TWEEDIE EVANS CONSULTING

London Borough of Hillingdon

Willow Tree Depot, Ditchfield Road

Geoenvironmental and Geotechnical Assessment

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1 INTRODUCTION

1.1 Terms of Reference

1.1.1 Tweedie Evans Consulting Ltd (TEC) has been appointed by Baily Garner LLP on behalf of London Borough of Hillingdon to undertake a Preliminary Geoenvironmental and Geotechnical Assessment of Willow Tree Depot, Ditchfield Road. All works were undertaken in accordance with our proposal letter dated 29th January 2018 and referenced RE.1712003/1712004/1712005 (Rev A).

1.2 Background

1.2.1 The site is located off Ditchfield Road, to the east of Yeading in the London Borough of Hillingdon and covers an area of approximately 0.24 hectares with the centre of the site situated at approximate National Grid Reference 512240, 182060. The nearest postcode to the site is UB4 9BH (Figure 1).

1.2.2 The site currently comprises an irregular shaped parcel of land containing a single L-shaped single storey with associated concrete hardstanding used for car parking and loading within the centre, while the rest of the site is laid to soft landscaping.

1.2.3 It is understood that it is proposed to redevelop the site for residential purposes comprising the construction of 11No. low rise units with associated car parking and private gardens (Figure 2).

1.2.4 A Preliminary Geoenvironmental and Geotechnical Assessment of the site was prepared by TEC in April 2018, as detailed within the following report:

- TEC - Preliminary Geoenvironmental and Geotechnical Assessment; Willow Tree Depot, Ditchfield Road. Prepared for London Borough of Hillingdon. Document reference 1712005.001.01, dated April 2018.

1.2.5 This phase of assessment involved the development of an outline conceptual site model, based upon desk study research and a reconnaissance survey.

1.2.6 Historic mapping recorded the site to have been part of a landfill. As a consequence, it was considered likely that the ground conditions at the site include a significant thickness of made ground of unknown composition. In accordance with current guidance this landfill is considered to be of high to very high generation potential based on the age of last input (1991).

1.2.7 In addition, the site was previously been utilised as a depot and therefore, the potential for on-site residual contamination from this historic land uses cannot be discounted.

1.2.8 Based upon our conceptual understanding of the site and the proposed end use, the main potential Significant Pollutants Linkages identified are considered to be

- Human Health (future site users and potential development structures) – migration, ingress and inhalation of ground gasses associated with the former landfill on site, made ground on-site and potential off-site sources; and

- Human Health (current and future site users and construction workers) – potential exposure to contaminants potentially present within the underlying ground materials or from identified off-site sources through ingestion, inhalation and dermal pathways;

1.2.9 Given the assessment provided within the report, additional works were recommended to fully define the potential geoenvironmental and geotechnical issues associated with the site.

1.2.10 Therefore, the aim of this phase of works it to provide information on the geoenvironmental constraints and considerations associated with the site is relation to the proposed development, to enable refinement of the risk assessment undertaken within the preliminary geoenvironmental and geotechnical assessment report and provide additional information of engineering considerations and constraints associated within the proposed development.

1.3 Scope of Works

1.3.1 The scope of work undertaken as part of this report is presented below:

- Generic Quantitative Risk Assessment. This phase of assessment involves refinement of the site conceptual model developed as part of the Preliminary Risk Assessment based on the findings of an intrusive investigation. Generic assessment criteria and assumptions, if appropriate, are used to evaluate potentially unacceptable risks. Should unacceptable risks be identified, a feasible remediation options appraisal is provided and/or a Detailed Quantitative Risk Assessment is recommended. The purpose of the Detailed Quantitative Risk Assessment is to further refine the conceptual model and use more detailed site specific information and criteria to determine whether there are unacceptable risks.

- Preliminary Geotechnical Assessment. General recommendations regarding likely engineering abnormalities are provided on the basis of the findings of an intrusive investigation, together with preliminary foundation design recommendations for the proposed development.

1.3.2 The above scope of work has been undertaken in accordance with current guidance such as CLR 11 *'Model Procedures for the Management of Land Contamination'* (Environment Agency, 2004), BS10175+A1 (2013) and, where appropriate NHBC and Eurocode 7.

1.3.3 The report is presented in the following format.

- Generic Quantitative Risk Assessment:
  Section 2 – Desk Study Information
  Section 3 - Intrusive Investigation
  Section 4 - Encountered Ground Conditions
  Section 5 - Contamination Characterisation
  Section 6 - Refined Conceptual Model

- Preliminary Geotechnical Assessment:
  Section 7 - Ground Engineering

- *Section 8 - Conclusions and Recommendations*

2 DESK STUDY INFORMATION

2.1.1 A review of salient information from the previous TEC desk study phases of assessment undertaken for the site are summarised below in Table 2.1.

Table 2.1: Desk Study – Site Setting and Environmental Data

Site History	Earliest available mapping (1868) indicates the site was undeveloped prior to 1914. Marshland is depicted within the southern section of the site, while a footpath is depicted along the northern boundary. From 1914, a gravel pit is marked within the eastern section of the site, which is noted to expand towards the centre/north until 1938. By 1985, the site is displayed in its current layout and is subsequently marked as a depot.
Surrounding Land Use	The site is bound to the north and east by residential properties, and Ditchfield Road to the south and west. Identified potentially contaminative current and historic processes in proximity to the site include a clay mill (~100m south-east), a civil defence training area (~20m north), an electrical sub-station (~140m north) and a number of gravel pits (up to ~250m south and east).
Geology and Hydrogeology	The published geology for the site is shown on British Geological Survey (BGS) Sheet No. 255 (Beaconsfield) as the Langley Silt Member, described by the BGS as silt and clay, commonly yellow-brown and massively bedded, underlain by the London Clay Formation, described by the BGS as bioturbated or poorly laminated blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. This commonly contains thin courses of carbonate concretions and disseminated pyrite. Estimated soil chemistry reports suggest that natural lead concentrations in the underlying materials on site exceed the Tier 1 SSV limits for human health for a residential end use. The Langley Silt Member and London Clay Formation are designated by the Environment Agency as Unproductive Strata. There are no reported groundwater abstractions or licensed discharge consents to groundwater recorded within 500m of the site, and the site is not reported to be located within an Environment Agency Source Protection Zone (SPZ).
Hydrology	The nearest surface water feature is the Grand Union Canal (Paddington Branch), located approximately 480m south-east of the site. The Environment Agency classifies the Grand Union Canal (Paddington Branch) as GQA River Quality Grade E. It is anticipated that any shallow groundwater within the superficial deposits may flow in a general south-east direction, towards the Grand Union Canal (Paddington Branch). A single licensed surface water abstraction has been recorded from a river located ~500m north-east of the site, relating to the extraction of surface water for spray irrigation. The site is reported to be located within an area classified by the Environment Agency as Flood Zone 1; suggesting a low probability of flooding.

Ground Gas	The reported underlying materials of the Langley Silt Member and London Clay Formation may be classified as of negligible ground gas generation potential, with a negligible risk for on site development and a negligible risk of lateral migration. Based on the historic use of the site as a landfill, any remaining landfill materials may provide a potential source of ground gas, subject to thickness and chemical composition. In accordance with current guidance, the landfill is considered to be of high to very high generation potential based on the date of last input. The site area is reported to be located within an Intermediate probability radon affected area as 1 to 3% of homes are at or above the Action Level. Therefore, it is reported that no radon protection measures are necessary in the construction of new dwellings or extensions.
Overall Environmental Setting	Based on the above environmental and site setting, the overall environmental setting of the site is considered to be low.

3 INTRUSIVE INVESTIGATION

3.1 Background

3.1.1 The ground investigation was undertaken in general accordance with the scope of investigation outlined by Tully De'Ath Consultants, as detailed within the document titled 'Specification for Site Investigation – Willow Tree Depot, Hayes' dated 30 November 2018.

3.1.2 The stated aim of the investigation was to advise on the contamination potential of the site and include recommendations for further testing or remediation strategy if necessary as well as providing an interpretative geological and engineering report to allow a foundation and retaining wall design to be developed.

3.1.3 All site works were undertaken in accordance with BS5930:2015, BS10175+A1 (2013) and, where appropriate, Eurocode 7. Works were supervised by a suitably experienced geoenvironmental consultant from TEC.

3.2 Methodology

3.2.1 The intrusive investigation was undertaken between 13th and 16th February 2018 and comprised the advancement of 1No. cable percussive boreholes to c.15m depth, 4No. dynamic sample boreholes to a maximum depth of 5.0mbgl and 6No. trial pits to a maximum depth of 4.0mbgl within the approximate locations outlined by Tully De'Ath within the specification for site investigation.

3.2.2 Exploratory hole locations are presented in Figure 3 and the reasoning behind each investigation location is given in Table 3.1, as follows:

Table 3.1: Exploratory Hole Rationale

Location	Location Rationale
BH01	• Description and classification of underlying ground materials; • Sampling of deeper natural ground materials for geotechnical laboratory testing; and • In situ testing of the deeper natural materials.
WS01 – WS04	• Description and classification of underlying materials; • Sampling of shallow ground materials for chemical and geotechnical laboratory testing; • In-situ testing of the underlying natural materials; and • Installation of combined ground gas and groundwater monitoring wells.
TP01 to TP06	• Description and classification of underlying materials; and • Sampling of shallow ground materials for chemical and geotechnical laboratory testing.

3.2.3 A detailed description of encountered ground conditions is shown on exploratory hole logs presented in Appendix C.

3.3 Field Testing

3.3.1 Standard Penetration Testing (SPT) was carried out at standard intervals within cable percussive and dynamic sample boreholes to allow an indicative strength profile of the underlying materials to be obtained.

3.3.2 Hand shear vane (HSV) and pocket penetrometer (PP) testing was carried out on encountered cohesive deposits to provide preliminary strength values of the underlying natural materials.

3.3.3 Dynamic Cone Penetrometer (DCP-TRL) testing was carried out at 3No. locations in areas of proposed parking and pavement, to assist with their preliminary design (Appendix G).

3.3.4 A MiniRAE Lite (10.6eV UV lamp) photo-ionisation detected (PID) was used on site to screen soil samples for the presence of total volatile organic compounds (VOC's), prior to laboratory testing. The corresponding results are presented on the exploratory hole logs in Appendix C.

3.3.5 Upon installation of the ground gas monitoring standpipes, an initial round of ground gas monitoring was undertaken out utilising a Gas Analyser GFM-430.

3.4 Chemical Testing

3.4.1 Laboratory testing was scheduled on the basis of field observations.

3.4.2 Representative soil samples were collected and chemically tested at i2 Analytical, a UKAS/MCERTS accredited laboratory, for a selection of the following parameters:

Soils (Totals)

- *Heavy metals and metalloids;*
- *Total Organic Carbon (TOC);*
- *Phenols (monohydric);*
- *Total Cyanide;*
- *Sulphate, sulphide, elemental sulphur and pH;*
- *Speciated Polyaromatic Hydrocarbons (PAH);*
- *Total Petroleum Hydrocarbons (TPH-CWG); and*
- *Asbestos Screen.*

3.4.3 Geochemical certificates of analysis are presented Appendix D.

3.5 Geotechnical Testing

3.5.1 As outlined in the Tully de'Ath specification, selected soil samples were submitted for geotechnical analysis at K4 Soils. Laboratory testing was scheduled upon the basis of field observations for a selection of the following:

- *Moisture content;*
- *Atterberg Limits;*
- *Quick Undrained Triaxial (Multi-stage) tests; and*
- *Oedometer Consolidation.*

3.5.2 Soil geotechnical certificates of analysis are presented in Appendix E.

3.6 General Sampling

3.6.1 Soil samples were collected directly into pre-labelled sample containers. During the course of the sampling care was taken to minimise head space of the sample containers. Once filled sample containers were placed within cool boxes containing ice packs to maintain as cool a temperature as possible, nominally 4°C.

3.6.2 Samples were collected by courier for delivery to the selected laboratories. All samples were accompanied by detailed chain of custody sheets.

4 ENCOUNTERED GROUND CONDITIONS

4.1 Introduction

4.1.1 A summary of encountered ground conditions for the site is provided below.

4.1.2 Detailed descriptions of encountered ground conditions are shown on exploratory hole logs presented in Appendix C. Photographs of the materials encountered are presented within Appendix A.

Made Ground

4.1.3 Made ground was encountered across the site to a maximum observed depth in excess of 4.0mbgl (TP02) and was observed to be variable across the site, although generally encountered as dark brown sandy clay, black gravelly sand or multi-coloured slightly clayey sandy gravel / gravelly sandy clay.

4.1.4 Gravel was observed to include red brick, yellow brick, wood fragments, fabric fragments, ash, glass, ceramic tile, marble tile, metal, plastic, tarmacadam, black carbonaceous material and chert with occasional cobbles of brick.

4.1.5 An organic odour was recorded throughout the made ground materials.

4.1.6 The depths of made ground was not confirmed within exploratory locations TP01a – TP01c due to early termination due to the presence of a suspected below ground service.

Natural Ground

4.1.7 While depicted on geological mapping, the Langley Silt Member was not encountered within exploratory hole locations, likely to be a result of historic extraction and subsequent landfilling across the site.

4.1.8 The London Clay Formation was encountered from a depth of 3.0mbgl and generally comprised firm becoming stiff and very stiff, medium to high, becoming very high strength, greyish brown / grey slightly gravelly, sandy, silty, clay. Gravel was generally observed to comprise lithorelicts of very stiff clay. Occasional fine selenite crystals were observed throughout.

4.2 Generalised Ground Profile

4.2.1 The general ground profile encountered at the site is summarised in Table 4.1 below.

Table 4.1: Generalised Ground Profile

Depth (mbgl)	Encountered Material
0.0 – 3.0 / >4.0	**Made Ground:** Variable, comprising dark brown sandy clay, black gravelly sand and multi-coloured slightly clayey sandy gravel / gravelly sandy clay. Gravel was observed to include red brick, yellow brick, wood fragments, fabric fragments, ash, glass, ceramic tile, marble tile, metal, plastic, tarmacadam, black carbonaceous material and chert. Occasional cobbles of brick. Strong organic odour throughout.

Depth (mbgl)	Encountered Material
3.0/4.0 – >15.0	**London Clay Formation:** firm becoming stiff and very stiff, medium to high, becoming very high strength, greyish brown / grey slightly gravelly, sandy, silty, clay. Gravel of subangular to subrounded lithorelicts of very stiff clay. Occasional fine selenite crystals throughout. Becoming very stiff below 14.5m depth.

4.3 Groundwater and Perched Water

4.3.1 Perched Water strikes encountered during the site works are shown on the exploratory hole logs in Appendix C and summarised in Table 4.2 below.

Table 4.2: Perched water Strikes

Location	Date	Groundwater Strike (mbgl)	Strata
TP02	15/02/2018	2.0	Made Ground
TP03	15/02/2018	3.0	Made Ground
WS01	16/02/2018	2.6	Made Ground
WS02	16/02/2018	2.4	Made Ground
WS03	16/02/2018	2.5	Made Ground
WS04	16/02/2018	2.5	Made Ground

4.3.2 The groundwater strikes were all recorded in the made ground materials, suggesting the presence of a perched water body within the historic landfill materials present across the site.

4.3.3 Following completion of the works, groundwater levels were recorded as part of the on-going ground gas monitoring works. Perched water levels were recorded between 2.4mbgl and 4.72mbgl.

4.4 Contamination Summary

4.4.1 An organic odour was recorded throughout the made ground materials. No further visual or olfactory evidence of potentially gross contamination was recorded within encountered ground materials

4.4.2 In addition, Field screening of total Volatile Organic Compounds (VOC) using a photo-ionisation detector (PID) recorded concentrations of 0.0ppm (i.e. below the limit of detection of the instrument) within screened soil samples.

5 CONTAMINATION CHARACTERISATION

5.1 Legislation

5.1.1 Contaminated Land is defined in Part IIA of the Environmental Protection Act (1990) as:

5.1.2 "Any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reasons 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."

**Section 86 of the Water Act 2003 amends section 78A of Environmental Protection Act 1990 for Controlled Waters.*

5.2 Generic Quantitative Risk Assessment

Human Health Screening

5.2.1 Current legislation and guidance on the assessment of contaminated land promotes a tiered risk approach (CLR 11). The generic quantitative risk assessment comprises a screening of identified contaminants against generic guideline values that are appropriate to the site setting and the receptors concerned. For risks to human health the basis for these generic guideline values are the methodologies set out by the Environment Agency's Contaminated Land Exposure Assessment (CLEA) guidelines.

5.2.2 The following regulatory and industry guidance has been utilised for the selection of Generic Assessment Criteria utilised as part of the GQRA. The order of the guidance listed is in terms of hierarchy for selection of GACs (where the land uses and parameters are considered most applicable).

1. *Category 4 Screen Levels (C4SLs) – DEFRA (2014)*
2. *Soil Guidance Values (SGVs) – Environment Agency (2009)*
3. *Suitable for Use Levels (S4ULs) – LQM/CIEH (2015)*
4. *EIC/AGS/CL:AIRE GAC (2009)*

5.2.3 The C4SLs for arsenic, cadmium, chromium (VI) and lead have been utilised as part of the GQRA. Benzene and benzo(a)pyrene C4SLs have not been utilised as part of the Tier 1 screening as they are based upon 6% soil organic matter (SOM) as opposed to 1% SOM utilised by LQM/CIEH (2015).

5.2.4 SGVs have been utilised, where appropriate, for dioxins, furans and dioxin-like PCBs; nickel; inorganic mercury and selenium (residential SGV used for proposed residential end use). SGVs for organic compounds are not utilised as they are derived using a 6% soil organic matter as opposed to 1% SOM utilised by LQM/CIEH (2015).

5.2.5 In the absence of a published UK derived GAC for cyanide, the GQRA for total cyanide is based upon comparison of recorded values against the Dutch Intervention Value for free cyanide (VROM 2000).

5.2.6 S4ULs and EIC/AGS/CL:AIRE GACs are adopted for the remaining potential contaminants using the hierarchy noted above.

5.2.7 The purpose of the site investigation was to provide information to establish the suitability of the site for a residential development. Therefore, the standard land use for the site, for use in the generic assessment, has been defined as "*Residential with homegrown produce*" in accordance with current guidance.

Ground Gas Screening

5.2.8 An initial qualitative risk screening assessment based upon the methodology for characterising gassing sites detailed within the following documents has been undertaken:

- CIRIA Report C665 (2007) '*Assessing risks posed by hazardous ground gases to buildings (revised)'*;
- NHBC (March 2007) '*Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present'*;
- BS8485:2015 *'Code of Practice for the characterisation and remediation from ground gas in affected developments'*;
- BS8576:2013 '*Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)';* and
- Wilson S., Card C*.* and Haines S. (2009) '*Ground Gas Handbook'*.

5.2.9 The objectives of the screening assessment are to provide a general characterisation of the ground materials within the site based on the investigation works undertaken to-date. This information is used to provide a preliminary assessment of gassing potential for the materials encountered at the site. This, together with ground gas data collected as part of the monitoring undertaken to date, is used to provide a qualitative conceptual model of identified risk in relation to the proposed development.

5.3 Soil Analysis - Human Health

5.3.1 Soil samples were collected and analysed from made ground materials. Certificates of analysis for samples are contained within Appendix D.

5.3.2 Current regulatory guidance for the statistical assessment of environmental data within a contaminated land context is detailed within the CIEH and CL:AIRE joint publication titled '*Guidance on Comparing Soil Concentration Data with a Critical Concentration'* (2008). However, as judgemental sampling has been undertaken, statistical assessment as detailed in CL:AIRE (2008) has not been carried out as part of this assessment. Therefore, to identify Contaminants of Potential Concern (COPC) as part of this preliminary assessment, the analytical results for the ground materials sampled have been assessed by the screening of individual analyses against the relevant Tier 1 Site Screening Values (SSVs) adopted.

5.3.3 For generic assessment purposes, SSVs have been conservatively selected, where appropriate, based upon a sandy soil and Soil Organic Matter (SOM) of 1%.

Made Ground

5.3.4 10No. samples of made ground were scheduled for analysis from the site. The results obtained from made ground are summarised in Table 5.1 below:

Table 5.1: Soil Analysis Summary

Contaminant	Max (mg/kg)	Min (mg/kg)	SSV (mg/kg)	No. of Tests	No. of Exceedances
Arsenic	110	7.8	37[1]	10	**5**
Boron	31	1	290[3]	10	0
Cadmium	3.8	<0.2	22[1]	10	0
Chromium (total)	46	17	910[3]	10	0
Chromium (VI)	<1.2	<1.2	21[1]	10	0
Copper	800	19	2400[3]	10	0
Lead	3200	49	200[1]	10	**7**
Mercury	2.2	<0.3	170[2]	10	0
Nickel	120	8.9	130[2]	10	0
Selenium	<1.0	<1.0	350[2]	10	0
Zinc	1600	30	3700[3]	10	0
Beryllium	16	0.56	1.7[3]	10	**7**
Vanadium	110	26	410[3]	10	0
Barium	770	36	1300[4]	10	0
Cyanide (Total)	2	<1	20[5]	10	0
Total Phenol (Monohydric)	<1	<1	120[3]	10	0
Total Sulphate as SO_4	8000	820	-	5	-
Water Soluble Sulphate (SO_4) – g/l	2.2	0.016	-	10	-
Sulphide	150	<1.0	-	10	-
pH	9.0	5.9	-	10	-
Total Organic Carbon (%)	7.0	0.8	-	10	-
Naphthalene	2.8	<0.05	2.3[3]	10	**1**
Acenaphthylene	<0.05	<0.05	170[3]	10	0
Acenaphthene	0.41	<0.05	210[3]	10	0
Fluorene	0.63	<0.05	170[3]	10	0
Phenanthrene	5.6	<0.05	95[3]	10	0
Anthracene	1.3	<0.05	2400[3]	10	0
Fluoranthene	11	<0.05	280[3]	10	0
Pyrene	9.6	<0.05	620[3]	10	0
Benzo(a)anthracene	6.9	<0.05	7.2[3]	10	0
Chrysene	4.8	<0.05	15[3]	10	0
Benzo(b)fluoranthene	8.5	<0.05	2.6[3]	10	**5**
Benzo(k)fluoranthene	4.7	<0.05	77[3]	10	0
Benzo(a)pyrene	7.5	<0.05	2.2[3]	10	**4**
Indeno(1,2,3-cd)pyrene	4.7	<0.05	27[3]	10	0
Dibenz(a,h)anthracene	0.99	<0.05	0.24[3]	10	**4**
Benzo(g,h,i)perylene	5.1	<0.05	320[3]	10	0
Total PAH	70	<0.8	-	10	0
Benzene	<1.0	<1.0	0.087[3]	5	0
Toluene	<1.0	<1.0	130[3]	5	0
Ethylbenzene	<1.0	<1.0	47[3]	5	0
p & m-xylene	<1.0	<1.0	56[3]	5	0
o-xylene	<1.0	<1.0	60[3]	5	0
MTBE	<1.0	<1.0	49[4]	5	0
TPH Aliphatic C5-C6	<0.001	<0.001	42[3]	5	0
TPH Aliphatic C6-C8	<0.001	<0.001	100[3]	5	0
TPH Aliphatic C8-C10	<0.001	<0.001	27[3]	5	0

Contaminant	Max (mg/kg)	Min (mg/kg)	SSV (mg/kg)	No. of Tests	No. of Exceedances
TPH Aliphatic C10-C12	2.6	<1.0	130[3]	5	0
TPH Aliphatic C12-C16	24	<2.0	1100[3]	5	0
TPH Aliphatic C16-C21	130	<8.0	65000[3]	5	0
TPH Aliphatic C21-C35	1100	<8.0	65000[3]	5	0
TPH Aromatic C5-C7	<0.001	<0.001	70[3]	5	0
TPH Aromatic C7-C8	<0.001	<0.001	130[3]	5	0
TPH Aromatic C8-C10	<0.001	<0.001	34[3]	5	0
TPH Aromatic C10-C12	<1.0	<1.0	74[3]	5	0
TPH Aromatic C12-C16	3.9	<2.0	140[3]	5	0
TPH Aromatic C16-C21	49	<10	260[3]	5	0
TPH Aromatic C21-C35	460	<10	1100[3]	5	0
TPH (C10-C40)	1900	<10	-	5	-

Notes:
1 DEFRA C4SLs (2014) based on "*Residential with homegrown produce"* end use
2 Environment Agency SGVs (2009) based on "*Residential"* end use
3 LQM/CIEH S4ULs (2015) based on "*Residential with homegrown produce"* end use
4 CL:AIRE, AGS & EIS (2009) based on "*Residential*" end use
5 Dutch Intervention Value for free cyanide (VROM 2000)

5.3.5 A number of exceedances of the Tier 1 SSVs for a residential site end use were recorded within the encountered made ground for heavy metals and PAH's, as summarised below:

- Arsenic – WS03 at 2.5mbgl (110mg/kg); BH01 at 1.0mbgl (58mg/kg); TP02 at 3.0mbgl (74mg/kg); WS02 at 0.5mbgl (47mg/kg); and WS04 at 1.5mbgl (92mg/kg).
- Lead – TP03 at 2.0mbgl (640mg/kg); WS01 at 0.5mbgl (420mg/kg); WS03 at 2.5mbgl (3200mg/kg); BH01 at 1.0mbgl (1400mg/kg); TP02 at 3.0mbgl (1100mg/kg); WS02 at 0.5mbgl (1100mg/kg); and WS04 at 1.5mbgl (2200mg/kg).
- Beryllium - TP03 at 2.0mbgl (2.1mg/kg); WS01 at 0.5mbgl (2.5mg/kg); WS03 at 2.5mbgl (11mg/kg); BH01 at 1.0mbgl (5.1mg/kg); TP02 at 3.0mbgl (2.8mg/kg); WS02 at 0.5mbgl (4.1mg/kg); and WS04 at 1.5mbgl (16mg/kg).
- Benzo(b)fluoranthene - TP03 at 2.0mbgl (3.0mg/kg); WS03 at 2.5mbgl (2.8mg/kg); BH01 at 1.0mbgl (8.0mg/kg); WS02 at 0.5mbgl (8.5mg/kg); and WS04 at 1.5mbgl (6.2mg/kg).
- Benzo(a)pyrene - TP03 at 2.0mbgl (2.8mg/kg); BH01 at 1.0mbgl (7.5mg/kg); WS02 at 0.5mbgl (7.5mg/kg); and WS04 at 1.5mbgl (2.9mg/kg).
- Dibenz(a,h)anthracene - TP03 at 2.0mbgl (0.28mg/kg); BH01 at 1.0mbgl (0.99mg/kg); WS02 at 0.5mbgl (0.88mg/kg); and WS04 at 1.5mbgl (0.79mg/kg).

5.3.6 In addition, an asbestos screen undertaken on all samples materials recorded the presence of loose Chrysotile fibres within the following samples:

- BH01 at 1.0mbgl; WS01 at 0.5mbgl and WS02 at 0.5mbgl.

5.3.7 All remaining samples recorded asbestos as 'not-detected'.

5.4 Ground Gas

5.4.1 3No. rounds of ground gas monitoring have been undertaken to-date.

5.4.2 All gas monitoring was undertaken using a calibrated GFM 430 infra-red gas analyser fitted with an internal flow pod. The monitoring results are presented in Appendix F and summarised in Table 5.2 below.

Table 5.2: Summary of Ground Gas Monitoring Data

Borehole	Response Zone/Strata	Evidence of potential source of ground gas	No. of monitoring occasions	Methane (%)	Carbon dioxide (%)	Min. Oxygen (%)	Flow (l/hr)	Water levels (mbgl)	Range of atmospheric pressure (mb)
WS01	Made Ground	Historic Landfill	3	0.0	4.9(1) 4.5(2)	1.8	1.7(1) 1.6(2)	2.65 – 2.83	984 - 1021
WS02				0.0	5.3(1,2)	14.6	1.3(1,2)	2.45 – 4.72	984 - 1020
WS03				0.0	6.2(1,2)	12.0	1.8(1) 1.6(2)	2.42 – 3.1	984 - 1019

5.4.3 Atmospheric pressures recorded during the monitoring visits ranged between 984mb and 1021mb. Atmospheric trends have varied during the monitoring with periods of both low and high pressure recorded.

5.4.4 Maximum flow rates of between 1.3l/hr (WS02) and 1.8l/hr (WS03) were recorded during the monitoring.

5.4.5 No measurable concentrations of methane were recorded within installed monitoring wells during the monitoring undertaken to date (i.e. below instrument level of detection).

5.4.6 Carbon dioxide was recorded at a maximum concentration of 6.2%v/v within WS03. Maximum and stable concentrations ranged between 4.9%v/v and 5.3%v/v within the remaining boreholes.

5.4.7 Methane concentrations are noted to be below the current screening level (i.e. 1% methane) presented in current guidance for a high sensitivity end use, e.g. residential development.

5.4.8 However, carbon dioxide concentrations recorded during the monitoring visits exceed the screening level presented in current guidance for a high sensitivity end use (i.e. 5% carbon dioxide).

5.4.9 Reduced concentrations of oxygen (minimum 1.8%v/v) were recorded within WS01 during the first and second monitoring visits. Marginally reduced concentrations were recorded within WS02 and WS03, with minimum concentrations of 14.6%v/v and 12.0%v/v recorded respectively.

5.4.10 Based on the encountered ground conditions and gas monitoring undertaken to-date, the proposed development would be characterised, in accordance with current guidance as having a maximum Gas Screening Value (GSV) of 0.0l/hr for methane and 0.1l/hr for carbon dioxide (based on maximum methane concentrations of 0%v/v, maximum stable concentration of carbon dioxide of 6.2%v/v and maximum stable flow rates of 1.6l/hr).

5.4.11 Therefore, based on the ground gas monitoring undertaken to-date, the site would be classified as Characteristic Situation 2 in accordance with current guidance based upon recorded GSVs and maximum recorded concentrations.

5.4.12 Notwithstanding this, the site is recorded to be located within a historic landfill, with final waste input date recorded to be the early 1990's. In addition, made ground was encountered across the site to depths in excess of 4.0mbgl.

5.4.13 A strong organic odour was recorded throughout the made ground during the intrusive works. Furthermore, Total Organic Carbon (TOC) was recorded to be variable, with concentrations of between 0.8% and 7.0% recorded.

5.4.14 Therefore, further ground gas monitoring is recommended to fully define the ground gas regime on site. In accordance with current guidance, a minimum of 3No additional rounds over a period of six months will be required. Although given the identified source, it cannot be discounted that this will need to be increased to further monitoring over a period of twelve months.

5.4.15 It is reported that the site lies within an Intermediate probability radon area, as 1-3% of homes are reported to be at or above the action level. No radon protective measures are reported as necessary in the construction of new dwellings or extensions.

6 REFINED CONCEPTUAL MODEL

6.1 Introduction

6.1.1 The Preliminary Risk Assessment undertaken as part of this report identified the presence of potential significant pollutant linkages associated with the site and surrounds. Therefore, in accordance with the approach recommended in CLR11, additional information was collected about the site and its surroundings as part of a Generic Quantitative Risk Assessment. Based upon this additional information and the proposed development layout, the site conceptual model has been refined and pollutant linkages confirmed for evaluation where considered necessary.

6.2 Hazard Identification

6.2.1 Potential sources of contamination have been identified on and within the vicinity of the site and are presented in Table 6.1.

Table 6.1: Identified Hazards

Identified Hazard/Source	Location	Details
Made ground	On site	Made ground was encountered across the site to depths in excess of 4.0mbgl. Contaminants of potential concern (CoPC), including arsenic, lead, beryllium and PAHs were recorded in excess of the relevant SSVs within the made ground across the site. In addition, asbestos fibres were recorded within samples of the made ground recovered from the centre of the site within the area of the former depot. The made ground is considered a potential source of ground gas generation based on the observed thickness and composition.
Potentially contaminative current and historic processes (Depot)	On site	Laboratory analysis of representative samples collected from site recorded the exceedances of a number of CoPC (lead, arsenic and PAH's), which may be associated with the former depot present on site. In addition, asbestos fibres were recorded within samples of the made ground recovered from the the area of the former depot.
Potentially contaminative current and historic processes (Landfill)	On site	Made ground was recorded across the site to depths in excess of 4.0mbgl. Laboratory analysis of representative samples collected from site recorded the exceedances of a number of CoPC (lead, arsenic and PAH's), which may be associated with the historic landfill. A strong organic odour was recorded throughout the made ground. TOC of up to 7.0% was recorded within encountered materials. Ground gas monitoring undertaken to date may classify the site as characteristic situation 2. Notwithstanding this, further monitoring is recommended to fully define the ground gas regime on site.

Identified Hazard/Source	Location	Details
Potentially contaminative current and historic processes	Off site	While a number of potentially contaminative land uses have been identified in proximity to the site, based on field observations and cohesive nature of the underlying natural ground materials, significant on-site contamination from off-site sources is considered to be low.

6.3 Identified Potential Receptors and Pathways

6.3.1 Potential receptors identified as part of the generic risk assessment are:

- Current/future site users; and
- Construction workers.

6.3.2 Potential contaminant pathways identified as part of the generic risk assessment include:

- Dermal contact – contact with soil, dust or water;
- Ingestion - ingestion of soil, dust or water; and
- Inhalation – inhalation of soil, dust or vapours.

6.4 Hazard Assessment and Risk Estimation

6.4.1 Potential significant pollutant linkages identified as part of this preliminary risk assessment are summarised in the Outline Site Conceptual Model presented in Table 6.2. References to risk estimations are made in accordance with the methodology presented in CIRIA publication C552 (2001) titled *'Contaminated Land Risk Assessment: A Guide to Good Practice'* and summarised in Appendix B.

Table 6.2: Refined Conceptual Model (Hazard Assessment and Risk Estimation)

Identified Hazard/ Source	Identified Receptor	Potential Pathway to Receptors	Associated Hazard	Scale of Impact	Potential Consequence of Source-Receptor Linkage	Potential Likelihood for Significant Source-Receptor Linkage	Risk Classification
Made Ground – On Site	Future site users and construction workers	Exposure to potential contaminants through inhalation, ingestion and dermal contact pathways.	Risk of harm to human health	Local	Medium	**Likely:** CoPC have been recorded within the made ground materials across the site including lead, arsenic, beryllium and PAH's. Furthermore, asbestos fibres have also been recorded within the shallow and deeper made ground. Therefore, where soft landscaping is proposed and where made ground remains on site after finished site levels have been achieved, exposure to potential contaminants cannot be discounted.	**Moderate Risk**
Potentially contaminative current and historic processes on site (Depot)	Future site users and construction workers	Exposure to contaminants through ingestion, inhalation and dermal contact	Risk to human health	Local	Medium	**Likely:** Elevated contaminant concentrations have been recorded across the site, which may be associated with the former use as a depot. In addition, asbestos fibres were recorded within samples of the made ground recovered from the area of the former depot.	**Moderate Risk**
Potentially contaminative historic processes on site (Landfill)	Future site users and construction workers	Exposure to contaminants through ingestion, inhalation and dermal contact	Risk to human health	Local	Medium	**Likely:** Possible landfill materials have been recorded across the site to depths in excess of 4.0mbgl. Laboratory analysis of representative materials recorded the exceedance of a number of CoPC when considering a residential site end use. While initial ground gas monitoring undertaken to-date indicates the site may be classified as CS2, given the reported age of the encountered waste materials, visual and olfactory records associated with encountered materials and the proposed site end use, further monitoring is recommended to fully define the ground gas regime on site.	**Moderate Risk**

Identified Hazard/ Source	Identified Receptor	Potential Pathway to Receptors	Associated Hazard	Scale of Impact	Potential Consequence of Source-Receptor Linkage	Potential Likelihood for Significant Source-Receptor Linkage	Risk Classification
Potentially contaminative current and historic processes – off site	Current and future site users and construction workers	Potential on-site migration of contaminants	Risk of harm to human health	Local	Medium	**Unlikely:** While a number of potentially contaminative land uses have been recorded in proximity to the site, given visual and olfactory evidence and cohesive nature of the underlying natural materials, no evidence of significant migration of contamination from identified sources has been recorded.	**Low Risk**

7 GROUND ENGINEERING

7.1 Proposed Development

7.1.1 The proposed development is understood to comprise the construction of 11No. low-rise residential units with associated car parking and private gardens.

7.1.2 Information provided within the Tully De'Ath 'specification for site investigation' indicates that it is proposed to utilise traditional strip and pad footings within the proposed development and loads of approximately 150kN/m are anticipated.

Site Preparation

7.1.3 A number of semi-mature and mature trees were observed along the northern boundary of the site and within the east and south-east of the site. Consideration to these features should be taken into account within the proposed development.

7.1.4 Following the demolition of the existing structures on site, consideration will need to be given to the removal of any associated foundations and hardstanding present.

7.1.5 Underground drainage structures were identified during the site reconnaissance, consideration should be given to the removal or re-alignment of any underground utilities, as appropriate.

7.2 Ground Conditions

7.2.1 The general ground profile encountered at the site is summarised in Table 7.1 below.

Table 7.1: Generalised Ground Profile

Depth (mbgl)	Encountered Material
0.0 – 3.0 / >4.0	**Made Ground:** Variable, comprising dark brown sandy clay, black gravelly sand and multi-coloured slightly clayey sandy gravel / gravelly sandy clay. Gravel was observed to include red brick, yellow brick, wood fragments, fabric fragments, ash, glass, ceramic tile, marble tile, metal, plastic, tarmacadam, black carbonaceous material and chert. Occasional cobbles of brick. Strong organic odour throughout.
3.0/4.0 – >15.0	**London Clay Formation:** firm becoming stiff and very stiff, medium to high, becoming very high strength, greyish brown / grey slightly gravelly, sandy, silty, clay. Gravel of subangular to subrounded lithorelicts of very stiff clay. Occasional fine selenite crystals throughout. Becoming very stiff below 14.5m depth.

Made Ground

7.2.2 No geotechnical testing was undertaken on samples of the made ground. However, as a part of the geochemical testing undertaken for the site, pH and sulphate testing was undertaken on samples of encountered made ground. The test data indicated sulphate concentrations in the range of 0.046g/l to 2.2g/l and pH values of 5.9 to 9.

Natural Strata

7.2.3 Geotechnical test results are discussed below. Geotechnical laboratory test certificates are provided in Appendix E with in situ tests being presented on the exploratory hole logs in Appendix C of this report.

7.2.4 Laboratory analysis was undertaken on 12No samples of the encountered London Clay Formation (natural strata). The results of these analyses are presented in Table 7.2 below.

Table 7.2: Summary of Laboratory Test Results - Natural Strata

Test	Number of Tests	Range of Results
Plasticity Index (%) *London Clay Formation*	4	37 – 48
Moisture Content (%) *London Clay Formation*	4	23 – 31
% passing 425µm sieve *London Clay Formation*	4	99
pH Value *London Clay Formation*	4	8.0 – 8.3
SO_4 (g/l in soil) *London Clay Formation*	4	0.21 – 0.48
Total Sulphur (%) *London Clay Formation*	4	0.033 – 0.44
SPT 'N' values *London Clay Formation*	15	14 – 31
Undrained Shear Strength –(kN/m^2) *London Clay Formation*	4	94 – 164

7.2.5 Plasticity Indices of the encountered London Clay ranged between 37% and 48%, corresponding to Modified Plasticity Indices of between 36.6% and 47.5%, suggesting the materials to be of medium to high volume change potential, in accordance with NHBC guidance (2018).

7.2.6 Standard Penetration Testing (SPTs) within the underlying London Clay Formation recorded 'N' values of between 14 and 31, suggesting the materials to be firm to stiff in consistency.

7.2.7 Quick Undrained Triaxial Tests (QUT) undertaken on 4No samples of the London Clay Formation at depths of 4.0mbgl 6.5mbgl, 8.0mbgl and 12.5mbgl recorded undrained shear strengths of between $94kN/m^2$ and $164kN/m^2$.

7.2.8 The hand shear vane (HSV) testing is noted to be relatively consistent with both the laboratory undrained triaxial and correlated strengths based on the SPT data (Stroud 1988) and suggest the cohesive materials to be of medium to high strength becoming high strength below approximately 4.0mbgl. Based upon the available data, it is suggested that a characteristic strength for the London Clay may be given by:

Undrained strength, $c_u = 25 + 8.75z$ - where z is depth in metres within the London Clay

7.2.9 Standard correlations with the SPT data, e.g. Stroud (1988), suggests the underlying superficial deposits to be of low to medium compressibility, with a coefficient of

compressibility, m_v, of between 0.07m^2/MN and 0.15m^2/MN given and it is considered that a characteristic coefficient of compressibility of 0.1m^2/MN may be appropriate for design.

7.2.10 DCP-TRL testing undertaken at 3No. locations recorded CBR values of between 3.1% and >200% below assumed formation level (>500mmbgl).

7.2.11 The geotechnical testing included the analysis for water soluble sulphate and pH testing within the natural ground. The results indicate sulphate concentrations of between 0.21g/l and 0.48g/l and pH values of between 8.0 and 8.3. In addition, given the identified presence of selenite crystals within the underlying London Clay, all chemical analysis within the natural ground included testing for total sulphate and total sulphur. Total sulphate was recorded between 0.05% and 0.118% and total sulphur was recorded between 0.033% and 0.44%.

7.3 Foundations

Ground Conditions

7.3.1 Made ground was recorded across the site to depths in excess of 4.0mbgl. This in turn was observed to be underlain by the London Clay Formation from a depth of 3.0mbgl and generally comprised firm becoming stiff and very stiff, medium to high, becoming very high strength, greyish brown / grey slightly gravelly, sandy, silty, clay. Gravel was generally observed to comprise lithorelicts of very stiff clay. Occasional fine selenite crystals were observed throughout.

Preliminary Foundation Design Recommendations

7.3.2 On the basis of these field observations of ground conditions encountered and the potential loads associated with the proposed development, it is considered that conventional foundations may not be suitable for loads proposed within the Tully De'Ath 'specification for site investigation'.

7.3.3 It is considered that a piled solution may be most appropriate for the proposed development and it is suggested that a specialist piling contractor should be consulted regarding the piling options and detailed design of the most appropriate option. However, it is considered likely that CFA piles would be most suitable at the site.

7.3.4 Consequently, based on the available information and for *budget purposes only*, when utilising a single CFA pile, an estimated resistance of approximately 300kN can be derived for a 300mm diameter pile in excess of 12.5m. It should be noted that where pile groups are utilised, depending on the pile spacing, there may be the need to deepen and/or widen the piles to achieve the same resistance per pile.

7.3.5 Given the likely volume change potential of the near surface deposits, a minimum void of 25mm against the side and 100mm below ground beams would be recommended.

7.4 Ground Floor Slabs

7.4.1 As a result of the anticipated foundation depth/type, the use of suspended floors are considered appropriate. The underlying superficial ground materials were recorded as medium volume change potential and it is suggested that a minimum void of 100mm should be utilised below suspended in situ concrete flooring where incorporated in the design. Where pre-cast concrete suspended floors are used a minimum void space of 250mm should be utilised to allow for 150mm of ventilation.

7.5 Preliminary Pavement Design

7.5.1 Dynamic Cone Penetration (DCP-TRL) tests were undertaken at 3No. locations across the site within the general area of the proposed access road. The results of the DCP tests are presented in Appendix G.

7.5.2 Using calculations outlined in Jones CR and R Rolt (1991), the results from DCP01 to DCP03 indicate adjusted California Bearing Ratio (CBR) values of between 3.1% and >200% below assumed formation level (500mmbgl).

7.5.3 Notwithstanding this, given the thickness of made ground encountered on site (>4.0mbgl), CBR values of <2.5% would be recommended for preliminary design purposes where road formation is proven to be within made ground due to the inherent variability of made ground materials.

7.5.4 It should be noted that all road formations should be proof rolled and soft spots removed and replaced with selected granular fill and, where adoptable, a pavement of sufficient thickness to prevent the penetration of frost should be employed.

7.6 Excavations

7.6.1 Excavations at the site for conventional foundations may be achievable using conventional equipment without the use of breakers.

7.6.2 Perched water was encountered within a number of locations across the site. Therefore, consideration to the potential requirement for localised dewatering should be given during excavation and formation works.

7.7 Protection of Buried Concrete

7.7.1 The results of the water soluble sulphate content and pH testing carried out on samples of the made ground and natural ground materials indicate that in accordance with BRE Special Digest 1 (2005), the underlying materials would yield an Aggressive Chemical Environment Class (ACEC) of between AC-1 and AC-3, requiring a Design Sulphate Class of DS-3.

7.7.2 However, the test data would suggest the presence of pyrite within the underlying London Clay Formation based upon the average concentrations of oxidisable sulphides present. Therefore, where concrete is to be exposed to disturbed ground within the London Clay a higher design sulphate class will be required. Given the range of oxidisable sulphides within the encountered natural ground materials (maximum 1.32%) DS-4 would be required for an ACEC of AC-4, which should be utilised where concrete is to be exposed to disturbed ground.

8 CONCLUSIONS & RECOMMENDATIONS

8.1 Conclusions

8.1.1 Tweedie Evans Consulting Ltd (TEC) has been appointed by Baily Garner LLP on behalf of London Borough of Hillingdon to undertake a Preliminary Geoenvironmental and Geotechnical Assessment of Willow Tree Depot, Ditchfield Road. All works were undertaken in accordance with our proposal letter dated 29th January 2018 and referenced RE.1712003/1712004/1712005 (Rev A).

8.1.2 The site is located off Ditchfield Road, to the east of Yeading in the London Borough of Hillingdon and covers an area of approximately 0.24 hectares with the centre of the site situated at approximate National Grid Reference 512240, 182060. The nearest postcode to the site is UB4 9BH.

8.1.3 The site currently comprises an irregular shaped parcel of land containing a single L-shaped single storey with associated concrete hardstanding used for car parking and loading within the centre, while the rest of the site is laid to soft landscaping.

8.1.4 It is understood that it is proposed to redevelop the site for residential purposes comprising the construction of 11No. low rise units with associated car parking and private gardens.

8.1.5 A Preliminary Geoenvironmental and Geotechnical Assessment of the site was prepared by TEC in April 2018, as detailed within the following report:

- TEC - Preliminary Geoenvironmental and Geotechnical Assessment; Willow Tree Depot, Ditchfield Road. Prepared for London Borough of Hillingdon. Document reference 1712005.001.01, dated April 2018.

8.1.6 The preliminary assessment recorded the presence of a number of potentially contaminative land uses on site including a historic landfill and former depot.

8.1.7 Notwithstanding this, the site is considered to be of low environmental sensitivity due primarily to the absence of nearby surface water receptors and the cohesive nature of underlying deposits.

8.1.8 Made ground was encountered during the intrusive works to depths in excess of 4.0mbgl. Laboratory analysis of representative samples recorded elevated concentrations of lead, arsenic, beryllium and several PAHs when considering a residential site end use. In addition, loose asbestos fibres were recorded within made ground samples.

8.1.9 Ground gas monitoring undertaken to date may classify the site as Characteristic Situation 2, based upon recorded gas screening values and maximum concentrations. Notwithstanding this, given the presence of the underlying landfill, further monitoring will be required in accordance with current guidance.

8.1.10 Based upon our current conceptual understanding of the site and proposed end use, a Significant Pollutant Linkages associated with the following cannot be discounted:

- Human health (future site end users and construction workers) – exposure to contaminants and asbestos fibres within made ground at the site via the ingestion, dermal contact and inhalation pathways; and
- Human health (proposed structures and future site users) – migration, ingress and inhalation of ground gases.

8.2 Geoenvironmental Risk Management Recommendations

Identification of Feasible Remediation Options

8.2.1 Significant risks identified within the conceptual model can be mitigated through the breaking of the significant pollution linkage by the removal of at least the source, receptor or pathway. Within reference to the site's conceptual models the following preliminary remediation approach has been prepared. This preliminary remediation approach may need to be presented in more detail within a Remediation Strategy, the content of which will require agreement in writing of the Regulatory Authorities prior to commencing any remediation on site.

Human Health

8.2.2 Exceedances of Tier 1 SSVs based on a "residential with homegrown produce" end use for lead, arsenic, beryllium and several PAHs have been identified within made ground samples taken from across the site. In addition, loose chrysotile asbestos fibres have been identified within made ground samples.

8.2.3 Therefore, where the soft landscaping is proposed in such areas after finished site levels have been achieved, exposure to potential contaminants cannot be discounted and it would be recommended that a suitable cover system be provided within such areas. In addition, given the recorded concentrations and the presence of asbestos, it is likely that the an engineered cover system will be required, comprising clean imported materials over a geotextile break layer.

8.2.4 It is recommended that the details of this clean cover system, including importation criteria and verification requirements are documented in a Remediation Strategy for the proposed development.

8.2.5 Given the presence of general made ground across the site, good brownfield site working practices should be adopted by construction workers to mitigate against identified potential risks.

8.2.6 Should water pipes be placed within the made ground on site, due consideration should be given to the UK Water Industry Research Ltd (UKWIR) guidance.

8.2.7 Based on our conceptual understanding of the site to-date, it would be anticipated that a similar ground profile to that encountered within this assessment is present across the site area. Should a greater thickness of made ground or visual or olfactory evidence of potentially significant contamination be identified during the development works, further investigation and assessment may be required.

Ground Gas

8.2.8 While based on the ground gas monitoring undertaken to-date, the site would be classified as Characteristic Situation 2 in accordance with current guidance based upon recorded GSVs and maximum recorded concentrations.

8.2.9 Notwithstanding this, the site is recorded to be located within a historic landfill, with final waste input date recorded to be the early 1990's. In addition, made ground was encountered across the site to depths in excess of 4.0mbgl.

8.2.10 A strong organic odour was recorded throughout the made ground during the intrusive works. Furthermore, Total Organic Carbon (TOC) was recorded to be variable, with concentrations of between 0.8% and 7.0% recorded.

8.2.11 Therefore, further ground gas monitoring is recommended to fully define the ground gas regime on site. In accordance with current guidance, a minimum of 3No additional rounds over a period of six months will be required. Although given the identified source, it cannot be discounted that this will need to be increased to further monitoring over a period of twelve months.

8.2.12 It is reported that the site lies within an Intermediate probability radon area, as 1-3% of homes are reported to be at or above the action level. No radon protective measures are reported as necessary in the construction of new dwellings or extensions.

8.3 Ground Engineering

Preliminary Foundation Design Recommendations

8.3.1 On the basis of these field observations of ground conditions encountered and the potential loads associated with the proposed development, it is considered that conventional foundations may not be suitable for use within the development.

8.3.2 It is considered that a piled solution may be most appropriate for the proposed development loads and it is suggested that a specialist piling contractor should be consulted regarding the piling options and detailed design of the most appropriate option. However, it is considered likely that CFA piles would be most suitable at the site.

8.3.3 Consequently, based on the available information and for *budget purposes only*, when utilising a single CFA pile, an estimated resistance of approximately 300kN can be derived for a 300mm diameter pile in excess of 12.5m. It should be noted that where pile groups are utilised, depending on the pile spacing, there may be the need to deepen and/or widen the piles to achieve the same resistance per pile.

8.3.4 Given the likely volume change of the near surface deposits, a minimum void of 25mm against the side and 100mm below ground beams would be recommended.

Ground Floor Slabs

8.3.5 As a result of the anticipated foundation depth/type, the use of suspended floors are considered appropriate. The underlying superficial ground materials were recorded as medium to high volume change potential and it is suggested that a minimum void of 100mm should be utilised below suspended in situ concrete flooring where incorporated in the design.

Preliminary Pavement Design

8.3.6 DCP-TRL testing undertaken across the site recorded CBR values of between 3.1% and >200% below assumed formation level (500mmbgl).

8.3.7 Notwithstanding this, given the thickness of made ground encountered on site (>4.0mbgl), CBR values of <2.5% would be recommended for preliminary design purposes where road formation is proven to be within made ground due to the inherent variability of made ground materials.

8.3.8 It should be noted that all road formations should be proof rolled and soft spots removed and replaced with selected granular fill and, where adoptable, a pavement of sufficient thickness to prevent the penetration of frost should be employed.

Excavations

8.3.9 Excavations of the materials immediately beneath the site should be achievable using conventional excavation plant.

8.3.10 Perched water ingress was recorded during intrusive and subsequent monitoring works. Therefore, consideration may be given to the use of localised dewatering during the excavation works.

Protection of Buried Concrete

8.3.11 The results of the water soluble sulphate content and pH testing carried out on samples of the made ground and natural ground materials indicate that in accordance with BRE Special Digest 1 (2005), the underlying materials would yield an Aggressive Chemical Environment Class (ACEC) of between AC-1 and AC-3, requiring a Design Sulphate Class of DS-3.

8.3.12 However, the test data would suggest the presence of pyrite within the underlying London Clay Formation based upon the average concentrations of oxidisable sulphides present. Therefore, where concrete is to be exposed to disturbed ground within the London Clay a higher design sulphate class will be required. Given the range of oxidisable sulphides within the encountered natural ground materials (maximum 1.32%) DS-4 would be required for an ACEC of AC-4, which should be utilised where concrete is to be exposed to disturbed ground.

TWEEDIE EVANS CONSULTING LIMITED

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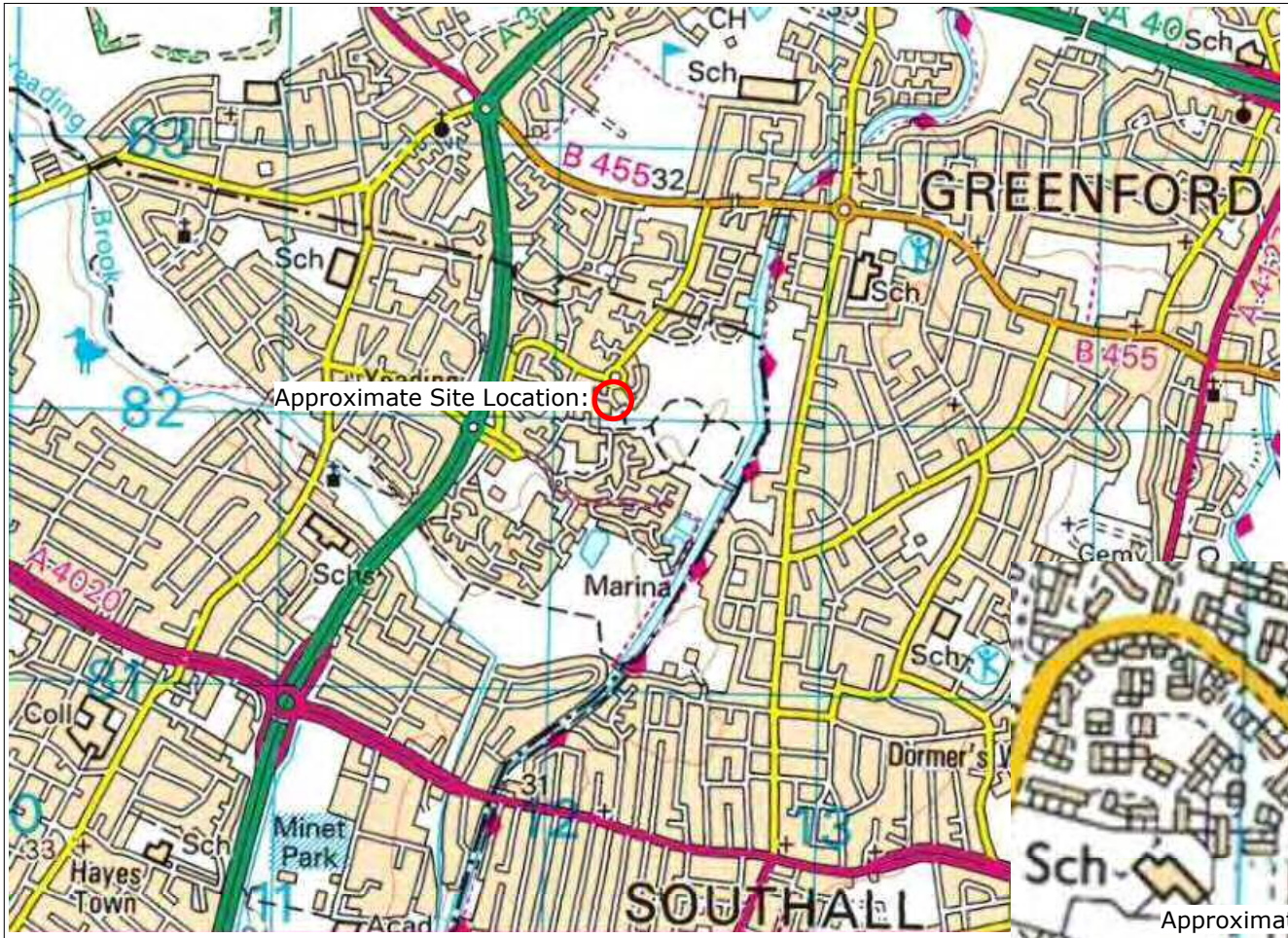
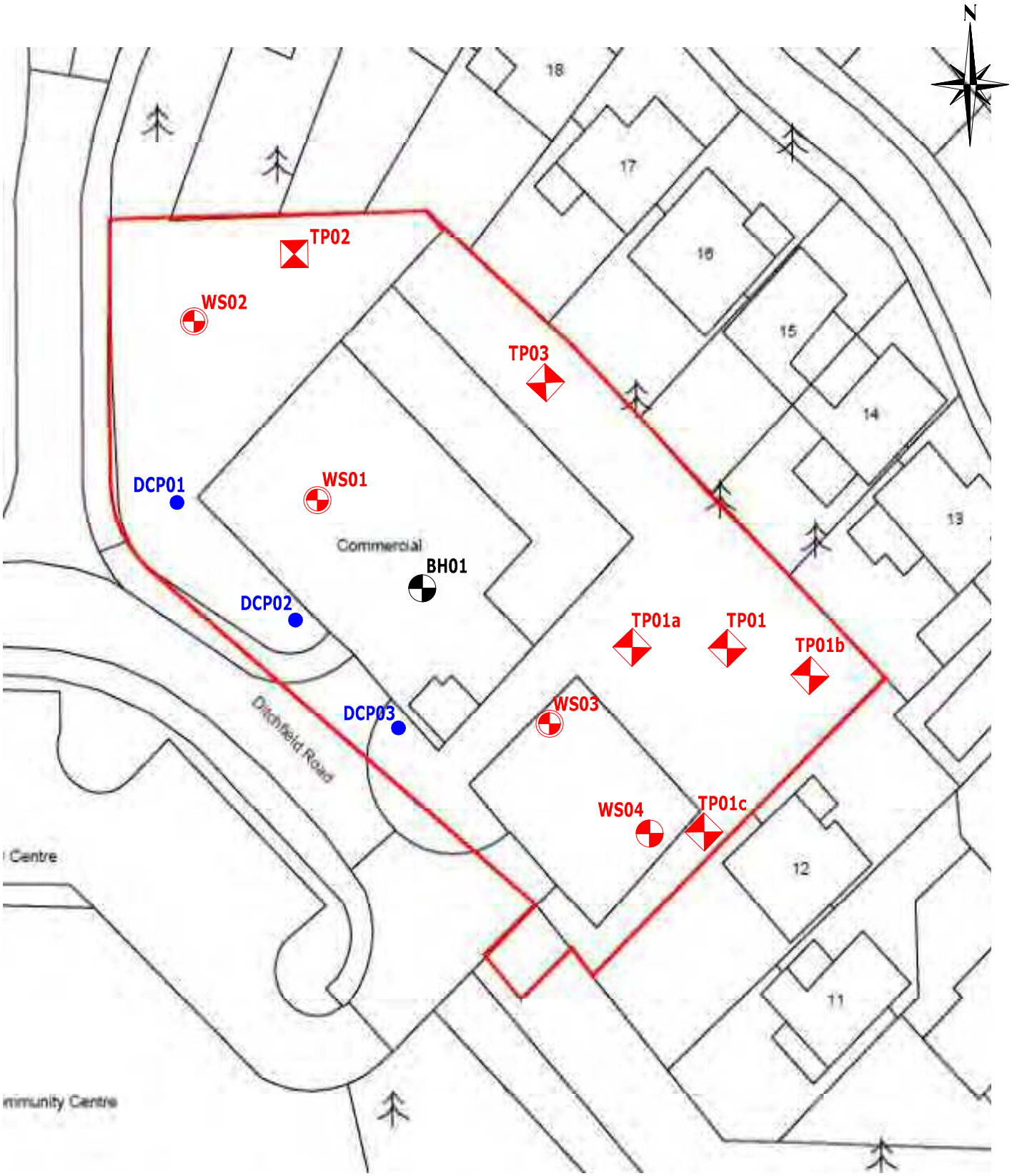
FIGURES



TEC TWEEDIE EVANS CONSULTING	Tweedie Evans Consulting The Olc Chape 35a Southover Wells, Somerset BA5 1UH	Tel 01749 677760 Fax 01749 679345 Email:info@tecon.co.uk www.tecon.co.uk	Site Name: Willow Tree Depot, Ditchfield Road	Drawing Name: Site Location Plan	Client Name: London Borough of Hillingdon	Project No: 1712005	Figure No: 1	Date: April 2018	Scale: NTS

Extract of Baily Garner Drawing 'Proposed Site Plan' (Drawing No: PL 10, Date: 20/12/2017).

TEC TWEEDIE EVANS CONSULTING	Tweedie Evans Consulting The Olc Chape 35a Southover Wells, Somerset BA5 1UH	Tel 01749 677760 Fax 01749 679345 Email:info@tecon.co.uk www.tecon.co.uk	Site Name: Willow Tree Depot, Ditchfield Road			Scale: NTS
Drawing Name: Proposed Development Plan			Client Name: London Borough of Hillingdon	Project No: 1712005	Date: April 2018	Figure No: 2



TEC Trial Pit:

TEC Window Sample Location:

TEC Cable Percussive Borehole Location:

TEC Window Sample with Installation Location:

TEC DCP-TRL Test Location:

Extract of Baily Garner Drawing 'Site Location Plan' (Drawing No: PL01, Date: 20/12/2017).

TEC TWEEDIE EVANS CONSULTING	Tweedie Evans Consulting The Olc Chape 35a Southover Wells, Somerset BA5 1UH	Tel 01749 677760 Fax 01749 679345 Email:info@tecon.co.uk www.tecon.co.uk	Site Name: Willow Tree Depot, Ditchfield Road		Scale: NTS
Drawing Name: Exploratory Hole Location Plan			Client Name: London Borough of Hillingdon	Project No: 1712005	Date: April 2018	Figure No: 3

APPENDIX A

Site Photographs

Photograph 1: View of TP01.

Photograph 2: Location of TP02 and encountered materials.

Photograph 3: View of TP02.

Photograph 4: Location of TP03.

Photograph 5: View of TP03.

Photograph 6: View of materials encountered at TP03.

Photograph 7: Location of WS01.

Photograph 8: View of materials encountered at WS01.

Photograph 9: Location of WS02.

Photograph 10: View of materials encountered at WS02.

Photograph 11: View of materials encountered at WS03.

Photograph 12: Location of WS04.

APPENDIX B

Risk Evaluation

Risk Evaluation

The qualitative assessment methodology presented in Ciria publication C552 (2001) titled *'Contaminated Land Risk Assessment: A Guide to Good Practice'* has been used by TEC for the basis of evaluating potential risk.

The method requires an assessment of the:

magnitude of the probability or likelihood of the risk occurring (Table 1); and
magnitude of the potential consequence or severity of the risk occurring (Table 2)

Table 1. Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the short-term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.

Table 2. Classification of Consequence

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resource. (Note: Water Resources Act contains no scope for considering significance of pollution). Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organisation forming part of such ecosystem (note: the definitions of ecological systems within the draft circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to human health ("significant harm" as defined in DETR, 2000). Pollution of sensitive water resources. (Note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem, (note: the definitions of ecological systems within draft circular on Contaminated Land, DETR, 2000).	Concentration of a contaminant from site exceeding the generic or site-specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ("significant harm" as defined in the draft circular on Contaminated Land, DETR, 2000). Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (for example foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc), easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discolouration of concrete.

The combination of the two factors is determined using Table 3 and the resulting level of risk is described in Table 4. The evaluation can be applied to each of the scenarios identified in the risk model and the overall risk assessed.

Table 3. Combination of Consequence with Probability

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	**Very High Risk**	**High Risk**	**Moderate Risk**	**Moderate/Low Risk**
	Likely	**High Risk**	**Moderate Risk**	**Moderate/Low Risk**	**Low Risk**
	Low Likelihood	**Moderate Risk**	**Moderate/Low Risk**	**Low Risk**	**Very Low Risk**
	Unlikely	**Moderate/Low Risk**	**Low Risk**	**Very Low Risk**	**Very Low Risk**

Table 4. Description of risks and likely action required

Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short-term and are likely over the longer-term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the long-term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Using the risk model the pollutant linkages are identified and a preliminary estimate of risk undertaken. If there is no pollutant linkage identified, then there is no risk. If the estimate of risk for all the linkages and exposure scenarios is very low at this stage then it is likely that no further assessment will be required.

APPENDIX C

Exploratory Hole Logs

CABLE PERCUSSIVE BOREHOLE RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Borehole:** BH01
Project No: 1712005.002	**Dates:** 14th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results: Blow Count	SPT Results: N Value	Remarks/ Data	Installation
0.00	Ground Surface			0.0				
	MADE GROUND Reinforced concrete hardstanding.							
	MADE GROUND Black gravelly sand. Gravel of red brick, ash, black carbonaceous material, tarmacadam, concrete and chert. Organic odour.		A	1.0	(2, 2) 3, 3, 3, 3	**12**		
				2.0	(2, 3) 4, 3, 3, 3	**13**		
				3.0	(2, 1) 2, 2, 2, 2	**8**		
3.60							HSV at 3.6m - 70, 65, 65 PP at 3.6m - 2.5, 2.0, 2.75, 2.75, 3.25	
	Stiff medium to high strength grey mottled orange-brown slightly gravelly sandy CLAY.		U	4.0	U100 in 52 blows			
			A	5.0	(2, 3) 4, 4, 5, 6	**19**	HSV at 5.0m - 70, 75, 75 PP at 5.0m - 2.75, 2.75, 3.0, 2.75, 3.5	
				6.0				
7.00			U		U100 in 71 blows		HSV at 7.0m - 112.5, 112.5, 112.5 PP at 7.0m - 3.75, 4.0, 4.25, 4.25, 4.0	
	Stiff high strength grey-brown slightly gravelly sandy CLAY. Gravel of subangular to subrounded lithorelicts of very stiff clay. Occasional fine selenite throughout.		T	7.0				
				8.0	(3, 3) 4, 6, 7, 7	**24**		
			A	9.0			HSV at 9.0m - 112.5, 100, 100 PP at 9.0m - 3.5, 4.0, 3.5, 4.25, 4.5	
			U		U100 in 82 blows			
				10.0				
				11.0	(3, 5) 5, 6, 7, 8	**26**	HSV at 11.0m - 162.5, 162.5, 162.5 PP at 11.0m - 4.5, 4.5, 4.5, 4.5, 4.5	
			T	12.0				
			U		U100 in 90 blows		HSV at 13.0m - 112.5, 137.5, 112.5 PP at 13.0m - 4.5, 4.5, 3.75, 4.25, 4.0	
				13.0				
				14.0				
	.....becoming very stiff below 14.5m.				(4, 5) 7, 7, 8, 9	**31**		
15.00				15.0			HSV at 15.0m - 100, 125, 100 PP at 15.0m - 3.75, 3.75, 3.5, 3.75, 4.0	
	Borehole Terminated							

Notes:

A:	250ml and 60ml Amber Glass Jars
T:	Plastic Tub (1Kg)
B:	Bulk Sample
U:	Undisturbed Sample
SPT:	Standard Penetration Test
HSV:	Hand Shear Vane

Plant: Dando 2000

Water observations: No groundwater encountered.

General remarks:
HSV units = kPa, PP units = kg/cm^2

Logged by: JW	Checked by: CH	Approved by: RE

TRIAL PIT RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Trial Pit:** TP01
Project No: 1712005.002	**Dates:** 15th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend Side B	Depth (m)	Sample Details	Remarks
0.00	Ground Surface		0.00		
	MADE GROUND Dark brown gravelly sandy clay. Gravel of red brick, black carbonaceous material, plastic, fabric fragments, wood fragments, ceramic tile and chert. Frequent fine rootlets.			A	
0.40					
0.50	MADE GROUND Light brown sandy gravel of chert.				
	Trial Pit Terminated		1.00		
			2.00		
			3.00		
			4.00		
			5.00		

Excavation Details:	Dimensions:	Notes and Remarks:
Date excavated: 15th February 2018 Date backfilled: 15th February 2018 Plant: JCB 3CX Shoring: n/a Stability: Stable	B: 0.5m A: 1.5m	Trial pit terminated at 0.5mbgl due to suspected services. A = Amber jar Water observations: No groundwater encountered.

Logged by: JW	Checked by: CH	Approved by: RE

TRIAL PIT RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Trial Pit:** TP01a
Project No: 1712005.002	**Dates:** 15th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
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info@tecon.co.uk

Depth (m)	Description	Legend Side B	Depth (m)	Sample Details	Remarks
0.00	Ground Surface		0.00		
0.40	MADE GROUND Dark brown gravelly sandy clay. Gravel of red brick, black carbonaceous material, plastic, fabric fragments, wood fragments, ceramic tile and chert. Frequent fine rootlets.				
0.50	MADE GROUND Light brown sandy gravel of chert.				
	Trial Pit Terminated		1.00		
			2.00		
			3.00		
			4.00		
			5.00		

Excavation Details:	Dimensions:	Notes and Remarks:
Date excavated: 15th February 2018 Date backfilled: 15th February 2018 Plant: JCB 3CX Shoring: n/a Stability: Stable	B: 1.5m A: 0.5m	Trial pit terminated at 0.5mbgl due to suspected services. Water observations: No groundwater encountered.

Logged by: JW	Checked by: CH	Approved by: RE

TRIAL PIT RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Trial Pit:** TP01b
Project No: 1712005.002	**Dates:** 15th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend Side B	Depth (m)	Sample Details	Remarks
0.00	Ground Surface		0.00		
0.40	MADE GROUND Dark brown gravelly sandy clay. Gravel of red brick, black carbonaceous material, plastic, fabric fragments, wood fragments, ceramic tile and chert. Frequent fine rootlets.				
0.50	MADE GROUND Light brown sandy gravel of chert.				
	Trial Pit Terminated		1.00		
			2.00		
			3.00		
			4.00		
			5.00		

Excavation Details:	Dimensions:	Notes and Remarks:
Date excavated: 15th February 2018 Date backfilled: 15th February 2018 Plant: JCB 3CX Shoring: n/a Stability: Stable	B: 0.5m A: 1.5m	Trial pit terminated at 0.5mbgl due to suspected services. Water observations: No groundwater encountered.

Logged by: JW	Checked by: CH	Approved by: RE

TRIAL PIT RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Trial Pit:** TP01c
Project No: 1712005.002	**Dates:** 15th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend Side B	Depth (m)	Sample Details	Remarks
0.00	Ground Surface		0.00		
	MADE GROUND Dark brown gravelly sandy clay. Gravel of red brick, black carbonaceous material, plastic, fabric fragments, wood fragments, ceramic tile and chert. Frequent fine rootlets.			A	
0.40					
0.50	MADE GROUND Light brown sandy gravel of chert.				
	Trial Pit Terminated		1.00		
			2.00		
			3.00		
			4.00		
			5.00		

Excavation Details:	Dimensions:	Notes and Remarks:
Date excavated: 15th February 2018 Date backfilled: 15th February 2018 Plant: JCB 3CX Shoring: n/a Stability: Stable	B: 0.5m A: 1.5m	Trial pit terminated at 0.5mbgl due to suspected services. Water observations: No groundwater encountered.

Logged by: JW	Checked by: CH	Approved by: RE

TRIAL PIT RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Trial Pit:** TP02
Project No: 1712005.002	**Dates:** 15th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend Side B	Depth (m)	Sample Details	Remarks
0.00	Ground Surface		0.00		
	MADE GROUND Dark brown gravelly sandy clay. Gravel of red brick, yellow brick, concrete, black carbonaceous material, plastic, wood fragments and chert. Frequent fine rootlets.				PID at 0.2m - 0.0
0.40	MADE GROUND Multicoloured slightly clayey sandy gravel. Gravel of red brick, black carbonaceous material, tarmacadam, yellow brick, plastic, fabric fragments, wood fragments, ceramic tile and chert. Occasional cobble of red brick and yellow brick. Strong organic odour.		1.00	A	
			2.00		PID at 2.0m - 0.0
			3.00	A	
4.00	Trial Pit Terminated		4.00		
			5.00		

Excavation Details:	Dimensions:	Notes and Remarks:
Date excavated: 15th February 2018 Date backfilled: 15th February 2018 Plant: JCB 3CX Shoring: n/a Stability: Not Stable	B: 0.6m A: 3.6m	A = Amber jar, PID = Photo-Ionisation Detector PID units = ppm Water observations: Perched water encountered at 2.0mbgl.

Logged by: JW	Checked by: CH	Approved by: RE

TRIAL PIT RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Trial Pit:** TP03
Project No: 1712005.002	**Dates:** 15th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend Side B	Depth (m)	Sample Details	Remarks
0.00	Ground Surface		0.00		
0.50	MADE GROUND Dark brown gravelly sandy clay. Gravel of red brick, yellow brick, concrete, black carbonaceous material, plastic, wood fragments and chert. Frequent fine rootlets.			A	PID at 0.4m - 0.0
3.20	MADE GROUND Multicoloured slightly clayey sandy gravel. Gravel of red brick, black carbonaceous material, plastic, yellow brick, ceramic tile, glass, wood fragments, ash and chert. Strong organic odour.		1.00 2.00 3.00	A	PID at 2.0m - 0.0
4.00	Firm medium to high strength grey mottled orange-brown sandy CLAY.			T	HSV at 3.2m - 75, 85, 80 PP at 3.2m - 3.5, 3.75, 4.0, 3.5, 3.75
	Trial Pit Terminated		4.00 5.00		

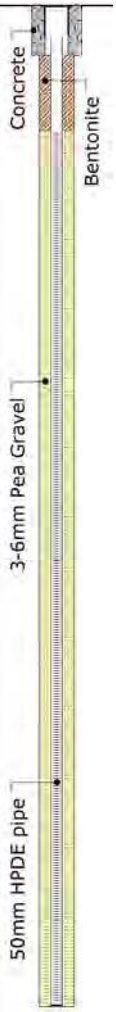
Excavation Details:	Dimensions:	Notes and Remarks: A = Amber jar, T = 1kg Plastic tub HSV = Hand Shear Vane, PP = Pocket Penetrometer, PID = Photo-Ionisation Detector HSV units = kPa, PP units = kg/cm^2, PID units = ppm
Date excavated: 15th February 2018 Date backfilled: 15th February 2018 Plant: JCB 3CX Shoring: n/a Stability: Not Stable	B: 0.6m A: 3.6m	Water observations: Perched water encountered at 3.0mbgl.
		Logged by: JW | Checked by: CH | Approved by: RE

DYNAMIC SAMPLING RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Borehole:** WS01
Project No: 1712005.002	**Dates:** 16th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results: Blow Count	SPT Results: N Value	Remarks/ Data	Installation
0.00	Ground Surface			0.0				
0.20	MADE GROUND Reinforced concrete hardstanding.							
1.00	MADE GROUND Green-grey gravelly sandy clay. Gravel of red brick, black carbonaceous material and chert. Organic odour.		A				PID at 0.5m - 0.0	
2.20	MADE GROUND Black, red and yellow gravelly sand. Gravel of red brick, yellow brick, ash, black carbonaceous material and tarmacadam.			1.0	(1, 5) 5, 4, 5, 4	18		
2.60	MADE GROUND Green-grey gravelly sandy clay. Gravel of red brick, yellow brick and black carbonaceous material. Organic odour.			2.0	(1, 0) 1, 0, 1, 0	2	PID at 2.0m - 0.0	
3.60	MADE GROUND Purple and red sandy gravel of red brick.			3.0	(1, 2) 2, 2, 3, 4	11		
5.00	Firm to stiff medium to high strength grey mottled orange-brown sandy CLAY.		T A	4.0	(2, 2) 3, 4, 4, 6	17	HSV at 3.6m - 75, 85, 70 PP at 3.6m - 2.5, 3.0, 2.5, 3.0, 3.0	
	Borehole Terminated			5.0	(2, 3) 2, 3, 4, 5	14	HSV at 4.8m - 87.5, 112.5, 100 PP at 4.8m - 3.0, 3.0, 3.5, 4.0, 4.25	



Notes:

A:	250ml and 60ml Amber Glass Jars
T:	Plastic Tub (1Kg)
SPT:	Standard Penetration Test
HSV:	Hand Shear Vane (kPa)
PP:	Pocket Penetrometer (kg/cm2)
PID:	Photo-Ionisation Detector (ppm)
B:	Large disturbed sample

Plant: Dando Terrier

Water observations: Perched water encountered at 2.6mbgl.

General remarks:

Logged by: JW	Checked by: CH	Approved by: RE

DYNAMIC SAMPLING RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Borehole:** WS02
Project No: 1712005.002	**Dates:** 16th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results: Blow Count	SPT Results: N Value	Remarks/ Data	Installation
0.00	Ground Surface			0.0				
	MADE GROUND Dark brown, black and green-grey sandy gravelly clay. Gravel of red brick, yellow brick, glass, plastic, fabric fragments, metal, black carbonaceous material, ceramic tile and chert. Frequent fine rootlets to 0.4mbgl. Organic odour.		A				PID at 0.5m - 0.0	Concrete; Bentonite
				1.0	(0, 1) 2, 5, 5, 6	18		
1.50								
	MADE GROUND Black and red gravelly sand. Gravel of red brick, black carbonaceous material, glass, ceramic tile, marble tile, plastic and chert.							
2.00				2.0	(0, 2) 1, 2, 2, 2	7	PID at 2.0m - 0.0	3-6mm Pea Gravel
	MADE GROUND Green-grey and black gravelly sandy clay. Gravel of red brick, black carbonaceous material, ceramic tile and chert. Organic odour. .....purple and black sandy gravel of black carbonaceous material and red brick between 2.4m and 2.5mbgl.							
3.00				3.0	(2, 2) 3, 3, 4, 4	14	HSV at 3.0m - 62.5, 75, 75 PP at 3.0m - 3.25, 2.75, 3.0, 3.25, 3.5	
	Firm medium to high strength grey mottled orange-brown sandy CLAY.		A					50mm HPDE pipe
				4.0	(2, 2) 2, 3, 4, 5	14	HSV at 4.0m - 87.5, 125, 100 PP at 4.0m - 4.25, 4.25, 4.25, 4.0, 4.5	
			T					
5.00				5.0	(2, 2) 2, 3, 4, 6	15	HSV at 5.0m - 100, 125, 100 PP at 5.0m - 3.5, 3.5, 3.75, 3.5, 3.75	
	Borehole Terminated							

Notes:

A:	250ml and 60ml Amber Glass Jars
T:	Plastic Tub (1Kg)
SPT:	Standard Penetration Test
HSV:	Hand Shear Vane (kPa)
PP:	Pocket Penetrometer (kg/cm2)
PID:	Photo-Ionisation Detector (ppm)
B:	Large disturbed sample

Plant: Dando Terrier

Water observations: Perched water encountered at 2.4mbgl.

General remarks:

Logged by: JW	Checked by: CH	Approved by: RE

DYNAMIC SAMPLING RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Borehole:** WS03
Project No: 1712005.002	**Dates:** 16th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
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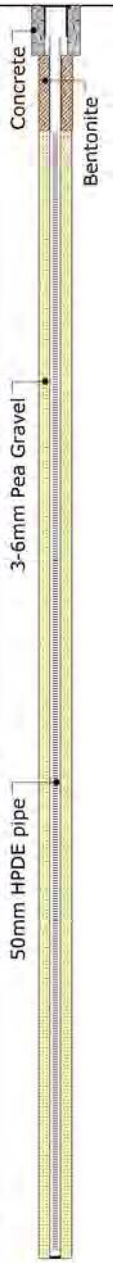
Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results: Blow Count	SPT Results: N Value	Remarks/ Data	Installation
0.00	Ground Surface			0.0				
0.25	MADE GROUND Reinforced concrete hardstanding.							
0.70	MADE GROUND Black, red and green-grey gravelly sandy clay. Gravel of red brick, black carbonaceous material, concrete, yellow brick, plastic, glass, ceramic tile and chert. Organic odour.						PID at 0.5m - 0.0	
	MADE GROUND Black, red and purple gravelly sand. Gravel of black carbonaceous material, ash, red brick and tarmacadam.			1.0	(2, 1) 1, 1, 2, 2	6		
				2.0	(1, 0) 1, 1, 1, 1	4	PID at 2.0m - 0.0	
			A					
3.00	Firm high strength grey mottled orange-brown sandy CLAY.			3.0	(2, 2) 2, 3, 4, 5	14	HSV at 3.0m - 90, 90, 90 PP at 3.0m - 3.75, 3.25, 3.5, 3.5, 3.5	
4.00	NO RECOVERY			4.0	(2, 3) 3, 5, 5, 7	20		
4.80								
5.00	Stiff high to very high strength grey mottled orange-brown sandy CLAY.		T	5.0	(2, 3) 3, 4, 5, 5	17	HSV at 4.8m - 137.5, 150, 162.5 PP at 4.8m - 4.0, 3.5, 3.5, 4.0, 3.5	
	Borehole Terminated							



Notes:

A:	250ml and 60ml Amber Glass Jars
T:	Plastic Tub (1Kg)
SPT:	Standard Penetration Test
HSV:	Hand Shear Vane (kPa)
PP:	Pocket Penetrometer (kg/cm2)
PID:	Photo-Ionisation Detector (ppm)
B:	Large disturbed sample

Plant: Dando Terrier

Water observations: Perched water encountered at 2.5mbgl.

General remarks:
No recovery between 4.0m and 4.8mbgl due to collapse of made ground.

Logged by: JW	Checked by: CH	Approved by: RE

DYNAMIC SAMPLING RECORD

Project Title: Willow Tree Depot, Ditchfield Road	**Borehole:** WS04
Project No: 1712005.002	**Dates:** 16th February 2018
Client: London Borough of Hillingdon	

TWEEDIE EVANS CONSULTING
www.tecon.co.uk
info@tecon.co.uk

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results: Blow Count	SPT Results: N Value	Remarks/ Data	Installation
0.00	Ground Surface			0.0				
0.25	MADE GROUND Reinforced concrete hardstanding.							
	MADE GROUND Multicoloured sandy gravelly clay. Gravel of red brick, yellow brick, concrete, black carbonaceous material, plastic, glass, ceramic tile, ash, tarmacadam and chert. Organic odour.						PID at 0.5m - 0.0	
	.....pockets of black, red and purple gravelly sand. Gravel of black carbonaceous material, ash, red brick and tarmacadam.			1.0	(2, 2) 2, 2, 2, 2	**8**		
			A					
				2.0	(1, 1) 1, 1, 1, 1	**4**	PID at 2.0m - 0.0	
3.00	Firm to stiff high strength grey mottled orange-brown sandy CLAY.			3.0	(2, 1) 2, 3, 4, 4	**13**	HSV at 3.0m - 85, 90, 90 PP at 3.0m - 3.5, 3.5, 3.5, 3.5, 3.5	
			T					
				4.0	(2, 2) 3, 4, 5, 6	**18**	HSV at 4.0m - 137.5, 125, 137.5 PP at 4.0m - 4.0, 4.0, 3.5, 3.5, 3.5	
5.00	Borehole Terminated			5.0	(2, 2) 2, 3, 4, 5	**14**		

Notes:

A:	250ml and 60ml Amber Glass Jars
T:	Plastic Tub (1Kg)
SPT:	Standard Penetration Test
HSV:	Hand Shear Vane (kPa)
PP:	Pocket Penetrometer (kg/cm2)
PID:	Photo-Ionisation Detector (ppm)
B:	Large disturbed sample

Plant: Dando Terrier

Water observations: Perched water encountered at 2.5mbgl.

General remarks:

Logged by: JW	Checked by: CH	Approved by: RE

APPENDIX D

Geochemical Certificates of Analysis

Jordan Wright
Tweedie Evans Consulting Ltd
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Analytical Report Number : 18-77138

Project / Site name:	Willow Tree Depot, Ditchfield Road	**Samples received on:**	22/02/2018
Your job number:	1712005.001	**Samples instructed on:**	22/02/2018
Your order number:		**Analysis completed by:**	08/03/2018
Report Issue Number:	1	**Report issued on:**	08/03/2018
Samples Analysed:	14 soil samples		

Signed:

Rexona Rahman
Head of Customer Services
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Analytical Report Number: 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Lab Sample Number				914689	914690	914691	914692	914693
Sample Reference				TP01	TP02	TP03	WS01	WS03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	1.00	2.00	0.50	2.50
Date Sampled				15/02/2018	15/02/2018	15/02/2018	16/02/2018	16/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	13	21	30	17	36
Total mass of sample received	kg	0.001	NONE	0.52	0.52	0.57	0.54	0.44
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	Chrysotile- Loose Fibres	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	5.9	6.9	7.7	9.0	7.4
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	820	2300	1500	2100	8000
Total Sulphate as SO_4	%	0.005	MCERTS	-	-	-	-	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.046	1.0	0.59	1.0	2.2
Sulphide	mg/kg	1	MCERTS	< 1.0	27	150	65	75
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	-	-	-	-	-
Total Sulphur	%	0.005	MCERTS	-	-	-	-	-
Ammonium as NH_4	mg/kg	0.5	MCERTS	-	-	-	-	-
Ammonium as NH_4 (leachate equivalent)	mg/l	0.05	MCERTS	-	-	-	-	-
Total Organic Carbon (TOC)	%	0.1	MCERTS	3.6	0.8	2.6	1.9	7.0
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	-	-	-	-	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	2.8
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.41
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.63
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.6	0.74	2.8
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.31	0.18	0.66
Fluoranthene	mg/kg	0.05	MCERTS	0.31	< 0.05	3.5	2.1	4.1
Pyrene	mg/kg	0.05	MCERTS	0.27	< 0.05	2.8	2.1	4.2
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.13	< 0.05	2.0	1.5	2.1
Chrysene	mg/kg	0.05	MCERTS	0.18	< 0.05	2.3	1.2	1.8
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	3.0	2.2	2.8
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.6	0.99	1.3
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	2.8	2.0	2.0
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.3	1.2	1.4
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.28	0.23	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.5	1.4	1.9
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	0.89	< 0.80	22.9	15.9	28.9

Analytical Report Number: 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Lab Sample Number				914689	914690	914691	914692	914693
Sample Reference				TP01	TP02	TP03	WS01	WS03
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	1.00	2.00	0.50	2.50
Date Sampled				15/02/2018	15/02/2018	15/02/2018	16/02/2018	16/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	7.8	21	35	29	110
Barium (aqua regia extractable)	mg/kg	1	MCERTS	36	130	200	360	65
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	0.56	1.4	2.1	2.5	11
Boron (water soluble)	mg/kg	0.2	MCERTS	1.0	12	15	8.5	15
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	17	32	28	40	32
Copper (aqua regia extractable)	mg/kg	1	MCERTS	19	40	110	220	560
Lead (aqua regia extractable)	mg/kg	1	MCERTS	49	110	640	420	3200
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	0.9	0.8	1.1
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	8.9	28	38	47	81
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	26	51	61	65	79
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	30	75	130	330	690
Magnesium (water soluble)	mg/kg	5	NONE	-	-	-	-	-
Magnesium (leachate equivalent)	mg/l	2.5	NONE	-	-	-	-	-
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	< 10	< 10	48	120	1900
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	2.6
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	3.8	24
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	9.1	130
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	55	1100
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	68	1200
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	3.9	< 2.0	3.4
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	< 10	13	< 10	49
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	< 10	31	27	460
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	48	34	510

Analytical Report Number: 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Lab Sample Number				914694	914695	914696	914697	914698
Sample Reference				BH01	TP02	TP03	WS02	WS04
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.00	3.00	0.20	0.50	1.50
Date Sampled				13/02/2018	15/02/2018	15/02/2018	16/02/2018	16/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	24	25	20	17	23
Total mass of sample received	kg	0.001	NONE	0.47	0.59	0.55	0.54	0.39
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	Chrysotile- Loose Fibres	-	-	Chrysotile- Loose Fibres	-
Asbestos in Soil	Type	N/A	ISO 17025	Detected	Not-detected	Not-detected	Detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.2	7.6	7.5	7.7	7.9
Total Cyanide	mg/kg	1	MCERTS	2	< 1	< 1	< 1	2
Total Sulphate as SO_4	mg/kg	50	MCERTS	-	-	-	-	-
Total Sulphate as SO_4	%	0.005	MCERTS	-	-	-	-	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	2.0	1.3	0.016	0.028	0.87
Sulphide	mg/kg	1	MCERTS	61	41	< 1.0	1.4	3.1
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	-	-	-	-	-
Total Sulphur	%	0.005	MCERTS	-	-	-	-	-
Ammonium as NH_4	mg/kg	0.5	MCERTS	-	-	-	-	-
Ammonium as NH_4 (leachate equivalent)	mg/l	0.05	MCERTS	-	-	-	-	-
Total Organic Carbon (TOC)	%	0.1	MCERTS	4.6	2.2	2.2	3.3	5.7
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	-	-	-	-	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	1.1	< 0.05	< 0.05	0.53	0.42
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	0.23	< 0.05	< 0.05	0.33	< 0.05
Fluorene	mg/kg	0.05	MCERTS	0.31	< 0.05	< 0.05	0.30	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	2.9	0.51	0.25	5.6	0.76
Anthracene	mg/kg	0.05	MCERTS	0.74	0.12	< 0.05	1.3	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	7.5	1.5	0.49	11	1.7
Pyrene	mg/kg	0.05	MCERTS	7.3	1.4	0.48	9.6	1.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	5.8	1.0	0.30	6.9	1.5
Chrysene	mg/kg	0.05	MCERTS	4.6	0.91	0.24	4.8	2.1
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	8.0	1.5	0.34	8.5	6.2
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	4.7	0.82	0.15	4.2	2.6
Benzo(a)pyrene	mg/kg	0.05	MCERTS	7.5	1.2	0.36	7.5	2.9
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	4.7	0.82	< 0.05	4.1	4.1
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.99	< 0.05	< 0.05	0.88	0.79
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	5.1	0.94	< 0.05	4.6	3.5
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	61.1	10.7	2.61	70.0	27.9

Analytical Report Number: 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Lab Sample Number				914694	914695	914696	914697	914698
Sample Reference				BH01	TP02	TP03	WS02	WS04
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.00	3.00	0.20	0.50	1.50
Date Sampled				13/02/2018	15/02/2018	15/02/2018	16/02/2018	16/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	58	74	9.6	47	92
Barium (aqua regia extractable)	mg/kg	1	MCERTS	240	370	68	630	770
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	5.1	2.8	1.1	4.1	16
Boron (water soluble)	mg/kg	0.2	MCERTS	21	11	1.5	2.5	31
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	3.8	< 0.2
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	44	31	30	46	40
Copper (aqua regia extractable)	mg/kg	1	MCERTS	540	370	26	520	800
Lead (aqua regia extractable)	mg/kg	1	MCERTS	1400	1100	52	1100	2200
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	2.2	0.6	< 0.3	2.2	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	68	58	20	62	120
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	72	68	49	70	110
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	830	490	78	1600	630
Magnesium (water soluble)	mg/kg	5	NONE	-	-	-	-	-
Magnesium (leachate equivalent)	mg/l	2.5	NONE	-	-	-	-	-
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-	-	-	-	-
Toluene	µg/kg	1	MCERTS	-	-	-	-	-
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	-
p & m-xylene	µg/kg	1	MCERTS	-	-	-	-	-
o-xylene	µg/kg	1	MCERTS	-	-	-	-	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	-
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	-	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	-

Analytical Report Number: 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Lab Sample Number				914699	914700	914701	914702	
Sample Reference				BH01	BH01	WS01	WS02	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				5.00	9.00	4.00	3.00	
Date Sampled				13/02/2018	13/02/2018	16/02/2018	16/02/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	21	20	15	17	
Total mass of sample received	kg	0.001	NONE	0.42	0.44	0.46	0.45	
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	
Asbestos in Soil	Type	N/A	ISO 17025	-	-	-	-	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.2	8.3	8.3	8.0	
Total Cyanide	mg/kg	1	MCERTS	-	-	-	-	
Total Sulphate as SO_4	mg/kg	50	MCERTS	-	-	-	-	
Total Sulphate as SO_4	%	0.005	MCERTS	0.050	0.089	0.118	0.105	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.21	0.48	0.24	0.31	
Sulphide	mg/kg	1	MCERTS	-	-	-	-	
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	80	78	26	33	
Total Sulphur	%	0.005	MCERTS	0.033	0.440	0.043	0.044	
Ammonium as NH_4	mg/kg	0.5	MCERTS	0.9	4.6	93	94	
Ammonium as NH_4 (leachate equivalent)	mg/l	0.05	MCERTS	0.09	0.46	9.32	9.41	
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	-	-	
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	< 2.0	< 2.0	< 2.0	< 2.0	
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	-	-	-	-	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	-	-	-	
Acenaphthylene	mg/kg	0.05	MCERTS	-	-	-	-	
Acenaphthene	mg/kg	0.05	MCERTS	-	-	-	-	
Fluorene	mg/kg	0.05	MCERTS	-	-	-	-	
Phenanthrene	mg/kg	0.05	MCERTS	-	-	-	-	
Anthracene	mg/kg	0.05	MCERTS	-	-	-	-	
Fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	
Pyrene	mg/kg	0.05	MCERTS	-	-	-	-	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	
Chrysene	mg/kg	0.05	MCERTS	-	-	-	-	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-	-	-	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-	-	-	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-	-	-	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-	-	-	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	-	-	-	

Analytical Report Number: 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Lab Sample Number				914699	914700	914701	914702	
Sample Reference				BH01	BH01	WS01	WS02	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				5.00	9.00	4.00	3.00	
Date Sampled				13/02/2018	13/02/2018	16/02/2018	16/02/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Barium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Beryllium (aqua regia extractable)	mg/kg	0.06	MCERTS	-	-	-	-	
Boron (water soluble)	mg/kg	0.2	MCERTS	-	-	-	-	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	-	-	-	
Chromium (hexavalent)	mg/kg	1.2	MCERTS	-	-	-	-	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	-	-	-	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	-	-	-	
Magnesium (water soluble)	mg/kg	5	NONE	67	84	49	57	
Magnesium (leachate equivalent)	mg/l	2.5	NONE	33	42	24	28	
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-	-	-	-	
Toluene	µg/kg	1	MCERTS	-	-	-	-	
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	-	
p & m-xylene	µg/kg	1	MCERTS	-	-	-	-	
o-xylene	µg/kg	1	MCERTS	-	-	-	-	
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	-	
Petroleum Hydrocarbons								
TPH C10 - C40	mg/kg	10	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	-	
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	-	
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	-	
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	-	

Analytical Report Number : 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
914689	TP01	None Supplied	0.20	Brown loam and sand with gravel and vegetation.
914690	TP02	None Supplied	1.00	Brown clay and sand.
914691	TP03	None Supplied	2.00	Brown clay with coal and gravel
914692	WS01	None Supplied	0.50	Brown clay and sand with gravel and brick.
914693	WS03	None Supplied	2.50	Brown clay and sand with gravel and brick.
914694	BH01	None Supplied	1.00	Brown clay and sand with gravel and vegetation.
914695	TP02	None Supplied	3.00	Brown clay and sand with gravel and brick.
914696	TP03	None Supplied	0.20	Brown loam and clay with gravel and vegetation.
914697	WS02	None Supplied	0.50	Brown clay and sand with gravel and vegetation.
914698	WS04	None Supplied	1.50	Brown sand with gravel and coal.
914699	BH01	None Supplied	5.00	Brown clay.
914700	BH01	None Supplied	9.00	Brown clay.
914701	WS01	None Supplied	4.00	Brown clay with gravel.
914702	WS02	None Supplied	3.00	Brown clay with gravel.

Analytical Report Number : 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
Hexavalent chromium in soil (Lower Level)	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS

Analytical Report Number : 18-77138

Project / Site name: Willow Tree Depot, Ditchfield Road

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphate in soil as %	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L038	D	MCERTS
Total Sulphur in soil as %	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038	W	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding.	L076-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS
Water Soluble Nitrate (2:1) as N in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH01		S	18-77138	914694	c	Sulphide in soil	L010-PL	c
BH01		S	18-77138	914694	c	Total cyanide in soil	L080-PL	c
TP01		S	18-77138	914689	c	Total cyanide in soil	L080-PL	c
TP02		S	18-77138	914690	c	Total cyanide in soil	L080-PL	c
TP02		S	18-77138	914695	c	Total cyanide in soil	L080-PL	c
TP03		S	18-77138	914691	c	Total cyanide in soil	L080-PL	c
TP03		S	18-77138	914696	c	Total cyanide in soil	L080-PL	c

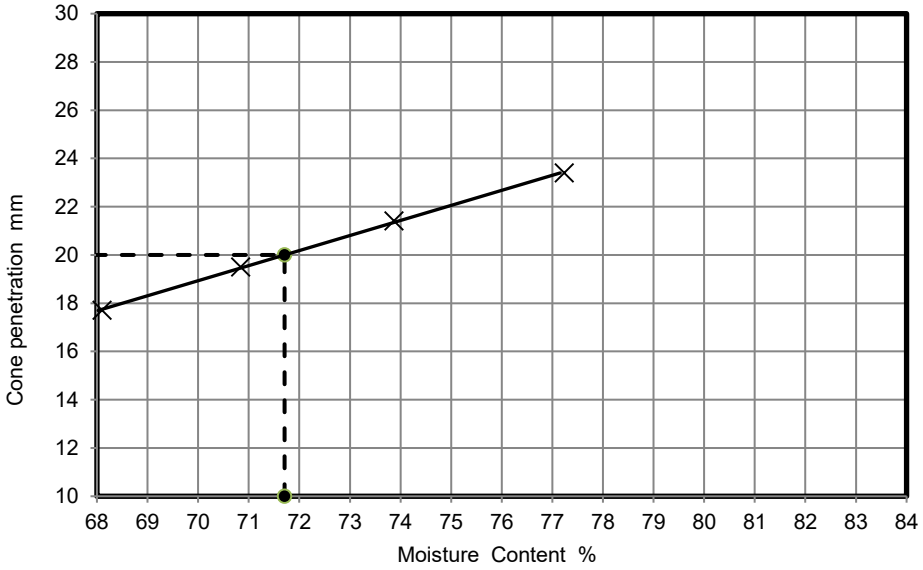
Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

APPENDIX E

Soil Geotechnical Certificates of Analysis

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

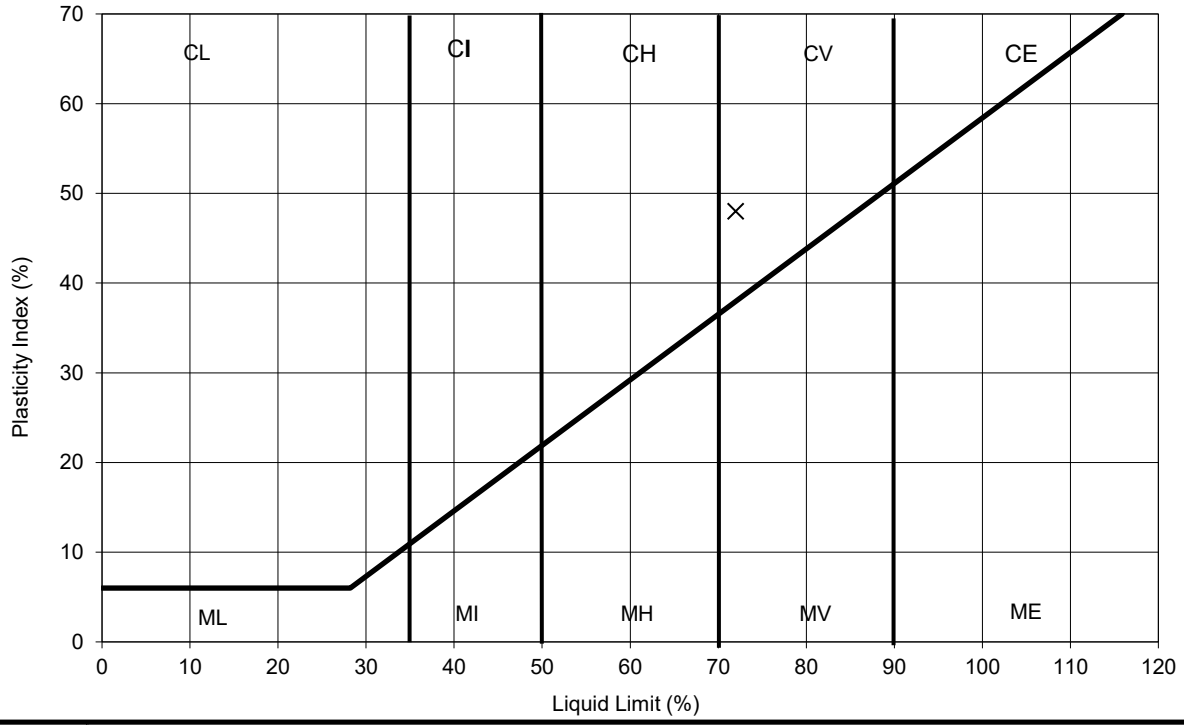
				Job No.	24110
				Borehole/Pit No.	BH01
Site Name	Willow Tree Depot, Ditchfield Road			Sample No.	-
Project No.	1712005.001	Client	TEC	Depth Top	7.00 m
Soil Description	Dark grey silty CLAY with rare fm sub-angular gravel			Depth Base	- m
				Sample Type	D
				Samples received	21/02/2018
				Schedules received	23/02/2018
				Project Started	23/02/2018
				Date Tested	09/03/2018



NATURAL MOISTURE CONTENT	**30**	**%**
% PASSING 425µm SIEVE	**99**	**%**
LIQUID LIMIT	**72**	**%**
PLASTIC LIMIT	**24**	**%**
PLASTICITY INDEX	**48**	**%**

Remarks

PLASTICITY INDEX



TEST METHOD

BS1377: Part 2 :Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method
BS1377: Part 2 :Clause 5.0 : 1990: Determination of the plastic limit and plasticity index
BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

Checked and Approved

Initials: J.P
Date: 12/03/2018

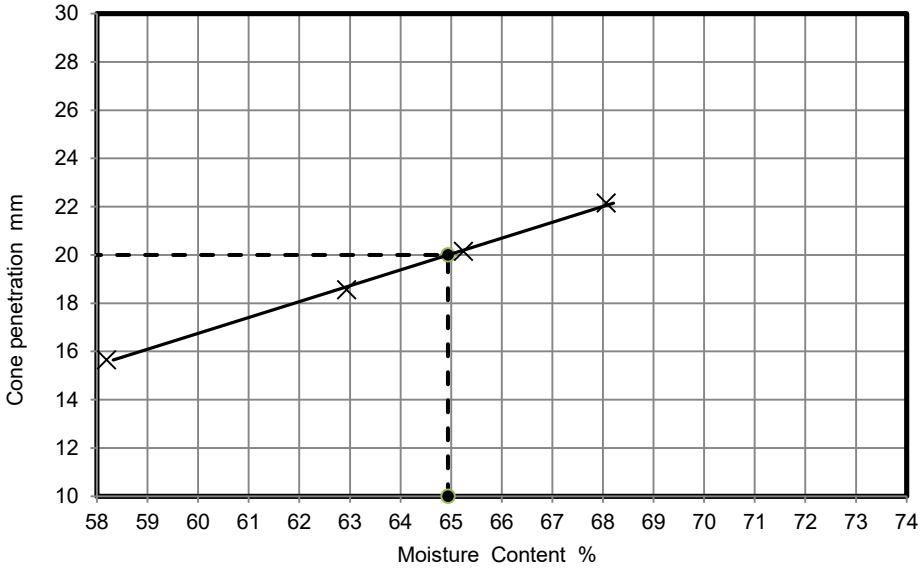
Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU
Tel: 01923 711 288 Email: James@k4soils.com

2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

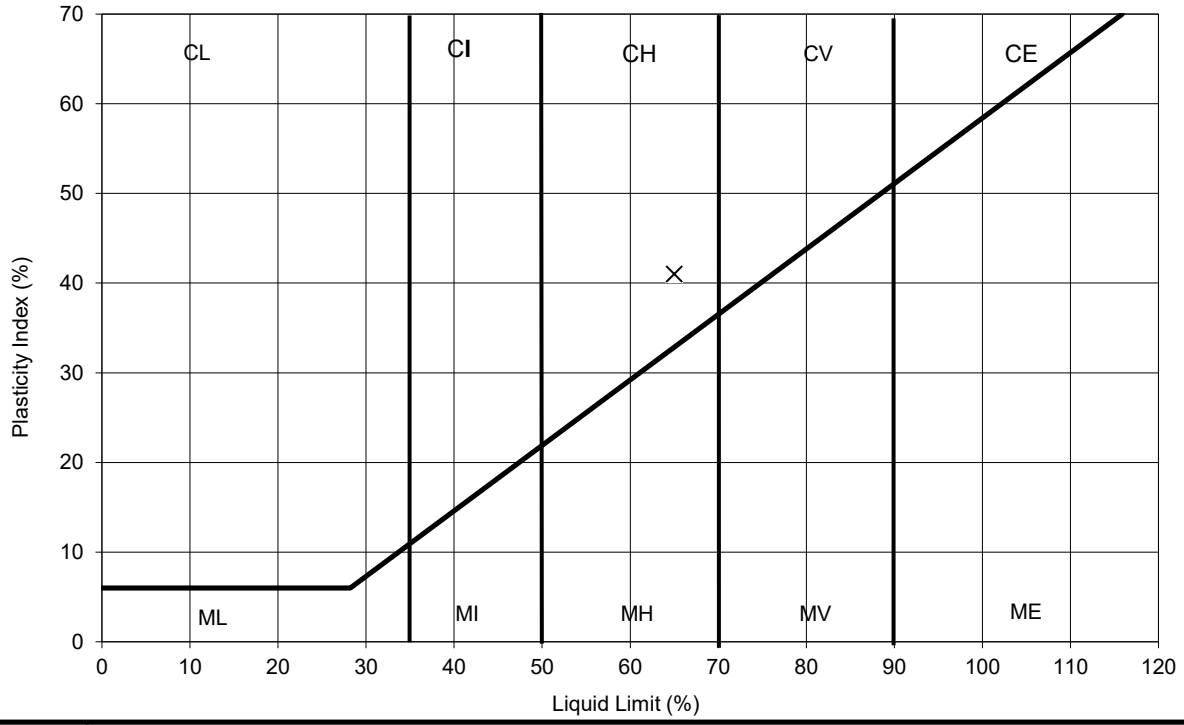
				Job No.	24110
				Borehole/Pit No.	BH01
Site Name	Willow Tree Depot, Ditchfield Road			Sample No.	-
Project No.	1712005.001	Client	TEC	Depth Top	12.00 m
Soil Description	Dark grey silty CLAY with rare fine siltstone fragments and black carbonaceous deposits			Depth Base	- m
				Sample Type	D
				Samples received	21/02/2018
				Schedules received	23/02/2018
				Project Started	23/02/2018
				Date Tested	09/03/2018



NATURAL MOISTURE CONTENT	**31**	**%**
% PASSING 425µm SIEVE	**99**	**%**
LIQUID LIMIT	**65**	**%**
PLASTIC LIMIT	**24**	**%**
PLASTICITY INDEX	**41**	**%**

Remarks

PLASTICITY INDEX



TEST METHOD

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BS1377: Part 2 :Clause 5.0 : 1990: Determination of the plastic limit and plasticity index
BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU
Tel: 01923 711 288 Email: James@k4soils.com

Checked and Approved

Initials: J.P
Date: 12/03/2018

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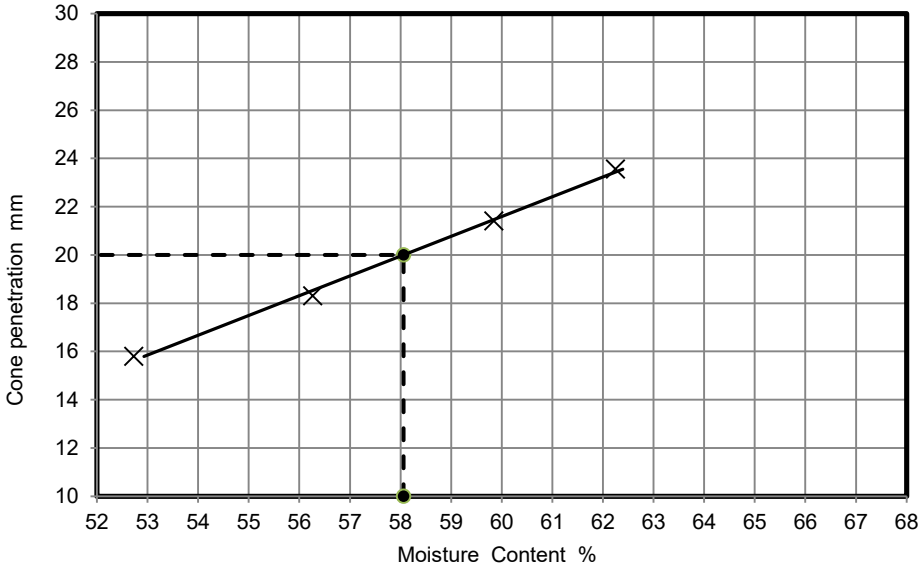
Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

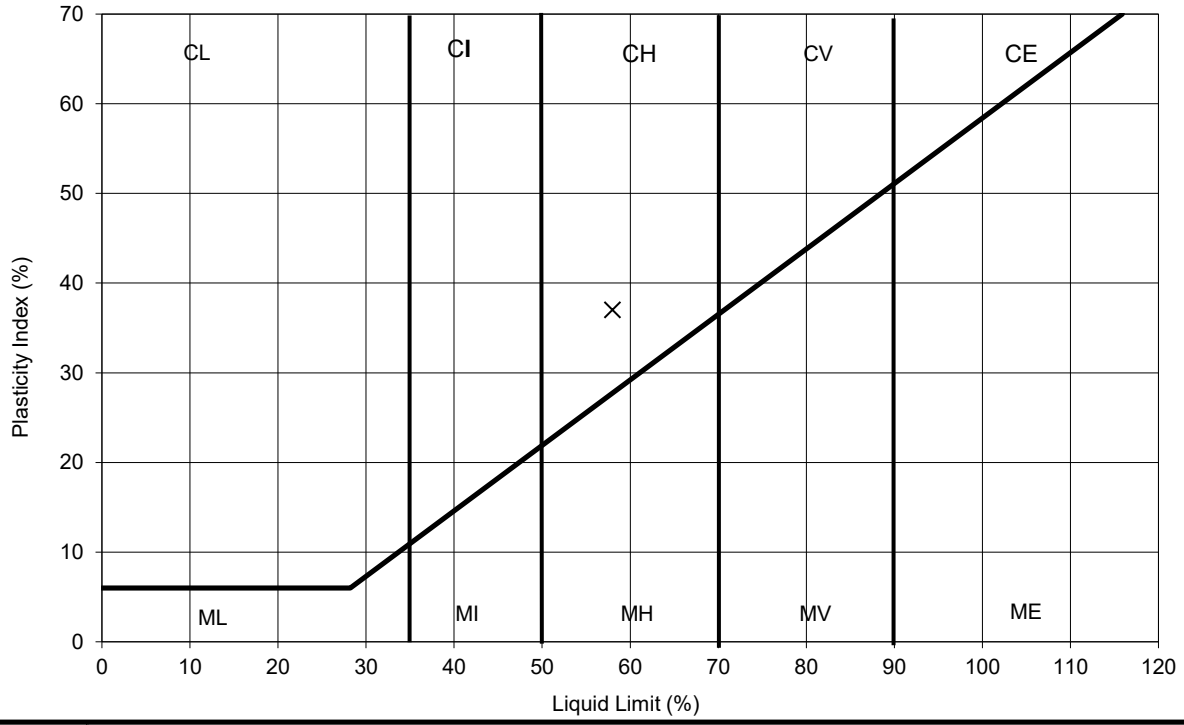
	LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX			Job No.	24110
				Borehole/Pit No.	WS01
Site Name	Willow Tree Depot, Ditchfield Road			Sample No.	-
Project No.	1712005.001	Client	TEC	Depth Top	3.60 m
Soil Description	Orangish brown, brown and grey mottled slightly sandy silty CLAY with rare fine sub-angular gravel			Depth Base	- m
				Sample Type	D
				Samples received	21/02/2018
				Schedules received	23/02/2018
				Project Started	23/02/2018
				Date Tested	09/03/2018



NATURAL MOISTURE CONTENT	**23**	**%**
% PASSING 425µm SIEVE	**99**	**%**
LIQUID LIMIT	**58**	**%**
PLASTIC LIMIT	**21**	**%**
PLASTICITY INDEX	**37**	**%**

Remarks

PLASTICITY INDEX



TEST METHOD

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BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

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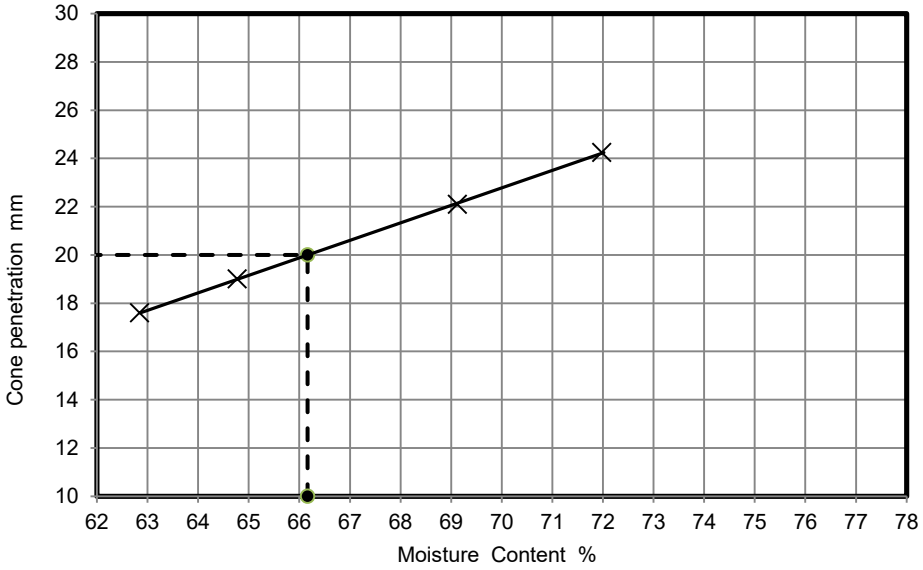
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

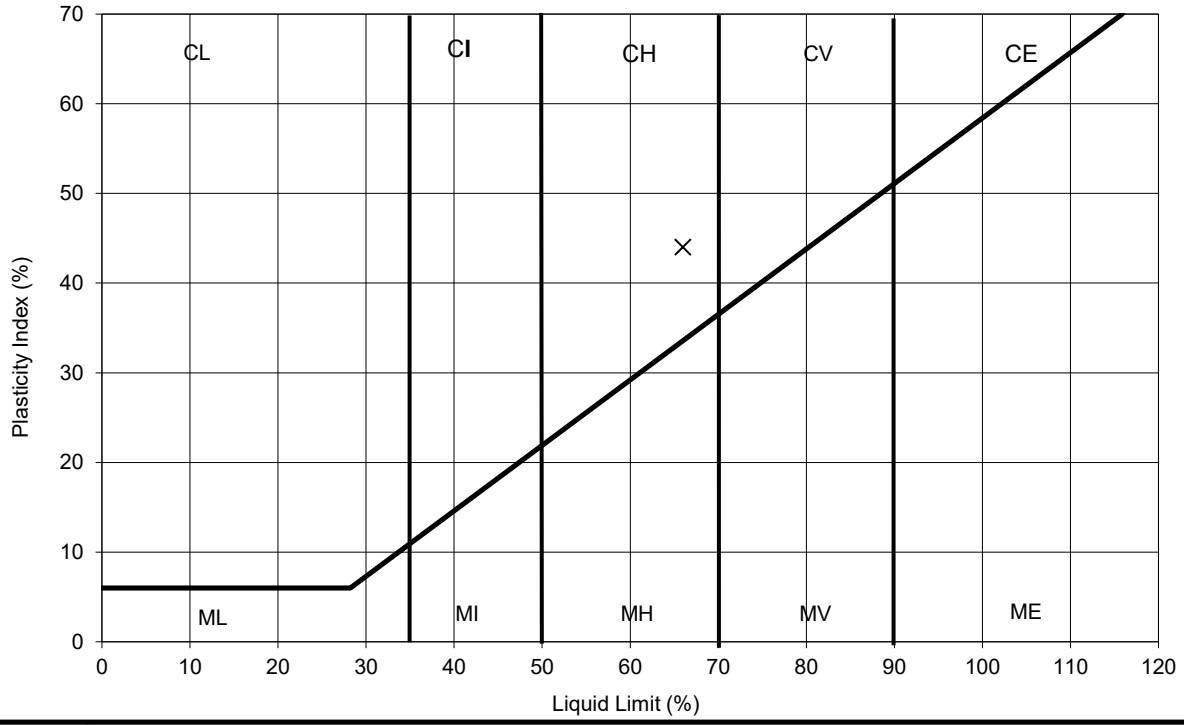
				Job No.	24110
				Borehole/Pit No.	WS03
Site Name	Willow Tree Depot, Ditchfield Road			Sample No.	-
Project No.	1712005.001	Client	TEC	Depth Top	4.80 m
Soil Description	Brown silty CLAY with rare fine sub-angular gravel and rare pockets of orange fine sand			Depth Base	- m
				Sample Type	D
				Samples received	21/02/2018
				Schedules received	23/02/2018
				Project Started	23/02/2018
				Date Tested	09/03/2018



NATURAL MOISTURE CONTENT	**27**	**%**
% PASSING 425µm SIEVE	**99**	**%**
LIQUID LIMIT	**66**	**%**
PLASTIC LIMIT	**22**	**%**
PLASTICITY INDEX	**44**	**%**

Remarks

PLASTICITY INDEX



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Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU
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Checked and Approved

Initials: J.P
Date: 12/03/2018

2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No.	Project Name	Programme	
24110	Willow Tree Depot, Ditchfield Road	Samples received	21/02/2018
		Schedule received	23/02/2018
Project No.	Client	Project started	23/02/2018
1712005.001	TEC	Testing Started	09/03/2018

Hole No.	Sample				Soil Description	NMC	Passing 425µm	LL	PL	PI	Remarks
	Ref	Top m	Base m	Type		%	%	%	%	%	
BH01	-	7.00	-	D	Dark grey silty CLAY with rare fm sub-angular gravel	30	99	72	24	48	
BH01	-	12.00	-	D	Dark grey silty CLAY with rare fine siltstone fragments and black carbonaceous deposits	31	99	65	24	41	
WS01	-	3.60	-	D	Orangish brown, brown and grey mottled slightly sandy silty CLAY with rare fine sub-angular gravel	23	99	58	21	37	
WS03	-	4.80	-	D	Brown silty CLAY with rare fine sub-angular gravel and rare pockets of orange fine sand	27	99	66	22	44	

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3, 4.4 and 5.0

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU

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Checked and Approved

Initials **J.P**

Date: 12/03/2018

2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

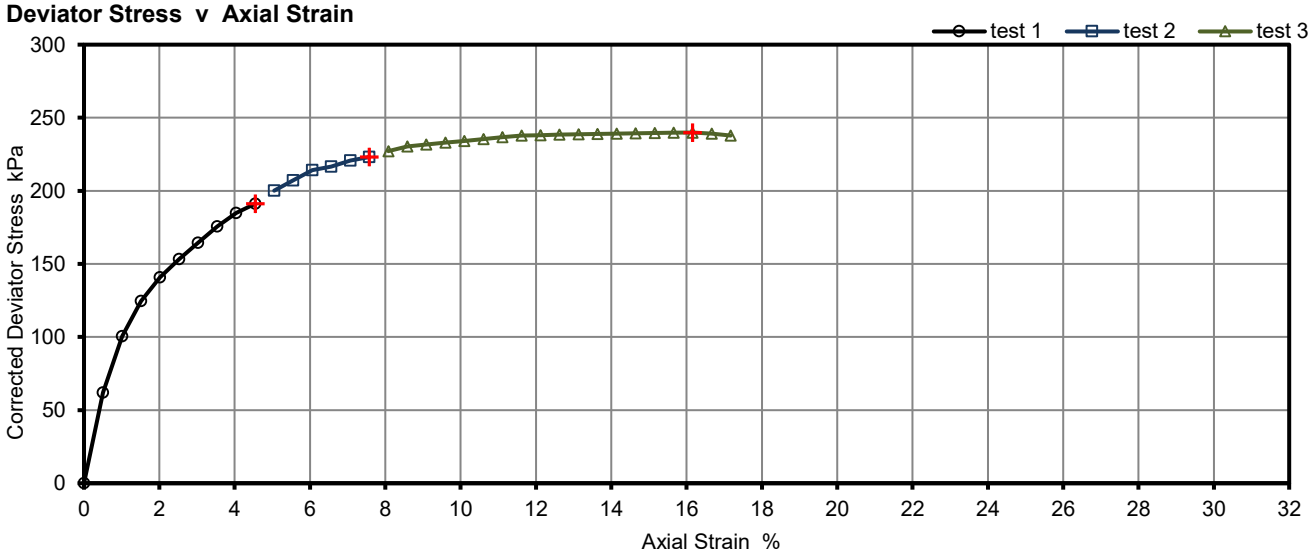
	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test			Job Ref	24110
				Borehole/Pit No.	BH01
Site Name	Willow Tree Depot, Ditchfield Road			Sample No.	-
Project No.	1712005.001	Client	TEC	Depth Top	4.00 m
Soil Description	High strength fissured brown mottled bluish grey silty CLAY			Depth Base	- m
				Sample Type	U
				Samples received	21/02/2018
				Schedules received	23/02/2018
Test Method	BS1377:Part 7:1990, clause 9, multistage test on a single specimen			Date of test	08/03/2018

Remarks

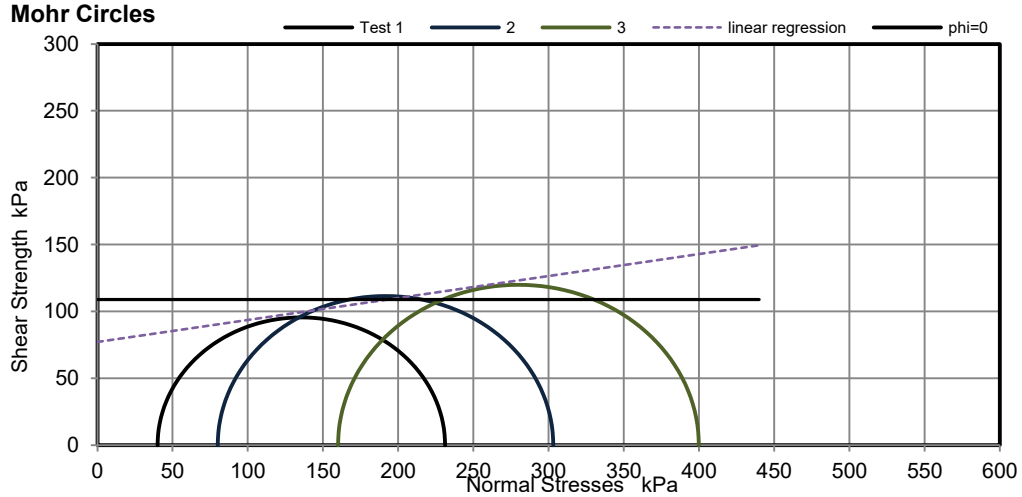
Position within sample

Length	mm	198.0		
Diameter	mm	102.0		
Bulk Density	Mg/m3	2.06		
Moisture Content	%	25		
Dry Density	Mg/m3	1.64		
Rate of Strain	%/min	2.00		
Stage Number		1	2	3
Cell Pressure	kPa	40	80	160
Axial Strain	%	4.5	7.6	16.2
Deviator Stress, (σ1 - σ3)f	kPa	191.2	223.1	239.9
Shear strength, cu	kPa	95.6	111.6	119.9
Mode of failure		Brittle		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 109 kPa

Linear Regression

ϕu 9.3 °

cu 77 kPa

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

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Date: 12/03/2018

UKAS TESTING 2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

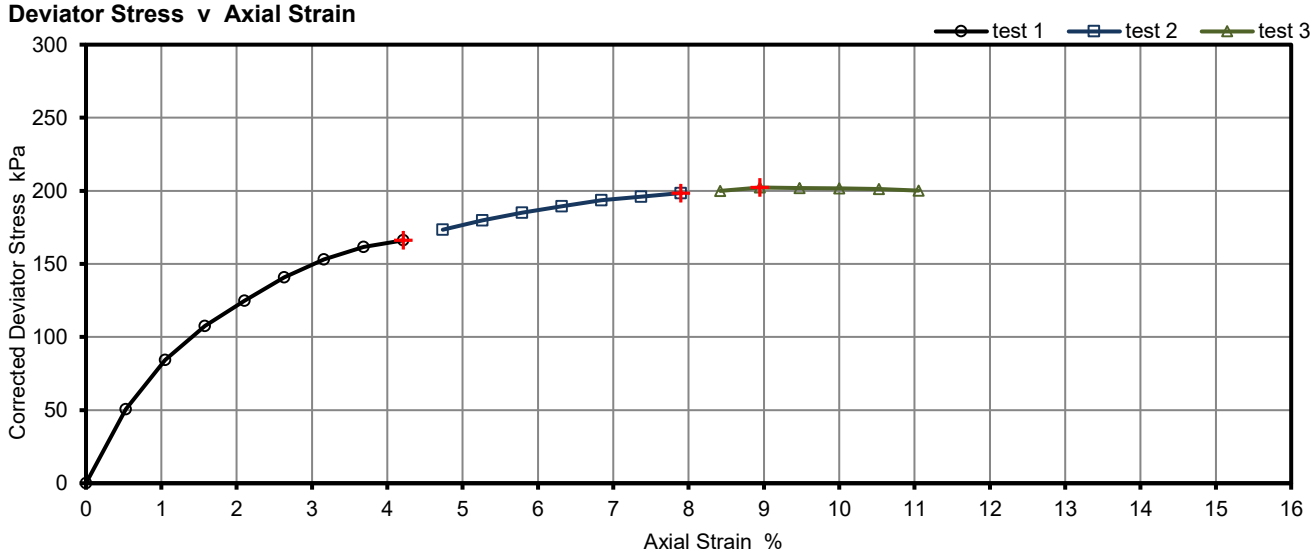
	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test			Job Ref	24110
				Borehole/Pit No.	BH01
Site Name	Willow Tree Depot, Ditchfield Road			Sample No.	-
Project No.	1712005.001	Client	TEC	Depth Top	6.50 m
Soil Description	High strength fissured dark grey silty CLAY			Depth Base	- m
				Sample Type	U
				Samples received	21/02/2018
				Schedules received	23/02/2018
Test Method	BS1377:Part 7:1990, clause 9, multistage test on a single specimen			Date of test	08/03/2018

Remarks

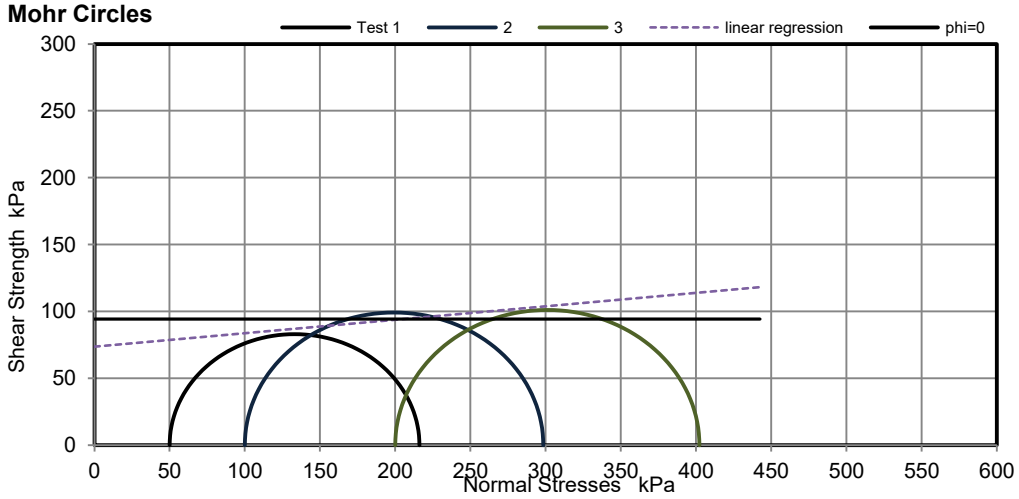
Position within sample

Length	mm	190.0		
Diameter	mm	102.0		
Bulk Density	Mg/m3	2.02		
Moisture Content	%	31		
Dry Density	Mg/m3	1.55		
Rate of Strain	%/min	2.00		
Stage Number		1	2	3
Cell Pressure	kPa	50	100	200
Axial Strain	%	4.2	7.9	8.9
Deviator Stress, (σ1 - σ3)f	kPa	166.1	198.5	202.3
Shear strength, cu	kPa	83.1	99.2	101.1
Mode of failure		Brittle		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 94 kPa

Linear Regression

ϕu 5.7 °

cu 74 kPa

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Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

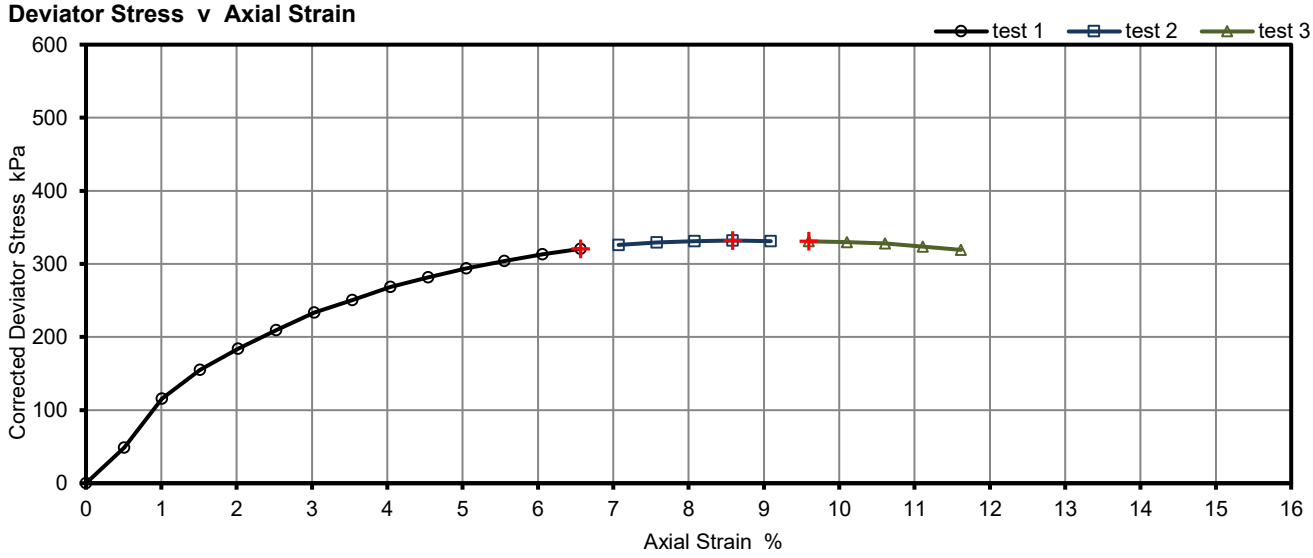
Site Name	Willow Tree Depot, Ditchfield Road			Job Ref	24110
				Borehole/Pit No.	BH01
Project No.	1712005.001	Client	TEC	Sample No.	-
				Depth Top	9.50 m
Soil Description	Very high strength fissured dark grey silty CLAY			Depth Base	- m
				Sample Type	U
				Samples received	21/02/2018
				Schedules received	23/02/2018
Test Method	BS1377:Part 7:1990, clause 9, multistage test on a single specimen			Date of test	08/03/2018

Remarks

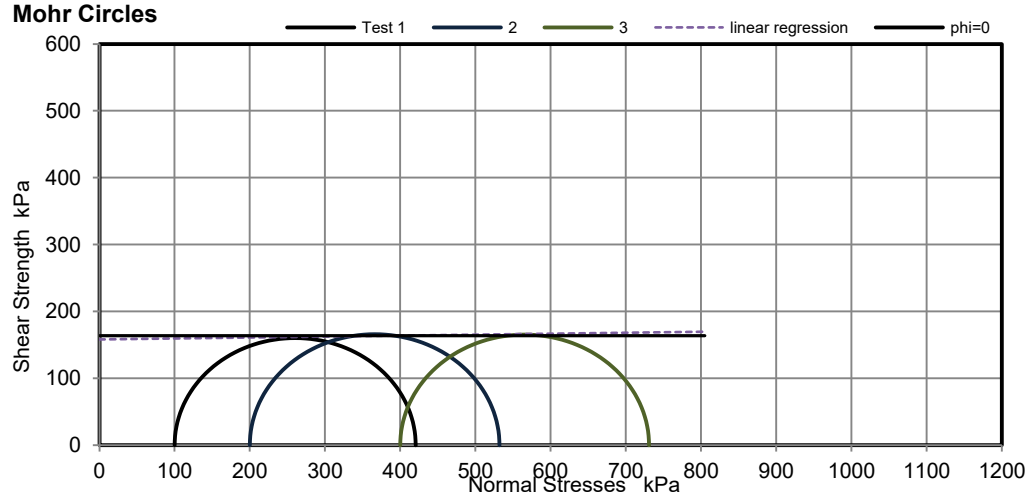
Position within sample

Length	mm	198.0		
Diameter	mm	102.0		
Bulk Density	Mg/m3	2.07		
Moisture Content	%	26		
Dry Density	Mg/m3	1.64		
Rate of Strain	%/min	2.00		
Stage Number		1	2	3
Cell Pressure	kPa	100	200	400
Axial Strain	%	6.6	8.6	9.6
Deviator Stress, (σ1 - σ3)f	kPa	320.6	332.0	330.9
Shear strength, cu	kPa	160.3	166.0	165.5
Mode of failure		Brittle		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 164 kPa

Linear Regression

ϕu 0.8 °

cu 158 kPa

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Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

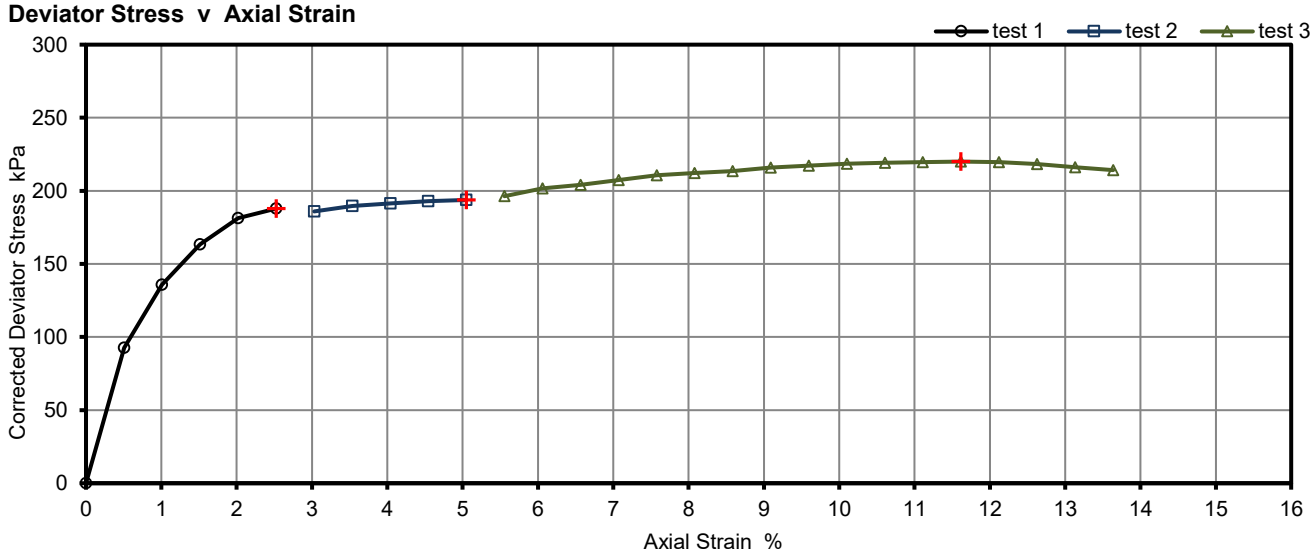
Site Name	Willow Tree Depot, Ditchfield Road			Job Ref	24110
				Borehole/Pit No.	BH01
Project No.	1712005.001	Client	TEC	Sample No.	-
				Depth Top	12.50 m
Soil Description	High strength slightly fissured dark grey silty CLAY			Depth Base	- m
				Sample Type	U
				Samples received	21/02/2018
				Schedules received	23/02/2018
Test Method	BS1377:Part 7:1990, clause 9, multistage test on a single specimen			Date of test	08/03/2018

Remarks

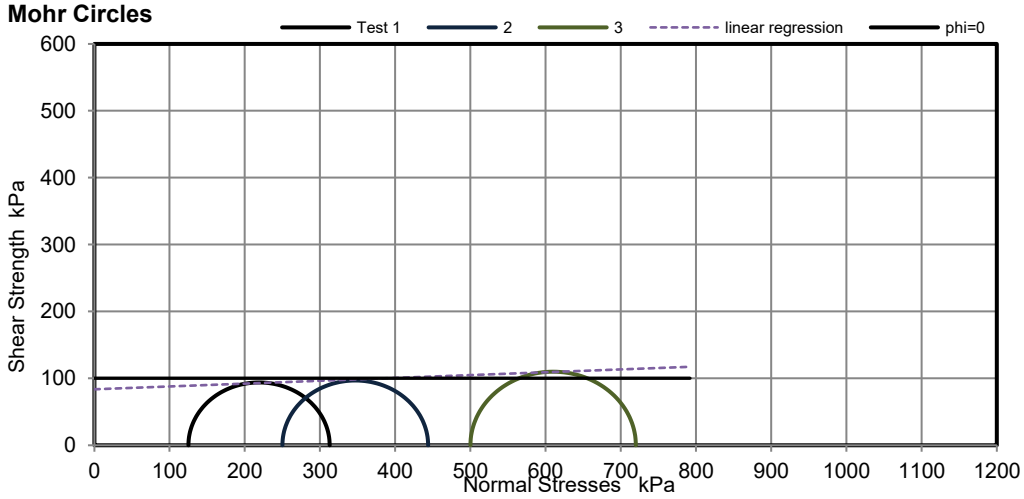
Position within sample

Length	mm	198.0		
Diameter	mm	102.0		
Bulk Density	Mg/m3	2.02		
Moisture Content	%	29		
Dry Density	Mg/m3	1.57		
Rate of Strain	%/min	2.00		
Stage Number		1	2	3
Cell Pressure	kPa	125	250	500
Axial Strain	%	2.5	5.1	11.6
Deviator Stress, (σ1 - σ3)f	kPa	187.8	193.8	220.0
Shear strength, cu	kPa	93.9	96.9	110.0
Mode of failure		Brittle		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 100 kPa

Linear Regression

ϕu 2.4 °

cu 84 kPa

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UKAS TESTING 2519

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Unconsolidated Undrained Triaxial Compression tests without measurement of pore pressure
Summary of Results

Tests carried out in accordance with BS1377:Part 7 : 1990 clause 8 or 9 as appropriate to test

Job No.	Project Name	Programme	
24110	Willow Tree Depot, Ditchfield Road	Samples received	21/02/2018
		Schedule received	23/02/2018
Project No.	Client	Project started	23/02/2018
1712005.001	TEC	Testing Started	08/03/2018

Hole No.	Sample Ref	Sample Top m	Sample Base m	Sample Type	Soil Description	Test Type	Density bulk Mg/m3	Density dry Mg/m3	w %	Length mm	Diameter mm	σ3 kPa	At failure Axial strain %	At failure σ1 - σ3 kPa	At failure cu kPa	At failure Mode	Remarks
BH01	-	4.00	-	U	High strength fissured brown mottled bluish grey silty CLAY	UUM	2.06	1.64	25	198	102	40 80 160	4.5 7.6 16.2	191 223 240	96 112 120	B	
BH01	-	6.50	-	U	High strength fissured dark grey silty CLAY	UUM	2.02	1.55	31	190	102	50 100 200	4.2 7.9 8.9	166 198 202	83 99 101	B	
BH01	-	9.50	-	U	Very high strength fissured dark grey silty CLAY	UUM	2.07	1.64	26	198	102	100 200 400	6.6 8.6 9.6	321 332 331	160 166 165	B	
BH01	-	12.50	-	U	High strength slightly fissured dark grey silty CLAY	UUM	2.02	1.57	29	198	102	125 250 500	2.5 5.1 11.6	188 194 220	94 97 110	B	

Legend				
	UU - single stage test (single and multiple specimens)	σ3	Cell pressure	Mode of failure ; B - Brittle
	UUM - Multistage test on a single specimen	σ1 - σ3	Maximum corrected deviator stress	P - Plastic
	suffix R - remoulded or recompacted	cu	Undrained shear strength, ½ (σ1 - σ3)	C - Compound

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APPENDIX F

Ground Gas Monitoring Results

Ground Gas Monitoring Data Sheet

Name of Site:	Willow Tree Depot, Ditchfield Road				
Project Code:	1712005.002				
Date: 16th February 2018	***Equipment***		***Last Three Days***		
Completed by: JW	**Gas Analyser:**	GFM430	**Atmospheric Trend:**	1010 - 1003Pa (falling)	
Authorised by: RE	**Condition:**	Good	**Temperature Range:**	-3 - 10°C	
	Dipmeter:	Red	**Rainfall:**	1.0 - 3.0mm	
	Condition:	Good			

On-site Weather Conditions: Sunny, dry

General Site Conditions / Ground Conditions / On site Activities: Concrete over made ground

GAS MONITORING TO BE UNDERTAKEN IN ACCORDANCE WITH TEC METHOD STATEMENT

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS01	0	1.7	7.0	0.0	0.1	20.1	0	2	0			
Time: 15:27	15	1.6	6.0	0.0	0.4	6.1	0	1	1			
Atmospheric Pressure (mb)	30	1.6	6.0	0.0	0.5	3.4	0	1	1			
Before: 1021	45	1.7	7.0	0.0	0.5	2.5	0	1	2			
After: 1021	60	1.5	6.0	0.0	0.5	2.2	0	2	2			
Well Condition: Good	120	1.6	6.0	0.0	0.4	2.3	0	3	4			Very silty at base.
	180			0.0	0.3	4.2	0	3	3			
Well Diameter: 50mm	240											
	300									2.83m	3.77m	
	360											

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS02	0	0.7	1.0	0.0	0.2	20.2	0	1	1			
Time: 15:47	15	0.6	2.0	0.0	0.2	20.0	0	1	1			
Atmospheric Pressure (mb)	30	0.5	2.0	0.0	0.4	20.0	0	2	2			
Before: 1020	45	0.7	1.0	0.0	0.5	19.9	0	2	1			
After: 1020	60	0.6	1.0	0.0	0.4	19.9	0	1	2			
Well Condition: Good	120	0.6	1.0	0.0	0.4	19.8	0	1	1			Bung had to be removed before testing to fix gas tap.
	180	0.6	1.0	0.0	0.4	19.8	0	1	1			
Well Diameter: 50mm	240											
	300									4.72m	5.05m	
	360											

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS03	0	1.4	5.0	0.0	0.3	12	1.6	1	1			
Time: 15:56	15	1.8	7.0	0.0	0.4	13.6	0	24	4			
Atmospheric Pressure (mb)	30	1.6	6.0	0.0	0.9	14	0	5	5			
Before: 1019	45	1.6	6.0	0.0	0.8	14.1	0	2	6			
After: 1019	60	1.5	6.0	0.0	0.8	14.3	0	2	5			
Well Condition: Good	120	1.5	6.0	0.0	0.8	14.6	0	3	6			
	180	1.4	5.0	0.0	1.0	14.4	0	2	6			
Well Diameter: 50mm	240											
	300									3.1m	4.65m	

Ground Gas Monitoring Data Sheet

Name of Site:	Willow Tree Depot, Ditchfield Road				
Project Code:	1712005.002				
Date: 5th March 2018	***Equipment***		***Last Three Days***		
Completed by: AM	**Gas Analyser:**	GFM430	**Atmospheric Trend:**	995Pa - 985Pa (falling)	
Authorised by: RE	**Condition:**	Good	**Temperature Range:**	-2°C - 11°C	
	Dipmeter:	Red	**Rainfall:**	4.56mm	
	Condition:	Good			

On-site Weather Conditions: Cloudy, dry

General Site Conditions / Ground Conditions / On site Activities: Concrete and grass over made ground

GAS MONITORING TO BE UNDERTAKEN IN ACCORDANCE WITH TEC METHOD STATEMENT

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS01	0	1.5	6.0	0.0	0.1	19.9	0	0	0			
Time: 13:00	15	1.5	6.0	0.0	4.6	5.8	0	1	1			
Atmospheric Pressure (mb)	30	1.5	6.0	0.0	4.8	2.3	0	1	3			
Before: 984	45	1.5	6.0	0.0	4.9	2.0	0	1	3			
After: 985	60	1.4	5.0	0.0	4.9	1.8	0	2	2			
Well Condition: Good	120	1.5	6.0	0.0	4.9	3.1	0	2	2			Very silty at base.
	180	1.5	6.0	0.0	4.4	4.8	0	3	3			
Well Diameter: 50mm	240			0.0	4.5	4.5	0	1	2			
	300									2.60m	3.77m	
	360											

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS02	0	1.3	5.0	0.0	0.1	19.7	0	1	2			
Time: 13:20	15	1.3	5.0	0.0	4.4	15.4	0	2	1			
Atmospheric Pressure (mb)	30	1.2	4.0	0.0	4.5	15.0	0	2	1			
Before: 984	45	1.2	4.0	0.0	4.5	15.0	0	2	2			
After: 984	60	1.3	5.0	0.0	4.5	14.9	0	1	2			
Well Condition: Good	120	1.2	4.0	0.0	4.6	14.7	0	2	1			
	180	1.3	5.0	0.0	4.7	14.6	0	1	1			
Well Diameter: 50mm	240											
	300									2.40m	4.90m	
	360											

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS03	0	1.7	6.0	0.0	0.1	20.6	0	0	0			
Time: 13:40	15	1.5	6.0	0.0	0.2	19.5	0	2	1			
Atmospheric Pressure (mb)	30	1.5	6.0	0.0	0.2	19.4	0	2	1			
Before: 984	45	1.7	6.0	0.0	0.2	19.3	0	1	2			
After: 984	60	1.5	6.0	0.0	0.3	19.2	0	2	2			
Well Condition: Good	120	1.7	6.0	0.0	0.8	18.5	0	2	2			
	180	1.6	6.0	0.0	1.2	17.9	0	2	2			
Well Diameter: 50mm	240			0.0	1.7	17.4	0	2	2			
	300			0.0	2.0	16.9	0	2	2	2.70m	4.65m	

Ground Gas Monitoring Data Sheet

Name of Site:	Willow Tree Depot, Ditchfield Road				***On-site Weather Conditions:*** Cloudy, dry
Project Code:	1712005.002				
Date: 10th April 2018	***Equipment***		***Last Three Days***		
Completed by: AM	**Gas Analyser:**	GFM430	**Atmospheric Trend:**	1010-998hPa	
Authorised by: RE	**Condition:**	Good	**Temperature Range:**	8-18°C	***General Site Conditions / Ground Conditions / On site Activities:*** Concrete and grass over made ground
	Dipmeter:	Green 15m	**Rainfall:**	10.16mm	
	Condition:	Good			

GAS MONITORING TO BE UNDERTAKEN IN ACCORDANCE WITH TEC METHOD STATEMENT

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS01	0	0.7	4.0	0.0	0.1	20.1	0	0	0			
Time: 13:06	15	0.7	4.0	0.0	0.1	20.8	0	0	0			
Atmospheric Pressure (mb)	30	0.9	3.0	0.0	0.1	20.8	0	0	0			
Before: 998	45	0.7	4.0	0.0	0.2	20.7	0	0	0			
After: 998	60	0.7	4.0	0.0	0.2	20.6	0	0	0			
Well Condition: Good	120	0.7	4.0	0.0	0.5	20.2	0	0	0			
	180	0.7	4.0	0.0	0.7	19.9	0	0	0			
Well Diameter: 50mm	240			0.0	0.1	20.7	0	0	0	2.65m	3.65m	
	300											

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS02	0	0.6	2.0	0.0	0.0	20.5	0	0	0			
Time: 13:20	15	0.7	2.0	0.0	5.1	13.5	0	0	0			
Atmospheric Pressure (mb)	30	0.5	1.0	0.0	5.2	12.9	0	0	0			
Before: 998	45	0.7	2.0	0.0	5.2	12.7	0	0	0			
After: 998	60	0.6	2.0	0.0	5.3	12.7	0	0	0			
Well Condition: Good	120	0.7	2.0	0.0	5.3	12.6	0	0	0			
	180	0.6	2.0	0.0	5.3	12.7	0	0	0			
Well Diameter: 50mm	240									2.45m	4.88m	
	300											
	360											

Borehole Information	Time (seconds)	Borehole Flow Rate (l/hr)	DP (Pa)	Gas Concentrations						Groundwater Level	Borehole Depth	Comments
				CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	LEL (%)	H_2S (ppm)	CO (ppm)			
BH ref: WS03	0	1.2	4.0	0.0	0.1	20.4	0	0	0			
Time: 12:48	15	1.0	4.0	0.0	1.8	17.4	0	0	0			
Atmospheric Pressure (mb)	30	1.0	3.0	0.0	1.8	16.8	0	0	0			
Before: 998	45	1.3	4.0	0.0	1.8	16.6	0	0	0			
After: 998	60	1.2	4.0	0.0	1.9	16.5	0	1	0			
Well Condition: Good	120	1.2	4.0	0.0	2.5	15.4	0	1	0			
	180	1.2	4.0	0.0	3.7	14.4	0	0	0			
Well Diameter: 50mm	240			0.0	4.6	13.6	0	0	1	2.42m	4.5m	
	300			0.0	5.3	12.9	0	1	0			
	360			0.0	5.8	12.3	0	0	0			
	420			0.0	6.2	11.6	0	0	0			

APPENDIX G

DCP-TRL Results

Dynamic Cone Penetration Test Data (DCP-TRL)

Willow Tree Depot, Ditchfield Road DCP01

TWEEDIE EVANS CONSULTING

Cumulative Blow Count	Penetration (mm)	Penetration Index (DPI) mm/blow	Estimated CBR[1] (%)	Adjusted CBR[2] (%)
0	50			
1	193	143.0	1.6	1.2
3	220	13.5	19.3	14.9
4	242	22.0	11.5	9.0
5	265	23.0	11.0	8.6
6	290	25.0	10.1	8.0
7	314	24.0	10.5	8.4
9	352	19.0	13.4	10.9
10	374	22.0	11.5	9.4
11	438	64.0	3.7	3.1
12	477	39.0	6.3	5.3
13	498	21.0	12.1	10.3
14	524	26.0	9.6	8.3
15	553	29.0	8.6	7.5
16	580	27.0	9.3	8.1
17	616	36.0	6.8	6.1
18	640	24.0	10.5	9.4
19	675	35.0	7.0	6.4
20	700	25.0	10.1	9.2
22	746	23.0	11.0	10.2
23	786	40.0	6.1	5.7
24	830	44.0	5.5	5.3
25	865	35.0	7.0	6.8
26	899	34.0	7.3	7.1
28	920	10.5	25.2	24.6
31	931	3.7	76.5	75.0

Date:	16/02/2018
Project:	Willow Tree Depot, Ditchfield Road
Project No.	1712005.002
Test No.	DCP01
Operator:	JW
Soil Type:	Made ground
Surface Moisture:	Moderate

Notes/Comments

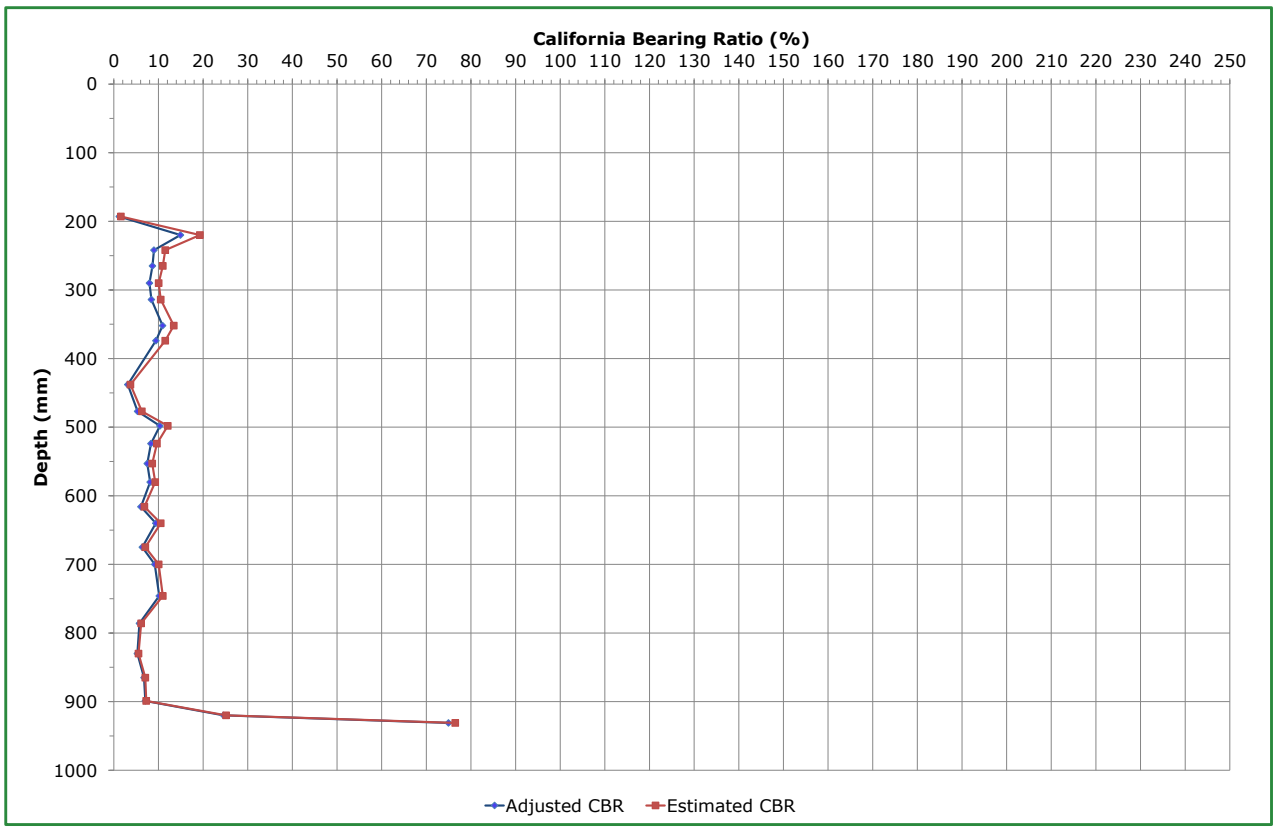
Notes:

1. CBR Value calculated using Jones C R and J Rolt (1991), "*Operating instructions for the TRL dynamic cone penetrometer*" (2nd edition). Information Note. Crowthorne: Transport Research Laboratory, as follows:

$$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057\ \text{Log}_{10}(\text{DPI})$$

2. Adjusted CBR vaules obtined from Table 4.2 of Simon Done and Piouslin Samuel (2006), *"Measuring Road Pavement Strength and Designing Low Volume Sealed Roads using the Dynamic Cone Penetrometer"* Unpublished TRL Project Report UPR/IE/76/06 Project Record No R7783.

The CBR Adjustment Factors are applied to unpaved roads on the assumption that the effect of moisture will be a maximum at the top surface and will reduce linearly to zero at a depth of 1000 mm.



Dynamic Cone Penetration Test Data (DCP-TRL)

Willow Tree Depot, Ditchfield Road DCP02

TWEEDIE EVANS CONSULTING

Cumulative Blow Count	Penetration (mm)	Penetration Index (DPI) mm/blow	Estimated CBR[1] (%)	Adjusted CBR[2] (%)
0	143			
1	193	50.0	4.8	3.7
2	213	20.0	12.7	9.8
4	247	17.0	15.1	11.8
5	270	23.0	11.0	8.7
6	295	25.0	10.1	8.0
7	324	29.0	8.6	6.9
8	355	31.0	8.0	6.5
9	378	23.0	11.0	9.0
10	402	24.0	10.5	8.7
11	430	28.0	8.9	7.4
12	452	22.0	11.5	9.7
13	476	24.0	10.5	8.9
15	510	17.0	15.1	13.0
17	552	21.0	12.1	10.5
18	585	33.0	7.5	6.6
19	609	24.0	10.5	9.3
20	629	20.0	12.7	11.4
22	667	19.0	13.4	12.1
23	688	21.0	12.1	11.0
24	712	24.0	10.5	9.6
26	755	21.5	11.8	11.0
27	778	23.0	11.0	10.3
28	798	20.0	12.7	12.0
30	840	21.0	12.1	11.5
31	860	20.0	12.7	12.2
32	883	23.0	11.0	10.6
33	910	27.0	9.3	9.0
34	945	35.0	7.0	6.9
35	953	8.0	33.5	33.1

Date:	16/02/2018
Project:	Willow Tree Depot, Ditchfield Road
Project No.	1712005.002
Test No.	DCP02
Operator:	JW
Soil Type:	Made ground
Surface Moisture:	Moderate

Notes/Comments

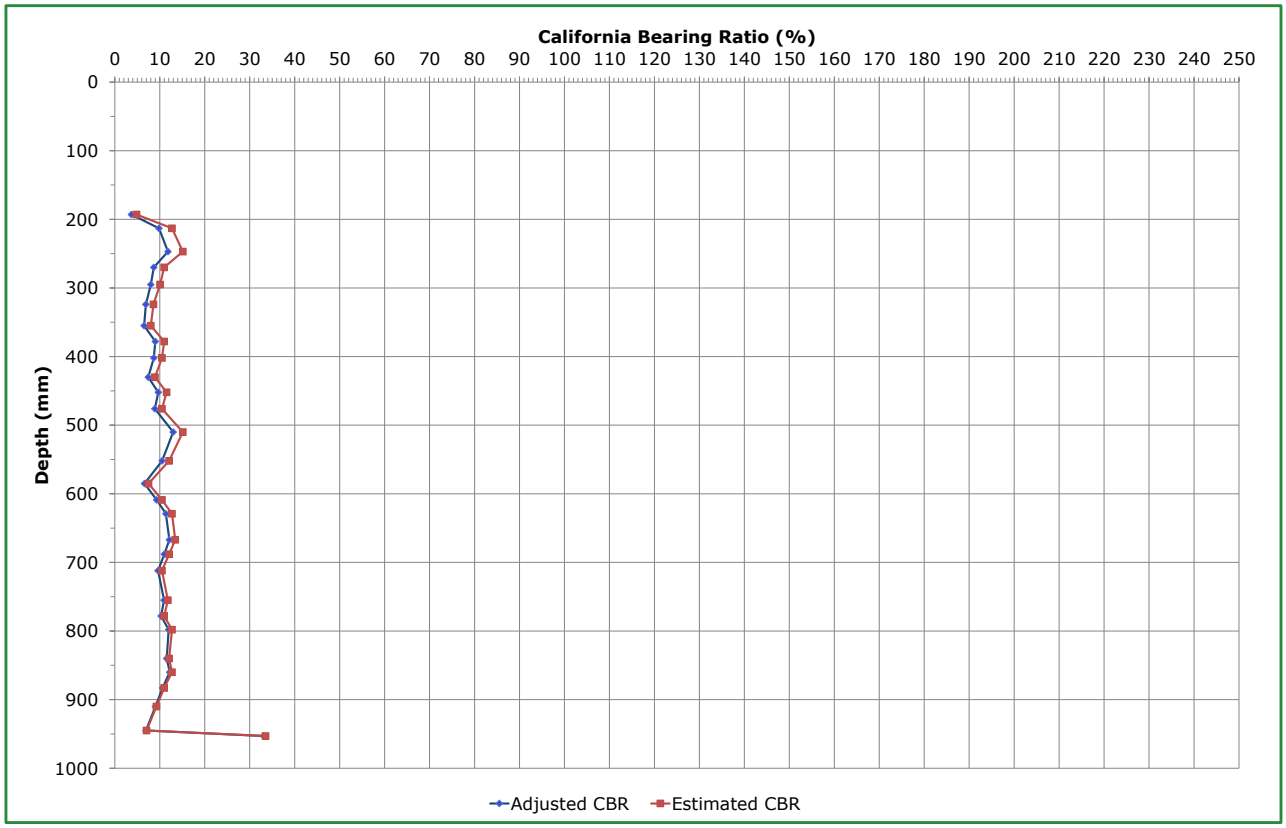
Notes:

1. CBR Value calculated using Jones C R and J Rolt (1991), "*Operating instructions for the TRL dynamic cone penetrometer*" (2nd edition). Information Note. Crowthorne: Transport Research Laboratory, as follows:

$$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057\ \text{Log}_{10}(\text{DPI})$$

2. Adjusted CBR vaules obtined from Table 4.2 of Simon Done and Piouslin Samuel (2006), "*Measuring Road Pavement Strength and Designing Low Volume Sealed Roads using the Dynamic Cone Penetrometer*" Unpublished TRL Project Report UPR/IE/76/06 Project Record No R7783.

The CBR Adjustment Factors are applied to unpaved roads on the assumption that the effect of moisture will be a maximum at the top surface and will reduce linearly to zero at a depth of 1000 mm.



Dynamic Cone Penetration Test Data (DCP-TRL)

Willow Tree Depot, Ditchfield Road DCP03

TWEEDIE EVANS CONSULTING

Cumulative Blow Count	Penetration (mm)	Penetration Index (DPI) mm/blow	Estimated CBR[1] (%)	Adjusted CBR[2] (%)
0	105			
1	175	70.0	3.4	2.6
2	215	40.0	6.1	4.7
3	246	31.0	8.0	6.3
4	280	34.0	7.3	5.7
5	335	55.0	4.4	3.5
6	390	55.0	4.4	3.6
7	453	63.0	3.8	3.2
8	520	67.0	3.5	3.1
9	553	33.0	7.5	6.5
10	582	29.0	8.6	7.6
12	614	16.0	16.1	14.3
14	637	11.5	22.8	20.4
16	657	10.0	26.5	23.9
18	679	11.0	23.9	21.7
20	699	10.0	26.5	24.2
36	720	1.3	226.6	208.2
47	741	1.9	152.5	141.0
55	762	2.6	108.9	101.4
60	792	6.0	45.4	42.7
62	813	10.5	25.2	23.8
65	835	7.3	36.8	35.0
67	865	15.0	17.3	16.6
68	900	35.0	7.0	6.8
69	941	41.0	6.0	5.9

Date:	16/02/2018
Project:	Willow Tree Depot, Ditchfield Road
Project No:	1712005.002
Test No:	DCP03
Operator:	JW
Soil Type:	Made ground
Surface Moisture:	Moderate

Notes/Comments

Notes:

1. CBR Value calculated using Jones C R and J Rolt (1991), "*Operating instructions for the TRL dynamic cone penetrometer*" (2nd edition). Information Note. Crowthorne: Transport Research Laboratory, as follows:

$$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057\ \text{Log}_{10}(\text{DPI})$$

2. Adjusted CBR vaules obtined from Table 4.2 of Simon Done and Piouslin Samuel (2006), "*Measuring Road Pavement Strength and Designing Low Volume Sealed Roads using the Dynamic Cone Penetrometer*" Unpublished TRL Project Report UPR/IE/76/06 Project Record No R7783.

The CBR Adjustment Factors are applied to unpaved roads on the assumption that the effect of moisture will be a maximum at the top surface and will reduce linearly to zero at a depth of 1000 mm.