no remediation is undertaken [2] – Pathway exists only during the construction period		

7.6 Summary of Risk Evaluation

7.6.1 The above assessment identifies that the 'source – pathway – receptor' linkage potentially occurs with PAH compounds impacting upon the identified receptors. Therefore, it would be necessary to manage the risk at this location by either eliminating one of the links or by minimising the potential effects.

7.6.2 The elevated concentration of PAH is present the made ground (WS02 at 0.50m) where ash has been noted. The remaining of the results are below the relevant guideline values for a commercial end use.

7.6.3 The risks relating to the development of the site are therefore considered to be very low as the site will be covered by hardstanding. The only risk present will be during the construction phase.

7.7 Waste

7.7.1 Waste Acceptance Criteria analysis has been carried out on one sample of soil.

7.7.2 With the exception of total organic carbon the analysis results were all below the threshold values for inert waste.

7.7.3 One value of total organic carbon (7.6%, BH01) is above the limit value of 6% for hazardous waste.

7.7.4 One value of Loss of ignition (11%, combined BH01) is above the limit value of 10% for hazardous waste.

7.7.5 Final classification of waste rests with the receiving landfill. Early discussions should be held with the landfill operator to determine likely waste classification for exported materials.

8.0 MANAGEMENT OF CONTAMINATION

8.1 Remediation and Verification

8.1.1 The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, ref. 9.35, is applicable to the redevelopment of sites that may be affected by contamination.

8.1.2 The risk management process set out in the Model Procedures has three main components:

- Risk assessment
- Options appraisal
- Implementation

8.1.3 This initial risk assessment has identified the presence of elevated PAH compounds within Made Ground within the vicinity of WS02 at 0.50m. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.

8.1.4 The remediation strategy will need to review methods of reducing or controlling the identified unacceptable risks. This could be done by removing or treating the sources of contamination, removing or modifying the pathways or removing or modifying the behaviour of the receptors, to ensure there is no significant risk of significant harm to either human health from the identified contamination, in relation to the proposed end use.

8.1.5 An important part of the risk management process is identifying and informing all stakeholders with an interest in the outcome of the risk management project. To this end, if the regulators have not yet been contacted with regard to the redevelopment of this site, it is recommended that they be supplied with a copy of both the Phase 1 Desk Study and this Phase 2 Site Investigation report in order to enable liaison to be undertaken with them.

8.1.6 Following liaison with the relevant regulatory bodies, a remediation strategy could be formulated, which should incorporate an options appraisal and summarise in detail the chosen remedial approach, along with the verification proposals. The remediation strategy should then be approved by the relevant regulatory authorities prior to implementation.

8.1.7 Where remediation is required, a verification report will need to be formulated following implementation of the remediation strategy, which should provide a complete record of all remedial activities conducted on site and include all the data obtained to support the remedial objectives and demonstrate that the remediation has been effective. Any unexpected conditions encountered during the remedial works should also be detailed within the verification report.

8.1.8 A number of potential remedial options for dealing with the contamination identified at this site, by removing the contamination source(s) or treating the contamination source(s), are detailed below:

8.1.9 As the site is to be covered by buildings or hard standing, no pathway is likely to exist between any source of contamination and the human receptors by ingestion or dermal contact, therefore no further remedial action is likely to be required. However there remains a residual risk to construction workers. This may be managed by suitable site practices as discussed below.

8.1.10 The made ground from areas where elevated concentrations of PAH compounds were identified, around WS02 may be removed.

8.1.11 In order to minimise the impact on future maintenance workers, where services are to be placed at a depth that puts them at or below the level of the source of contamination, it would be prudent to line the trenches and surround the services with clean inert material.

8.2 Management of Unidentified Sources of Contamination

8.2.1 There is the possibility that other sources of contamination may be present on the site, which were not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.

- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.

- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

8.3 Consultation

8.3.1 During the development of a contaminated site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.

- **Environment Agency.** Where a site is within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.

8.3.2 Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

8.4 Risk Management During Site Works

8.4.1 During ground works, some simple measures may have to be put in place to mitigate the risk of contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.

- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.

- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.

- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.

8.4.2 Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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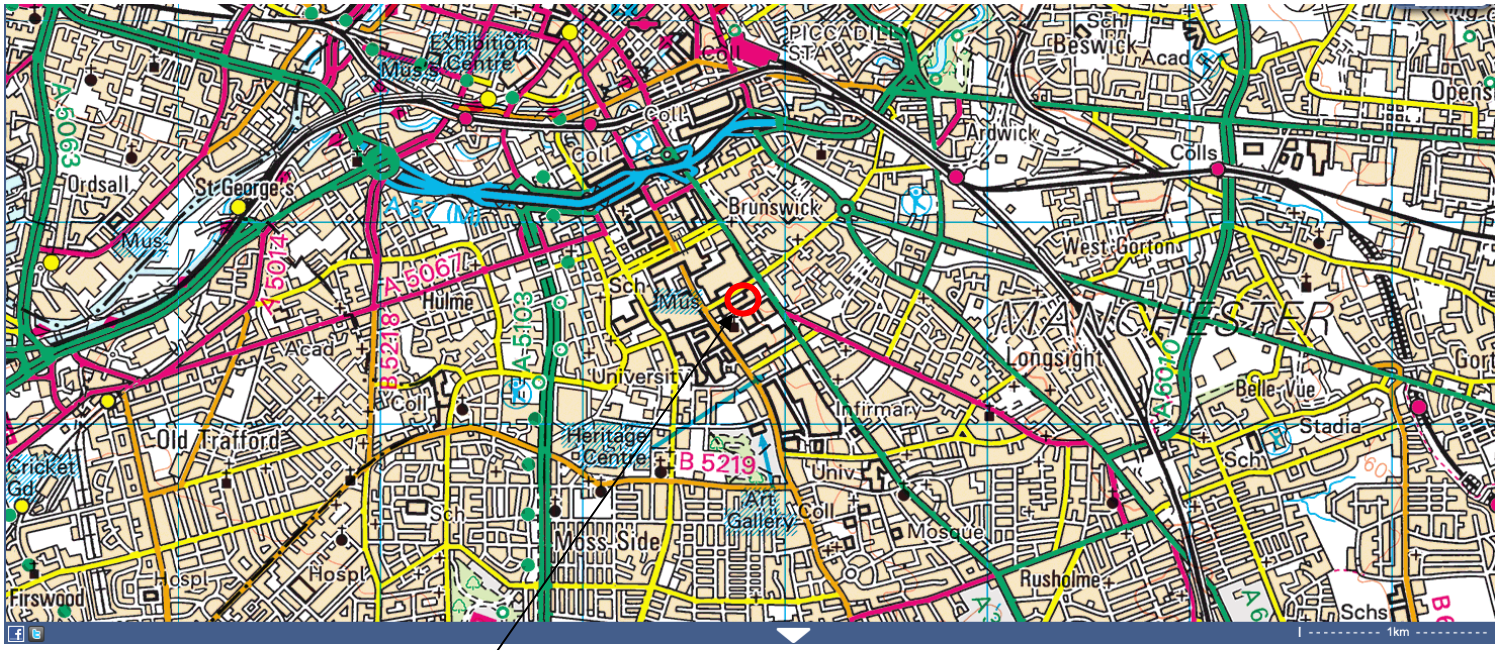
Principal Engineering Geologist

APPENDIX 1

DRAWINGS



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Site

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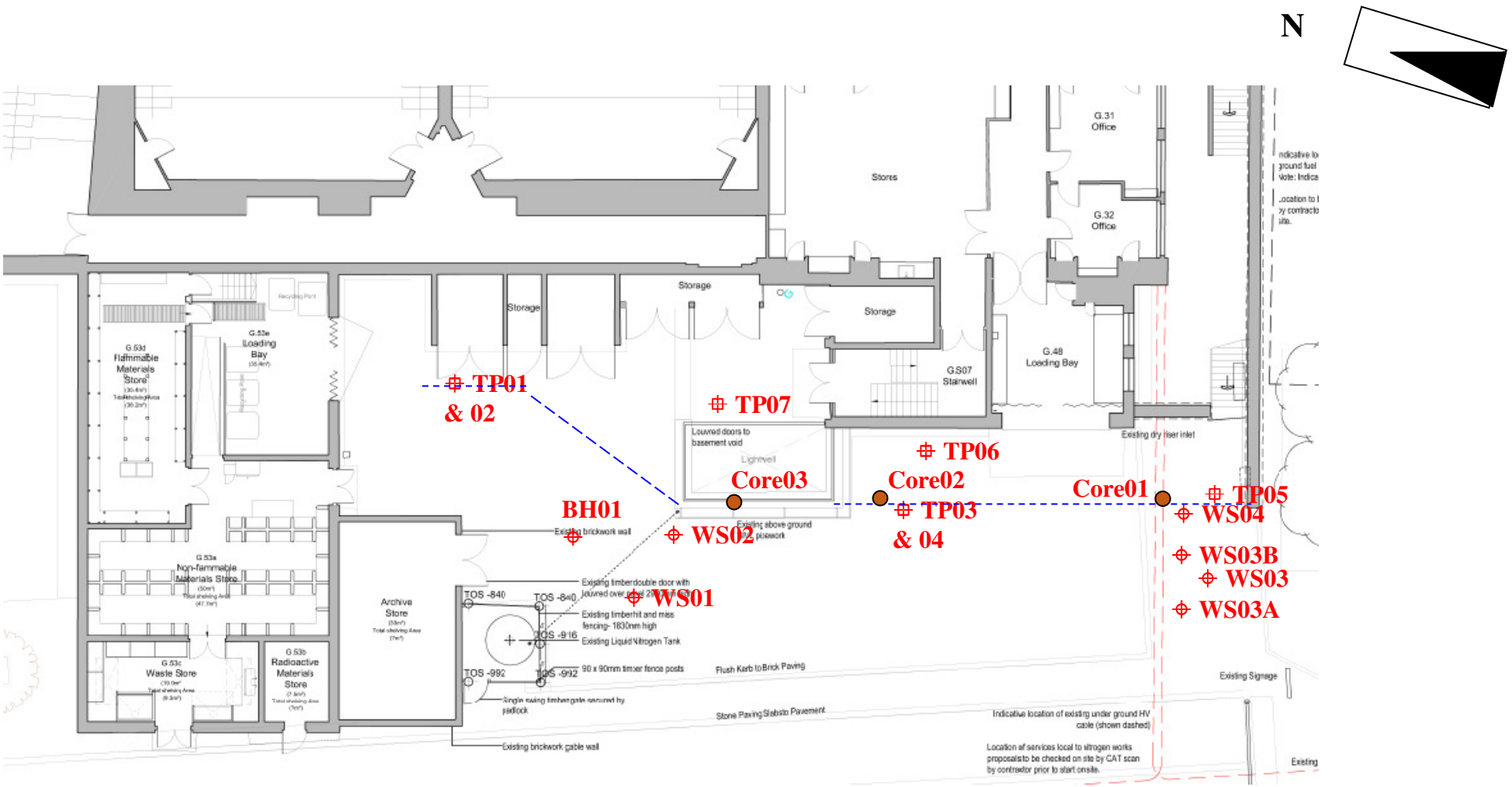
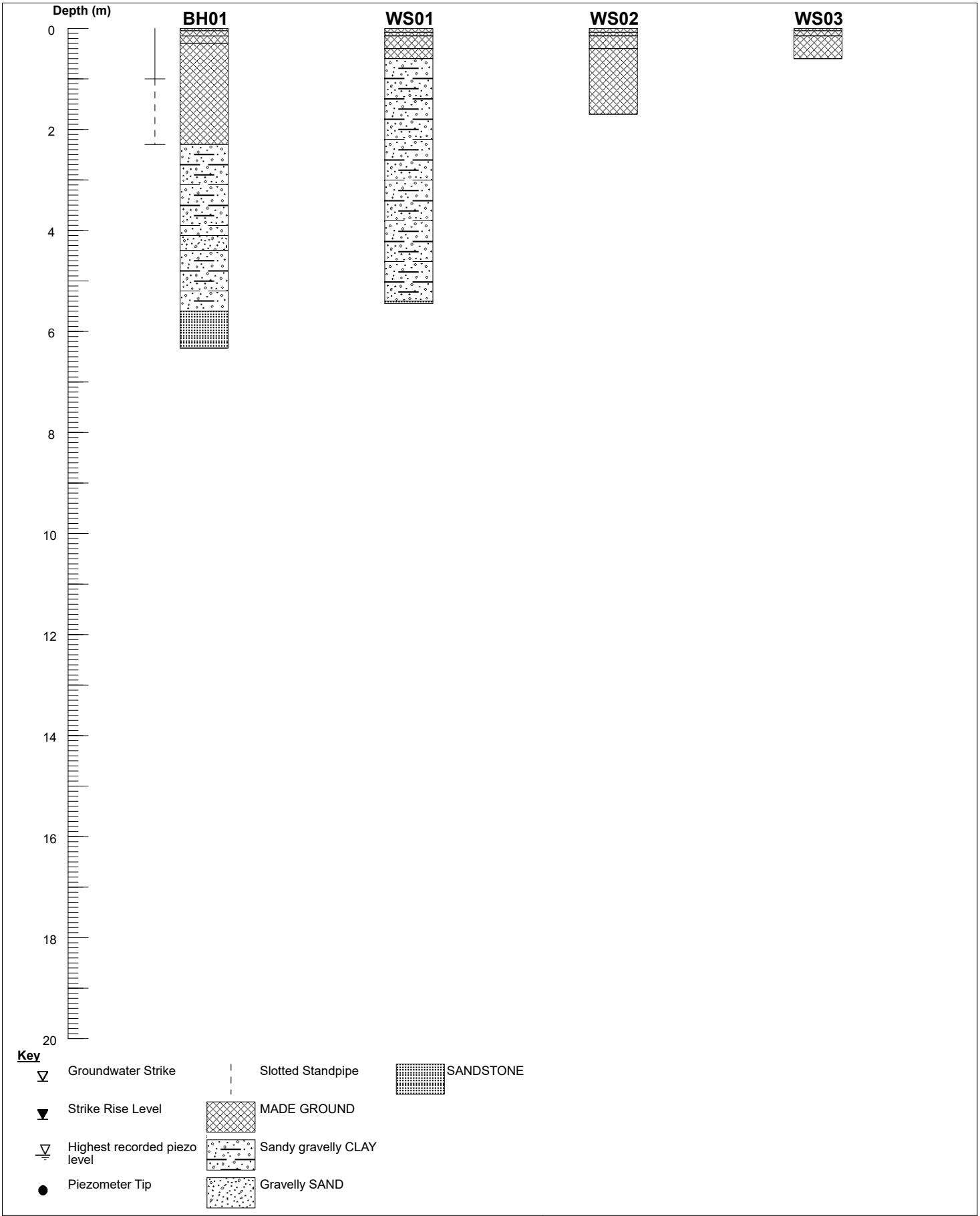
PROJECT: 41887 Chemistry Building, University of Manchester,
FIGURE No. A1.1 **SCALE: As Indicated**
TITLE: Site Location Plan
IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists



Blue line – retaining wall/concrete edge

PROJECT: 41887 University of Manchester (Chemistry Building)	
FIGURE No. A1.2	**SCALE: As Indicated**
TITLE: Borehole Location Plan	

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists



IAN FARMER ASSOCIATES

Nominal Section

Site	Date Drawn	Date Checked	Sheet	Job Number
University of Manchester (Chemistry Building)	22/06/2016		1/2	41887
Client	**Drawn By**	**Checked By**	**Scale**	**Figure No.**
Gardiner & Theobald LLP			1:100[V]	41887.1

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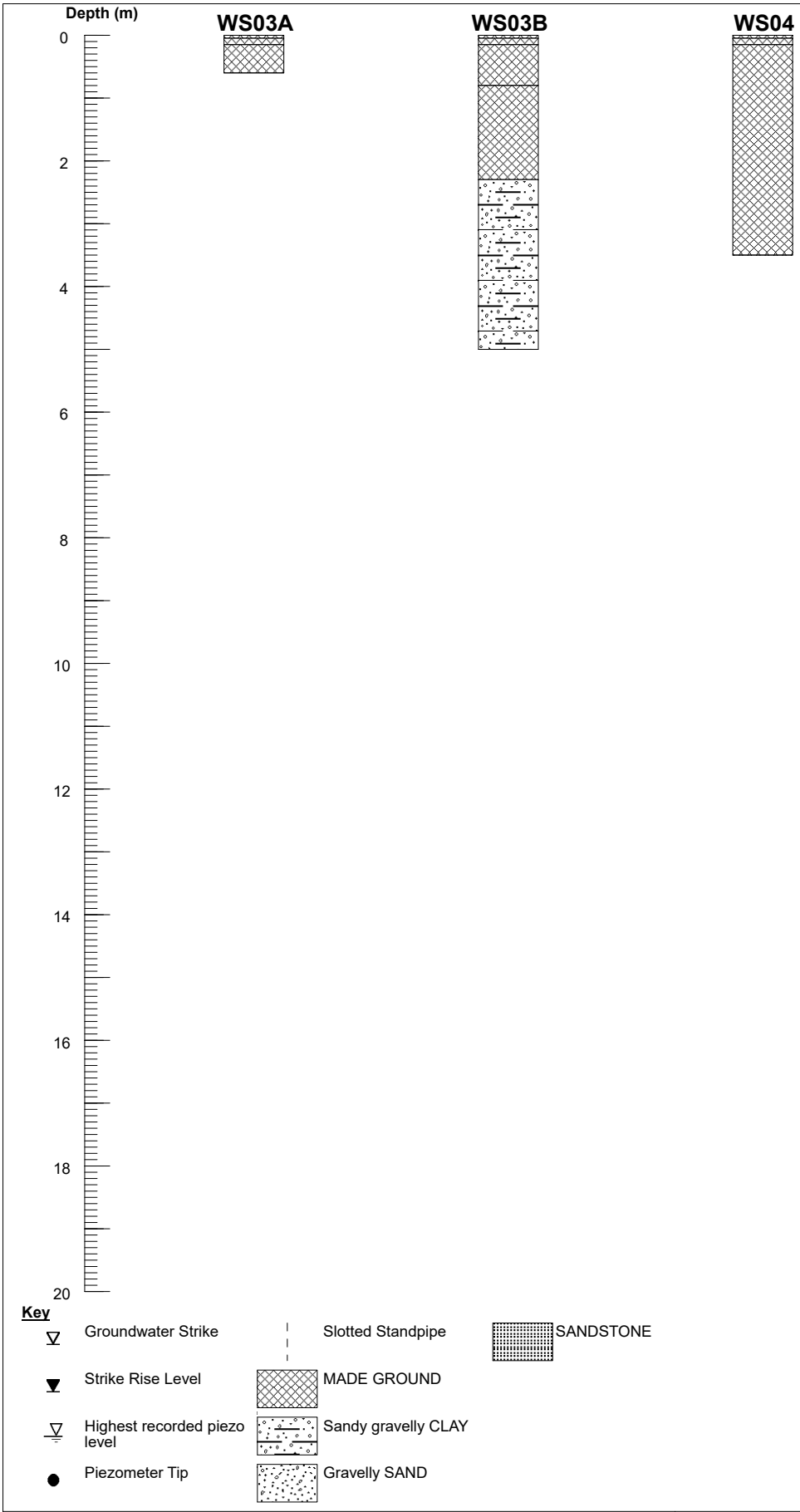

IAN FARMER ASSOCIATES

Nominal Section

Site	Date Drawn	Date Checked	Sheet	Job Number
University of Manchester (Chemistry Building)	22/06/2016		2/2	41887
Client	**Drawn By**	**Checked By**	**Scale**	**Figure No.**
Gardiner & Theobald LLP			1:100[V]	41887.1

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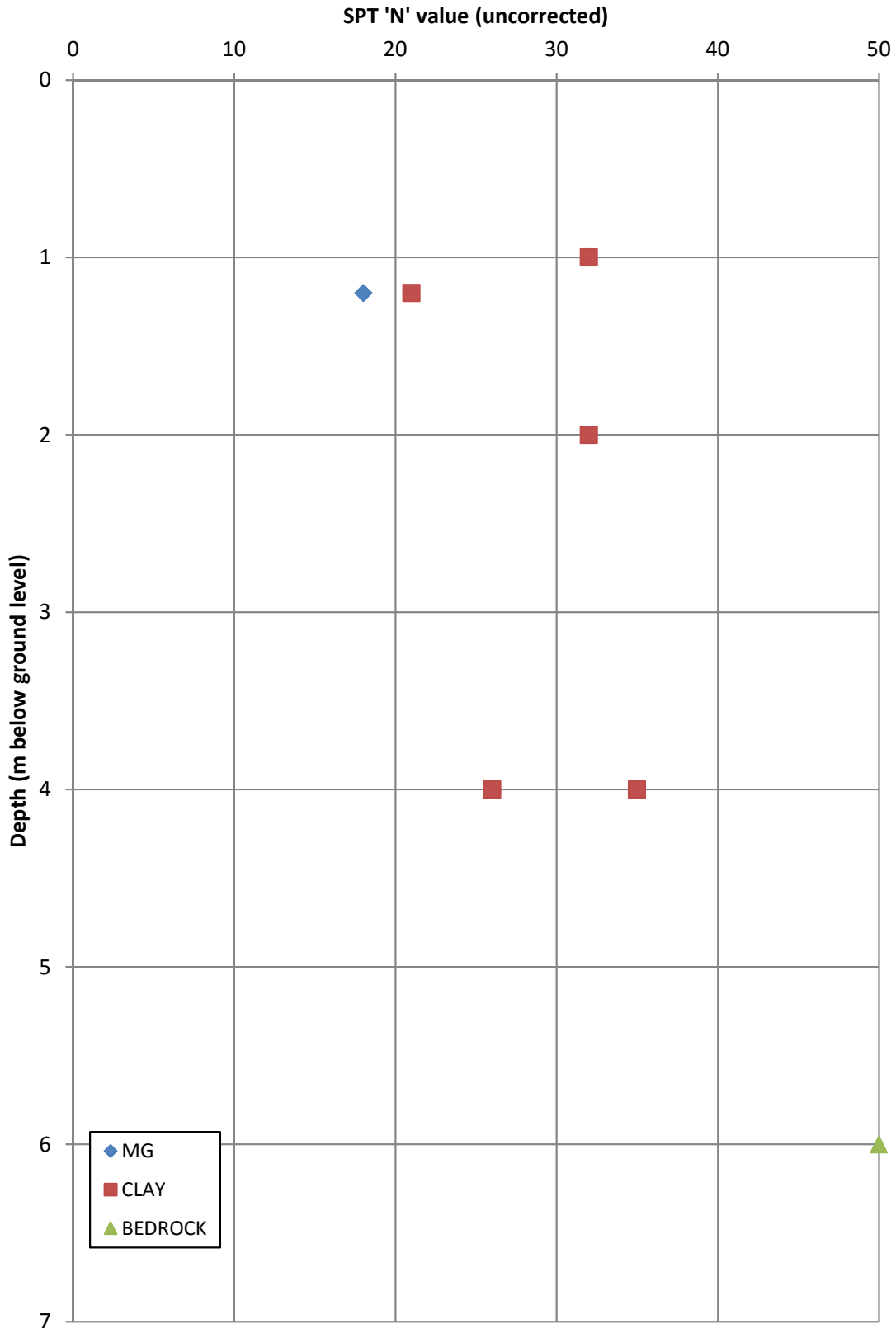
Figure A1.4 University of Manchester - Chemistry Building
SPT 'N' value versus depth



© Copyright. All rights reserved. This drawing must not be reproduced without permission.
Do not scale from this drawing. All dimension are in millimetres unless otherwise stated.
Any discrepancies should be reported to the Architect.

Clinical waste store

Stores

G.31 Office

G.32 Office

Store (10.9m²)

Indicative location of under ground fuel tank shown dashed. Note: Indicative only.

Location to be checked on site by contractor prior to start on site.

Rear exit out to grassed area beyond

New External Receiver Compound (31.4m²)

Gas Cylinders
New gas cylinder storage cage

Empty Gas Cylinders
New gas cylinder storage cage

FILL POINT WITH TWIN PCFP & 1No OOFP c/w DEAD MANS FOOT

Gas fill Station
New gas fill station cage

LAB COATS ETC

New opening in existing wall to connect existing workshop to new loading bay

Loading Bay

Scissor lift

Retractable edge guarding

Retractable Access restriction

Louvered enclosure

DEWAR VESSEL REFILL WAITING AREA

Remove existing screen set and infill with new wall

Bollard

New masonry wall to form new store

Existing window openings blocked up

Existing dry riser inlet to be relocated

New access opening in existing wall to allow escape route

New doorset in existing wall

Maintain clear escape access to basement level

New external access to new loading bay. Fully louvred doors.

IBC Recycling Point

New barrier protection to new building access

New Nitrogen Generation Facility (64m²)

Concrete service yard with markings in thermosetting paint

New external access to new loading bay. Double doors with roller shutter externally.

Dispensing & Receiving (16.8m²)

Store 1 (46.9m²)
Shelving
4No @ 17.3m²
= 69.2m²

New access and escape stair to new raised area

Waste Store & Processing (23.6m²)

Acid waste area

Store 3 (17.9m²)
Shelving
4No @ 6m²
= 24m²

Stone paving slabs to match existing to demark pedestrian routes

Eye wash station

New dry riser inlet

Caged roof access ladder

Stone paving slabs to match existing to demark pedestrian routes

Black Euro bin

Black Euro bin

Existing tree to be removed

Black Euro bin

Black Euro bin

Black Euro bin

Cardboard cage

Cardboard cage

Cardboard cage

New bin and recycle store

Glass Euro bin

Existing bin store

New Liquid Nitrogen Supply Vessel (29.9m²)

New vehicular access to proposed loading area

New build footprint to remain within existing public/private back of pavement demarcation

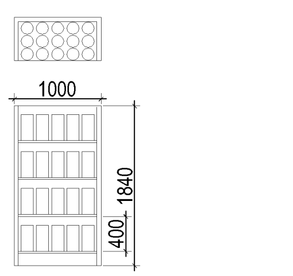
Stone Paving Slabsto Pavement

Temporary Liquid Nitrogen Supply Vessel location

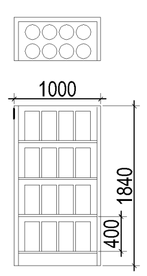
Stone Setts to Service Road

SITE PLAN AS PROPOSED

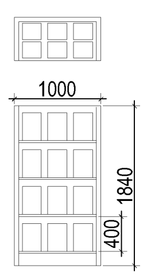
1:150 @ A3



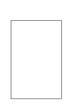
2.5l Winchester
Drawn at 140mm d x 300mm h
15 containers per shelf per m
60 containers per m for 4 shelves



5l Bottle
Drawn at 170mm d x 340mm h
8 containers per shelf per m
32 containers per m for 4 shelves



10l Drum
Drawn at 190mm w x 220mm d x 320mm h
6 containers per shelf per m
24 containers per m for 4 shelves

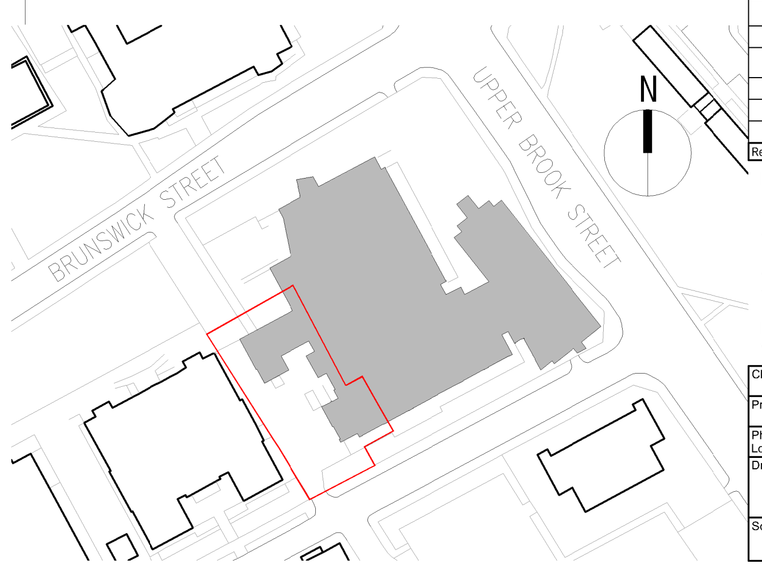


205l Drum
Drawn at 580mm d x 900mm h

Note: Shelvirg elevations and plan indicative only to illustrate potential capacity

STORAGE

1:100 @ A3



Revision	Description	Date	Drawn	Checked
P8	Drawing number revised. Position of scissor lift, layout and extent of gas bottle storage, clinical waste store updated to suit client discussions. Bin store included to suitUniversity requirements. Stores layout updated to suit M&E proposals and include eye wash, and 1 no. fume cupboard as requested by client. Roof access ladder relocated to have fenced enclosure. Service yard materials noted.	19.05.16	JC	OC
P7	Stores layout updated to suit client comments, external louvre sizes updated, removable edge guarding included, guarding included to scissor lift, dry riser relocated, roller shutter included to loading bay, edge of canopy repositioned.	09.03.16	JC	TF
P6	Stores layout updated to suit client comments and M&E requirements	22.02.16	JC	TF
P5	Layout updated to suit M&E Engineers proposals	16.02.16	JC	TF
P4	Arrangement of waste processing and non-flammable materials store revised to suit client discussions	08.02.16	JC	TF
P3	Indicative location for fuel tank included	29.01.16	JC	TF
P2	Position of new external receiver compound and new nitrogen generation facility switched following design review with EDPI	22.01.16	JC	TF
P1	Generel Revisions	08.01.16	JC	TF
-	First Issue. Issued for Comment/ Approval.			

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HALLIDAY MEECHAM ARCHITECTS

Client:	University of Manchester
Project:	Nitrogen Works
Phase/ Location:	Chemistry Building
Drawing:	Ground Floor Site plan PROPOSED

Scale @ A1	Scale @ A3	Date:	Drawn:	Checked:	Job No.	Drawing No.	Revision
1:75	1:150	03.11.15	CB	TF	4727	5376-HMA-02-GF-DR-05-20001	P8

APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 9.4 and BS 5930, ref 9.2.

A2.1.2 Trial Pits

Shallow trial pits are generally dug by mechanical excavator, however, in difficult access locations or adjacent to structures, such pits may be hand dug. Pits are best used where the ground will stand unsupported and generally, the maximum depth of machine dug pits is 4m to 5m. Where personnel are required to enter pits, it is essential that side support is provided. Entry by personnel into unsupported pits deeper than 1.2m is not allowed for health and safety reasons.

Trial pits allow the in-situ condition of the ground to be examined both laterally and vertically and also allow discontinuities to be recorded. The field record should give the orientation of the pit with details of which face was logged, assessment of stability of sides of pit and groundwater as well as the strata encountered. Photographs of the pit should also be taken.

In-situ testing, such as hand penetrometer, hand vane, Macintosh probe, or similar, can be undertaken in the sides or base of pits while both disturbed and undisturbed samples recovered.

It is generally advisable to backfill the pits as soon as possible, open pits should not be left unattended.

A2.1.3 Light Cable Percussion Boring

For routine soil exploration to depths in excess of 3m, the light cable percussion rig is generally employed for boring through soils and weak rocks, refs 9.2, 9.4 and 9.5 It consists of a powered winch and tripod frame, with running wheels that are permanently attached so that the rig may be towed behind a suitable vehicle. The rig is towed into position and set up using its own winching system.

The locations of services are checked to make sure the borehole is not situated unacceptably near any services. Regardless of the proximity of services, a CAT scan is undertaken at the borehole location and a trial hole dug to 1.20m by hand.

Boreholes are advanced in soil by the percussive action of the cable tool. The force of the cylindrical tool as it is dropped a short distance cuts a plug of cohesive soil that is removed by the tool.

In non-cohesive soils, the borehole is advanced by a ‘shell’, otherwise known as a ‘bailer’ or ‘sand pump’, which incorporates a clack valve. Material is transferred into the shell and retained by the clack valve. The water level in a borehole is maintained above that in the surrounding granular soil to allow for temporary reductions in the head of water as the shell is withdrawn from the borehole. Water should flow from the borehole into the surrounding soil at all times to prevent ‘piping’ and loosening the soil at the base of the hole. The casing is always advanced with the borehole in granular soil so that material is drawn from the base rather than the borehole sides.

Obstructions to boring are overcome by fitting a serrated chiselling ring to the base of the percussion tool. For large obstructions, a heavy chisel with a hardened cutting edge may have to be used.

Disturbed samples are taken in polythene bags, jars or tubs that are sealed against air or water loss.

Undisturbed samples are generally taken in cohesive materials at changes in strata and at one metre intervals to 5 metres then at 1.5 metre intervals to the full depths of the borehole. The general purpose open-tube sampler is suitable for firm to stiff clays, but is often used to retrieve disturbed samples of weak rocks, soft or hard clay and also clayey sand or silts. This has been adopted for

routine use, and usually consists of a 100mm internal diameter tube (U100), which is capable of taking soil samples up to 450mm in length. The undisturbed samples are sealed at each end using micro-crystalline wax to prevent drying.

Standard penetration tests are generally carried out in non-cohesive soils but also in stiff clays and soft rocks at frequencies similar to that of undisturbed sampling.

A2.1.4 Drive-in Window Sampler

The drive-in window sampler, ref 9.7, consists generally of a track mounted window sampler and a series of cylindrical sample tubes, generally varying in diameter from 98mm to 35mm. A cutting shoe is fitted to the bottom of each tube, while a window, representing about a quarter of the circumference, is cut along the length of the tube. Soil samples are extracted through the window of the tube.

The borehole is extended by using progressively smaller diameter tubes.

Alternatively, undisturbed samples may be collected in plastic liners, known as *windowless sampling*.

A2.1.5 Dynamic Probing Super Heavy, DPSH

This covers the determination of the resistance of in-situ soil to a 90° cone being driven dynamically, ref 9.9 and 9.6 (use this ref only if subbies have calibrated equipment). Dynamic Probing can be used to determine presence of variations in strata, however, since samples are not recovered, it should be carried out in conjunction with sampling.

In principle, the test consists of driving a 90° cone of 20cm² cross-sectional area into the ground using a 63.5kg drop hammer falling a standard height of 750mm. At regular intervals, in order to minimise friction on the shaft, the rods are turned.

The results are recorded as the number of blows of the hammer to drive the cone 100mm, N_{100}, together with the torque to turn the rods.

As an approximate correlation, the resistance determined by the DPSH may be related directly to the SPT 'N' value as:

$$\text{'N' value} = N_{100}$$

A2.2 IN-SITU TESTS

A2.2.1 Standard Penetration Test

The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref 9.4, BS 1377, Part 9, 1990 ref 9.9 and ISO 22476 ref 9.5

The standard penetration test, **SPT**, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone replacing the split spoon sampler, **CPT.**

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of 300mm is achieved. The penetration for 50 blows is

recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.

- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.

- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

A2.3 SAMPLES

U represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded.

U NR indicates undisturbed sample not recovered

B represents large bulk disturbed samples

D represents small disturbed sample

E represents environmental contamination sample

V represents vial contamination sample

W represents water sample

$\underline{\nabla}$ represents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref 9.8, supplemented by section 6 of BS 5930, ref. 9.2 have been used in the soil descriptions contained within this report.

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Site	Borehole Number
University of Manchester (Chemistry Building)	BH01

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 6.00m		Gardiner & Theobald LLP	41887
	Location	**Dates** 19/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						0.05	MADE GROUND: Block paving.			
						(0.10)				
						0.15	MADE GROUND: Sand.			
						(0.15)				
0.30	D1					0.30	MADE GROUND: Tarmacadam.			
0.50	E4						MADE GROUND: Medium dense, light brown to brown, gravelly, fine to coarse grained SAND. Gravel is angular to subangular, fine to coarse including tarmacadam, brick and concrete. Between 0.05m and 2.00m: ash content. Between 0.05m and 2.30m: soft brown clay pockets.			
0.50-1.00	B2									
1.00	E5									
1.20-1.65	SPT N=18		DRY	12,11/5,4,5,4		(2.00)				
1.20-1.65	D3									
1.20-2.00	B6									
2.00-2.45	SPT N=35	1.50	DRY	12,15/17,6,6,6						
2.00	E7									
2.00-2.45	D8									
2.00-2.50	B9					2.30	Stiff, brown with grey mottled, slightly gravelly, slightly sandy CLAY. Gravel is subangular to subrounded, fine and medium including mudstone and sandstone.			
2.60	D10									
3.00	E11						At 3..00m: high strength.			
3.00-3.45	U12 (P/0.45)	3.00	DRY	62 blows		(1.80)				
3.50	D13									
4.00-4.45	SPT N=26	4.00	DRY	3,4/4,5,7,10		4.10				
4.00-4.45	D15					(0.30)	Brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded including mudstone.			
4.00-4.50	B14					4.40				
							Stiff, brown with grey mottled, slightly gravelly, slightly sandy CLAY. Gravel is subangular to subrounded, fine and medium including mudstone and sandstone.			
5.00-5.45	U (P/NR)	5.00	DRY	100 blows		(1.20)				
5.00-5.50	B16									
5.60	D17					5.60	Extremely weak, red brown SANDSTONE recovered as sand and gravel, distinctly weathered.			
6.00-6.33	SPT 50/175	6.00	DRY	12,15/20,21,9		(0.73)				
6.00-6.33	D18					6.33	Complete at 6.33m			

Remarks
Chiselling from 5.60m to 6.00m for 0.75 hours. Excavating from 0.00m to 1.20m.

Scale (approx)	Logged By
1:40	AG

Figure No. 41887.BH01

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IAN FARMER ASSOCIATES

Site	Number
University of Manchester (Chemistry Building)	WS01

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Gardiner & Theobald LLP	41887
	Location	**Dates** 18/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.08	MADE GROUND: Block paving.		
					0.15 (0.25)	MADE GROUND: Light brown, fine to coarse SAND.		
0.30	D1				0.40 (0.20)	MADE GROUND: Tarmacadam.		
0.50	D2				0.60	MADE GROUND: Firm, brown, slightly mottled light grey and grey, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, siltstone, mudstone, timber, brick and concrete.		
0.50	E3							
0.60-1.20	B4							
0.80	D5							
0.80	E6							
1.20-1.65	SPT N=21		2,2/3,5,5,8			Stiff, brown slightly mottled light grey, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, siltstone and mudstone.		
1.20-1.65	D7							
1.30	D8							
1.80	D9							
2.00-2.45	SPT N=31		3,5/6,7,8,10					
2.00-2.45	D10							
2.30	D11							
2.80	D12							
3.00-3.45	SPT N=32		4,5/7,7,8,10		(4.80)			
3.00-3.45	D13							
4.00-4.45	SPT N=35		4,5/6,8,10,11					
5.00-5.45	SPT N=60		6,7/9,11,15,25					
					5.40 5.45	Red brown, weathered SANDSTONE recvoered as slightly silty, fine and medium sand.		
						Complete at 5.45m		

Remarks
Toe of retaining wall not encountered.
Excavating from 0.00m to 1.20m.

Scale (approx)	Logged By
1:40	TB

Figure No. 41887.WS01

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IAN FARMER ASSOCIATES

Site	Number
University of Manchester (Chemistry Building)	WS02

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Gardiner & Theobald LLP	41887
	Location	**Dates** 18/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.08	MADE GROUND: Block paving.		
					0.15 (0.25)	MADE GROUND: Light brown, fine to coarse SAND.		
					0.40	MADE GROUND: Tarmacadam.		
0.50	D1					MADE GROUND: Grey, very sandy, angular to subangular, fine to coarse GRAVEL including limestone, concrete, ash and brick.		
0.50	E2							
					(1.30)			
						Below 1.30m: with clay.		
1.50	D3							
1.50	E4							
1.70	D5				1.70	At 1.70m: concrete obstruction.		
						Terminated at 1.70m		

Remarks
Window sampler borehole terminated at 1.70m due to concrete obstruction, assumed toe of retaining wall.
Excavating from 0.00m to 1.20m.

Scale (approx)	Logged By
1:40	TB

Figure No. 41887.WS02

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IAN FARMER ASSOCIATES

Site	Number
University of Manchester (Chemistry Building)	WS03

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated			Gardiner & Theobald LLP	41887
	Location	**Dates** 18/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05			
					(0.10)	MADE GROUND: Paving slab.		
					0.15			
					(0.45)	MADE GROUND: Light brown, medium and coarse SAND.		
					0.60	MADE GROUND: Grey brown, very clayey, sandy, angular to subangular, fine to coarse GRAVEL with medium cobble content. Gravel includes brick, sandstone and concrete.		
						Terminated at 0.60m		

Remarks
Inspection pit terminated at 0.60m due to black armoured cable encountered, window sample position, relocated to WS03A, 0.50m NW.
Excavating from 0.00m to 0.60m.

Scale (approx)	Logged By
1:40	TB

Figure No. 41887.WS04

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IAN FARMER ASSOCIATES

Site	Number
University of Manchester (Chemistry Building)	WS03A

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Gardiner & Theobald LLP	41887
	Location	**Dates** 18/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05	MADE GROUND: Paving slab.		
					(0.10)			
					0.15	MADE GROUND: Light brown, medium and coarse SAND.		
					(0.45)			
					0.60	MADE GROUND: Grey brown, sandy, very clayey, angular to subangular, fine to coarse GRAVEL with medium cobble content. Gravel includes brick, sandstone and concrete.		
						Terminated at 0.60m		

Remarks
Inspection pit terminated at 0.60m, due to cable encountered. Window sample position relocated to WS03B 0.20m NE.
Excavating from 0.00m to 1.20m.

Scale (approx)	Logged By
1:40	TB

Figure No. 41887.WS03A

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Site	Number
University of Manchester (Chemistry Building)	WS03B

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Gardiner & Theobald LLP	41887
	Location	**Dates** 18/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05	MADE GROUND: Paving slab.		
					(0.10)			
					0.15	MADE GROUND: Light brown, medium and coarse SAND.		
					(0.65)	MADE GROUND: Grey brown, sandy, very clayey, angular to subangular, fine to coarse GRAVEL with medium cobble content. Gravel includes brick, sandstone and concrete.		
0.80	D1				0.80	MADE GROUND: Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse including sandstone, brick, concrete and metal fragments.		
0.80	E2							
1.50	D3				(1.50)			
1.50	E4							
					2.30	Stiff, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, siltstone and mudstone.		
2.50	D6							
2.50	E7							
2.80	D5							
3.00	D8							
					(2.70)			
4.00	E9							
					5.00			
5.00	D10					Complete at 5.00m		

Remarks
Toe of retaining wall not encountered.
Excavating from 0.00m to 1.20m.

Scale (approx)	Logged By
1:40	TB

Figure No. 41887.WS03B

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Site	Number
University of Manchester (Chemistry Building)	WS04

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated.			Gardiner & Theobald LLP	41887
	Location	**Dates** 18/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05	MADE GROUND: Paving slab.		
					(0.10)			
					0.15	MADE GROUND: Light brown, medium and coarse SAND.		
						MADE GROUND: Grey brown, very clayey, sandy, angular to subangular, fine to coarse GRAVEL with medium cobble content. Gravel includes brick, sandstone and concrete.		
					(3.35)			
					3.50	At 3.50m: continue probe.		
						Complete at 3.50m		

Remarks
Hand excavated inspection pit to 1.20m. Window sample hole extended to 3.50m with probing equipment. Probing rods refused at 3.50m on obstruction; assumed toe of retaining wall.
Excavating from 0.00m to 1.20m.

Scale (approx)	Logged By
1:40	TB

Figure No. 41887.WS04

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP01

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated	0.70m x 0.45m x 0.42m		Gardiner & Theobald LLP	41887
	Location	**Dates** 19/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05	MADE GROUND: Block paving.		
					0.10 (0.32)	MADE GROUND: Light brown, medium and coarse SAND.		
					0.42	MADE GROUND: Tarmacadam.		
						Complete at 0.42m		

Plan

Remarks

Concrete slab encountered at 0.42m.
Please refer to sketch for further details.

Scale (approx)	Logged By	Figure No.
1:40	TB	41887.TP01

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP02

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated	1.52m x 0.45m x 0.75m		Gardiner & Theobald LLP	41887
	Location	**Dates** 19/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05	MADE GROUND: Block paving.		
					0.10 (0.35)	MADE GROUND: Light brown, medium and coarse SAND.		
					0.45 (0.30)	MADE GROUND: Tarmacadam.		
					0.75	MADE GROUND: Brown, sandy, angular to subangular, fine to coarse GRAVEL with high cobble content including brick, sandstone, concrete and limestone.		
						Complete at 0.75m		

Plan

Remarks

Retaining wall encountered.
Unable to advance beyond 0.75m due to possible previous concrete structure.
Please refer to sketch for further details.

Scale (approx)	Logged By	Figure No.
1:40	TB	41887.TP02

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP03

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated	0.85m x 0.60m x 0.35m		Gardiner & Theobald LLP	41887
	Location	**Dates** 19/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05	MADE GROUND: Block paving.		
					0.15 (0.20)	MADE GROUND: Light, brown, medium and coarse SAND.		
					0.35	MADE GROUND: Tarmacadam.		
						Complete at 0.35m		

Plan

Remarks

Concrete slab encountered at 0.35m.
Core hole drilled to determine thickness of slab at 225mm.
Please refer to sketch for further details.

Scale (approx)	Logged By	Figure No.
1:40	TB	41887.TP03

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP04

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated.	1.60m x 0.60m x 1.00m		Gardiner & Theobald LLP	41887
	Location	**Dates** 19/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.05 (0.05)	MADE GROUND: Block paving.		
					0.15 (0.20)	MADE GROUND: Light, brown, medium and coarse SAND.		
					0.35 (0.15)	MADE GROUND: Tarmacadam.		
0.70	B1				0.50 (0.50)	MADE GROUND: Light, grey, subangular, coarse GRAVEL including limestone.		
0.70	D2				1.00	MADE GROUND: Brown, slightly clayey, very sandy, angular to subangular, fine to coarse GRAVEL with low cobble content including sandstone, concrete, brick, limestone, rebar and timber.		
						Complete at 1.00m		

Plan

Remarks

Retaining wall encountered.
Please refer to sketch for further details.

Scale (approx)	Logged By	Figure No.
1:40	TB	41887.TP04

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP05

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated.	0.90m x 0.40m x 0.15m		Gardiner & Theobald LLP	41887
	Location	**Dates** 01/05/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.10 (0.10)	MADE GROUND: Concrete.		
					0.15 (0.05)	MADE GROUND: Concrete.		
						Complete at 0.15m		

Plan

Remarks

Trial pit remained dry and stable during excavation.
Engineer notes, 3 hours used with hydraulic breaker to excavated 0.15m of material, proving exceptionally strong concrete.

Scale (approx)	Logged By	Figure No.
1:40	MH	41887.TP05

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP06

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated.	0.48m x 0.50m x 0.60m		Gardiner & Theobald LLP	41887
	Location	**Dates** 30/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.10	MADE GROUND: Concrete.		
					(0.50)	MADE GROUND: Concrete. At 0.15m: rebar.		
					0.60	Complete at 0.60m		

Plan

Remarks

Hand pit remained dry and stable during excavation.

Scale (approx)	Logged By	Figure No.
1:40	MH	41887.TP06

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	TP07

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated.	0.50m x 0.40m x 0.50m		Gardiner & Theobald LLP	41887
	Location	**Dates** 30/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.10	MADE GROUND: Concrete.		
					(0.40)	MADE GROUND: Light pink concrete. At 0.25m: rebar.		
					0.50	Complete at 0.50m		

Plan

Remarks

Hand pit remained dry and stable during excavation.

Scale (approx)	Logged By	Figure No.
1:40	MH	41887.TP07

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	CORE 01

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Horizontal Core			Gardiner & Theobald LLP	41887
	Location	**Dates** 22/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					0.10	MADE GROUND: One coarse of brick.		
					(0.31)	MADE GROUND: Concrete with subangular to angular, clasts of fine and medium limestone.		
					0.41	Complete at 0.41m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:40	DD	41887.CORE 01

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Site	Trial Pit Number
University of Manchester (Chemistry Building)	CORE 02

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Horizontal Core			Gardiner & Theobald LLP	41887
	Location	**Dates** 22/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.11) 0.11	MADE GROUND: One coarse of brick.		
					(0.33) 0.44	MADE GROUND: Concrete with subangular to rounded, clasts of fine and medium igneous lithologies.		
						Complete at 0.44m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:40	KA	41887.CORE 02

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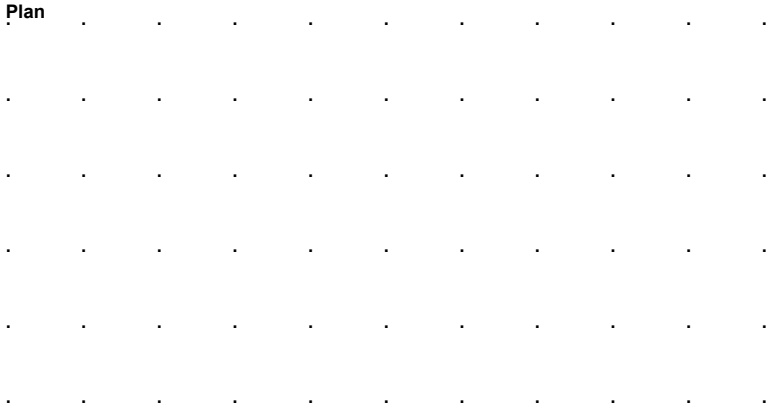
Site	Trial Pit Number
University of Manchester (Chemistry Building)	CORE 03

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Horizontal Core			Gardiner & Theobald LLP	41887
	Location	**Dates** 22/04/2016	**Engineer** Curtins	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.12) 0.12	MADE GROUND: One coarse of brick.		
					(0.33) 0.45	MADE GROUND: Concrete with angular to subangular, clasts of fine and medium limestone and also plastic.		
					0.51	Weathered MUDSTONE recovered as gravel.		
						Complete at 0.51m		

Plan



Remarks

Scale (approx)	Logged By	Figure No.
1:40	KA	41887.CORE 03

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APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are as below:

Test Name	Procedures BS1377:1990 Part:Clause
Moisture Content	2:3
Liquid Limit	2:4
Plastic Limit and Plastic Index	2:5
Particle Size Distribution	9.2
Sedimentation	9.4
Mass Loss on Ignition	3.4
Sulphate content	3:5
pH Value	3:9
Compaction Test	4:3
California Bearing Ratio	4:7
Consolidation	5:3
Bulk Density	7:2*
Laboratory Vane Tests	7:3*
Triaxial Compression	
Total Stress Single-Stage	7:8
Total Stress Multi-Stage	7:9
Desiccation	Note 1*

Note 1 - BRE Information paper IP4 issued February 1993
* Tests are not included in UKAS accreditation

A3.1.2 Where an external laboratory carried out testing, their report, including test methods is included in this Appendix.

A3.1.3 A summary sheet of laboratory test results undertaken by Ian Farmer Laboratories is included, however where copies of the individual test results are required these will be provided on request.

A3.1.4 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 MOISTURE CONTENT

A3.2.1 Unless stated to the contrary, the moisture content of a soil sample was determined by the standard oven drying method, BS 1377, Part 1, Test 3. The result is reported to an accuracy of ±0.5%

A3.3 ATTERBERG LIMITS

A3.3.1 The Liquid Limit, **LL**, is the moisture content at which the soil passes from the liquid to plastic state. Unless stated to the contrary, the Liquid Limit was determined using the four point, cone penetrometer method, Test 4. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

A3.3.2 The Plastic Limit, **PL**, is the moisture content at which soil passes from the plastic to solid state and becomes too dry to remain in a plastic condition. The Plastic Limit was determined using the method described in Test 5. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

A3.3.3 The Plasticity Index, **PI**, is the numerical difference between the liquid and plastic limits, corresponding to the range of moisture contents over which a soil is in a plastic state. The determination of the Plasticity Index is covered by Test 5.

A3.4 SOIL CLASSIFICATION

A3.4.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.4.2 This line is defined from experimental evidence and does not represent a well defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.4.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90
Extremely High Plasticity (E)	LL greater than 90

A3.4.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

A3.5 SHEAR STRENGTH TESTS

A3.5.1 The shear strength tests have been carried out in accordance with the procedures given in BS1377, Part 7.

The type of test referred to is:

A3.5.2 U1(100) - Undrained triaxial compression test on single specimen of 100mm diameter at a lateral pressure approximately equal to overburden pressure.

A3.5.3 UM(100) - Multi-stage undrained triaxial compression test on a specimen of 100mm diameter. An initial low cell pressure is applied and the deviator stress increased until failure is imminent. The cell pressure is then increased and the procedure repeated until the failure stress at three different cell pressures have been determined.

A3.5.4 U1(38) - Undrained triaxial compression test on a single specimen of 38mm diameter at a lateral pressure approximately equal to overburden pressure.

A3.5.5 U(38) - Undrained triaxial compression test on set of three specimens of 38mm diameter at three differential lateral pressures.

A3.5.6 Consolidated undrained triaxial – The Effective Stress Parameters were determined in accordance with the procedure detailed in BS1377: Part 8:1990 Clause 7 and the samples were prepared in accordance with clause 4.

A3.5.7 Small shearbox – The peak, and in some cases residual, shear stress parameters were determined in accordance with the procedure detailed in BS1377: Part 7: 1990 Clause 4 and the samples were prepared in accordance with clause 4.

A3.6 CHEMICAL TESTS

A3.6.1 The total sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3:1990, Test 5. The results are recorded to an accuracy of ±0.1%.

A3.6.2 The water soluble sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The results are recorded to an accuracy of ±0.1g/l.

A3.6.3 The sulphate content of groundwater was determined using the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The results are record to an accuracy of ±0.1g/l.

A3.6.4 The pH value was determined electrometrically using the procedures given in BS 1377: Part 3: 1990, Test 9. The results are recorded to an accuracy of ±0.1 pH units.

A3.6.5 The total sulphur content of soil was determined using the ignition in oxygen method detailed in TRL Report 447, Test 4B.

A3.6.6 The organic content of soil was determined in accordance with the chemical method detailed in BS1377: Part 3:1990 Clause 3. The sample was prepared in accordance with Clause 3.4.2.

A3.6.7 The organic content of soil was determined in accordance with the loss on ignition method detailed in BS1377: Part 3:1990 Clause 4. The sample was prepared in accordance with Clause 4.3.2.

IAN FARMER ASSOCIATES

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Tel. 0191 482 8500 Fax. 0191 482 8520 Email. washington@ianfarmer.co.uk Internet. www.ianfarmer.co.uk

F.A.O.

Test Report - 41887 /1

Site:	University of Manchester (Chemistry Building)
Job Number:	41887
Originating Client:	Gardiner & Theobald LLP
Originating Reference:	41887
Date Sampled:	Not Given
Date Scheduled:	26/04/2016
Date Testing Started:	10/05/2016
Date Testing Finished:	25/05/2016
Remarks:	

Authorised By: D. Smith

Daniel Smith
Laboratory Supervisor

Date: 25/05/2016

constructionline
UK REGISTER OF PRE-QUALIFIED CONSTRUCTION SERVICES

Ian Farmer Associates (1998) Limited. Registered in England and Wales No. 3661447
Registered Office: Unit 4 Faraday Close, Pattinson North Industrial Estate, Washington, NE38 8QJ
Offices in: Coventry (024) 7630 3422. Harpenden, Herts. (01582) 460 018. Llanelli (01554) 566 566.
Motherwell (01698) 230 231. Newcastle upon Tyne (0191) 482 8500. Truro (01827) 261 775.
Warrington (01925) 855 440.

AGS ASSOCIATION OF GEOTECHNICAL & GEOENVIRONMENTAL SPECIALISTS

UKAS TESTING
1464

IAN FARMER ASSOCIATES

Laboratory Test Report | 41887 / 1

Site: University of Manchester (Chemistry Building) **Job Number:** 41887

Client: Gardiner & Theobald LLP **Page:** 2

DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Water Content %	Sample Passing 425 µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Water Content %						
BH01	2.60	D10	Sieved	14	87	15.0	43	21	22	-0.26	CI	Brown CLAY
BH01	3.50	D13	Natural	14	91	15.0	33	17	16	-0.13	CL	Brown CLAY
WS01	0.80	D5	Natural	22	99	22.0	49	22	27	0.01	CI	Brown CLAY
WS03B	2.50	D6	Natural	19	98	19.0	44	21	23	-0.07	CI	Brown gravelly CLAY

Method of Preparation: BS EN ISO 17890:Part 1:2014, Clause 5.1 Water content test specimen preparation
BS 1377:Part 1:1990, Clause 7.4 Preparation of samples for classification tests
BS 1377:Part 2:1990, Clasue 4.2 Sample preparation

Method of Test: BS EN ISO 17890:Part 1:2014, Clause 5.2 Water content test execution
BS 1377:Part 2:1990, Clause 4.3 or 4.4 Determination of the liquid limit
BS 1377:Part 2:1990, Clause 5.3 Determination of the plastic limit and plasticity index

UKAS TESTING
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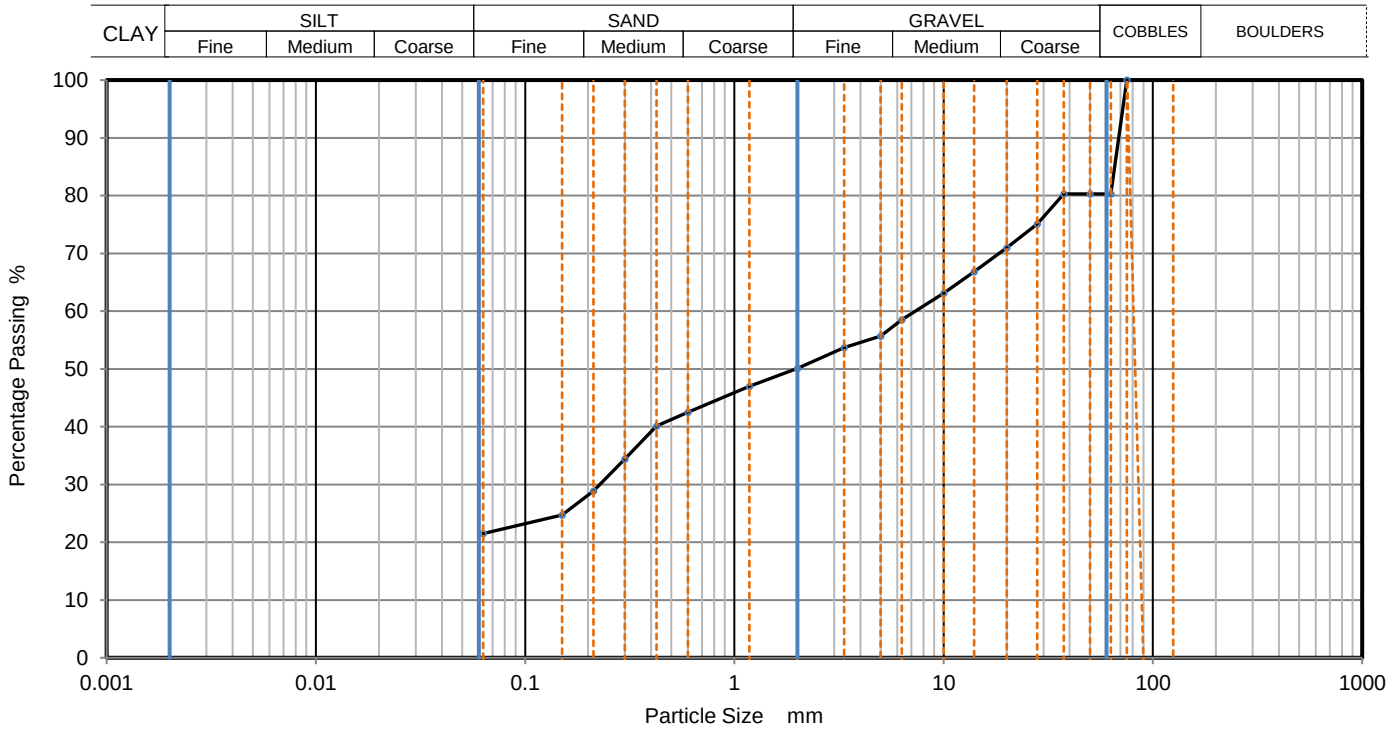
Laboratory Test Report | 41887 / 1

Site: University of Manchester (Chemistry Building) **Job Number:** 41887

Client: Gardiner & Theobald LLP **Page:** 3

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH01	1.20	B6	Wet Sieve	Brown gravelly sandy CLAY



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	80		
50	80		
37.5	80		
28	75		
20	71		
14	67		
10	63		
6.3	59		
5	56		
3.35	54		
2	50		
1.18	47		
0.6	43		
0.425	40		
0.3	34		
0.212	29		
0.15	25		
0.063	22		

Dry Mass of sample, g: 2397

Sample Proportions	% dry mass
Very coarse	20
Gravel	30
Sand	29
Fines <0.063mm	22

Grading Analysis		
D100	mm	75
D60	mm	7.32
D30	mm	0.228
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method

UKAS TESTING
1464

IAN FARMER ASSOCIATES

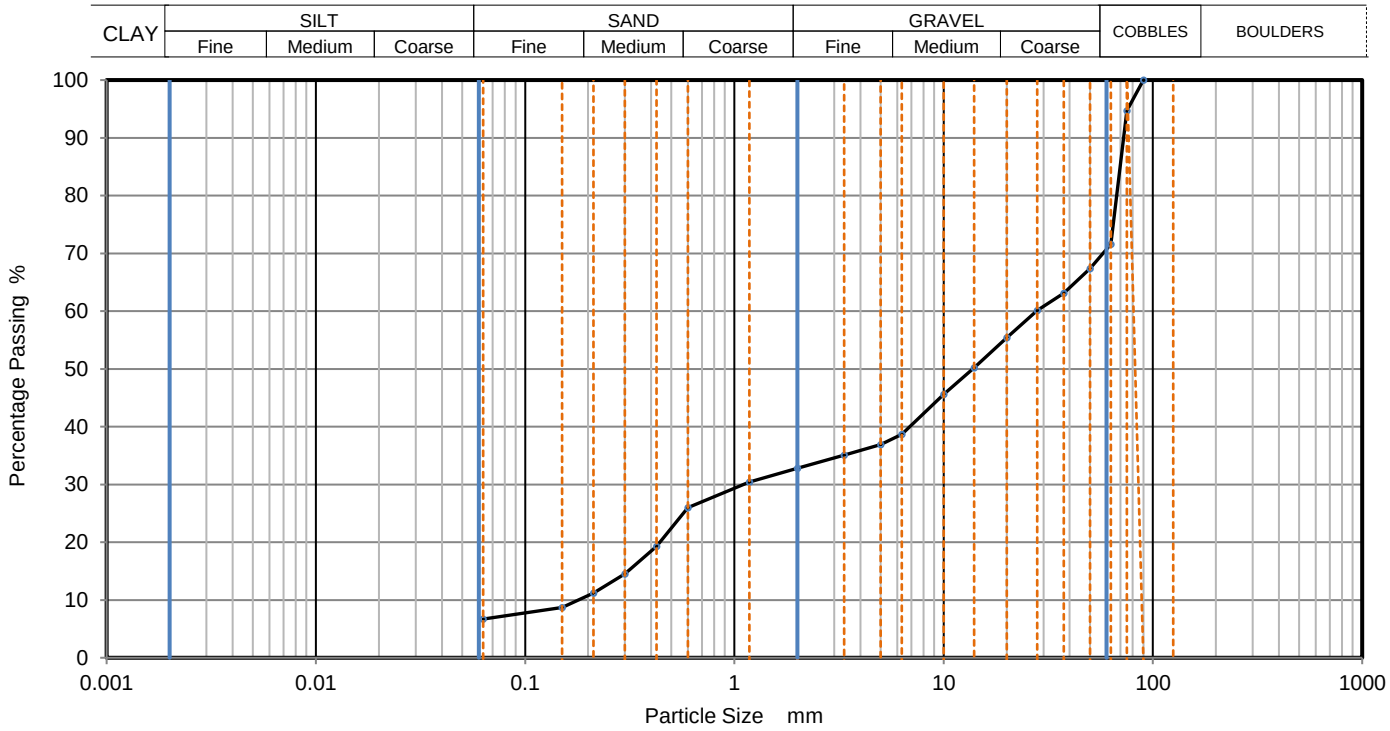
Laboratory Test Report | 41887 / 1

Site: University of Manchester (Chemistry Building) **Job Number:** 41887

Client: Gardiner & Theobald LLP **Page:** 4

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
TP04	0.70	B1	Wet Sieve	Brown clayey gravelly SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
90	100		
75	95		
63	72		
50	67		
37.5	63		
28	60		
20	55		
14	50		
10	46		
6.3	39		
5	37		
3.35	35		
2	33		
1.18	30		
0.6	26		
0.425	19		
0.3	15		
0.212	11		
0.15	9		
0.063	7		

Dry Mass of sample, g: 12620

Sample Proportions	% dry mass
Very coarse	28
Gravel	39
Sand	26
Fines <0.063mm	7

Grading Analysis		
D100	mm	90
D60	mm	27.8
D30	mm	1.11
D10	mm	0.18
Uniformity Coefficient		150
Curvature Coefficient		0.25

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method

UKAS TESTING
1464

Site: University of Manchester (Chemistry Building) **Job Number:** 41887

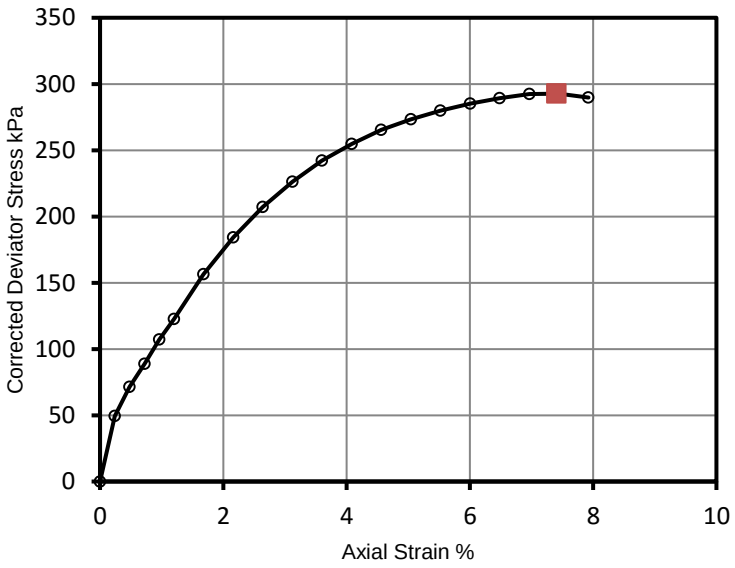
Client: Gardiner & Theobald LLP **Page:** 5

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

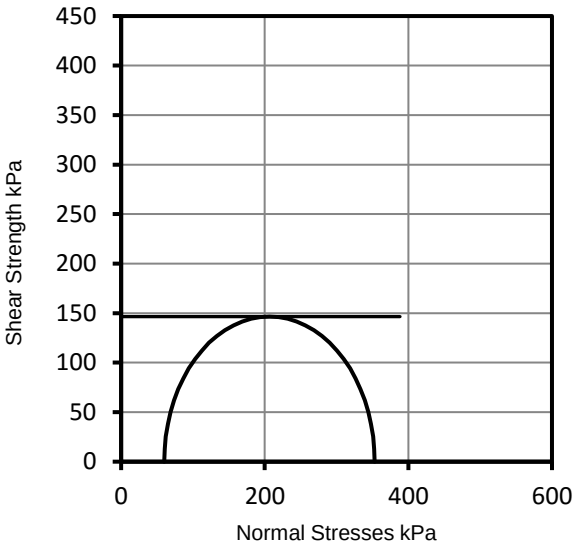
Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	3.00	U12	**Brown gravelly CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	436.09
	Depth from Top (mm)	60.14
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		208.22
Diameter (mm)		101.39
Moisture Content (%)		18.50
Bulk Density (Mg/m3)		2.09
Dry Density (Mg/m3)		1.76
Membrane Thickness (mm)		0.48
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	60
	Axial Strain (%)	7.4
	Membrane Corr. (kPa)	0.86
	Deviator Stress, (σ1 - σ3)f (kPa)	293
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	146
	Mode of Failure	Compound

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

IAN FARMER ASSOCIATES

Laboratory Test Report	41887 / 1

Site: University of Manchester (Chemistry Building) **Job Number:** 41887

Client: Gardiner & Theobald LLP **Page:** 6

DETERMINATION OF THE ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

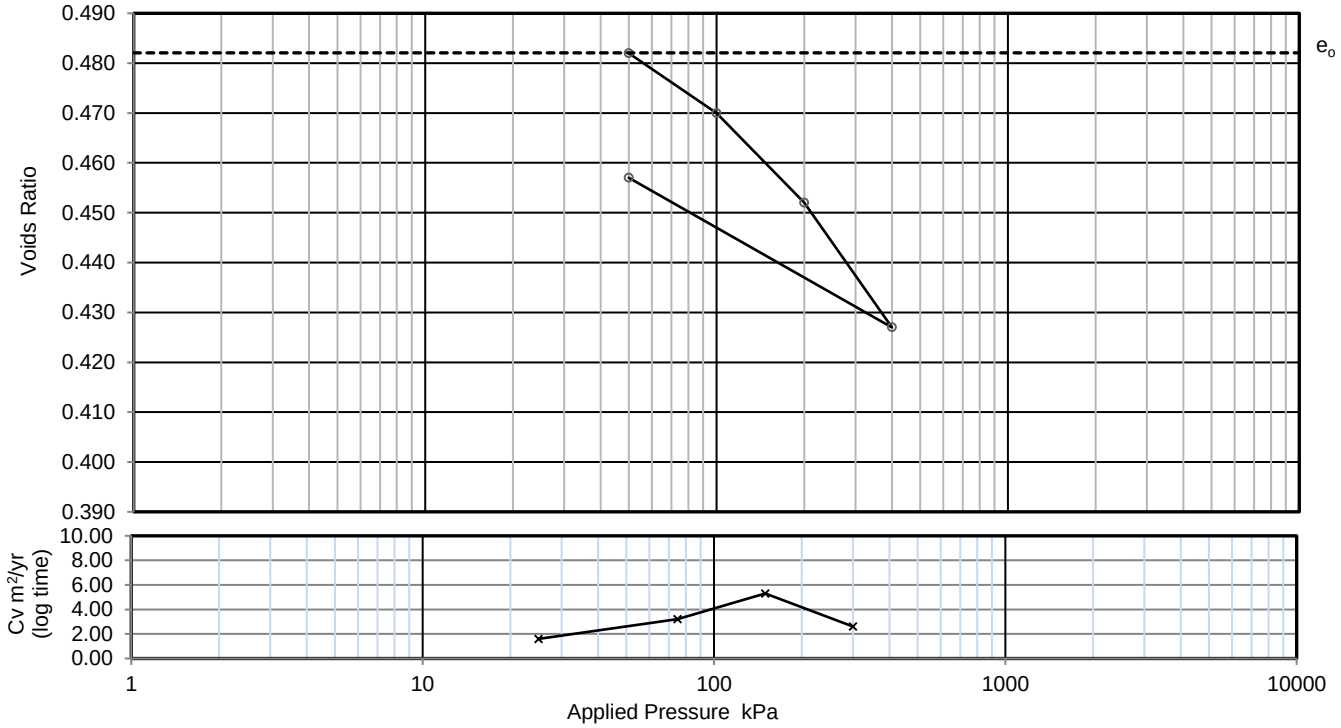
Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	3	U12	Brown gravelly CLAY

Initial Specimen



Length of Sample (mm)	436.09
Depth from top of specimen (mm)	60.14
Condition of Sample:	Undisturbed
Orientation:	Vertical

Diameter (mm)	74.82
Particle density (Mg/m³)	2.65 assumed
Swelling Pressure (kPa)	45
Lab Temp. (°C)	22



Applied Pressure kPa	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec	Voids ratio
45.0	-	-	-	-	0.482
50	0.0053	1.6	3.8	0.00031	0.482
100	0.16	3.2	16	0.00036	0.470
200	0.12	5.3	11	0.0012	0.452
400	0.083	2.6	7.8	0.00092	0.427
50	0.059				0.457

	Initial	Final
Height (mm)	18.79	18.47
Water Content (%)	19.5	20.9
Bulk density (Mg/m³)	2.14	2.20
Dry density (Mg/m³)	1.79	1.82
Voids Ratio	0.482	0.457
Degree of Saturation (%)	107	121

Method of Preparation: BS 1377:Part 5:1990, clause 3.3 Preparation of specimen
BS 1377:Part 5:1990, clause 3.4 Preparation and assembly of apparatus

Method of Test: BS 1377:Part 5:1990, clause 4.3 Measurement of swelling presure
BS 1377:Part 5:1990, clause 3.5 Determination of the one-dimensional consolidation properties

UKAS TESTING
1464

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Test Report - 41887 /1

Site:	University of Manchester (Chemistry Building)
Job Number:	41887
Originating Client:	Gardiner & Theobald LLP

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

Date: 25/05/2016

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 16-64699

03-May-16

Client	Ian Farmer Associates 17 Rivington Court Hardwick Grange Woolston Warrington Cheshire WA1 4RT
Our Reference	16-64699
Client Reference	41887
Order No	40645
Contract Title	University of Manchester
Description	9 Soil samples.
Date Received	27-Apr-16
Date Started	27-Apr-16
Date Completed	03-May-16
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By



Rob Brown
Business Manager

UKAS TESTING
2139

Summary of Chemical Analysis

Soil Samples

Our Ref 16-64699
Client Ref 41887
Contract Title University of Manchester

				Lab No	978070	978071	978072	978073	978074	978075	978076	978077	978078
				Sample ID	BH01	BH01	BH01	WS01	WS01	WS02	WS03b	WS03b	TP04
				Depth	0.30	1.20	6.00	0.50	1.30	0.50	1.50	3.00	0.70
				Other ID									
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	19/4/16	19/4/16	19/4/16	18/4/16	18/4/16	18/4/16	18/4/16	18/4/16	19/4/16
				Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**										
Inorganics													
pH	DETSC 2008#			10.4	11.3	8.4	8.6	8.2	9.0	8.2	8.2	10.4
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	200	240	17	120	48	19	28	29	260

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 16-64699
Client Ref 41887
Contract University of Manchester

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
978070	BH01 0.30 SOIL	19/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978071	BH01 1.20 SOIL	19/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978072	BH01 6.00 SOIL	19/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978073	WS01 0.50 SOIL	18/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978074	WS01 1.30 SOIL	18/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978075	WS02 0.50 SOIL	18/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978076	WS03b 1.50 SOIL	18/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978077	WS03b 3.00 SOIL	18/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
978078	TP04 0.70 SOIL	19/4/16	PT 1L	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

APPENDIX 4

CHEMICAL TESTS

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Report Number: 565352-1

Date of Report: 05-May-2016

Customer: Ian Farmer Associates
17 Rivington Court
Warrington
Cheshire
WA1 4RT

Customer Contact: Ms Hannah Hadwin

Customer Job Reference: 41887
Customer Purchase Order: 40643
Customer Site Reference: University of Manchester Schedule 2
Date Job Received at SAL: 20-Apr-2016
Date Analysis Started: 26-Apr-2016
Date Analysis Completed: 04-May-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

1549

Report checked and authorised by :
Bianca Prince
Customer Service Manager

Issued by :
Bianca Prince
Customer Service Manager

SAL Reference: 565352
Project Site: University of Manchester Schedule 2
Customer Reference: 41887

Soil Analysed as Soil
Miscellaneous

					SAL Reference	**565352 001**	**565352 002**
					Customer Sample Reference	**BH01**	**BH01**
					Depth	**1.0**	**3.0**
					Date Sampled	**19-APR-2016**	**19-APR-2016**
					Type	**Sandy Soil**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**		
Asbestos ID	T27	AR			N.D.	-
Moisture @105C	T162	AR	0.1	%	**17**	**15**
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1
Chromium VI	T6	AR	1	mg/kg	<1	<1
Cyanide(Total)	T546	AR	1	mg/kg	**1**	-
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	**0.60**	**0.12**
Total Organic Carbon	T21	M40	0.1	%	**19**	**1.0**
pH	T7	AR			**7.7**	**9.7**

SAL Reference: 565352
Project Site: University of Manchester Schedule 2
Customer Reference: 41887

Soil Analysed as Soil
Heavy Metals(9)

					SAL Reference	**565352 001**	**565352 002**
					Customer Sample Reference	**BH01**	**BH01**
					Depth	**1.0**	**3.0**
					Date Sampled	**19-APR-2016**	**19-APR-2016**
					Type	**Sandy Soil**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**		
Arsenic	T6	M40	2	mg/kg	**100**	**10**
Cadmium	T6	M40	1	mg/kg	<1	<1
Chromium	T6	M40	1	mg/kg	**35**	**25**
Copper	T6	M40	1	mg/kg	**160**	**32**
Lead	T6	M40	1	mg/kg	**410**	**33**
Mercury	T6	M40	1	mg/kg	<1	<1
Nickel	T6	M40	1	mg/kg	**37**	**27**
Selenium	T6	M40	3	mg/kg	<3	<3
Zinc	T6	M40	1	mg/kg	**230**	**83**

SAL Reference: 565352
Project Site: University of Manchester Schedule 2
Customer Reference: 41887

Soil Analysed as Soil

TPH (CWG) with MTBE, BTEX

SAL Reference	**565352 001**
Customer Sample Reference	**BH01**
Depth	**1.0**
Date Sampled	**19-APR-2016**
Type	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units	
Benzene	T209	M105	10	µg/kg	(13) <10
Toluene	T209	M105	10	µg/kg	<10
EthylBenzene	T209	M105	10	µg/kg	<10
M/P Xylene	T209	M105	10	µg/kg	<10
O Xylene	T209	M105	10	µg/kg	<10
Methyl tert-Butyl Ether	T209	M105	10	µg/kg	<10
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	<0.100
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	(13) **2**
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	(13) **17**
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	(13) **27**
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	(13) **16**
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	(13) **5**
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	(13) **50**
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	(13) **200**
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	(13) **200**

SAL Reference: 565352
Project Site: University of Manchester Schedule 2
Customer Reference: 41887

Soil Analysed as Soil

PAH US EPA 16 (B and K split)

SAL Reference	**565352 001**	**565352 002**
Customer Sample Reference	**BH01**	**BH01**
Depth	**1.0**	**3.0**
Date Sampled	**19-APR-2016**	**19-APR-2016**
Type	**Sandy Soil**	**Clay**

Determinand	Method	Test Sample	LOD	Units		
Naphthalene	T207	M105	0.1	mg/kg	**2.5**	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	**0.2**	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	**2.0**	<0.1
Fluorene	T207	M105	0.1	mg/kg	**1.2**	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	**14**	**0.2**
Anthracene	T207	M105	0.1	mg/kg	**3.1**	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**14**	**0.2**
Pyrene	T207	M105	0.1	mg/kg	**16**	**0.2**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	**6.3**	<0.1
Chrysene	T207	M105	0.1	mg/kg	**7.5**	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	**5.6**	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	**4.7**	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	**5.5**	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	**3.3**	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	**1.2**	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	**3.7**	<0.1
PAH(total)	T207	M105	0.1	mg/kg	**91**	**0.5**

Index to symbols used in 565352-1

Value	Description
AR	As Received
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
N.D.	Not Detected
13	Results have been blank corrected.
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos

Method Index

Value	Description
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T2	Grav
T209	GC/MS (Head Space)(MCERTS)
T546	Colorimetry (CF)
T162	Grav (1 Dec) (105 C)
T207	GC/MS (MCERTS)
T6	ICP/OES
T7	Probe
T21	OX/IR
T909	GCxGC
T27	PLM

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Asbestos ID	T27	AR			SU	001
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-002
Moisture @105C	T162	AR	0.1	%	N	001-002
Chromium VI	T6	AR	1	mg/kg	N	001-002
Cyanide(Total)	T546	AR	1	mg/kg	M	001
Phenols(Mono)	T546	AR	1	mg/kg	M	001-002
Retained on 10mm sieve	T2	M40	0.1	%	N	001-002
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-002
Total Organic Carbon	T21	M40	0.1	%	N	001-002
pH	T7	AR			M	001-002
Arsenic	T6	M40	2	mg/kg	M	001-002
Cadmium	T6	M40	1	mg/kg	M	001-002
Chromium	T6	M40	1	mg/kg	M	001-002
Copper	T6	M40	1	mg/kg	M	001-002
Lead	T6	M40	1	mg/kg	M	001-002
Mercury	T6	M40	1	mg/kg	M	001-002
Nickel	T6	M40	1	mg/kg	M	001-002
Selenium	T6	M40	3	mg/kg	M	001-002
Zinc	T6	M40	1	mg/kg	M	001-002
Benzene	T209	M105	10	µg/kg	M	001
Toluene	T209	M105	10	µg/kg	M	001
EthylBenzene	T209	M105	10	µg/kg	M	001
M/P Xylene	T209	M105	10	µg/kg	M	001
O Xylene	T209	M105	10	µg/kg	M	001
Methyl tert-Butyl Ether	T209	M105	10	µg/kg	M	001
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	N	001
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	N	001
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	N	001
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	M	001
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	M	001
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	M	001
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	M	001

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	N	001
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	N	001
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	N	001
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	M	001
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	M	001
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	M	001
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	M	001
Naphthalene	T207	M105	0.1	mg/kg	M	001-002
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-002
Acenaphthene	T207	M105	0.1	mg/kg	M	001-002
Fluorene	T207	M105	0.1	mg/kg	M	001-002
Phenanthrene	T207	M105	0.1	mg/kg	M	001-002
Anthracene	T207	M105	0.1	mg/kg	U	001-002
Fluoranthene	T207	M105	0.1	mg/kg	M	001-002
Pyrene	T207	M105	0.1	mg/kg	M	001-002
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-002
Chrysene	T207	M105	0.1	mg/kg	M	001-002
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-002
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-002
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-002
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-002
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-002
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-002
PAH(total)	T207	M105	0.1	mg/kg	U	001-002

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Report Number: 565188-1

Date of Report: 05-May-2016

Customer: Ian Farmer Associates
17 Rivington Court
Warrington
Cheshire
WA1 4RT

Customer Contact: Ms Hannah Hadwin

Customer Job Reference: 41887
Customer Purchase Order: 40636
Customer Site Reference: University of Manchester
Date Job Received at SAL: 20-Apr-2016
Date Analysis Started: 26-Apr-2016
Date Analysis Completed: 05-May-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

1549

Report checked and authorised by :
Bianca Prince
Customer Service Manager

Issued by :
Bianca Prince
Customer Service Manager

SAL Reference: 565188
Project Site: University of Manchester
Customer Reference: 41887

Soil Analysed as Soil
Miscellaneous

SAL Reference			**565188 001**	**565188 002**	**565188 003**	**565188 011**	**565188 012**
Customer Sample Reference			**WS01**	**WS01**	**WS02**	**WS03B**	**WS03B**
Depth			**0.50**	**0.80**	**0.50**	**1.50**	**2.50**
Date Sampled			**18-APR-2016**	**18-APR-2016**	**18-APR-2016**	**20-APR-2016**	**20-APR-2016**
Type			**Clay**	**Clay**	**Clay**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Asbestos ID	T27	AR			N.D.	-	N.D.	N.D.	-
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Moisture @105C	T162	AR	0.1	%	**17**	**19**	**9.9**	**24**	**16**
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Cyanide(Total)	T546	AR	1	mg/kg	<1	-	<1	<1	-
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	**0.05**	**0.04**	**0.02**	**0.02**	**0.02**
Total Organic Carbon	T21	M40	0.1	%	**2.7**	**0.9**	**6.8**	**1.5**	**0.8**
pH	T7	AR			**8.6**	**8.1**	**7.9**	**8.0**	**11.9**

SAL Reference: 565188
Project Site: University of Manchester
Customer Reference: 41887

Soil Analysed as Soil
Heavy Metals(9)

SAL Reference					**565188 001**	**565188 002**	**565188 003**	**565188 011**	**565188 012**
Customer Sample Reference					**WS01**	**WS01**	**WS02**	**WS03B**	**WS03B**
Depth					**0.50**	**0.80**	**0.50**	**1.50**	**2.50**
Date Sampled					**18-APR-2016**	**18-APR-2016**	**18-APR-2016**	**20-APR-2016**	**20-APR-2016**
Type					**Clay**	**Clay**	**Clay**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Arsenic	T6	M40	2	mg/kg	**15**	**13**	**13**	**9**	**7**
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**31**	**36**	**26**	**27**	**30**
Copper	T6	M40	1	mg/kg	**53**	**26**	**81**	**30**	**21**
Lead	T6	M40	1	mg/kg	**93**	**19**	**86**	**54**	**11**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**30**	**57**	**32**	**22**	**33**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**78**	**73**	**160**	**130**	**67**

SAL Reference: 565188
Project Site: University of Manchester
Customer Reference: 41887

Soil Analysed as Soil

TPH (CWG) with MTBE, BTEX

SAL Reference	**565188 001**
Customer Sample Reference	**WS01**
Depth	**0.50**
Date Sampled	**18-APR-2016**
Type	**Clay**

Determinand	Method	Test Sample	LOD	Units	
Benzene	T209	M105	10	µg/kg	(13) <10
Toluene	T209	M105	10	µg/kg	<10
EthylBenzene	T209	M105	10	µg/kg	<10
M/P Xylene	T209	M105	10	µg/kg	<10
O Xylene	T209	M105	10	µg/kg	<10
Methyl tert-Butyl Ether	T209	M105	10	µg/kg	<10
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	<0.100
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	(13) <1
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	(13) <1
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	(13) <1
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	(13) <2
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	<0.10
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	(13) <2
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	(13) <1
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	**(13) 2**
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	**(13) 3**

SAL Reference: 565188
Project Site: University of Manchester
Customer Reference: 41887

Soil Analysed as Soil

PAH US EPA 16 (B and K split)

				SAL Reference	**565188 001**	**565188 002**	**565188 003**	**565188 011**	**565188 012**
				Customer Sample Reference	**WS01**	**WS01**	**WS02**	**WS03B**	**WS03B**
				Depth	**0.50**	**0.80**	**0.50**	**1.50**	**2.50**
				Date Sampled	**18-APR-2016**	**18-APR-2016**	**18-APR-2016**	**20-APR-2016**	**20-APR-2016**
				Type	**Clay**	**Clay**	**Clay**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1	**520**	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	**4.1**	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	<0.1	**320**	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	<0.1	**240**	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	**0.5**	**0.2**	**1300**	**0.2**	<0.1
Anthracene	T207	M105	0.1	mg/kg	**0.2**	<0.1	**370**	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**0.9**	**0.3**	**1200**	**0.4**	<0.1
Pyrene	T207	M105	0.1	mg/kg	**0.8**	**0.2**	**980**	**0.4**	<0.1
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	**0.3**	<0.1	**440**	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	**0.3**	**0.1**	**390**	**0.2**	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	**0.3**	<0.1	**380**	**0.1**	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	**0.3**	<0.1	**200**	**0.1**	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	**0.2**	<0.1	**310**	**0.1**	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	**0.2**	<0.1	**160**	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	**45**	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	**0.2**	<0.1	**160**	**0.1**	<0.1
PAH(total)	T207	M105	0.1	mg/kg	**4.3**	**0.8**	**7000**	**1.5**	<0.1

Index to symbols used in 565188-1

Value	Description
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
AR	As Received
N.D.	Not Detected
13	Results have been blank corrected.
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos

Method Index

Value	Description
T6	ICP/OES
T546	Colorimetry (CF)
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T27	PLM
T7	Probe
T162	Grav (1 Dec) (105 C)
T2	Grav
T21	OX/IR
T207	GC/MS (MCERTS)
T909	GCxGC
T209	GC/MS (Head Space)(MCERTS)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Asbestos ID	T27	AR			SU	001,003,011
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-003,011-012
Moisture @105C	T162	AR	0.1	%	N	001-003,011-012
Chromium VI	T6	AR	1	mg/kg	N	001-003,011-012
Cyanide(Total)	T546	AR	1	mg/kg	M	001,003,011
Phenols(Mono)	T546	AR	1	mg/kg	M	001-003,011-012
Retained on 10mm sieve	T2	M40	0.1	%	N	001-003,011-012
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-003,011-012
Total Organic Carbon	T21	M40	0.1	%	N	001-003,011-012
pH	T7	AR			M	001-003,011-012
Arsenic	T6	M40	2	mg/kg	M	001-003,011-012
Cadmium	T6	M40	1	mg/kg	M	001-003,011-012
Chromium	T6	M40	1	mg/kg	M	001-003,011-012
Copper	T6	M40	1	mg/kg	M	001-003,011-012
Lead	T6	M40	1	mg/kg	M	001-003,011-012
Mercury	T6	M40	1	mg/kg	M	001-003,011-012
Nickel	T6	M40	1	mg/kg	M	001-003,011-012
Selenium	T6	M40	3	mg/kg	M	001-003,011-012
Zinc	T6	M40	1	mg/kg	M	001-003,011-012
Benzene	T209	M105	10	µg/kg	M	001
Toluene	T209	M105	10	µg/kg	M	001
EthylBenzene	T209	M105	10	µg/kg	M	001
M/P Xylene	T209	M105	10	µg/kg	M	001
O Xylene	T209	M105	10	µg/kg	M	001
Methyl tert-Butyl Ether	T209	M105	10	µg/kg	M	001
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	N	001
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	N	001
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	N	001
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	M	001
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	M	001
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	M	001
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	M	001

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	N	001
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	N	001
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	N	001
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	M	001
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	M	001
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	M	001
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	M	001
Naphthalene	T207	M105	0.1	mg/kg	M	001-003,011-012
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-003,011-012
Acenaphthene	T207	M105	0.1	mg/kg	M	001-003,011-012
Fluorene	T207	M105	0.1	mg/kg	M	001-003,011-012
Phenanthrene	T207	M105	0.1	mg/kg	M	001-003,011-012
Anthracene	T207	M105	0.1	mg/kg	U	001-003,011-012
Fluoranthene	T207	M105	0.1	mg/kg	M	001-003,011-012
Pyrene	T207	M105	0.1	mg/kg	M	001-003,011-012
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-003,011-012
Chrysene	T207	M105	0.1	mg/kg	M	001-003,011-012
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-003,011-012
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-003,011-012
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-003,011-012
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-003,011-012
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-003,011-012
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-003,011-012
PAH(total)	T207	M105	0.1	mg/kg	U	001-003,011-012

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Hadfield Street
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Scientific Analysis Laboratories Ltd

Certificate of Analysis

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Report Number: 565383-2

Date of Report: 06-May-2016

Customer: Ian Farmer Associates
17 Rivington Court
Warrington
Cheshire
WA1 4RT

Customer Contact: Ms Hannah Hadwin

Customer Job Reference: 41887
Customer Purchase Order: 40649
Customer Site Reference: University of Manchester Chem Building
Date Job Received at SAL: 20-Apr-2016
Date Analysis Started: 26-Apr-2016
Date Analysis Completed: 05-May-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING 1549

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Bianca Prince
Customer Service Manager

Issued by :
Bianca Prince
Customer Service Manager

SAL Reference: 565383
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
Suite S

SAL Reference	**565383 001**	**565383 002**
Customer Sample Reference	**TP04**	**BH01**
Depth	**0.70**	**0.50**
Date Sampled	**20-APR-2016**	**19-APR-2016**
Type	**Sandy Soil**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units		
Ammonia expressed as NH3	T22	AR	5	mg/kg	**11**	**16**
Moisture @105C	T162	AR	0.1	%	**17**	**21**
Chloride	T686	AR	1	mg/kg	(64) **6**	(64) **4**
Nitrate	T686	AR	1	mg/kg	(64) **3**	(64) **2**
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	**0.08**	**0.15**
SO4(Total)	T6	M40	0.01	%	**0.36**	**0.22**
VOC Screen (Extra Peaks)	T54	M105	100	µg/kg	<100	<100

SAL Reference: 565383
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
TPH (CWG)

SAL Reference	**565383 001**	**565383 002**
Customer Sample Reference	**TP04**	**BH01**
Depth	**0.70**	**0.50**
Date Sampled	**20-APR-2016**	**19-APR-2016**
Type	**Sandy Soil**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units		
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	<0.100	<0.100
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	<0.10	<0.10
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	<0.10	<0.10
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	(13,9) <10	(13) <1
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	(9,13) <10	(13) **4**
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	(13) **10**	(13) **4**
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	(13) **17**	(13) **5**
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	<0.10	<0.10
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	<0.10	<0.10
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	<0.10	<0.10
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	(9,13) <10	(13) <2
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	(13,9) <10	(13) **5**
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	(13) **65**	(13) **27**
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	(13) **170**	(13) **38**

SAL Reference: 565383
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
Volatile Organic Compounds (USEPA 624) (MCERTS)

SAL Reference	**565383 001**	**565383 002**
Customer Sample Reference	**TP04**	**BH01**
Depth	**0.70**	**0.50**
Date Sampled	**20-APR-2016**	**19-APR-2016**
Type	**Sandy Soil**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units		
1,1,1,2-Tetrachloroethane	T209	M105	50	µg/kg	<50	<50
1,1,1-Trichloroethane	T209	M105	50	µg/kg	<50	<50
1,1,2,2-Tetrachloroethane	T209	M105	50	µg/kg	<50	<50
1,1,2-Trichloroethane	T209	M105	50	µg/kg	<50	<50
1,1-Dichloroethane	T209	M105	50	µg/kg	<50	<50
1,1-Dichloroethylene	T209	M105	50	µg/kg	<50	<50
1,1-Dichloropropene	T209	M105	50	µg/kg	<50	<50
1,2,3-Trichloropropane	T209	M105	50	µg/kg	<50	<50
1,2,4-Trimethylbenzene	T209	M105	50	µg/kg	<50	<50
1,2-dibromoethane	T209	M105	50	µg/kg	<50	<50
1,2-Dichlorobenzene	T209	M105	50	µg/kg	<50	<50
1,2-Dichloroethane	T209	M105	50	µg/kg	<50	<50
1,2-Dichloropropane	T209	M105	50	µg/kg	<50	<50
1,3,5-Trimethylbenzene	T209	M105	50	µg/kg	<50	<50
1,3-Dichlorobenzene	T209	M105	50	µg/kg	<50	<50
1,3-Dichloropropane	T209	M105	50	µg/kg	<50	<50
1,4-Dichlorobenzene	T209	M105	50	µg/kg	<50	<50
2,2-Dichloropropane	T209	M105	50	µg/kg	<50	<50
2-Chlorotoluene	T209	M105	50	µg/kg	<50	<50
4-Chlorotoluene	T209	M105	50	µg/kg	<50	<50
Benzene	T209	M105	10	µg/kg	(13) <10	(13) <10
Bromobenzene	T209	M105	50	µg/kg	<50	<50
Bromochloromethane	T209	M105	50	µg/kg	<50	<50
Bromodichloromethane	T209	M105	50	µg/kg	<50	<50
Bromoform	T209	M105	50	µg/kg	<50	<50
Bromomethane	T209	M105	50	µg/kg	<50	<50
Carbon tetrachloride	T209	M105	50	µg/kg	<50	<50
Chlorobenzene	T209	M105	50	µg/kg	<50	<50
Chlorodibromomethane	T209	M105	50	µg/kg	<50	<50
Chloroethane	T209	M105	50	µg/kg	<50	<50
Chloroform	T209	M105	50	µg/kg	<50	<50
Chloromethane	T209	M105	50	µg/kg	<50	<50
Cis-1,2-Dichloroethylene	T209	M105	50	µg/kg	<50	<50
Cis-1,3-Dichloropropene	T209	M105	50	µg/kg	<50	<50
Dibromomethane	T209	M105	50	µg/kg	<50	<50
Dichlorodifluoromethane	T209	M105	50	µg/kg	<50	<50
Dichloromethane	T209	M105	50	µg/kg	<50	<50
EthylBenzene	T209	M105	10	µg/kg	<10	<10
Isopropyl benzene	T209	M105	50	µg/kg	<50	<50
M/P Xylene	T209	M105	10	µg/kg	<10	<10
n-Propylbenzene	T209	M105	50	µg/kg	<50	<50
O Xylene	T209	M105	10	µg/kg	<10	<10
p-Isopropyltoluene	T209	M105	50	µg/kg	<50	<50
S-Butylbenzene	T209	M105	50	µg/kg	<50	<50
Styrene	T209	M105	50	µg/kg	<50	<50
T-Butylbenzene	T209	M105	50	µg/kg	<50	<50
Tetrachloroethene	T209	M105	50	µg/kg	<50	<50
Toluene	T209	M105	10	µg/kg	<10	<10
Trans-1,2-Dichloroethene	T209	M105	50	µg/kg	<50	<50
Trans-1,3-Dichloropropene	T209	M105	50	µg/kg	<50	<50
Trichloroethene	T209	M105	50	µg/kg	<50	<50
Trichlorofluoromethane	T209	M105	50	µg/kg	<50	<50
Vinyl chloride	T209	M105	50	µg/kg	<50	<50

SAL Reference: 565383
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
Target Alcohols (x10)

SAL Reference	**565383 001**	**565383 002**
Customer Sample Reference	**TP04**	**BH01**
Depth	**0.70**	**0.50**
Date Sampled	**20-APR-2016**	**19-APR-2016**
Type	**Sandy Soil**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units		
2 Butanol	T23	AR	10	mg/kg	(151) <100	(151) <100
2-ethyl-1-hexanol	T23	AR	1	mg/kg	(151) <10	(151) <10
Ethanol	T23	AR	10	mg/kg	(151) <100	(151) <100
Isobutanol	T23	AR	10	mg/kg	(151) <100	(151) <100
Methanol	T23	AR	10	mg/kg	(151) <100	(151) <100
n-butanol	T23	AR	10	mg/kg	(151) <100	(151) <100
Isopropanol	T23	AR	10	mg/kg	(151) <100	(151) <100
Propyl alcohol	T23	AR	10	mg/kg	(151) <100	(151) <100
Tertiary Butanol	T23	AR	10	mg/kg	(151) <100	(151) <100

Index to symbols used in 565383-2

Value	Description
AR	As Received
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
9	LOD raised due to dilution of sample
64	Analysis was performed by an alternative technique
13	Results have been blank corrected.
151	LOD determined by volume of solvent used during extraction
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T22	Titration
T209	GC/MS (Head Space)(MCERTS)
T162	Grav (1 Dec) (105 C)
T23	GC/MS (DI)
T6	ICP/OES
T54	GC/MS (Headspace)
T686	Discrete Analyser
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T909	GCxGC

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Ammonia expressed as NH3	T22	AR	5	mg/kg	N	001-002
Chloride	T686	AR	1	mg/kg	N	001-002
Moisture @105C	T162	AR	0.1	%	N	001-002
Nitrate	T686	AR	1	mg/kg	N	001-002
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-002
SO4(Total)	T6	M40	0.01	%	N	001-002
VOC Screen (Extra Peaks)	T54	M105	100	µg/kg	N	001-002
2 Butanol	T23	AR	10	mg/kg	N	001-002
2-ethyl-1-hexanol	T23	AR	1	mg/kg	N	001-002
Ethanol	T23	AR	10	mg/kg	N	001-002
Isobutanol	T23	AR	10	mg/kg	N	001-002
Methanol	T23	AR	10	mg/kg	N	001-002

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
n-butanol	T23	AR	10	mg/kg	N	001-002
Isopropanol	T23	AR	10	mg/kg	N	001-002
Propyl alcohol	T23	AR	10	mg/kg	N	001-002
Tertiary Butanol	T23	AR	10	mg/kg	N	001-002
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	N	001-002
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	N	001-002
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	N	001-002
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	M	001-002
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	M	001-002
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	M	001-002
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	M	001-002
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	N	001-002
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	N	001-002
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	N	001-002
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	M	001-002
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	M	001-002
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	M	001-002
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	M	001-002
1,1,1,2-Tetrachloroethane	T209	M105	50	µg/kg	M	001-002
1,1,1-Trichloroethane	T209	M105	50	µg/kg	M	001-002
1,1,2,2-Tetrachloroethane	T209	M105	50	µg/kg	U	001-002
1,1,2-Trichloroethane	T209	M105	50	µg/kg	M	001-002
1,1-Dichloroethane	T209	M105	50	µg/kg	M	001-002
1,1-Dichloroethylene	T209	M105	50	µg/kg	M	001-002
1,1-Dichloropropene	T209	M105	50	µg/kg	M	001-002
1,2,3-Trichloropropane	T209	M105	50	µg/kg	U	001-002
1,2,4-Trimethylbenzene	T209	M105	50	µg/kg	M	001-002
1,2-dibromoethane	T209	M105	50	µg/kg	M	001-002
1,2-Dichlorobenzene	T209	M105	50	µg/kg	M	001-002
1,2-Dichloroethane	T209	M105	50	µg/kg	M	001-002
1,2-Dichloropropane	T209	M105	50	µg/kg	M	001-002
1,3,5-Trimethylbenzene	T209	M105	50	µg/kg	M	001-002
1,3-Dichlorobenzene	T209	M105	50	µg/kg	M	001-002
1,3-Dichloropropane	T209	M105	50	µg/kg	M	001-002
1,4-Dichlorobenzene	T209	M105	50	µg/kg	M	001-002
2,2-Dichloropropane	T209	M105	50	µg/kg	U	001-002
2-Chlorotoluene	T209	M105	50	µg/kg	U	001-002
4-Chlorotoluene	T209	M105	50	µg/kg	U	001-002
Benzene	T209	M105	10	µg/kg	M	001-002
Bromobenzene	T209	M105	50	µg/kg	M	001-002
Bromochloromethane	T209	M105	50	µg/kg	M	001-002
Bromodichloromethane	T209	M105	50	µg/kg	M	001-002
Bromoform	T209	M105	50	µg/kg	M	001-002
Bromomethane	T209	M105	50	µg/kg	U	001-002
Carbon tetrachloride	T209	M105	50	µg/kg	M	001-002
Chlorobenzene	T209	M105	50	µg/kg	M	001-002
Chlorodibromomethane	T209	M105	50	µg/kg	M	001-002
Chloroethane	T209	M105	50	µg/kg	M	001-002
Chloroform	T209	M105	50	µg/kg	M	001-002
Chloromethane	T209	M105	50	µg/kg	U	001-002
Cis-1,2-Dichloroethylene	T209	M105	50	µg/kg	M	001-002
Cis-1,3-Dichloropropene	T209	M105	50	µg/kg	M	001-002
Dibromomethane	T209	M105	50	µg/kg	M	001-002
Dichlorodifluoromethane	T209	M105	50	µg/kg	M	001-002
Dichloromethane	T209	M105	50	µg/kg	U	001-002
EthylBenzene	T209	M105	10	µg/kg	M	001-002
Isopropyl benzene	T209	M105	50	µg/kg	M	001-002
M/P Xylene	T209	M105	10	µg/kg	M	001-002
n-Propylbenzene	T209	M105	50	µg/kg	M	001-002
O Xylene	T209	M105	10	µg/kg	M	001-002
p-Isopropyltoluene	T209	M105	50	µg/kg	M	001-002
S-Butylbenzene	T209	M105	50	µg/kg	M	001-002
Styrene	T209	M105	50	µg/kg	U	001-002
T-Butylbenzene	T209	M105	50	µg/kg	M	001-002
Tetrachloroethene	T209	M105	50	µg/kg	M	001-002
Toluene	T209	M105	10	µg/kg	M	001-002
Trans-1,2-Dichloroethene	T209	M105	50	µg/kg	M	001-002
Trans-1,3-Dichloropropene	T209	M105	50	µg/kg	M	001-002
Trichloroethene	T209	M105	50	µg/kg	M	001-002
Trichlorofluoromethane	T209	M105	50	µg/kg	M	001-002

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Vinyl chloride	T209	M105	50	µg/kg	M	001-002

SCIENTIFIC ANALYSIS LABORATORIES
DELIVERING SCIENCE

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Report Number: 576477-1

Date of Report: 21-Jun-2016

Customer: Ian Farmer Associates
17 Rivington Court
Warrington
Cheshire
WA1 4RT

Customer Contact: Ms Hannah Hadwin

Customer Job Reference: 41887
Customer Purchase Order: 40587
Customer Site Reference: University of Manchester Chem Building
Date Job Received at SAL: 20-Apr-2016
Date Analysis Started: 10-Jun-2016
Date Analysis Completed: 21-Jun-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Bianca Prince
Customer Service Manager

Issued by :
Bianca Prince
Customer Service Manager

Waste Acceptance Criteria

Customer Sample Reference : BH01 (565383/002)
SAL Sample Reference : 576477 001
Project Site : University of Manchester Chem Building
Customer Reference : 41887
Top Depth : 0.50
Depth : 0.50
Test Portion Mass (g) : 175
Date Sampled : 19-APR-2016
Type : Sandy Soil

Soil Summary					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
Acid Neutralising Capacity (pH 4)	Titration	2.0	Mol/kg	N	<2.0			
Acid Neutralising Capacity (pH 7)	Titration	2.0	Mol/kg	N	<2.0			
BTEX (Sum)	Calc	0.040	mg/kg	U	<0.040	6.0		
Loss on Ignition	Grav	0.1	%	N	11			**10.0**
Moisture	Grav	0.1	%	N	19			
PAH (Sum)	Calc	1.6	mg/kg	N	48	100.0		
PCB EC7 (Sum)	Calc	0.00035	mg/kg	U	(2) <0.0035	1.0		
pH	Probe			M	7.7		>6.0	
Total Organic Carbon	OX/IR	0.1	%	N	7.6	3.0	5.0	**6.0**
TPH C10-C40 (sum)	Calc	1	mg/kg	N	(13) 110	500.0		

10:1 Leachate					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
Antimony (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.036	0.06	0.7	5.0
Arsenic (Dissolved)	Calc / ICP/MS (Filtered)	0.0020	mg/kg	N	0.13	0.5	2.0	25.0
Barium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.35	20.0	100.0	300.0
Cadmium (Dissolved)	Calc / ICP/MS (Filtered)	0.00020	mg/kg	N	<0.00020	0.04	1.0	5.0
Chloride	Calc / Discrete Analyser	10	mg/kg	N	<10	800.0	15000.0	25000.0
Chromium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.015	0.5	10.0	70.0
Copper (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.0054	2.0	50.0	100.0
Dissolved Organic Carbon	Calc / OX/IR	10	mg/kg	N	25	500.0	800.0	1000.0
Fluoride	Calc / Discrete Analyser	0.50	mg/kg	N	6.9	10.0	150.0	500.0
Lead (Dissolved)	Calc / ICP/MS (Filtered)	0.0030	mg/kg	N	<0.0030	0.5	10.0	50.0
Mercury (Dissolved)	Calc / ICP/MS (Filtered)	0.00050	mg/kg	N	<0.00050	0.01	0.2	2.0
Molybdenum (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.16	0.5	10.0	30.0
Nickel (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.4	10.0	40.0
Phenols(Mono)	Calc / Colorimetry	1.0	mg/kg	N	<1.0	1.0		
Selenium (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.0099	0.1	0.5	7.0
Sulphate	Calc / Discrete Analyser	5.0	mg/kg	N	2100	**1000.0**	20000.0	50000.0
Total Dissolved Solids	Calc	100	mg/kg	N	3400	4000.0	60000.0	100000.0
Zinc (Dissolved)	Calc / ICP/MS (Filtered)	0.020	mg/kg	N	<0.020	4.0	50.0	200.0

From: EC Directive 99/31/EC and Landfill Regulations 2002 (as ammended)

Notes:- Cumulative release at L/S=10 (mg/kg of dry matter) in accordance with BS EN 12457. Soil leaching procedure is not covered by our UKAS accreditation

SAL Reference: 576477
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
MCERTS Preparation

SAL Reference	**576477 001**
Customer Sample Reference	**BH01 (565383/002)**
Test Sample	**AR**
Top Depth	**0.50**
Depth	**0.50**
Date Sampled	**19-APR-2016**
Type	**Sandy Soil**

Determinand	Method	LOD	Units	Symbol	
Moisture @105C	Grav (1 Dec) (105 C)	0.1	%	N	**19**

SAL Reference: 576477
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
BTEX

SAL Reference	**576477 001**
Customer Sample Reference	**BH01 (565383/002)**
Test Sample	**M105**
Top Depth	**0.50**
Depth	**0.50**
Date Sampled	**19-APR-2016**
Type	**Sandy Soil**

Determinand	Method	LOD	Units	Symbol	
Benzene	GC/MS (Head Space)(MCERTS)	10	µg/kg	M	(13) <10
EthylBenzene	GC/MS (Head Space)(MCERTS)	10	µg/kg	M	<10
Meta/Para-Xylene	GC/MS (Head Space)(MCERTS)	10	µg/kg	M	<10
Ortho-Xylene	GC/MS (Head Space)(MCERTS)	10	µg/kg	M	<10
Toluene	GC/MS (Head Space)(MCERTS)	10	µg/kg	M	<10

SAL Reference: 576477
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
Total Petroleum Hydrocarbons

SAL Reference	**576477 001**
Customer Sample Reference	**BH01 (565383/002)**
Test Sample	**M105**
Top Depth	**0.50**
Depth	**0.50**
Date Sampled	**19-APR-2016**
Type	**Sandy Soil**

Determinand	Method	LOD	Units	Symbol	
Total Petroleum Hydrocarbons	GC/FID	1	mg/kg	M	(13) **79**
Total Petroleum Hydrocarbons (C35-C40)	GC/FID	1	mg/kg	N	(13) **28**

SAL Reference: 576477
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
Total and Speciated USEPA16 PAH

SAL Reference	**576477 001**
Customer Sample Reference	**BH01 (565383/002)**
Test Sample	**M105**
Top Depth	**0.50**
Depth	**0.50**
Date Sampled	**19-APR-2016**
Type	**Sandy Soil**

Determinand	Method	LOD	Units	Symbol	
Naphthalene	GC/MS (MCERTS)	0.1	mg/kg	M	**0.8**
Acenaphthylene	GC/MS (MCERTS)	0.1	mg/kg	U	<0.1
Acenaphthene	GC/MS (MCERTS)	0.1	mg/kg	M	**1.0**
Fluorene	GC/MS (MCERTS)	0.1	mg/kg	M	**0.8**
Phenanthrene	GC/MS (MCERTS)	0.1	mg/kg	M	**7.3**
Anthracene	GC/MS (MCERTS)	0.1	mg/kg	U	**1.5**
Fluoranthene	GC/MS (MCERTS)	0.1	mg/kg	M	**6.9**
Pyrene	GC/MS (MCERTS)	0.1	mg/kg	M	**6.7**
Benzo(a)Anthracene	GC/MS (MCERTS)	0.1	mg/kg	M	**4.2**
Chrysene	GC/MS (MCERTS)	0.1	mg/kg	M	**4.2**
Benzo(b/k)Fluoranthene	GC/MS (MCERTS)	0.1	mg/kg	M	**6.5**
Benzo(a)Pyrene	GC/MS (MCERTS)	0.1	mg/kg	M	**3.6**
Indeno(123-cd)Pyrene	GC/MS (MCERTS)	0.1	mg/kg	M	**1.7**
Dibenzo(ah)Anthracene	GC/MS (MCERTS)	0.1	mg/kg	M	**0.5**
Benzo(ghi)Perylene	GC/MS (MCERTS)	0.1	mg/kg	M	**2.0**
Polyaromatic Hydrocarbons (Total)	GC/MS (MCERTS)	0.1	mg/kg	U	**48**
Coronene	GC/MS	0.1	mg/kg	N	**0.3**
Phenol	GC/MS (MCERTS)	0.1	mg/kg	M	<0.1

SAL Reference: 576477
Project Site: University of Manchester Chem Building
Customer Reference: 41887

Soil Analysed as Soil
PCB EC7

SAL Reference	**576477 001**
Customer Sample Reference	**BH01 (565383/002)**
Test Sample	**M105**
Top Depth	**0.50**
Depth	**0.50**
Date Sampled	**19-APR-2016**
Type	**Sandy Soil**

Determinand	Method	LOD	Units	Symbol	
Polychlorinated biphenyl BZ#28	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50
Polychlorinated biphenyl BZ#52	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50
Polychlorinated biphenyl BZ#101	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50
Polychlorinated biphenyl BZ#118	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50
Polychlorinated biphenyl BZ#153	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50
Polychlorinated biphenyl BZ#138	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50
Polychlorinated biphenyl BZ#180	GC/MS (HR) (MCERTS)	0.05	µg/kg	M	(2) <0.50

Index to symbols used in 576477-1

Value	Description
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
2:1	Leachate to BS EN 12457-3 (2:1)
8:1	Leachate to BS EN 12457-3 (8:1)
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C

AR	As Received
13	Results have been blank corrected.
2	LOD Raised Due to Matrix Interference
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

This sample have been analysed exceeding recommended holding times. It is possible therefore that the results provided may be compromised.
Samples submitted for GC/MS (Headspace) analysis were submitted in inappropriate containers. It is possible therefore that the results provided may be compromised.

APPENDIX 5

DESIGN CONSIDERATIONS

APPENDIX 5

GEOTECHNICAL DESIGN CONSIDERATIONS

A5.1 ASSESSMENT OF GRANULAR SOIL CONDITION

A5.1.1 SPT 'N' values reported on the borehole logs are as measured in the field with no corrections applied.

A5.1.2 However for general design in sands the 'N' values should be normalised to 60% by the following equation:-

A5.1.3 N60 = Er/60.N where:-

N is the blow count and

Er is the energy ratio of the specific test equipment

A5.1.4 Further corrections for rod length and overburden pressure in sands may be applied in accordance with BS EN ISO 22476-3, ref 9.6.

A5.2 ASSESSMENT OF COHESIVE SOIL CONDITION

A5.2.1 In accordance with BS EN ISO 22475-1, ref. 9.7, and BS5930, ref.9.2, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref.9.4.

A5.2.2 Laboratory strength and consolidation testing should only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 9.5. This is due to possible disturbance during sampling, giving a weaker strength in testing.

A5.2.3 Therefore laboratory test values for c_u and m_v obtained from thick walled U100 samples should only be used as guidance and not used as absolute values for the shear strength and compressibility properties of the clay and only used to provide guidance to descriptive strength on the borehole records.

A5.2.4 Work undertaken by Stroud, ref. 9.11 determined a relationship between SPT 'N' values, plasticity undrained shear strength and compressibility of many over-consolidated clays. Further work by Stroud and Butler, ref.9.12, in which data was analysed from sites covering a wide range of glacial deposits, confirmed there to be a correlation between the 'N' value plasticity undrained shear strength and compressibility.

A5.2.5 The relationship was of the form:

$$Cu = f_1 \times N$$

and

$$mv = 1/(f_2 \times N)$$

Where c_u = Un-drained shear strength

m_v = Coefficient of compressibility

f_1 and f_2 = Factors

A5.2.6 It was determined by Stroud that f_1 varied between 4kPa for material of high plasticity and 6kPa for material of low plasticity. Similarly f_2 varied between 400kPa and 600kPa.

A5.3 GUIDELINES FOR THE DESIGN OF PILES FIRST APPROXIMATION OF WORKING LOAD

A5.3.1 PILING PARAMETERS – GENERAL

The ultimate carrying capacity, Qu, of a particular pile is taken as the sum of the ultimate shaft friction resistance, Qs, and the ultimate end bearing resistance, Qb. This may be expressed as follows:-

$$Qu = Qs + Qb$$

$$= f.As + q.Ab$$

where f = unit shaft resistance

As = embedded surface area of pile

q = unit end bearing resistance

Ab = effective cross-sectional area of pile base

A5.3.2 COHESIVE SOILS

A5.3.2.1 Shaft Resistance

The ultimate shaft resistance, f, for piles in both compression or tension in cohesive soils is determined by applying a factor to the undrained shear strength, Cs, which exists in the soils along the embedded length of the pile, and is given by:-

$$f = \alpha.Cs$$

Where α is an adhesion factor, which for straight-shafted bored piles may be taken as 0.45 to 0.60.

Ultimate unit shaft friction should not exceed 100kN/m².

A5.3.2.2 End Bearing

For piles terminating in cohesive soils, the ultimate unit end bearing resistance q, is given by:-

$$q = Nc.Cb$$

where Cb is the undrained shear strength at the base of the pile

and Nc is a bearing capacity factor

The value of Nc for a cohesive material is variable, depending on the depth of the penetration of the pile into the bearing stratum. Generally, Nc could be taken to have a value of 9, except in the case of large diameter short piles where a lesser value should be used.

A5.3.3 COHESIONLESS SOILS

A5.3.3.1 Shaft Resistance

For piles driven in cohesionless soils the ultimate unit shaft resistance, f, may be calculated using the following method, which gives:-

$$f = 0.5\,\sigma' (D+d)\, Ks \tan \delta$$

where σ' = average effective unit weight of soil surrounding the pile

D = depth to the pile toe or to the base of the granular stratum whichever is the lesser

d = depth to the top of the granular stratum

δ = angle of friction between pile and soil (see below)

Ks = a coefficient (see below)

TABLE OF VALUES FOR Ks AND δ

Pile Type	δ	Ks		
		Relative Density		Tension Piles
		Low	High	
Steel	20°	0.5	1.5	0.5
Concrete	0.75ϕ	1.0	2.0	0.5

The value of ϕ may be interpreted from standard penetration tests.

For bored and cast-in-place piles, δ = 22° and Ks = 1 should be used to allow for loosening of the soil during boring.

It has been found that the ultimate unit shaft resistance does not exceed 100kN/m² and therefore this value should not be exceeded in design.

A5.3.3.2 End Bearing

The unit ultimate end bearing resistance (q) of piles in cohesionless soils may be calculated as follows:-

	q	=	□'.D.Nq
where	□'	=	average effective unit weight of soil surrounding the pile
	D	=	depth to pile toe
	Nq	=	bearing capacity factor

Values for Nq, where piles penetrate the bearing stratum by more than five diameters, may be taken from work carried out by Berezantsev, ref.9.20. In addition, the ultimate unit base resistance should not exceed a value of 11,000kN/m². For bored and cast-in-place piles the value of Nq used should correspond to loose soil conditions.

A5.3.4 FACTORS OF SAFETY

A5.3.4.1 Cohesive and Non-cohesive Soils

For cohesive and non-cohesive soils a factor of safety of 3 may be used to obtain the allowable or safe carrying capacity of piles from the ultimate carrying capacity.

APPENDIX 6

CONTAMINATION ASSESSMENT

APPENDIX 6

GENERAL NOTES ON CONTAMINATION ASSESSMENT

A6.1 STATUTORY FRAMEWORK AND DEFINITIONS

A6.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref 9.21, which was introduced by the Environment Act 1995, ref 9.22;

'Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.'

A6.1.2 The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the legislation was originally summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the final guidance document, CLR 11, ref 9.35 was published in 2004. CLR7 to 10 were withdrawn in 2008, with CLR 9 and 10 effectively replaced by the Environment Agency in the form of Science Reports SR2, ref 9.32 and SR3, ref 9.24. CLR11 remains valid and sets out the framework of the investigation process.

A6.1.3 In establishing whether a site fulfils the statutory definition of 'contaminated land' it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A6.1.4 A *'pollutant linkage'* may be defined as the link between a contaminant *'source'* and a *'receptor'* by means of a *'pathway'*.

A6.2 ASSESSMENT METHODOLOGY

A6.2.1 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A6.2.2 Stages 1 and 2 develop a *'conceptual model'* based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref 9.37. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A6.2.3 The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref 9.23. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. In the absence of specific information on contamination anticipated to be encountered, specific DoE 'Industry Profiles' provide guidance on the nature of contaminants relating to a variety of industrial processes and should be used as the basis for determining which contaminants are more likely to be present on a site.

A6.2.4 If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref 9.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a generic quantitative risk assessment (GQRA) to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A6.2.5 A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

A6.2.6 All site works should be in general accordance with the British Standards, BS 5930:2010, ref. 9.2, ISO 1997, ref 9.4 and BS 10175:2011, ref 9.2.

A6.2.7 The GQRA screens the results of the chemical analysis against generic guidance values, appropriate to the end-use of the site. Soils will be compared to Soil Guideline Values (SGV) where published, Generic Assessment Criteria (GAC) developed by LQM/CIEH, ref 9.26, or internal screening values generated using the Contaminated Land Exposure Assessment (CLEA) Software, Version 1.06, ref 9.27. Toxicological and physico-chemical/fate and transport data used to generate the AC has been derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs

   (DEFRA) documents;

2. Other documents produced by UK Government or state organisations;

3. European institution documents;

4. International organisation documents;

5. Foreign government institutions.

A6.2.8 For many of the contaminants considered, input data has been drawn from the relevant SGV where available, or existing toxicological reports published by the Environment Agency which have not yet been withdrawn/replaced. Fate and transport data has been derived in the first instance from Environment Agency (2008), ref 9.38.

A6.2.9 Recommendations for tolerable intakes of lead are based on evaluation of the relationship between exposure and blood lead levels. The existing toxicological report for lead considers a health criteria value based on an uptake dose, whereas the CLEA model estimates exposure in terms of an intake dose. At present, the CLEA model is not considered appropriate for determining a screening value for lead. In the absence of a current published assessment criterion, the SGV for lead reported in R&D Publication CLR 10 ref 9.33 have been used in this assessment. This will be updated in due course in light of any further published information.

A6.2.10 Chemical laboratory test results are processed as follows. A statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 9.29. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

A6.2.11 Initially the distribution of the data set is tested using the Shapiro-Wilk normality test, ref 9.31 to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.

A6.2.12 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

A6.2.13 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

A6.2.14 The potential receptors include:

1) Humans – current site occupants, construction workers, future site users and neighbouring site users.

2) Controlled Waters – surface water and groundwater resources

3) Plants – current and future site vegetation

4) Building materials

A6.2.15 The potential hazards to be considered in relation to contamination are:

a) Ingestion and inhalation.

b) Uptake of contaminants via cultivated vegetables.

c) Dermal contact

d) Phytotoxicity (the prevention or inhibition of plant growth)

e) Contamination of water resources

f) Chemical attack on building materials and services

g) Fire and explosion

A6.2.16 Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

A6.3 Generic Guidance Values Used Within Contamination Risk Assessment

Commercial End Use

	Determinant	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
		1% SOM	2.5% SOM	6% SOM	
PAH	Acenaphthene	85000 (57)	98000 (140)	100000	LQM CIEH GAC
	Acenaphthylene	84000 (86)	97000 (210)	100000	
	Anthracene	530000	540000		
	Benz(a)anthracene	90	95	97	
	Benzo(a)pyrene	14			
	Benzo(b)fluoranthene	100			
	Benzo(ghi)perylene	650	660		
	Benzo(k)fluoranthene	140			
	Chrysene	140			
	Dibenzo(ah)anthracene	13			
	Fluoranthene	23000			
	Fluorene	64000 (31)	69000	71000	
	Indeno(123-cd)pyrene	60	61	62	
	Napthalene	200 (76)	480 (180)	1100 (430)	
	Phenanthrene	22000		23000	
	Pyrene	54000			
Other Organics	Phenol	1100000 (24000)	1100000 (38000)	1200000	LQM CIEH GAC
Metals	Arsenic	640	640	640	EA 2009
	Beryllium	420	420	420	LQM CIEH GAC
	Boron	192000			LQM CIEH GAC
	Cadmium	230	230	230	EA 2009
	Chromium (III)	30400			LQM CIEH GAC
	Chromium (VI)	35			LQM CIEH GAC
	Copper	71700			LQM CIEH GAC
	Lead	750			CLEA SGV 10
	Inorganic Mercury	3640			EA 2009
	Nickel	1800			EA 2009
	Selenium	13000			EA 2009
	Vanadium	3160			LQM CIEH GAC
	Zinc	665000			LQM CIEH GAC

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC

A6.3.1 Generic Assessment Criteria for Petroleum Hydrocarbons

Commercial	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	2.5% SOM	6% SOM	
Aliphatic				
EC 5-6	3400 (300)	6200 (560)	13000 (1200)	LQM CIEH GAC
EC >6-8	8300 (140)	18000 (320)	42000 (740)	LQM CIEH GAC
EC >8-10	2100 (78)	5100 (190)	12000 (450)	LQM CIEH GAC
EC >10-12	10000 (48)	24000 (120)	49000 (280)	LQM CIEH GAC
EC >12-16	61000 (24)	83000 (59)	91000 (140)	LQM CIEH GAC
EC >16-35	1600000	1800000		LQM CIEH GAC
EC >35-44				LQM CIEH GAC
Aromatic				
EC 5-7 (benzene)	28000 (1200)	49000 (2300)	90000 (4700)	LQM CIEH GAC
EC >7-8 (toluene)	59000 (870)	110000 (1900)	190000 (4400)	LQM CIEH GAC
EC >8-10	3700 (610)	8600 (1500)	18000 (3600)	LQM CIEH GAC
EC >10-12	17000 (360)	29000 (900)	34500 (2200)	LQM CIEH GAC
EC >12-16	36000 (170)	37000	37800	LQM CIEH GAC
EC >16-21	28000	28000	28000	LQM CIEH GAC
EC >21-35				LQM CIEH GAC
EC >35-44				LQM CIEH GAC
Aliphatic and Aromatic				
EC >44-70	28000	28000	28000	LQM CIEH GAC
BTEX				
Benzene	28	57	95	EA 2009
Toluene	59000 (870)	130000 (2300)	4400	EA 2009
Ethylbenzene	17000 (520)	40000 (1500)	2800	EA 2009
Xylenes	6900 (480)	19000 (1300)	2600	EA 2009

SOM = Soil Organic Matter
BTEX screening values have been capped at the lower of the vapour and aqueous saturation limit where exceeded
Commercial xylene screening values are based on data for o-xylene

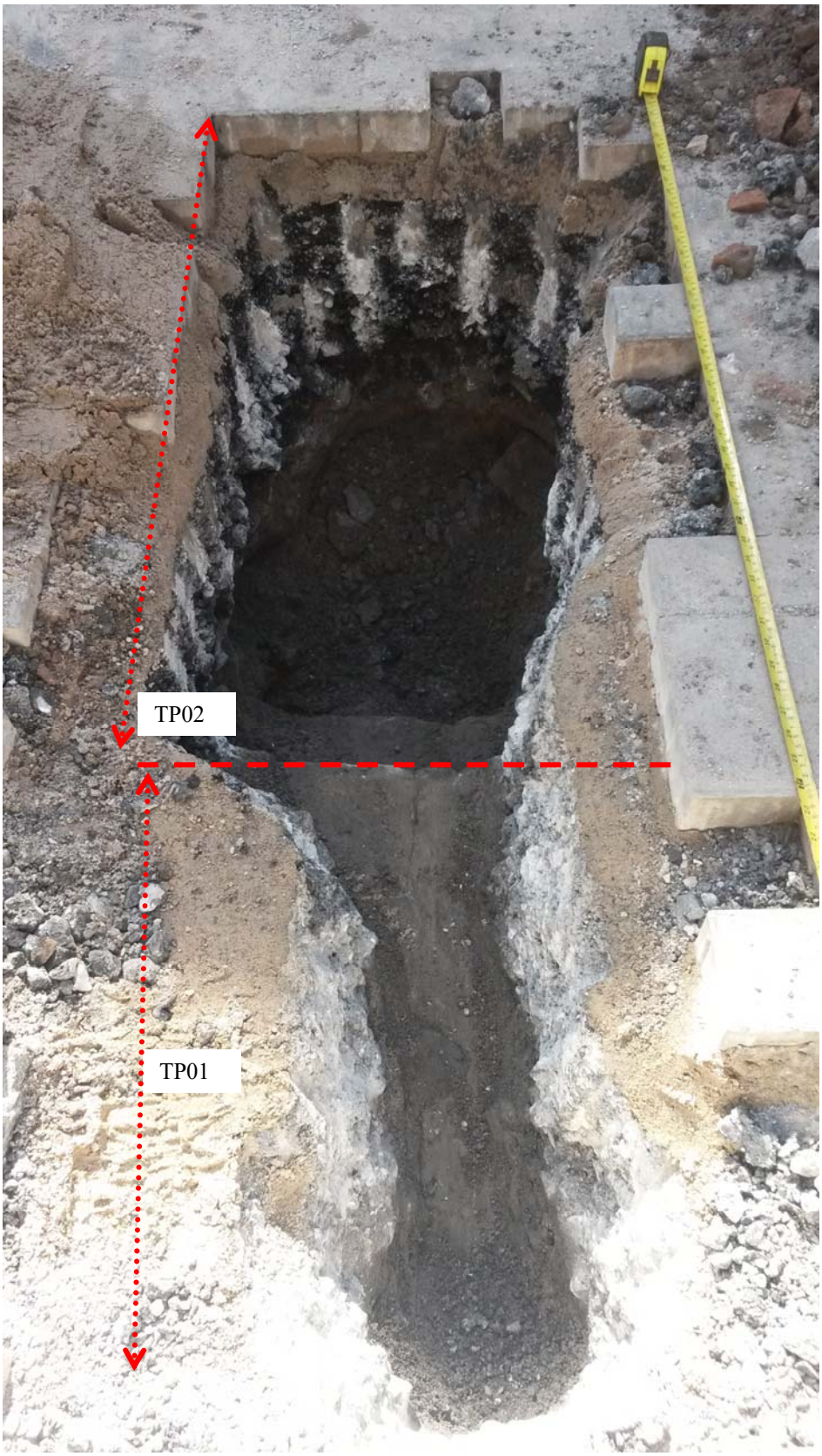
APPENDIX 7

PHOTOGRAPHS

Trial Pit Photographs
TP01 & 02

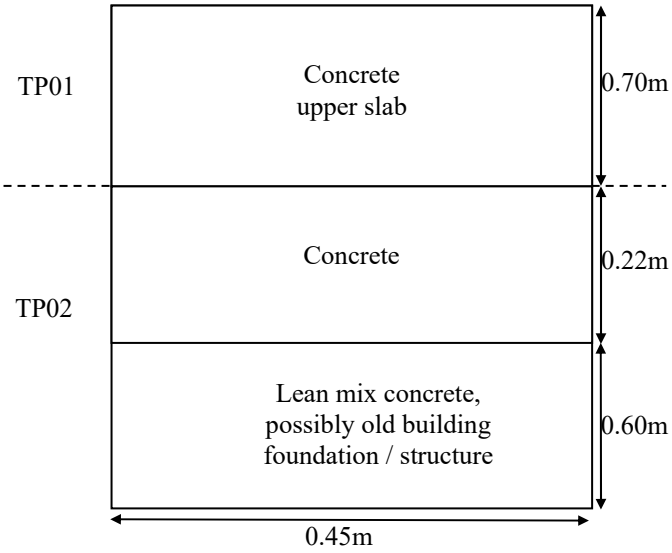


Trial Pit Photographs
TP01 & 02

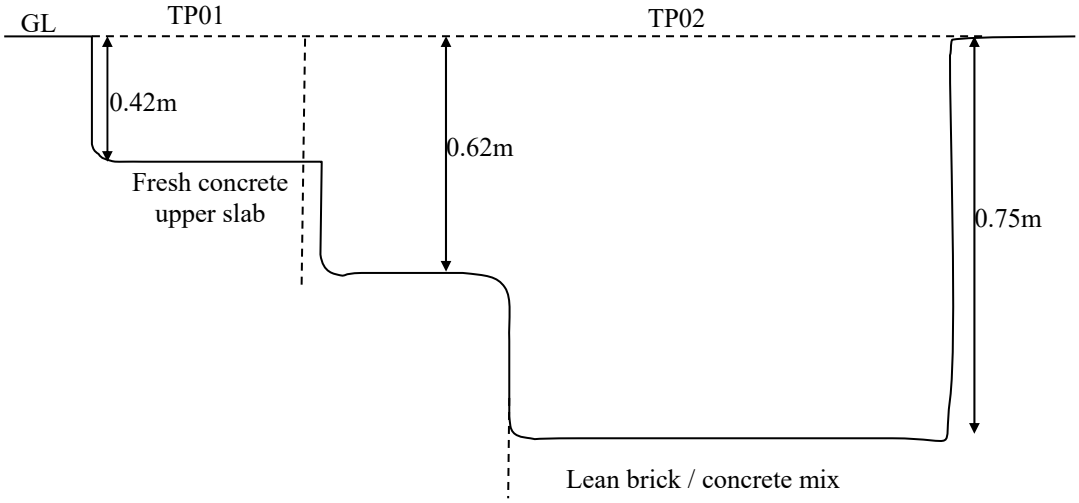


Trial Pit Drawings
TP01 & 02

Plan



Cross-section



Trial Pit Photographs
TP03 & 04

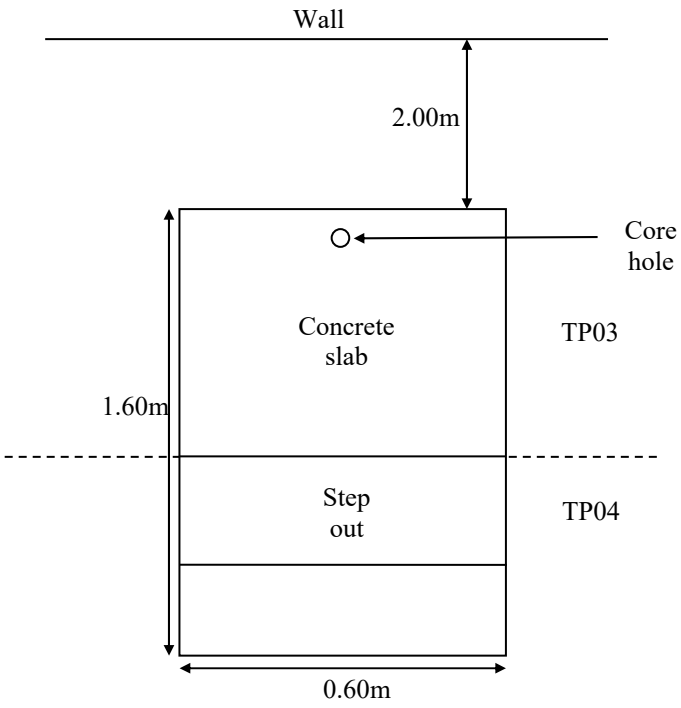


Trial Pit Photographs
TP03 & 04



Trial Pit Drawings
TP03 & 04

Plan



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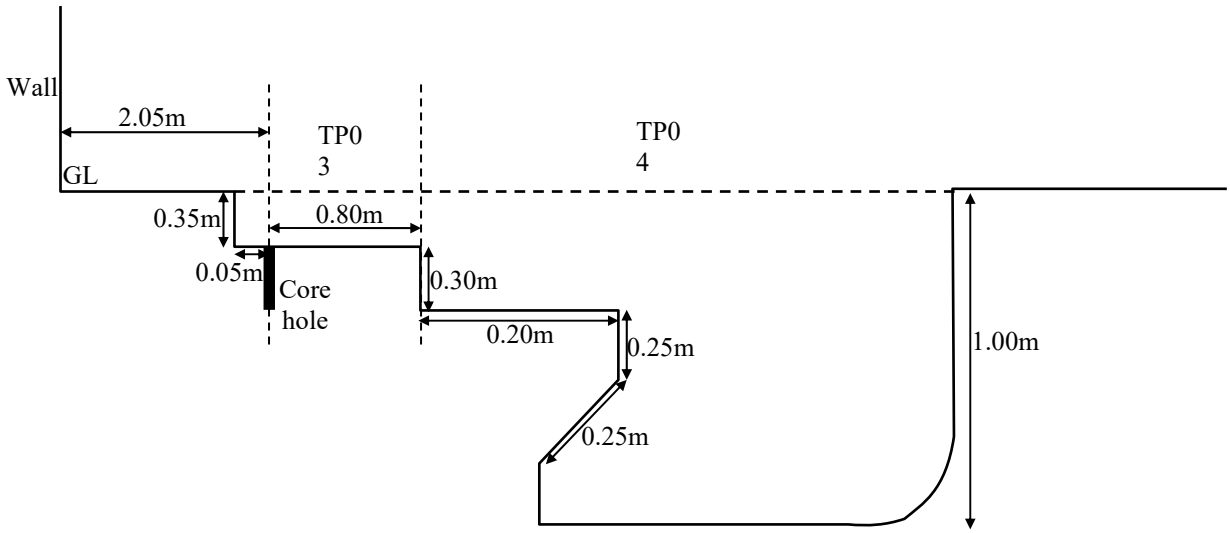

Trial Pit Photographs
TP06



Trial Pit Photographs
TP07



Wall Core Photographs

Core 01



Core 02



Wall Core Photographs

Core 03

