



Main Investigation Report

at

Palmer Park Sports Stadium, Wokingham Road, Reading RG6 1LF

for

Reading Borough Council

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This is not a valid document for use in the design of the project unless it is titled Final in the document status box.

Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Commission

Reading Borough Council commissioned Soils Limited to undertake an intrusive ground investigation and produce a Main Investigation Report on land at Palmer Park Sports Stadium, Wokingham Road, Reading RG6 1LF. The scope of the investigation was outlined in the Soils Limited quotation reference Q21595/rev102, dated 11th July 2019.

This document comprises the Main Investigation Report and incorporates the results, discussion and conclusions to this intrusive works.

This Main Investigation Report must be read in conjunction with the Preliminary Investigation Report undertaken on the above site by Soils Limited, Report ref: 17760/PIR, dated August 2019.

Standards

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards:

- BS 5930:2015 and BS EN ISO 22476-2&3:2005+A1:2011
- BS EN ISO 14688-1:2002+A1:2013
- BS EN ISO 14688-2:2004+A1:2013
- BS 10175:2011+A1:2013

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice was adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The chemical analyses were undertaken by DETS Environmental Limited in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce a trial hole.

Contents

Section 1	Introduction.....	1
1.1	Objective of Investigation.....	1
1.2	Location	1
1.3	Site Description.....	1
1.4	Proposed Development	1
1.5	Anticipated Geology.....	2
1.5.1	Taplow Gravel Member.....	2
1.5.2	Lambeth Group.....	2
1.5.3	Seaford and Newhaven Chalk Formation	2
1.6	Limitations and Disclaimers	3
Section 2	Site Works	5
2.1	Proposed Project Works	5
2.1.1	Actual Project Works.....	5
2.2	Ground Conditions	6
2.3	Ground Conditions Encountered in Trial Holes	8
2.3.1	Made Ground and Topsoil	8
2.3.2	Taplow Gravel Member.....	9
2.3.3	Lambeth Group.....	9
2.3.4	Seaford and Newhaven Chalk Formation	10
2.4	Roots/Rootlets	10
2.5	Groundwater	11
2.6	Foundation Exposures	11
Section 3	Discussion of Geotechnical In-Situ and Laboratory Testing	12
3.1	Standard Penetration Tests	12
3.2	Dynamic Probe Tests.....	12
3.3	Dynamic Cone Penetrometer Tests	13
3.4	Falling Head Soakage Tests.....	13
3.5	Quick Unconsolidated Undrained Triaxial Compression Tests.....	13
3.6	Atterberg Limit Tests.....	14
3.7	Particle Size Distribution Tests	14
3.8	Saturation Moisture Content Tests.....	14
3.9	Sulphate and pH Tests	15

Section 4	Foundation Design	16
4.1	General	16
4.1.1	Made Ground and Topsoil	16
4.1.2	Taplow Gravel Member	16
4.1.3	Lambeth Group	17
4.1.4	Seaford and Newhaven Chalk Formation	18
4.1.5	Roots	18
4.1.6	Groundwater	18
4.2	Foundation Scheme General	19
4.2.1	Guidance on Shrinkable Soils	19
4.3	Foundation Scheme	20
4.3.1	Shallow Foundations into the Taplow Gravel Member	20
4.3.2	Piled Foundations	21
4.3.3	Floor Slabs	22
4.4	Subsurface Concrete	22
4.5	Excavations	23
4.6	Pavements	23
4.7	Soakaways	23
Section 5	Determination of Chemical Analysis	25
5.1	Site Characterisation and Revised Conceptual Site Model	25
5.2	Soil Sampling	25
5.3	Determination of Chemical Analysis	26
Section 6	Qualitative Risk Assessment	27
6.1	Assessment Criteria	27
6.2	Representative Contamination Criteria - Soil	27
6.2.1	Asbestos	28
6.3	Risk to Groundwater	28
6.4	Soil Gas Risk Assessment	28
6.5	Tier 1 Quantitative Risk Assessment	29
6.5.1	Soils	29
6.5.2	Groundwater	30
6.5.3	Soil Gas	30
6.6	Duty of Care	30

6.7	Excavated Material	30
6.8	Re-use of Excavated Material On-site	31
6.9	Imported Material	32
6.10	Discovery Strategy	32

List of Figures

Figure 1 – Site Location Map	35
Figure 2 – Aerial Photograph	36
Figure 3 – Trial Hole Plan	37

List of Tables

Table 2.1 Final Depth of Trial Holes	6
Table 2.2 Ground Conditions	8
Table 2.3 Final Depth of Made Ground	8
Table 2.4 Final Depth of Taplow Gravel Member	9
Table 2.5 Final Depth of Lambeth Group	9
Table 2.6 Final Depth of Seaford and Newhaven Chalk Formation	10
Table 2.7 Depth of Root Penetration	10
Table 2.8 Groundwater Monitoring	11
Table 3.1 Indicative infiltration Rate	13
Table 3.2 Sulphate Content	15
Table 4.1 Allowable Bearing Capacities within the Taplow Gravel Member	20
Table 4.2 Aggressive Chemical Environment Concrete Classification	22
Table 5.1 Sampling Strategy	25
Table 5.2 Chemical Analysis Specification	26
Table 6.1 Summary of Chemical Analysis of Soils Sample Exceedance for Commercial Land-use Scenario	27
Table 6.2 Summary of Chemical Analysis of Soils Sample Exceedance for POS Park Land-use Scenario	27
Table 6.3 Soil Gas Monitoring Results	29
Table B.1.1 SPT "N" Blow Count Cohesive Classification	
Table B.1.2 SPT "N" Blow Count Granular Classification	

Table B.1.3 Interpretation of SPT “N” Blow Counts in Chalk

Table B.2.1 Interpretation of SPT Tests

Table B.2.2 Interpretation of DPSH Blow Counts

Table B.2.3 Interpretation of QUU Tests

Table B.2.4 Interpretation of Atterberg Limit Tests

Table B.2.5 Interpretation of PSD Tests

Table B.2.6 Interpretation of SMC Tests

Table D.1.1 CSM Revised Pre Testing

List of Appendices

Appendix A Field Work

Appendix A.1 Engineers Logs

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Appendix B.2 Interpretation

Appendix B.3 Geotechnical In-Situ and Laboratory Results

Appendix C Foundation Design

Appendix C.1 Preliminary Pile Design

Appendix D Chemical Laboratory Testing

Appendix D.1 Conceptual Site Model

Appendix D.2 Chemical Laboratory Results

Appendix D.3 General Assessment Criteria

Appendix E Information Provided by the Client

Section I Introduction

I.1 Objective of Investigation

Reading Borough Council commissioned Soils Limited to undertake an intrusive ground investigation and produce a Main Investigation Report to supply the client and their designers with information regarding ground conditions, to assist in preparing a foundation scheme for development that was appropriate to the settings present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed redevelopment. The investigation was to be made by means of in-situ testing and geotechnical laboratory testing undertaken on soil samples taken from the trial holes.

Soil samples were taken for chemical laboratory testing to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified as dictated by the Conceptual Site Model (CSM) in the Preliminary Investigation Report undertaken for the site by Soils Limited (Report ref: 17760/PIR, dated August 2019).

I.2 Location

The site was located at Palmer Park Sports Stadium, Wokingham Road, Reading RG6 1LF and had an approximate O.S Land Ranger Grid Reference of SU 738 730.

The site location plan is given in Figure 1.

I.3 Site Description

The site comprised an athletics track with grandstand, car park and tennis courts, with associated grounds and two storey sports facility. The site was relatively flat with a gentle gradient down to the west. The site was predominantly tarmac with areas of grass surrounding the site. Semi-mature and mature trees were recorded bordering the athletics track and tennis courts. The site was bordered by residential land use to the south and west, A329(M) motorway to the east with residential land beyond and open recreational land to the north.

An aerial photograph has been included in Figure 2.

I.4 Proposed Development

The proposed development was to comprise partial demolition, alteration and extension of the existing west facing two storey sports facility building to increase size and improve facilities. The principal extension was to be constructed on the north site of the existing building to house a new swimming pool. The proposed development was understood to

comprise areas of hard landscaping to include access road, car parking and pavements and areas of soft landscaping to include planters and recreational open space.

No proposed development plans were available at the time of reporting. Site plans provided by the client are presented in Appendix E.

1.5 Anticipated Geology

The 1:50,000 BGS map showed the site to be located upon the bedrock Lambeth Group with overlying superficial deposits of Taplow Gravel Member. The Seaford and Newhaven Chalk Formation was recorded underlying the Lambeth Group, at depth.

1.5.1 Taplow Gravel Member

The rivers of the south-east of England, including the River Thames and its tributaries, have been subject to at least three changes of level since Pleistocene times. One result has been the formation of a complex series of River Terrace Gravels. These terraces represent ancient floodplain deposits that became isolated as the river cut downwards to lower levels. The Taplow Gravel Formation is found at an elevation that approximates to the present floodplain gravel

The composition of the River Terrace Gravel varies greatly, depending on the source material available in the river's catchment. Deposits generally consist of sands and gravels of roughly bedded flint or chert gravels commonly in a matrix of silts and clays.

1.5.2 Lambeth Group

The Lambeth Group, formerly known as the Woolwich and Reading Beds, occurs in the London and Hampshire Basins, where it directly overlies the Chalk or Thanet Sand Formation, and is succeeded by the Harwich and London Clay Formations. Although generally less than 50 metres thick, its lithological variability and position beneath much of London has concerned tunnelling engineers since the early 19th century.

The relationship between the different depositional environments is seen in central and south-east London, where deposits of fine-grained sand, flint gravel beds, mottled clay, shell beds and altered beds form a complex interdigitating sequence, which is divided into three formations and several informal lithological units.

1.5.3 Seaford and Newhaven Chalk Formation

Seaford Chalk Formation can be described as firm white chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardgrounds and thin marls are known from the lowest beds. Some flint nodules are large to very large.

The Newhaven Chalk Formation is a soft white friable microporous limestone composed of coccolith biomicrites with a varying proportion of larger shell fragments.

At various levels clay sized material occurs as marl seams and partings. Close to the surface the upper few metres are invariably discoloured brown, due to leaching from the overlying strata. The interface with any overlying stratum is invariably extremely irregular as a result of localised weathering and general solution. Weathering by frost action may extend to a depth of several metres.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk. The features sometimes manifest themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

1.6 Limitations and Disclaimers

This Main Investigation Report relates to the site located at Palmer Park Sports Stadium, Wokingham Road, Reading RG6 1LF and was prepared for the sole benefit of Reading Borough Council (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at

the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data on any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 as:

"Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused".

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible best practice at the date of preparation of the report. The investigation and report do not address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets remains with Soils Limited. License is for the sole use of the client and may not be assigned, transferred or given to a third party.

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed redevelopment. The intended investigation, as outlined within the Soils Limited quotation (Q21595/rev102m dated 11th July 2019), was to comprise the following items:

- 2No. 4m dynamic boreholes
- 2No. 4m dynamic probes
- 1No. foundation exposure
- 10No. TRL-DCP probes
- Falling head soakage testing
- 2No. 15m deep cable percussive boreholes with alternate SPT/U100 testing at 1m centres for the top 5m bgl and at 1.5m centres thereafter
- Installation and monitoring of soil gas wells
- Contamination laboratory testing
- Geotechnical laboratory testing.

2.1.1 Actual Project Works

The actual project works were undertaken between 18th July 2019 and 1st August 2019 and comprised:

- 2No. dynamic boreholes (WS1 – WS2)
- 2No. super heavy dynamic probes (DP1 – DP2)
- 1No. foundation exposure (FE1)
- 10No. TRL-DCP probes (DCP01 – DCP10)
- Falling head soakage testing in BH1
- 2No. 15m deep cable percussive boreholes (BH1 – BH2)
- Installation of 2No. soil gas and groundwater monitoring wells to a depth of 15.00m bgl
- 12No. soil gas concentration, flow rate and groundwater level monitoring visits
- Contamination laboratory testing
- Geotechnical laboratory testing.

A soil gas/groundwater monitoring well was installed within each of trial holes BH1 and BH2 comprising 50mm pipework with a response zone comprising slotted pipe

with non-calcareous gravel surround with bentonite seal above. The headworks comprised a single gas tap with metal stopcock cover set in concrete.

The dynamic boreholes were backfilled with gravel and the foundation exposure backfilled with arisings upon completion.

All trial hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged, and sub sampled so that samples could be sent to the laboratory for both contamination and geotechnical testing.

2.2 Ground Conditions

Two cable percussive boreholes (BH1 – BH2) were drilled between 18th and 22nd July 2019 each to a depth of 15.00m below ground level (bgl) at locations selected by the client. Alternate SPT/U100 testing were undertaken at 1m intervals for the first 5m bgl and at 1.5m intervals thereafter, where applicable.

A combined soil gas/groundwater monitoring well was installed within each of trial holes BH1 and BH2 each to a depth of 15.00m bgl. The wells were to allow for continued monitoring of both groundwater levels, soil gas concentrations and flow rates, where present. A total of twelve post-works monitoring rounds were commissioned by the client.

On 23rd July 2019, two windowless sampler boreholes (WS1 – WS2) were drilled to depths ranging between 3.90m and 4.00m bgl at locations selected by the client. Two super heavy dynamic probes were driven prior and adjacent to their corresponding windowless sampler borehole to depths ranging between 5.90m and 6.00m bgl.

On 19th July 2019, ten TRL-DCP probes (DCP01 – DCP10) were undertaken at locations selected by Soils Limited and confirmed by the client.

On 1st August 2019, one foundation exposure (FE1) was excavated adjacent to the existing structure onsite at a location selected by the client. FE1 was terminated at 0.80m bgl on contact with utility cables and thick roots which prevented further advancement of the pit.

The maximum depths of trial holes have been included in Table 2.1.

All trial holes were scanned with a Cable Avoidance Tool (C.A.T.) and signal generator (Genny) prior to excavation to ensure the health and safety of the operatives.

Table 2.1 Final Depth of Trial Holes

Trial Hole	Depth (m bgl)	Trial Probe	Depth (m bgl)
BH1 ^W	15.00	DPI	5.90

Trial Hole	Depth (m bgl)	Trial Probe	Depth (m bgl)
BH2 ^w	15.00	DP2	6.00
WS1	3.90	DCP01	0.22
WS2	4.00	DCP02	0.57
FE1	0.80	DCP03	0.27
		DCP04	0.83
		DCP05	0.81
		DCP06	0.81
		DCP07	0.88
		DCP08	0.18
		DCP09	0.22
		DCP10	0.91

Note: w - well installation

The approximate trial hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the trial hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference should be made to the detailed records given within Appendix A, but for the purposes of discussion, the succession of conditions encountered in the trial holes in descending order can be summarised as:

Made Ground (MG)
Taplow Gravel Member (TPGR)
Lambeth Group (LMBE)
Seaford and Newhaven Chalk Formation (SECK)

The ground conditions encountered in the trial holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG	Anthropocene	0.00	0.40–1.20	0.75	Brown mottled greyish brown slightly gravelly sandy CLAY. Gravel comprised fragments of flint, clinker, chalk and brick.
TPGR	Holocene	0.40–1.20	5.80–10.30	5.00	Interbedded orangish brown very sandy clayey GRAVEL and greyish brown slightly gravelly sandy CLAY.
LMBE	Eocene	5.80–6.00	9.30–11.00	5.00	Orange and yellowish brown becoming dark grey slightly fine sandy CLAY.
SECK	L. Cretaceous	9.30–11.00	>15.00 ¹	Not proven ²	Structured CHALK recovered as white silty sandy GRAVEL with rare angular medium gravel sized clasts of flint.

Note: ¹ Final depth of trial hole. ² Base of strata not encountered. 0.00 denotes ground level.

2.3 Ground Conditions Encountered in Trial Holes

The ground conditions encountered in trial holes have been described below in descending order. The engineering logs are presented in Appendix A.1.

2.3.1 Made Ground and Topsoil

Soils described as Made Ground were encountered in all five trial holes from ground level to depths ranging between 0.40m and 1.20m bgl.

The Made Ground typically comprised brown mottled greyish brown slightly gravelly sandy CLAY with occasional roots/rootlets. Gravel was fragments of flint, clinker, chalk and brick.

The depths of Made Ground have been included in Table 2.3.

Table 2.3 Final Depth of Made Ground

Trial Hole	Depth (m bgl)
BH1	1.20
BH2	0.40
WS1	0.90
WS2	0.45
FE1	0.80 ¹

2.3.2 Taplow Gravel Member

Soils described as Taplow Gravel Member were encountered underlying the Made Ground and was proven to depths ranging between 5.80m and 10.30m bgl and inferred to full investigatory depths of 5.90m and 6.00m bgl in the dynamic probes.

The Taplow Gravel Member comprised interbedded orangish brown very sandy clayey GRAVEL and greyish brown slightly gravelly sandy CLAY. Gravel was subangular to subrounded clasts of flint. The unit was noted to comprise a greater coarse fraction in locations BH2 and WS/DP2. A horizon comprising slightly clayey medium occasionally coarse SAND was encountered in BH1 from 6.00m to 10.30m bgl.

The depth of Taplow Gravel Member has been included in Table 2.4.

Table 2.4 Final Depth of Taplow Gravel Member

Trial Hole	Depth (m bgl)
BH1	10.30
BH2	5.80
WS1/DPI	3.90 ¹ /5.90 ¹
WS2/DP2	4.00 ¹ /6.00 ¹
FE1	Not encountered

Note: ¹ Final depth of trial hole.

2.3.3 Lambeth Group

Soils described as the Lambeth Group were encountered in BH1 and BH2 underlying the Taplow Gravel Member from 10.30m and 5.80m bgl respectively and persisted to depths of between 11.00m and 9.30m respectively.

The Lambeth Group comprised orange and yellowish brown becoming dark grey slightly fine sandy CLAY.

The depth of Lambeth Group has been included in Table 2.5.

Table 2.5 Final Depth of Lambeth Group

Trial Hole	Depth (m bgl)
BH1	11.00
BH2	9.30
WS1/DPI	Not encountered
WS2/DPI	Not encountered

Note: ¹ Final depth of trial hole.

2.3.4 Seaford and Newhaven Chalk Formation

Soils described as Seaford and Newhaven Chalk Formation was encountered underlying the Lambeth Group and persisted to the full investigatory depth of 15.00m bgl.

The Seaford and Newhaven Chalk Formation comprised structured CHALK recovered as white silty sandy GRAVEL with rare medium gravel sized angular clasts of flint.

Chalk is a weak rock and as such the drilling process significantly modifies the in-situ fabric and structure of the soil.

The final depth of Seaford and Newhaven Chalk Formation has been included in Table 2.6.

Table 2.6 Final Depth of Seaford and Newhaven Chalk Formation

Trial Hole	Depth (m bgl)
BH1	15.00 ¹
BH2	15.00 ¹
Note: ¹ Final depth of trial hole.	

2.4 Roots/Rootlets

Roots/rootlets were observed in three of the five trial holes, persisting to the full investigatory depth of 0.80m bgl for FE1 and to 0.90m bgl within WS1 and WS2.

The depths of root penetration have been included in Table 2.7.

Table 2.7 Depth of Root Penetration

Trial Hole	Depth (m bgl)
BH1	None observed
BH2	None observed
WS1	0.90
WS2	0.90
FE1	0.80 ¹
Note: ¹ Final depth of trial hole.	

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. A direct observation such as from within a trial pit is necessary to gain a better indication of the maximum root depth.

2.5 Groundwater

No groundwater “strikes” were recorded during the construction of the trial holes onsite. Changes in groundwater level occur for reasons including seasonal effects and variations in drainage. The investigation was conducted in July (2019), when groundwater levels should be reducing from their annual maximum (highest) elevation, which typically occurs around March.

At the time of reporting, groundwater monitoring had been conducted within the standpipes installed onsite following the completion of site works on two occasions, with a further ten monitoring rounds scheduled, and has been presented in Table 2.8.

Table 2.8 Groundwater Monitoring

Trial Hole	Depth to Water (m bgl)		Base of Hole (m bgl)
	25/07/2019	05/08/2019	
BH1	10.20	13.44	15.00
BH2	13.30	Not accessible	15.00

Post-works groundwater monitoring recorded groundwater at depths of between 10.20m and 13.30m bgl on 25th July 2019, falling to 13.44m bgl in BH1 by 5th August 2019.

Groundwater monitoring was ongoing at the time of reporting and the results will be updated when complete.

2.6 Foundation Exposures

Foundation exposure was carried out in FE1 at a location selected by the client.

FE1 encountered a concrete foundation from a depth of 0.40m bgl which extended out from the brick wall by 0.90m and was 0.35m thick.

The foundation exposure was terminated at a depth of 0.80m on contact with utility cables and thick roots which prevented further advancement of the pit.

The full foundation sketch for FE1 is presented in Appendix A.1.

Section 3 Discussion of Geotechnical In-Situ and Laboratory Testing

3.1 Standard Penetration Tests

Standard Penetration Tests (SPTs) were undertaken in BH1 and BH2. The results were interpreted based on the classifications outlined in Appendix B.1.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. Raw field data are included within engineer logs in Appendix A.1. The energy ratio of the rig used was 72%.

The Taplow Gravel Member recorded SPT “N60” values between 17 and 50+ in granular beds and 23 in cohesive beds. The granular soils were classified as medium dense to very dense relative density and the cohesive soils were classified as high strength with inferred undrained cohesive strength of 115kPa.

The Lambeth Group recorded SPT “N60” value of 34 in BH2 classifying the cohesive soils as very high strength with inferred undrained cohesive strength of 170kPa.

The Seaford Chalk Formation recorded SPT “N60” values between 31 and 50+ inferring the chalk as CIRIA structured (C5 – A1) chalk.

A full interpretation of the SPT results are outlined in Appendix B.2, Table B.2.1.

3.2 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at two locations (DP1 - DP2) adjacent and prior to the drilling of their corresponding windowless sampler borehole to depths ranging between 5.90m and 6.00m bgl. The results were converted to equivalent SPT “N60” values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix B.1.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. The energy ratio of the rig used was 68.22%. Raw field data are presented in probe logs in Appendix B.3.

The Taplow Gravel Member recorded equivalent SPT “N60” values between 10 and 20 in cohesive beds and between 10 and 50+ in granular beds. Classifying the cohesive soils as medium to high strength with inferred undrained cohesive strength of 50kPa to 100kPa. The granular beds were classified as medium dense to very dense relative density.

A full interpretation of the DPSH tests are outlined in Appendix B.2, Table B.2.2.

3.3 Dynamic Cone Penetrometer Tests

The Transport Research Laboratory (TRL), Dynamic Cone Penetrometer (DCP) was undertaken at ten locations (DCP01 – DCP10) selected to achieve enough coverage of the site given no development plans were available. The results were interpreted based on the classification outlined in Appendix B.1.

The results from DCP testing indicated CBR values of between 2% and 238% for the soils encountered in the top 1.00m bgl. The higher CBR values encountered were anticipated to be coarser gravel clasts struck during the test.

The DCP results are presented in Appendix B.3.

3.4 Falling Head Soakage Tests

One falling head soakage test was undertaken within BH1. An **indicative** infiltration rate was calculated and outlined in Table 3.1. It must be emphasised that the indicative infiltration rate must not be used for design calculations and full in-situ testing must be undertaken to BRE 365 Soakaway Design standards.

Table 3.1 Indicative infiltration Rate

Trial Hole	Test No.	Indicative infiltration Rate (Ltr/sec)
BH1	I	4.56×10^{-3}

3.5 Quick Unconsolidated Undrained Triaxial Compression Tests

Quick Unconsolidated Undrained Triaxial Compression Test (QUU) was performed on one sample obtained from the cohesive soils from the Lambeth Group. The strength interpretation was based on the classification outlined in Table B.1.1.

The QUU testing indicated soils of the Lambeth Group were of a low strength with an undrained cohesion of 30kPa. This is significantly lower than anticipated and is likely to be the result of sampling disturbance rather than indicative of the insitu strengths of the Lambeth Group. This hypothesis is supported by the high sample blown count (60blows) recorded on the driller's logs, an SPT from the same unit within BH2 recorded an SPT N60 of 34 giving an inferred undrained cohesion of 170kPa and the engineer description of the surrounding soils (very stiff, approximately 150 – 300kPa anticipated undrained cohesion).

A full interpretation of the QUU tests are outlined in Table B.2.3, Appendix B.2 and the laboratory report in Appendix B.3.

3.6 Atterberg Limit Tests

Atterberg Limit tests were performed on one sample from the cohesive soils of the Taplow Gravel Member and one sample from the Lambeth Group. The results were classified in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

The cohesive horizons of the Taplow Gravel Member were classified as low volume change potential in accordance with BRE Digest 240 and no volume change potential in accordance with NHBC Standards Chapter 4.2.

The Lambeth Group was classified as medium volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

Whilst NHBC guidance is not strictly applicable to non-residential structures it has been referenced as the proposed development is considered to be both light and brittle.

A full interpretation of the Atterberg Limit tests are outlined in Table B.2.4, Appendix B.2 and the laboratory report in Appendix B.3.

3.7 Particle Size Distribution Tests

Particle Size Distribution (PSD) tests were performed on four samples from the granular soils of the Taplow Gravel Member.

The PSD tests classified three of the four samples as having no volume change in accordance with BRE Digest 240 and NHBC Chapter 4.2. Note that a cohesive soil is only classified as having a volume change potential if it is also plastic and an Atterberg Limit test can be conducted on the strata.

A full interpretation of the PSD tests are outlined in Table B.2.5, Appendix B.2 and the laboratory report in Appendix B.3.

3.8 Saturation Moisture Content Tests

Saturated Moisture Content (SMC) tests were performed three samples from the Seaford and Newhaven Chalk Formation. The results were classified based on Table 3.2, CIRIA Publication, Engineering in Chalk, C574, 2002.

The SMC tests classified the Seaford and Newhaven Chalk Formation as high density with dry density ranging between 1.71Mg/m^3 and 1.84Mg/m^3 . The tests were completed as non-standard due to insufficient volumes of intact chalk clasts present in the samples.

A full interpretation of the SMC tests are outlined in Table B.2.6, Appendix B.2 and the laboratory report in Appendix B.3.

3.9 Sulphate and pH Tests

One sample was taken from soils of Made Ground, two samples from the Taplow Gravel Member and one sample from the Lambeth Group for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'. A further eight water soluble sulphate (2:1) and pH tests were undertaken on samples of Made Ground as part of the contamination soil chemical analysis.

The results have been summarised in Table 3.2.

Table 3.2 Sulphate Content

Stratum	No. of Tests	W/S Sulphate (mg/l)	pH
MG	9	10 - 113	7.1 – 8.1
TPGR	2	12 – 13	7.7 – 8.0
LMBE	1	1120	5.4

The significance of the sulphate and pH Test results are discussed in Section 4.4 and the laboratory report in Appendix B.3.

Section 4 Foundation Design

4.1 General

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the trial holes.

4.1.1 Made Ground and Topsoil

The terms *Fill* and *Made Ground (non-engineered fill)* are used to describe material, which has been placed by man either for a particular purpose e.g. to form an embankment, or to dispose of unwanted material. For the former use, the Fill and/or Made Ground may well have been selected for the purpose and placed and compacted in a controlled manner. With the latter, great variations in material type, thickness and degree of compaction invariably occur and there can be deleterious or harmful matter, as well as potentially methanogenic organic material.

The BSI Code of Practice for Foundations, BS 8004:2015, Clause 4.1.2.2 states, *'Spread foundations should not be placed on non-engineered fill unless such use can be justified on the basis of a thorough ground investigation and detailed design.'*

Soils described as Made Ground were encountered in all five trial holes from ground level to depths ranging between 0.40m and 1.20m bgl. The Made Ground typically comprised brown mottled greyish brown slightly gravelly sandy CLAY with occasional roots/rootlets. Gravel was fragments of flint, clinker, chalk and brick. The depths of Made Ground have been included in Table 2.3.

A result of the inherent variability, particularly of uncontrolled Topsoil, Fill and/or Made Ground is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Topsoil and/or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

4.1.2 Taplow Gravel Member

Soils described as Taplow Gravel Member were encountered underlying the Made Ground and was proven to depths ranging between 5.80m and 10.30m bgl and inferred to full investigatory depths of 5.90m and 6.00m bgl in the dynamic probes.

The Taplow Gravel Member comprised interbedded orangish brown very sandy clayey GRAVEL and greyish brown slightly gravelly sandy CLAY. Gravel was subangular to subrounded clasts of flint. The unit was noted to comprise a greater coarse fraction in locations BH2 and WS/DP2. A horizon comprising slightly clayey medium occasionally coarse SAND was encountered in BH1 from 6.00m to 10.30m bgl.

The results from SPT testing inferred that the cohesive beds of the Taplow Gravel Member were of high strength with an undrained cohesion of 115kPa. The granular beds were classified as medium dense to very dense relative density.

The results from DPSH testing inferred that the cohesive soils of the Taplow Gravel Member were of medium to high strength with inferred undrained cohesions of between 50kPa and 100kPa. The granular beds were classified as medium dense to very dense relative density.

The cohesive horizons of the Taplow Gravel Member were classified as low volume change potential in accordance with BRE Digest 240 and no volume change potential in accordance with NHBC Chapter 4.2.

The PSD tests classified three of the four samples as having no volume change in accordance with BRE Digest 240 and NHBC Chapter 4.2. Note that a cohesive soil is only classified as having a volume change potential if it is also plastic and an Atterberg Limit test can be conducted on the strata.

The remaining three samples did not have a volume change potential in accordance with BRE Digest 240.

Soils of the Taplow Gravel Member are predominantly granular soils with interbedded cohesive bands. The cohesive bands will dominate the bearing and settlement characteristics of the soil and therefore the soils of the Taplow Gravel Member are expected to display low to moderate bearing capacities with moderate to high settlement characteristics. The soils of the Taplow Gravel Member were considered a suitable bearing stratum for the proposed development, subject to proposed finished levels and providing adequate bearing and settlement characteristics can be proven.

4.1.3 Lambeth Group

Soils described as the Lambeth Group were encountered in BH1 and BH2 underlying the Taplow Gravel Member from 10.30m and 5.80m bgl respectively and persisted to depths of between 11.00m and 9.30m respectively. The Lambeth Group comprised orange and yellowish brown becoming dark grey slightly fine sandy CLAY.

The results from SPT testing inferred that the Lambeth Group was of very high strength, with an inferred undrained cohesion of 115kPa.

The QUU testing indicated soils of the Lambeth Group were of a low strength with an undrained cohesion of 30kPa. This is significantly lower than anticipated and is likely to be the result of sampling disturbance rather than indicative of the insitu strengths of the Lambeth Group. This hypothesis is supported by the high sample blown count (60blows) recorded on the driller's logs, an SPT from the same unit within BH2 recorded an SPT N60 of 34 giving an inferred undrained cohesion of 170kPa and the engineer description of the surrounding soils (very stiff,

approximately 150 – 300kPa anticipated undrained cohesion).

Soils of the Lambeth Group are over consolidated cohesive soils and are expected to achieve moderate bearing capacities with moderate settlement characteristics. Soils of the Lambeth Group were considered a suitable bearing stratum for the adoption of a piled foundation solution, given the depth to its upper horizon.

4.1.4 Seaford and Newhaven Chalk Formation

Soils described as Seaford and Newhaven Chalk Formation was encountered underlying the Lambeth Group and persisted to the full investigatory depth of 15.00m bgl.

The Seaford and Newhaven Chalk Formation comprised structured CHALK recovered as white silty sandy GRAVEL with rare medium gravel sized angular clasts of flint.

The results from SPT testing inferred that the Seaford and Newhaven Chalk Formation comprised CIRIA structured chalk (C5 – A1).

The results from SMC tests indicated that the Seaford and Newhaven Chalk Formation comprised high density chalk, with dry densities of between 1.71Mg/m³ and 1.84Mg/m³.

Generally, soils of the Seaford and Newhaven Chalk Formation are structureless to weak rock and are anticipated to possess moderate bearing and settlement characteristics. The Seaford and Newhaven Chalk Formation would be suitable as a bearing stratum for a piled foundation solution, given the depth to the upper horizon.

4.1.5 Roots

Roots/rootlets were observed in three of the five trial holes, persisting to the full investigatory depth of 0.80m bgl for FE1 and to 0.90m bgl within WS1 and WS2. Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.1.6 Groundwater

No groundwater “strikes” were recorded during the construction of the trial holes onsite. Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in July (2019), when groundwater levels should be reducing from their annual maximum (highest) elevation, which typically occurs around March.

At the time of reporting, groundwater monitoring had been conducted within the standpipes installed onsite following the completion of site works on two occasions, with a further ten monitoring rounds scheduled, and has been presented in Table

2.8.

The results from further monitoring recorded groundwater at depths of between 10.20m and 13.30m bgl, falling to 13.44m bgl in BH1 by 5th August 2019. Groundwater monitoring was ongoing at the time of reporting and will be updated when complete.

4.2 Foundation Scheme General

The proposed development was to comprise partial demolition, alteration and extension of the existing west facing two storey building to increase size and improve facilities. The principal extension was to be constructed on the north site of the existing building to house a new swimming pool. The proposed development was understood to comprise areas of hard landscaping to include access road, car parking and pavements and areas of soft landscaping to include planters and recreational open space.

No proposed development plans were available at the time of reporting. Site plans provided by the client are presented in Appendix E.

4.2.1 Guidance on Shrinkable Soils

The Building Research Establishment (BRE) Digests 240, 241 and 242 provide guidance on 'best practice' for the design and construction of foundations on shrinkable soils.

The results from Atterberg Limits Tests showed that the more cohesive beds of the Taplow Gravel Member had low volume change potential in accordance with both BRE Digest 240 and NHBC Chapter 4.2.

Soils of the Lambeth Group were classified as medium volume change potential in accordance with BRE Digest 240 and NHBC Chapter 4.2.

Whilst NHBC guidance is not strictly applicable to non-residential structures it has been referenced as the proposed development is considered to be both light and brittle.

The BRE Digest 241 states: *"An increasingly common, potentially damaging situation is where trees or hedges have been cut down prior to building. The subsequent long-term swelling of the zone of clay desiccated by the roots, as moisture slowly returns to the ground, can be substantial. The rate at which the ground recovers is very difficult to predict and if there is any doubt that recovery is complete then bored pile foundations with suspended beams and floors should be used"*.

The BRE Digest 240 suggests: *"Two courses of action are open:*

Estimate the potential for swelling or shrinkage and try to avoid large changes in

the water content, for example by not planting trees near the foundations.

Accept that swelling or shrinkage will occur and take account of it. The foundations can be designed to resist resulting ground movements or the superstructure can be designed to accommodate movement without damage."

The design of foundations suitable to withstand movements is presented in BRE Digest 241 "Low-rise buildings on shrinkable clay soils: Part 2"

4.3 Foundation Scheme

Foundations **must not** be constructed within any Made Ground/Topsoil, where encountered, due to the likely variability and potential for large load induced settlements both total and differential.

Roots were encountered in three of the five trial holes persisting to depths of 0.90m bgl. If roots are encountered during the construction phase foundations **must not be placed within any live root penetrated** or desiccated **cohesive soils or those with a volume change potential**. Should the foundation excavations reveal such materials, the excavations **must** be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

The results of the intrusive investigation undertaken showed significant lateral variability in thickness and properties of the interbedded cohesive and granular beds of the Taplow Gravel Member, and thickness of Lambeth Group across the surveyed area.

Given the type of development shallow foundations can be considered for the proposed development. Piled foundations may be considered as a valid foundation option should larger applied loads be expected.

4.3.1 Shallow Foundations into the Taplow Gravel Member

Based on a 1.00 by 1.00m pad foundation, using commercial software Table 4.1 shows the calculated bearing values and anticipated settlement characteristics. Bearing capacities were calculated from 1.50m bgl.

Table 4.1 Allowable Bearing Capacities within the Taplow Gravel Member

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.50	1.00 x 1.00	85	<25
2.00		125	<25

For the allowable bearing value given above, settlements should not exceed the presented values, provided that excavation bases are carefully bottomed out and blinded or concreted as soon after excavation as possible and kept dry. Foundations must not be constructed over former structures and other hard spots. The foundations design must be suitable for the conditions present at the site.

The anticipated settlement includes both elastic settlement and long-term drained settlement (in the case of cohesive soils).

Care must be taken when placing pad foundations that the edge of each pad are located a minimum of 1.5x the width of the largest pad away from each other to avoid loads intersecting which can result in increased settlement and potential for foundation failure.

Anticipated settlements may be taken as proportional to the bearing capacity adopted (for the same configuration of foundation), therefore if the bearing value is halved the anticipated settlement will halve.

It has been assumed that the foundations to the existing structures have been grubbed out. Foundations must not be cast over such hard points without this being considered in the foundation design. Where foundations have been grubbed out the new foundation must be taken through the backfill material into the natural ground.

4.3.2 Piled Foundations

If adopted the piled foundations must be taken through any Made Ground into suitable strength soils of the Taplow Gravel Member, Lambeth Group and the Seaford and Newhaven Chalk Formation.

The construction of a piled foundation is a specialist job with the actual pile working load depending on the type pile and installation method. Prior to finalising the foundation design the advice from a reputable contractor who is familiar with the ground and groundwater conditions present at the site should be sought.

The load vertical capacities are provided for varying diameters and lengths of bored piles taken into the Taplow Gravel Member/Lambeth Group and Seaford and Newhaven Chalk Formation. These values have been calculated for the worst-case scenario, which modelled the Taplow Gravel Member/Lambeth Group as granular over the full borehole length. A Factor of safety of 3 was applied to both the shaft and base for the Taplow Gravel Member/Lambeth Group and a factor of safety of 1.5 and 10 was applied to the shaft and base respectively for the Seaford and Newhaven Chalk Formation.

The bearing values given in Appendix C.1., are applicable to single piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

From ground level the upper 4m of the pile shaft has been ignored in the preliminary pile design given.

To prevent necking of the green concrete, temporary casing may be required where the pile passes through the Made Ground and below the groundwater table (if encountered). To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

No allowance has been made for negative skin friction that could be generated where piles pass through Made Ground and Taplow Gravel Member deposits underlying the site. The negative skin friction must be applied to the pile working load and must not be factored.

4.3.3 Floor Slabs

Given the presence of Made Ground to depths of up to 1.20m bgl across the site, the floor slabs must be designed as suspended.

4.4 Subsurface Concrete

Sulphate concentration measured in 2:1 water/soil extracts for the Made Ground fell into Class **DS-1** of the BRE Special Digest 1 2005, '*Concrete in Aggressive Ground*'. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-1**. The pH of the soils tested ranged between 7.1 and 8.1.

Sulphate concentration measured in 2:1 water/soil extracts for the Taplow Gravel Member fell into Class **DS-1** of the BRE Special Digest 1 2005, '*Concrete in Aggressive Ground*'. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-1**. The pH of the soils tested ranged between 7.7 and 8.0.

Sulphate concentration measured in 2:1 water/soil extracts for the Lambeth Group fell into Class **DS-2** of the BRE Special Digest 1 2005, '*Concrete in Aggressive Ground*'. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-4z**. The pH of the soils tested was 5.4.

The DS and ACEC classifications are summarised in Table 4.2.

Table 4.2 Aggressive Chemical Environment Concrete Classification

Stratum	DS	ACEC
MG	DS-I	AC-I
TPGR	DS-I	AC-I
LMBE	DS-2	AC-4z

The classifications given were determined using the mobile groundwater case. The laboratory results are presented in Appendix B.3.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, '*Concrete in Aggressive Ground*' taking into account any possible

exposure of potentially pyrite bearing natural ground and the pH of the soils.

4.5 Excavations

Shallow excavations in the Made Ground are likely to be marginally stable in the short term at best.

Deeper excavations taken into the Taplow Gravel Member are likely to be unstable in both the short and long term and will require supporting. Taplow Gravel Member. Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose before excavations are entered by personnel.

Excavations beneath the groundwater table are likely to be unstable and dewatering of foundation trenches may be necessary.

4.6 Pavements

The Transport Research Laboratory (TRL) Dynamic Cone Penetrometer (DCP) was undertaken at eleven locations on site (DCP101 – DCP110). The results from dynamic cone penetrometer tests indicated CBR values of between 2% and 238% for the soils encountered in the top 1.00m bgl. The high CBR values encountered were anticipated to be coarser gravel clasts struck during the test.

When removing the top 400mm Made Ground the worst case CBR value was 6% which was considered suitable for design purposes for the majority of the road layout.

As CBR values were highly variable due to changes in moisture content and ground conditions, **in-situ testing must be undertaken** immediately prior to the installation of pavements/roads. Any soft spots at formation level should be dug out and replaced with a suitably compacted granular fill. Prior to construction the formation level should be proof rolled.

The cohesive soils of the Taplow Gravel Member should be considered as frost susceptible as plasticity index was recorded as <15%. The granular soils of the Taplow Gravel Member can be considered as non-frost susceptible as percentage fines were recorded at <10%.

4.7 Soakaways

A falling head soakage test was carried out in BH1 gave an indicative infiltration rate of 4.56×10^{-3} ltr/sec. The soils of the Taplow Gravel Member would likely achieve higher soakage rates and could be suitable for the adoption of soakaways but full in-situ testing to BRE 365 Soakaway Design would be required.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk within this area. These features sometimes manifesting themselves' at the surface, as shallow circular depressions.

Dissolution features can form due to manmade features such as deneholes. These features can then be reactivated or caused to collapse by the concentrated ingress of water from leaking drains or soakaways.

In line with current guidance (BRE Digest 365, NHBC and CIRIA C574) soakaways should be located remote from the proposed foundations, ideally greater than 20m away from the face of any existing or proposed footing.

In respect to the control of drainage CIRIA C574, Engineering in Chalk; 2002 states;

- “Concentrated ingress of water into the chalk can initiate new dissolution features, particularly in low-density chalk, and destabilise the loose backfill of existing ones. For this reason, any soakaways should be sited well away from foundations for structures, roads or railways, as indicated below:
- In areas where dissolution features are known to be prevalent, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations;
- Where the chalk is of low density, or its density is not known, soakaways should be sited at least 10m away from any foundations;
- Where the chalk is of medium density (or higher), the closest part of the soakaway should be at least 5m away from any foundations.
- For drainage systems, flexible jointed pipes should be used wherever possible; particular care should be taken for the avoidance of leaks in both water supply and drainage pipework.

The results from SMC tests indicated the chalk is of high density.

As the Chalk is a vitally important aquifer, the Environment Agency and local authority must be consulted when planning soakaway installations where chalk lies below the site even where it is mantled with superficial deposits.

Section 5 Determination of Chemical Analysis

5.1 Site Characterisation and Revised Conceptual Site Model

The Preliminary Investigation Report undertaken by Soils Limited (report ref: 17760/PIR dated August 2019) did not identify any on or off-site sources of contamination relative to the sites proposed end-use. In-line with the client's brief, soil samples were selected and tested for a range of potential brownfield contaminants.

The intrusive site investigation encountered Made Ground from ground level to depths between 0.40m and 1.20m bgl. The Made Ground comprised brown mottled greyish brown slightly gravelly sandy CLAY. The gravel comprised fragments of flint, clinker, chalk and brick.

Interbedded cohesive and granular superficial deposits of Taplow Gravel Member were encountered underlying the Made Ground, underlain by the Lambeth Group and Seaford and Newhaven Chalk Formation.

5.2 Soil Sampling

A non-targeted sampling strategy is appropriate when there is:

- No adequate information available regarding the likely locations of contamination;
- No sensitive areas where there is a need for a high degree of confidence.

A targeted sampling strategy is appropriate when there is:

- Adequate information available regarding the likely locations of contamination
- Sensitive areas where there is a need for a high degree of confidence.

A non-targeted sampling strategy was adopted, with sampling locations selected by the client. Table 5.1 outlines the sampling undertaken.

Table 5.1 Sampling Strategy

Sample	Strategy
BH1:0.35	Non-targeted
BH1:0.50-1.00	Non-targeted
BH1:1.20	Non-targeted
BH2:0.40	Non-targeted
BH2:0.50-1.00	Non-targeted
WS1:0.50	Non-targeted
WS1:0.80	Non-targeted
WS2:0.20	Non-targeted
WS2:0.50	Non-targeted
WS2:0.80	Non-targeted
BH1	Targeted - Groundwater
BH2	Targeted - Groundwater

5.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Preliminary Investigation Report and Main Investigation Report intrusive investigation. Table 5.2 outlines the specification for each sample tested.

Table 5.2 Chemical Analysis Specification

Substance	Locations: Depths (m bgl)											
	BH1:0.35 ^s	BH1:0.50 - 1.00 ^s	BH1:1.20 ^s	BH2:0.40 ^s	BH2:0.50 - 1.00 ^s	WS1:0.50 ^s	WS1:0.80 ^s	WS2:0.20 ^s	WS2:0.50 ^s	WS2:0.80 ^s	BH1 ^w	BH2 ^w
Asbestos Screen	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Total Phenols	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total Cyanide	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Organic Matter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ph	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Metals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Metalloids	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Organics	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PAHs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TPH-CWG	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
EPH Texas		✓			✓							
BTEX	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
WAC		✓			✓							

Notes: **Metals:** Cd, Cr, Pb, Hg, Ni, Se, CN, S, Cu, Zn, Bo, V. **metalloids:** As. **Organics:** USEPA 16 speciated PAH, TPH-CWG (speciated TPH), BTEX, VOC/SVOC. **WAC** Waste Acceptance Criteria certificate **Asbestos screening** was undertaken in accordance with HSG 248. ^s = Soil sample. ^w = Water sample.

Section 6 Qualitative Risk Assessment

6.1 Assessment Criteria

The assessment criteria used to determine risks to human health are derived and explained within Appendix D.3.

6.2 Representative Contamination Criteria - Soil

The proposed development was to comprise partial demolition, alteration and extension of the existing west facing two storey building to increase size and improve facilities. The principal extension was to be constructed on the north site of the existing building to house a new swimming pool. The proposed development was understood to comprise areas of hard landscaping to include access road, car parking and pavements and areas of soft landscaping to include planters and recreational open space.

No proposed development plans were available at the time of reporting. Site plans provided by the client are presented in Appendix E.

The chemical laboratory results were compared against the representative contaminants concentration for human health receptor to Soil Guideline Values (SGV), Category 4 Screening Levels (C4SL's) or Suitable 4 Use Level (S4UL).

The guideline values were assessed against both the "commercial" land-use scenario and more conservative "Public Open Space (POS) for park use".

Table 6.1 outlines the samples that have exceeded their relevant assessment criteria for commercial land-use and Table 6.2 outlines the sample that have exceeded their relevant assessment criteria for POS park land-use.

The full laboratory report is presented in Appendix D.2.

Table 6.1 Summary of Chemical Analysis of Soils Sample Exceedance for Commercial Land-use Scenario

Substance	Sample locations where SGV, C4SL or S4UL adopted were exceeded for the 'Commercial' land-use scenario
None	No exceedances

Table 6.2 Summary of Chemical Analysis of Soils Sample Exceedance for POS Park Land-use Scenario

Substance	Sample locations where SGV, C4SL or S4UL adopted were exceeded for the 'POS Park' land-use scenario
None	No exceedances

To assess the potential toxicity to the human health receptor from the concentrations of organic compounds tested for, Soil Organic Matter (SOM) tests were undertaken on the samples submitted for chemical testing, which revealed SOM values of between 0.5% and 1.7%. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate guideline value for organic determinants.

In summary, none of the samples tested recorded concentrations in excess of either commercial or POS park land-use screening values.

6.2.1 Asbestos

Although no asbestos containing material was identified in any of the samples tested, it is possible that asbestos is present in other areas of the site. If encountered, care must be taken to ensure any such material is separated and disposed of in an appropriate manner to a licensed waste facility under the supervision of a competent person using suitably licenced contractors.

6.3 Risk to Groundwater

Groundwater samples were obtained from each standpipe in-line with the clients brief as a potential risk to the underlying aquifer had been identified in the initial site model.

The chemical laboratory results were compared against the UK Drinking Water Standard (DWS). If no DWS was available for a given parameter, standards from the World Health Organisation (WHO) were used. DWS were chosen as an initial screen, as potable waters could be abstracted from the underlying aquifer and therefore present a direct risk to human receptors.

The groundwater chemical analysis did not record any substance concentrations in excess of the chosen groundwater screening values.

6.4 Soil Gas Risk Assessment

Monitoring of the standpipes installed within BH1 and BH2 has been undertaken on two occasions at the time of reporting, with a further ten monitoring visits scheduled to comply with the suggested requirements of CIRIA 665 based on the risks to the identified receptor.

The concentration of methane (both total and LEL), hydrogen sulphide, carbon monoxide, carbon dioxide and oxygen were measured using a portable infrared monitor. Readings of flowrate were taken with a differential manometer calibrated to give flow rate. A Photo Ionisation Detector (PID) was used to detect for Volatile Organic Compounds (VOCs).

The results from the soil gas monitoring undertaken to date is presented in Table 6.3.

Table 6.3 Soil Gas Monitoring Results

Date	WS	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	H ₂ S (ppm)	CO (ppm)	LEL (%)	aP (mb)	Flow (l/h)	H ₂ O (m bgl)	VOC (ppm)	Dp
25/07/19	ATM	0.0	0.0	21.0	0.0	0.0	0.0	1003	-	-	0.0	-
	BH1	0.0	4.9	16.7	0.0	0.0	0.0	1003	0.0	10.20	0.0	0
	BH2	0.0	0.0	20.3	0.0	0.0	0.0	1003	0.0	13.30	0.0	0
05/08/19	ATM	0.0	0.0	21.2	0.0	0.0	0.0	1004	-	-	0.0	-
	BH1	0.0	3.8	18.1	0.0	0.0	0.0	1004	n/a ¹	13.44	0.0	n/a ¹
	BH2	Well not accessible										
Minimum		0.0	0.0	16.7	0.0	0.0	0.0	1003	0.0	10.20	0.0	0
Maximum		0.0	4.9	20.3	0.0	0.0	0.0	1004	0.0	13.44	0.0	0

Note: reading of 0.0 = not detected (below detection level). VOC=Volatile Organic Compounds. Dp=Pressure Difference. ¹ Anomalous reading due to high wind conditions

The results from the spot soil gas monitoring undertaken to date indicate the presence of carbon dioxide at a maximum of concentration of 4.9% v/v in BH1 on 25th July 2019. No concentrations were recorded above detection level of the instrument for hydrogen sulphide, carbon monoxide or methane. Oxygen was recorded in the range of 16.7% to 20.3% by volume. Borehole flow rates were measured at 0.0l/hr and atmospheric pressure was recorded between 1003mb and 1004mb.

Based on the soil gas monitoring undertaken to date, technically the site's gassing regime appears representative of Characteristic Situation (CS) 1 under BS:8485 and CIRIA C665 guidance. This conclusion being based on the worst case hazardous gas concentration of carbon dioxide monitored to date multiplied by the maximum noted flow rate. However, no monitoring visit has yet been undertaken during a falling low pressure event at <1000mb ambient pressure (generally considered worst case), so confidence in the results to date can only be considered low. The presence of slightly elevated levels of carbon dioxide and no other associated gasses may be due to the underlying presence and dissolution of chalk over time. The results from the full soil gas risk assessment will be provided as an addendum on completion of the monitoring regime.

6.5 Tier I Quantitative Risk Assessment

Quantitative risk assessments are undertaken for the soil, groundwater and soil gas. The CSM has been updated to take account of the assessments below and presented in Appendix D.1. The full laboratory chemical report is presented in Appendix D.2.

6.5.1 Soils

None of the soil samples tested recorded determinant concentrations in excess of either commercial or POS park end-use screening values.

The Tier 1 Quantitative risk assessment therefore established that there was no risk to the human health receptors of construction workers or future end-users.

6.5.2 Groundwater

The Groundwater Risk Assessment established that **there was no risk** to the groundwater receptor, as there were no concentrations noted of determinants in excess of the DWS – considered the most suitable screening values in this case.

6.5.3 Soil Gas

The results from the limited soil gas monitoring undertaken to date indicate a site gassing regime representative of CS1, for which no protection measures are required. However, monitoring has not been completed at time of writing in compliance with the relevant guidance and the confidence in this preliminary conclusion is therefore low. The results from the full soil gas risk assessment will be provided as an addendum to this report on completion of the monitoring.

6.6 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust is generated as a result of construction activities. The site should be securely fenced at all times to prevent unauthorised access.

Washing facilities should be provided and eating restricted to mess huts.

Because of the identified potential for elevated levels of carbon dioxide in the ground gas monitoring to date, it would be strongly advised that suitable precautions be emplaced if entry into confined spaces is required during works.

6.7 Excavated Material

Excavated material as waste must be defined or classified prior to any disposal, transport, recycling or re-use at or by an appropriately licensed or exempt carrier and/or off-site disposal facility. The requirements inherent in both Duty of Care and Health and Safety must also be complied with. In order to determine what is to happen, what is suitable, appropriate and most effective in the disposal of wastes, especially those subject to CDM waste management plan requirements, several factors must be considered and competent advice should always be sought.

The amount, type and nature of the material to be removed will in part determine the amount and type of analysis that may be required to comply with current waste guidance, and thereby allow a competent person to suitably classify the material. Often this data is uncertain or unavailable, especially in the early stages of a project, and therefore further investigation, testing and analysis may be required as additional information regarding the development becomes available.

Wastes must be classified and defined by their solid characteristics to comply with current waste guidance. Existing information and analysis derived for environmental purposes may therefore be suitable for use in this context. Waste Acceptance Criteria (WAC) report the leachability of materials and therefore cannot be used to classify, characterise or define wastes. The only purpose of a WAC analysis is to determine the suitability of a given material for acceptance at one of the three different types of available licenced landfills (inert, stable non-reactive hazardous or hazardous).

WAC analysis was undertaken on two samples obtained from near surface soils and the certificates are included in Appendix D.2.

Other options are available that may lead to significant savings against disposal to landfill and expert advice should always be sought from a competent person to advise on their relative costs or benefits and advise on any additional analysis, sampling or investigation that may be required to reduce remaining uncertainties and comply with current guidance. Further consideration of results using HazWasteOnline™ can be undertaken on request to give an indication of potentially hazardous properties in the materials analysed.

6.8 Re-use of Excavated Material On-site

The re-use of on-site soils may be undertaken either under the Environmental Permitting Regulations 2007 (EPR), in which case soils other than uncontaminated soils are classed as waste, or under the CL:AIRE Voluntary Code of Practice (CoP) which was published in September 2008 and is accepted as an alternative regime to the EPR.

Under the EPR, material that is contaminated but otherwise suitable for re-use is also classified as waste and its re-use should be in accordance with the Environmental Permitting Regulations 2007 (EPR). Environmental Permit Exemptions (EPE) are for the re-use of non-hazardous or inert waste only; hazardous waste cannot be re-used under a permit exemption. EPE apply only to imported inert waste materials; inert material arising on site and recovered on site is not classified as waste and does not require an exemption. It is possible that materials arising on-site will be classified as inert and would not need an exemption.

Environmental Permit Exemptions are only allowed for certain activities, placing controls on the quantities that can be stored and re-used. The re-use of waste shall be within areas and levels defined in planning applications and permissions for the development. An EPE requires a site-specific risk assessment for the receptor site to demonstrate that the materials are suitable for use, i.e. that they will not give rise to harm to human health or pollution of the environment.

Under the CL:AIRE voluntary code of practice (CoP) materials excavated on-site are not deemed contaminated if suitable for re-use at specified locations or generally within the site.

Material that may have been classified as hazardous waste under the EPR may be re-used. The CoP regime requires that a 'Qualified Person' as defined under the CoP reviews the development of the Materials Management Plan, including review of Risk Assessments and Remediation Strategy/Design Statement together with documentation relating to Planning and Regulatory issues, and signs a Declaration which is forwarded to the Environment Agency and which confirms compliance with the CoP.

Should it be necessary to import materials from another site where materials are excavated and which is not material from a quarry or produced under a WRAP protocol, then an EPE would be necessary for the imported material whether the work was managed under the CoP or the EPR.

6.9 Imported Material

Any soil, which is to be imported onto the site, must undergo chemical analysis to permit classification prior to its importation and placement in order to ascertain its status with specific regard to contamination, i.e. to prove that it is suitable for the purpose for which it is intended.

6.10 Discovery Strategy

There may be areas of contamination not identified during the course of the investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

Care should be taken during excavation works especially to investigate any soils, which appear by eye (e.g. such as fibrous materials, large amounts of ash and unusual discolouration), odour (e.g. fuel, oil and chemical type odours or unusual odours such as sweet odours or fishy odours) or wellbeing (e.g. light headedness and/or nausea, burning of nasal passages and blistering or reddening of skin due to contact with soil) to be contaminated or of unusual and/or different character to standard soils or those analysed.

In the event of any discovery of potentially contaminated soils or materials, this discovery should be quarantined and reported to the most senior member of site staff or the designated responsible person at the site for action. The location, type and quantity must be recorded and the Local Authority, and a competent and appropriate third party Engineer/Environmental consultant notified immediately. An approval from the Local authority must be sought prior to implementing any proposed mitigation action.

The discovery strategy must remain on site at all times and must demonstrate a clear allocation of responsibility for reporting and dealing with contamination. A copy of the strategy must be placed on the health and safety notice board and /or displayed in a prominent area where all site staff are able to take note of and consult the document at any time. Any member of the workforce entering the site to undertake any excavation

must be made aware of the potential to discover contamination and the discovery strategy.

List of Figures

Figure 1 – Site Location Map	35
Figure 2 – Aerial Photograph	36
Figure 3 – Trial Hole Plan	37

List of Appendices

Appendix A Field Work

Appendix A.1 Engineers Logs

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Appendix B.2 Interpretation

Appendix B.3 Geotechnical In-Situ and Laboratory Results

Appendix C Foundation Design

Appendix C.1 Preliminary Pile Design

Appendix D Chemical Laboratory Testing

Appendix D.1 Conceptual Site Model

Appendix D.2 Chemical Laboratory Results

Appendix D.3 General Assessment Criteria

Appendix E Information Provided by the Client

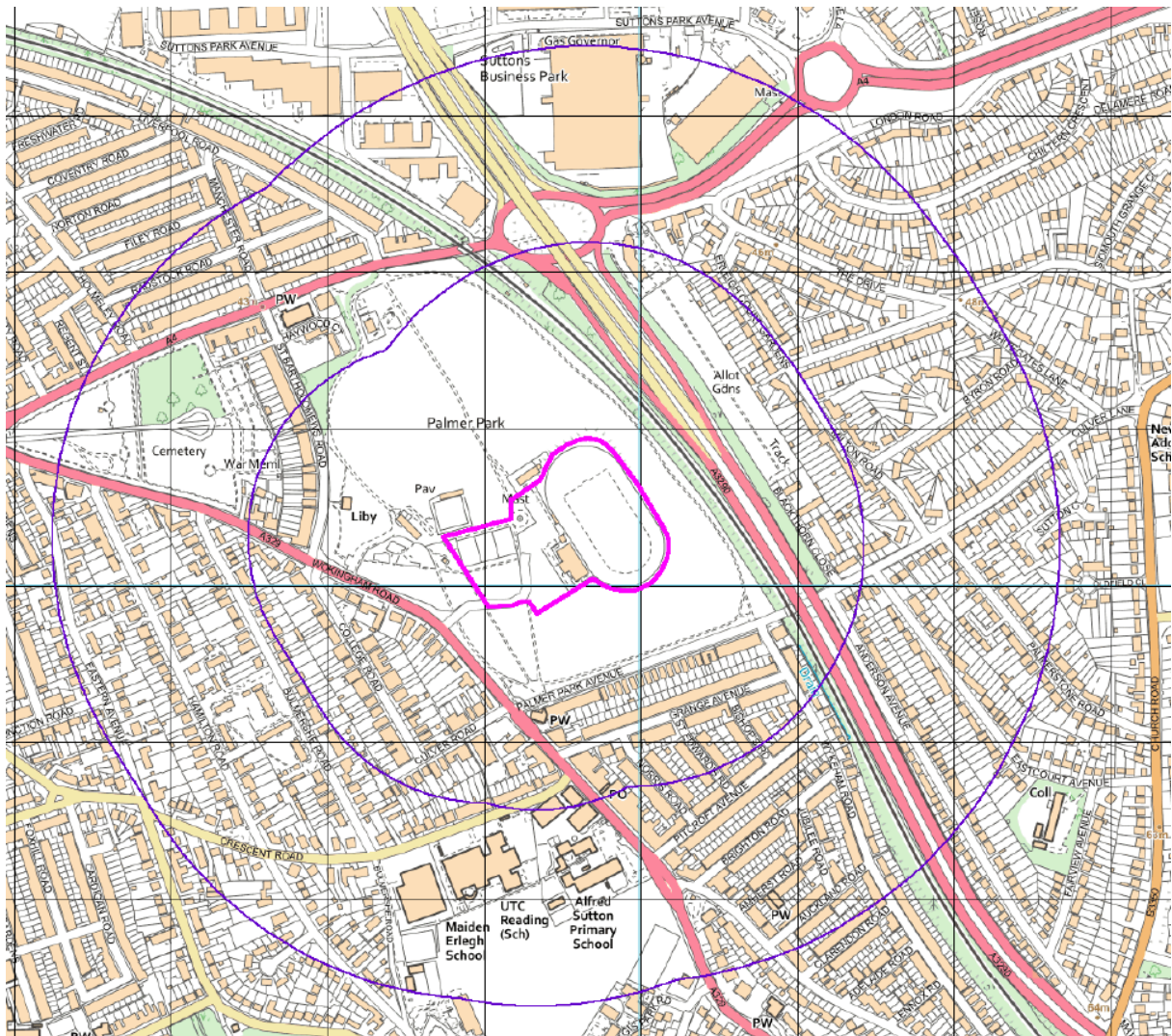


Figure I – Site Location Map



Job Number
17760

Project

Palmer Park Sports Stadium, Wokingham Road,
Reading RG6 1LF

Client
Reading Borough Council

Date
August 2019

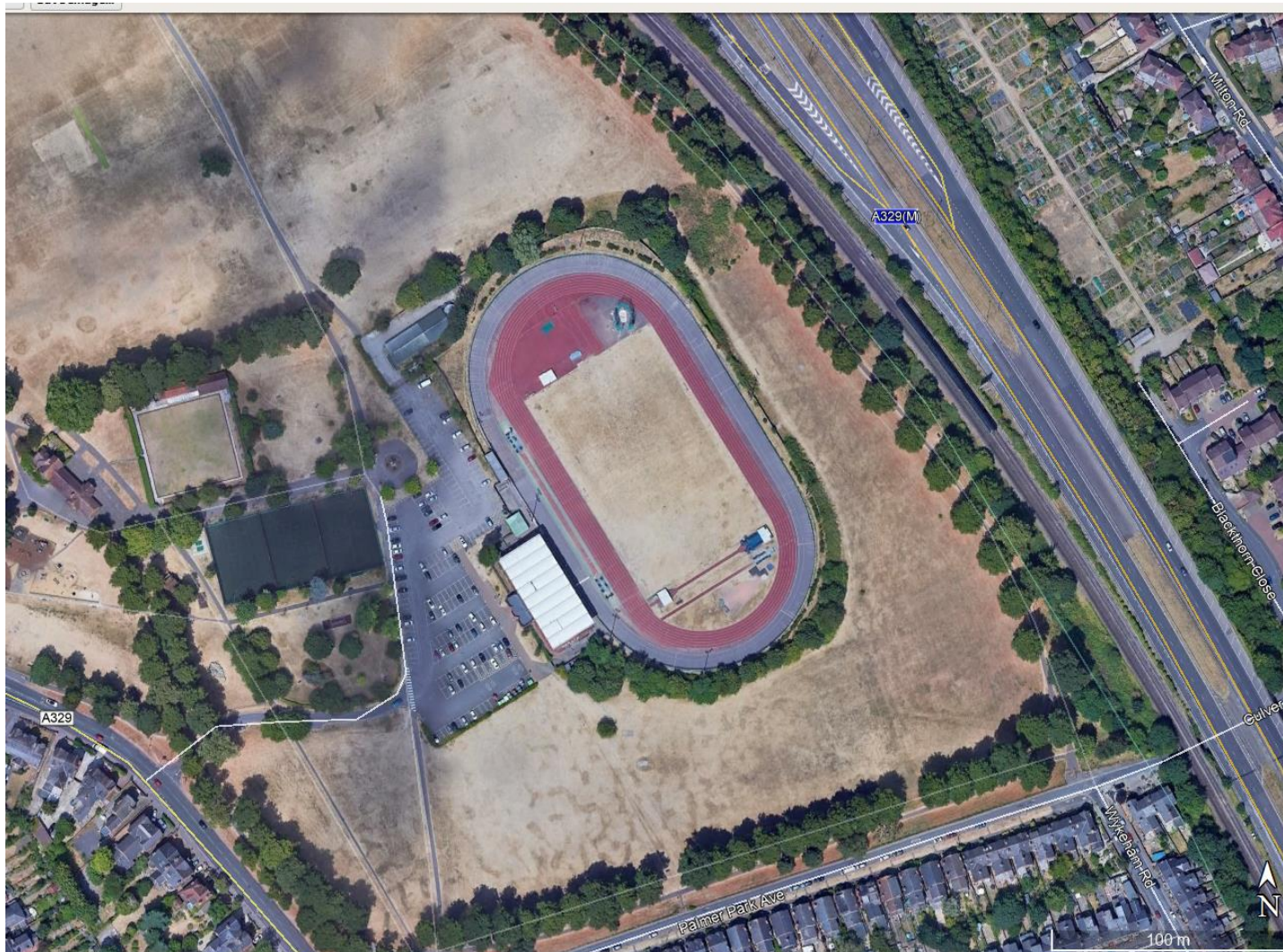


Figure 2 – Aerial Photograph

Project

Palmer Park Sports Stadium,
Wokingham Road, Reading RG6
1LF

Client

Reading Borough Council

Date

August 2019

Job Number

17760

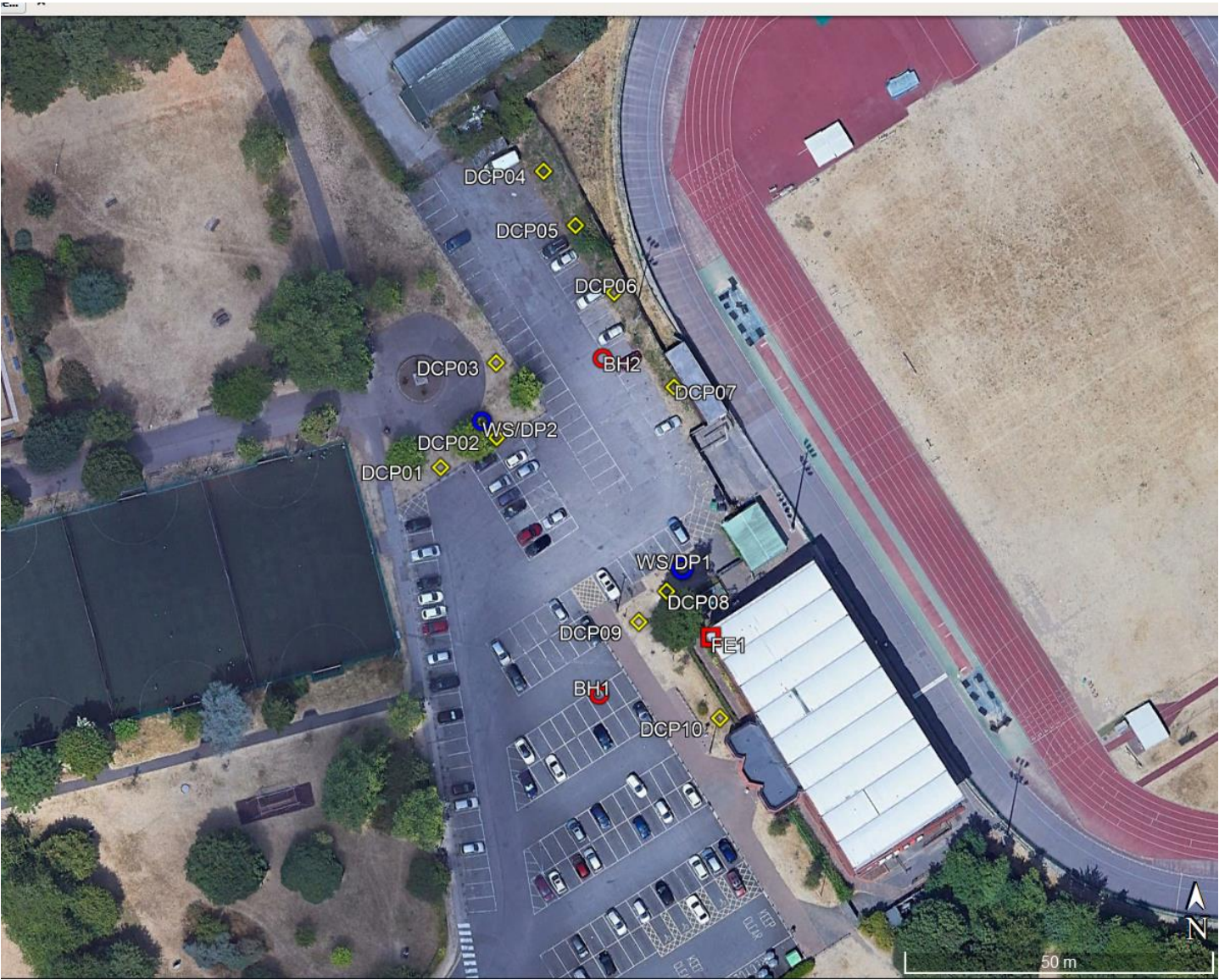


Figure 3 – Trial Hole Plan

Project
Palmer Park Sports Stadium,
Wokingham Road, Reading RG6
ILF

Client
Reading Borough Council

Date
August 2019

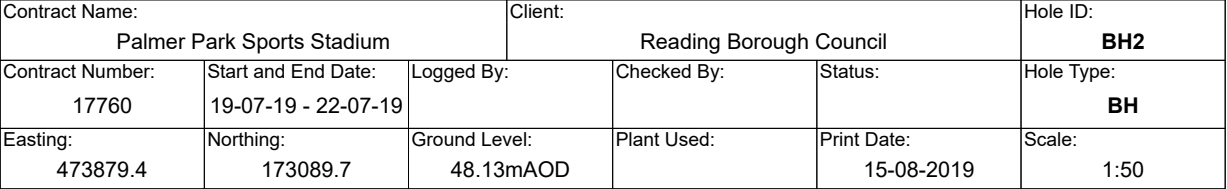
Job Number
17760

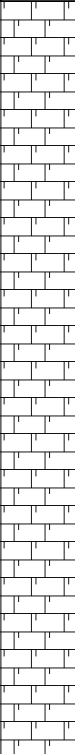
Appendix A Field Work

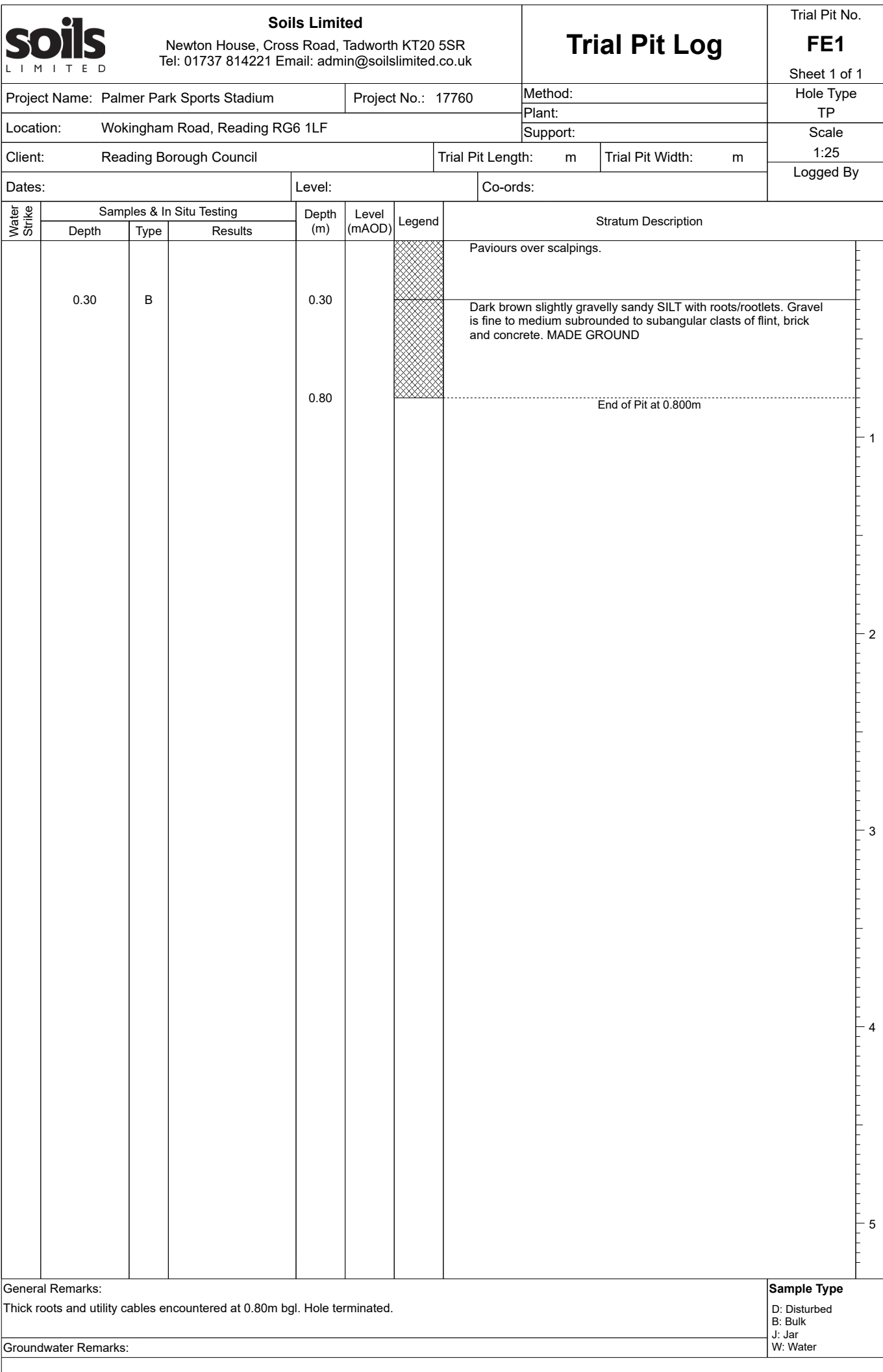
Appendix A.1 Engineers Logs

	Contract Name: Palmer Park Sports Stadium				Client: Reading Borough Council				Hole ID: BH1					
	Contract Number: 17760		Start and End Date: 18-07-19 - 19-07-19		Logged By: DW		Checked By:		Status:		Hole Type: BH			
	Easting: 473878.2		Northing: 173035.3		Ground Level: 48.70mAOD		Plant Used: D150		Print Date: 15-08-2019		Scale: 1:50			
Weather:			Termination: Depth reached				SPT Hammer: AR2144 Energy Ratio: 72%				Sheet 1 of 2			
Samples & In Situ Testing				Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation	
0.10	D		48.60	0.10		TARMAC. MADE GROUND.						1		
0.35	D		48.34	0.35		Black and grey mottled, angular to sub-angular, medium to coarse, gabbro gravel. MADE GROUND.								
0.85 - 1.00	B		(0.85)	47.50	1.20		Brown mottled, greyish brown, slightly gravelly, sandy CLAY. Gravel is angular to sub-rounded, fine to medium flint, clinker, chalk and brick. MADE GROUND.							
1.20	D						Brown, slightly gravelly, very sandy CLAY. Gravel is angular to sub-rounded, fine to coarse, flint. Rare grey clay pockets. TAPLOW GRAVEL MEMBER <i>D sample at 2.3 m contains both clay and sand pockets, possibly interbedded or reworked .</i>							
1.50 - 2.00	B	N=19 (3,4/4,4,5,6)	45.70	3.00		Brown, slightly clayey, medium to coarse SAND. Very rare, angular, fine flint gravel. TAPLOW GRAVEL MEMBER						3		
2.30	D													
2.50	SPT													
2.50 - 3.00	B													
3.50	SPT	N=14 (3,3/3,4,2,5)	44.40	4.30		Brown, sandy clayey GRAVEL. Gravel is angular to rounded, fine to coarse flint. TAPLOW GRAVEL MEMBER <i>Becomes sand and gravel at 5.5 m bgl.</i>						4		
3.50 - 4.00	D													
4.30	SPT													
4.50	B													
4.50 - 5.00	B	N=35 (3,4/5,7,10,13)	42.70	6.00		Yellowish brown slightly clayey medium occasionally coarse SAND. TAPLOW GRAVEL MEMBER						5		
5.50	D													
6.00	SPT													
6.00 - 6.50	B													
7.00	D	50 (7,13/50 for 170mm)	(4.30)									6		
7.50	SPT													
7.50 - 8.00	D													
8.50	D													
9.00	SPT	50 (8,15/50 for 90mm)										7		
	D													
												8		
												9		
												10		
Start & End of Shift Observations				Borehole Diameter		Casing Diameter		Remarks:						
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)							Dia (mm)
					15.00	150	10.50							150
Chiselling				Installation				Water Strikes						
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
					0.00	1.00	PLAIN	50						
					1.00	15.00	SLOTTED	50						
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

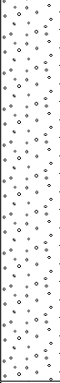
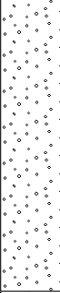
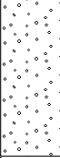
	Contract Name: Palmer Park Sports Stadium				Client: Reading Borough Council				Hole ID: BH1																							
	Contract Number: 17760		Start and End Date: 18-07-19 - 19-07-19		Logged By: DW		Checked By:		Status:		Hole Type: BH																					
	Easting: 473878.2		Northing: 173035.3		Ground Level: 48.70mAOD		Plant Used: D150		Print Date: 15-08-2019		Scale: 1:50																					
Weather:			Termination: Depth reached				SPT Hammer: AR2144 Energy Ratio: 72%				Sheet 2 of 2																					
Samples & In Situ Testing				Strata Details								Groundwater																				
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation																			
10.30	D	Ublow = 60	38.40	10.30		Yellowish brown slightly clayey medium occasionally coarse SAND. TAPLOW GRAVEL MEMBER						11																				
10.50 - 10.95	U			(0.70)		Very stiff, grey, slightly sandy CLAY. Sand is light greenish grey, and fine.. LAMBETH GROUP																										
11.00	D	N=59 (9,9/59 for 230mm)	37.70	11.00		White structured CHALK. recovered as white, soft, sub-angular to sub-rounded clasts in a silty comminuted matrix, with rare angular medium flint nodules. SEAFORD AND NEWHAVEN CHALK FORMATION						12																				
11.00 - 11.50	B			(4.00)										13																		
12.00	SPT D															13.00	D	13.50	SPT D	N=35 (5,8/9,8,9,9)	33.70	15.00	End of Borehole at 15.00m	15								
13.00	D																									14.50	D	15.00	SPT D	N=34 (7,9/10,8,7,9)	16	
13.50	SPT D																															
14.50	D	15.00	SPT D	N=34 (7,9/10,8,7,9)	33.70	15.00	End of Borehole at 15.00m	18																								
15.00	SPT D									15.00	SPT D	N=34 (7,9/10,8,7,9)	33.70	15.00	End of Borehole at 15.00m	19																
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:																							
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)																								
					15.00	150	10.50	150	Water Strikes																							
Chiselling					Installation				Strike (m) Casing (m) Sealed (m) Time (mins) Rose to (m) Remarks																							
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.																							
					0.00	1.00	PLAIN	50																								
					1.00	15.00	SLOTTED	50																								

[illegible]

	Contract Name: Palmer Park Sports Stadium				Client: Reading Borough Council				Hole ID: BH2					
	Contract Number: 17760		Start and End Date: 19-07-19 - 22-07-19		Logged By:		Checked By:		Status:		Hole Type: BH			
	Easting: 473879.4		Northing: 173089.7		Ground Level: 48.13mAOD		Plant Used:		Print Date: 15-08-2019		Scale: 1:50			
			Termination: Depth reached				SPT Hammer: AR2144 Energy Ratio: 72%				Sheet 2 of 2			
Samples & In Situ Testing				Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation	
10.50	SPT D	N=26 (3,4/5,5,7,9)	33.13	(5.70)		White structured CHALK recovered as white, soft, sub-angular to sub-rounded clasts in a silty comminuted matrix, with rare angular medium flint nodules. SEAFORD AND NEWHAVEN CHALK FORMATION					11			
11.50	D										12			
12.00	SPT D	N=26 (3,5/5,6,7,8)									13			
13.00	D										14			
13.50	SPT D	N=32 (5,6/6,9,8,9)									15			
14.50	D										16			
15.00	SPT D	N=41 (4,8/9,10,11,11)				End of Borehole at 15.00m						17		
											18			
											19			
											20			
Start & End of Shift Observations				Borehole Diameter		Casing Diameter		Remarks:						
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)							Dia (mm)
					15.00	150	9.00	150						
Chiselling				Installation				Water Strikes						
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
					0.00	1.00	PLAIN	50						
					1.00	15.00	SLOTTED	50						
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														



soils L I M I T E D	Contract Name: Palmer Park Sports Stadium				Client: Reading Borough Council				Hole ID: WS1					
	Contract Number: 17760		Start and End Date: 23-07-19		Logged By: DW		Checked By:		Status:		Hole Type: WS			
	Easting: 473889.3		Northing: 173061.8		Ground Level: 48.21mAOD		Plant Used: Archway		Print Date: 15-08-2019		Scale: 1:50			
Weather:			Termination:					Sheet 1 of 1						
Samples & In Situ Testing				Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation	
0.20	DJ		48.01	0.20		No sample, description from drillers logs; Turf covering made ground, large pieces of brick, small rootlets.						1		
0.50	DJ			(0.70)		Light greyish brown, slightly gravelly silty fine SAND. Gravel is angular to rounded, fine to coarse, flint, brick, basalt and rare clinker. occasional rootlets becoming rare from 0.5mbgl. MADE GROUND								
0.80	DJ		47.31	0.90		Brown slightly clayey very gravelly SAND. Gravel is angular to rounded, fine to coarse flint. TAPLOW GRAVEL MEMBER						2		
1.00	DJ			(0.60)		Brown slightly clayey very gravelly SAND. Gravel is angular to rounded, fine to coarse flint. TAPLOW GRAVEL MEMBER								
1.20	D		46.71	1.50		Orangish Brown mottled, slightly sandy clayey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse flint. Frequent sandy clay pockets, occasional organic black odourless staining. TAPLOW GRAVEL MEMBER						3		
1.60	D		46.51	1.70		Orangish brown mottled, slightly gravelly very sandy CLAY. Gravel is angular to sub rounded, fine to coarse, flint. Occasional black odourless organic staining. TAPLOW GRAVEL MEMBER								
1.80	D		46.31	1.90		Orangish Brown mottled, slightly sandy clayey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse flint. Frequent sandy clay pockets, occasional organic black odourless staining. TAPLOW GRAVEL MEMBER						4		
2.00	D			(0.70)		Orangish Brown mottled, slightly sandy clayey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse flint. Frequent sandy clay pockets, occasional organic black odourless staining. TAPLOW GRAVEL MEMBER								
2.60	D		45.61	2.60		Firm slightly greyish brown mottled and laminated slightly gravelly very sandy CLAY. Gravel is annular to sub rounded, fine to medium, flint. Sand is medium with occasional sandy clay lenses. TAPLOW GRAVEL MEMBER						5		
			45.21	3.00		Yellowish brown slightly gravelly, fine to coarse SAND. Gravel is sub angular to sub rounded, fine to medium, flint. TAPLOW GRAVEL MEMBER								
3.20	D		44.81	3.40		Soft orangish brown yellowish brown and brown laminated, very sandy CLAY. Sand is fine to medium, and features in frequent lenses. TAPLOW GRAVEL MEMBER						6		
3.60	D		44.51	3.70		Yellowish brown very gravelly SAND. Gravel is sub angular to sub rounded, fine to coarse, flint. TAPLOW GRAVEL MEMBER								
3.80	D		44.31	3.90		Yellowish brown very gravelly SAND. Gravel is sub angular to sub rounded, fine to coarse, flint. TAPLOW GRAVEL MEMBER						7		
						End of Borehole at 3.90m								
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)						
Chiselling					Installation		Water Strikes							
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

	Contract Name: Palmer Park Sports Stadium				Client: Reading Borough Council				Hole ID: WS2					
	Contract Number: 17760		Start and End Date: 23-07-19		Logged By: DW		Checked By:		Status:		Hole Type: WS			
	Easting: 473859.0		Northing: 173079.5		Ground Level: 48.14mAOD		Plant Used: Archway		Print Date: 15-08-2019		Scale: 1:50			
Weather:			Termination:					Sheet 1 of 1						
Samples & In Situ Testing				Strata Details								Groundwater		
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/Installation	
0.20	DJ		47.94	0.20		Grass over dry brown slightly sandy Earth. Angular to sub angular gravel, small rootlets. MADE GROUND						1		
0.50	DJ		47.69	0.45		Light greyish brown, slightly gravelly silty fine SAND. Gravel is angular to rounded, fine to coarse, flint, brick. Rare rootlets. MADE GROUND								
0.80	DJ			(0.45)		Light greyish brown, slightly silty very gravelly fine SAND. Gravel is sub angular to rounded, fine to coarse, flint. Rare rootlets. TAPLOW GRAVEL MEMBER								
1.00	D		47.24	0.90		Brown slightly clayey gravelly SAND. Gravel is sub angular to sub rounded, fine to coarse, flint. TAPLOW GRAVEL MEMBER						1		
1.30	D		46.94	1.20		Orangish brown to greyish brown mottled, slightly sandy clayey sub angular to sub rounded, fine to coarse flint GRAVEL. TAPLOW GRAVEL MEMBER								
1.50	D		46.79	1.35		Stiff reddish brown yellowish brown mottled, slightly sandy gravelly CLAY. Gravel is sub angular to sub rounded, fine to coarse, flint. Occasional fine ferruginous fragments. TAPLOW GRAVEL MEMBER						2		
2.00	D			(0.75)										
2.20	D		46.04	2.10		Orangish Brown mottled, slightly clayey very sandy GRAVEL. Gravel is sub angular to sub rounded, fine to coarse flint. TAPLOW GRAVEL MEMBER						3		
2.70	D			(1.90)										
3.20	D													
3.70	D											4		
			44.14	4.00		End of Borehole at 4.00m								
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)						
Chiselling					Installation				Water Strikes					
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.														

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Classification based on SPT “N” values:

The inferred undrained strength of the cohesive soils was based on the SPT “N” blow counts, derived from the relationship suggested by Stroud (1974) and classified using Table B.1.1. (Ref: Stroud, M. A. 1974, “The Standard Penetration Test – its application and interpretation”, Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.).

Table B.1.1 SPT “N” Blow Count Cohesive Classification

Classification	Undrained Cohesive Strength C_u (kPa)
Extremely low	<10
Very low	10 – 20
Low	20 – 40
Medium	40 – 75
High	75 – 150
Very high	150 – 300
Extremely high	> 300

Note: (Ref: BS EN ISO 14688-2:2004+A1:2013 Clause 5.3.)

The relative density of granular soils was classified based of the relationship given in Table B.1.2.

The *UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing*, NA 3.7 SPT test, BS EN 1997-2:2007, Annex F states “Relative density descriptions on borehole records should also be based on uncorrected SPT N values, unless significantly disturbed, using the density classification in BS 5930:2015, Table 7.

Table B.1.2 SPT “N” Blow Count Granular Classification

Classification	SPT “N” blow count (blows/300mm)
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Greater than 50

Note: (Ref: The Standard Penetration Test (SPT): Methods and Use, CIRIA Report 143, 1995)

Chalk samples recovered are disturbed by the sampling process. Therefore, it is difficult to assess an accurate chalk grade for in accordance with CIRIA C574 ‘Engineering in

Chalk'. In the absence of a standardised correlation between SPT "N" values and chalk grade for the most recent chalk classification (CIRIA C574) a broad indication of the in-situ chalk grade can be assessed using a paper by T.R.M. Wakeling from a site in Mundford, Norfolk, which compares SPT "N" values to the old Spink & Norbury chalk classification. From the Spink & Norbury classification it is possible to infer a basic CIRIA Grade (structureless or structured), as outlined in Table B.1.3.

Table B.1.3 Interpretation of SPT "N" Blow Counts in Chalk

SPT "N" Value Range	Spink & Norbury Grade	Inferred CIRIA Grade
<8	VI	Structureless (Dm)
8 – 15	V	Structureless (Dc)
15 – 20	IV	Structured chalk (C5 – A1)
20 - 25	III	Structured chalk (C5 – A1)
25 - 35	II	Structured chalk (C5 – A1)
>35	I	Structured chalk (C5 – A1)

Note:

Classification of DCP results to CBR:

The DCP consists of a cone fixed to the bottom of a 575mm vertical rod. An 8kg weight is repeatedly lifted and dropped onto an anvil at the mid-height of the rod to deliver a 'blow'. A vertical scale alongside the rod is used to measure the depth of penetration of the cone. These measurements are then converted to CBR values using the following equation derived from the DTP Interim Advice Note 73/06 – Design Guidance for Road Pavement Foundations:

$$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \times \text{Log}_{10}(\text{mm/blow})$$

Appendix B.2 Interpretation

Table B.2.1 Interpretation of SPT Tests

BH	Strata	SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
BH1	TPGR 1.20 – 3.00 Gravelly CLAY	23	High ($C_u = 115\text{kPa}$)
	TPGR 3.00 – 6.00 Sandy GRAVEL	17 – 42	Medium dense to dense
	TPGR 6.00 – 10.30 SAND	46 – 50+	Dense to very dense
	SECK 11.00 – 15.00 CHALK	41 – 50+	Structured chalk (C5 – A1)
BH2	TPGR 0.40 – 5.80 Sandy GRAVEL	35 – 50+	Dense to very dense
	LMBE 5.80 – 9.30 CLAY	34	Very high ($C_u = 170\text{kPa}$)
	SECK 9.30 – 15.00 CHALK	31 – 49	Structured chalk (C5 – A1)
Note: Rig efficiency: 72%			

Table B.2.2 Interpretation of DPSH Blow Counts

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
DPI	TPGR 0.90 – 1.80 Gravelly CLAY	10 – 20	Medium to high ($C_u = 50 – 100\text{kPa}$)
	TPGR 1.80 – 2.70 Sandy GRAVEL	30 – 50+	Dense to very dense
	TPGR ¹ 2.70 – 4.90 Clayey GRAVEL	10 – 20	Medium dense
	TPGR 4.90 – 5.50 Sandy GRAVEL	20 – 23	Medium dense
	TPGR 5.50 – 5.90 Sandy GRAVEL	50+	Very dense

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
DP2	TPGR Sandy GRAVEL 1.00 – 1.40	30 – 40	Dense
	TPGR Sandy GRAVEL 1.40 – 3.00	50+	Very Dense
	TPGR ¹ Sandy GRAVEL 3.00 – 5.70	30 – 42	Dense
	TPGR ¹ Clayey SAND 5.70 – 6.00	50+	Very Dense

Note: ¹ Ground conditions inferred past the base of windowless sampler boreholes. Rig efficiency: 68.22%.

Table B.2.3 Interpretation of QUU Tests

Location	Stratum	Sample Depth (m bgl)	Moisture Content (%)	Soil Strength	Shear Strength (kPa)
BHI	LMBE	6.00	24	Low	30

Table B.2.4 Interpretation of Atterberg Limit Tests

Stratum	Moisture Content (%)	Plasticity Index (%)	Passing 425µm Sieve (%)	Modified Plasticity Index (%)	Soil Classification	Volume Change Potential	
						BRE	NHBC
TPGR	7.4	12	47	6	CL	Low	None
LMBE	24	34	100	34	CH	Medium	Medium

Note: BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)

NHBC Volume Change Potential refers to NHBC Standards Chapter 4.2

Soils Classification based on British Soil Classification System

The most common use of the term clay is to describe a soil that contains enough clay-sized material or clay minerals to exhibit cohesive properties. The fraction of clay-sized material required varies, but can be as low as 15%. Unless stated otherwise, this is the sense used in Digest 240. The term can be used to denote the clay minerals. These are specific, naturally occurring chemical compounds, predominately silicates. The term is often used as a particle size descriptor. Soil particles that have a nominal diameter of less than 2 µm are normally considered to be of clay size, but they are not necessarily clay minerals. Some clay minerals are larger than 2 µm and some particles, 'rock flour' for example, can be finer than 2 µm but are not clay minerals.

(The Atterberg Limit Tests were undertaken in accordance with BS 1377:Part 2:1990 Clauses 3.2, 4.3 and 5)

Table B.2.5 Interpretation of PSD Tests

Location	Depth (m bgl)	Soil Description	Volume Change Potential		Passing 63µm Sieve (%)
			BRE	NHBC	
BHI	1.50-2.00	Slightly sandy gravelly CLAY	Yes	Yes	46
BHI	4.50-5.00	Very sandy clayey GRAVEL	No	No	9
BHI	5.50	Sandy clayey GRAVEL	No	No	7
BHI	7.50-8.00	Slightly clayey SAND	No	No	2

Location	Depth (m bgl)	Soil Description	Volume Change Potential		Passing 63µm Sieve (%)
			BRE	NHBC	

Note: BRE 240 states that a soil has a volume change potential when the clay fraction **exceeds 15%**. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve. NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.
(The Particle Size Distribution Tests were undertaken in accordance with BS 1377: Part 2: 1990 Clause 9)

Table B.2.6 Interpretation of SMC Tests

Location	Depth (m bgl)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Moisture Content (%)	Saturation Moisture Content (%)	Density Classification (CIRIA)
BH1	13.00	2.31	1.84	26	17	High
BH2	9.50	2.12	1.71	24	21	High
BH2	14.50	2.25	1.79	26	19	High

Note: (The Determination of Saturation Moisture Content of Chalk Tests were not made in accordance with BS 1377: Part 2: 1990 Clauses 3.3 as no intact chalk clasts of sufficient volume were present in the samples).

Appendix B.3 Geotechnical In-Situ and Laboratory Results

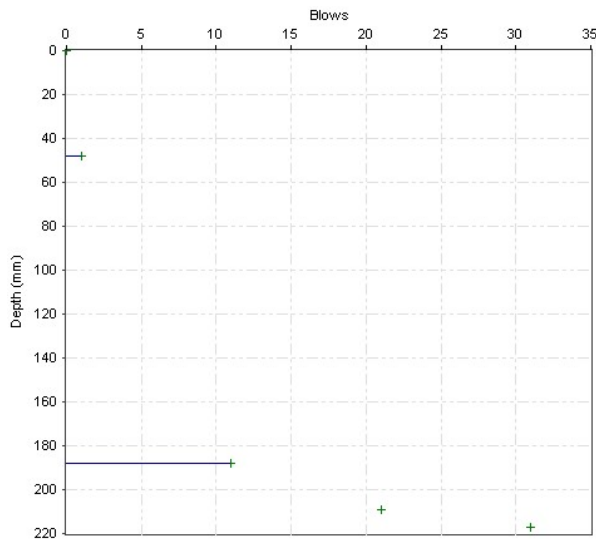
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

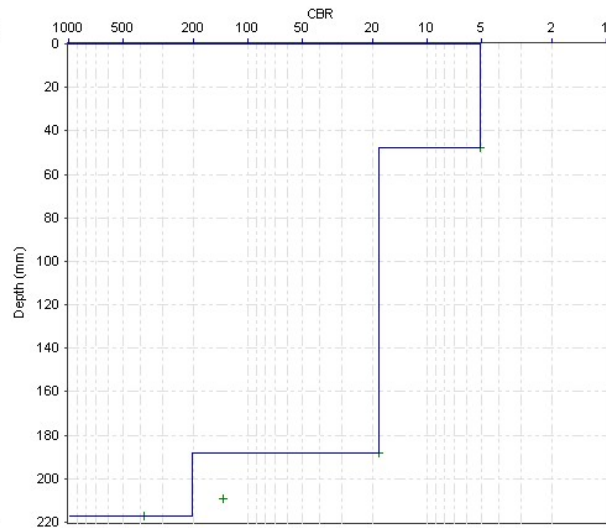
Chainage (km): 1.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 34
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 1.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	48.00	5	48	48	Base	0.01	0.03	0.03	0.03
2	14.00	19	140	188	Base	0.05	0.26	0.26	0.26
3	1.45	204	29	217	Base	0.14	0.16	0.16	0.16

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	0.45	0.45	0.45
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	0.45	0.45	0.45

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

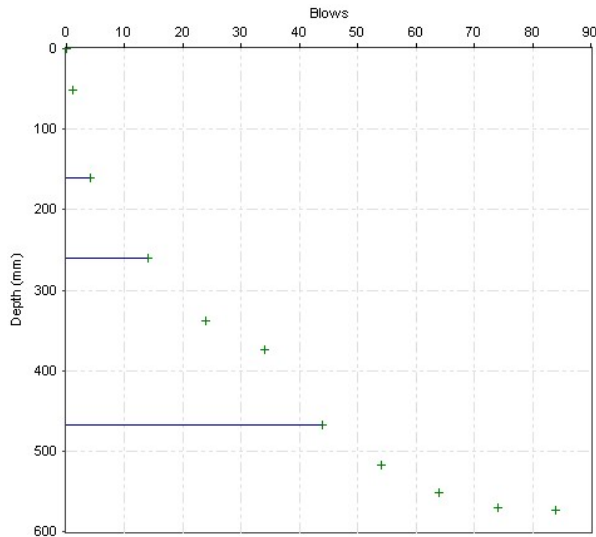
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

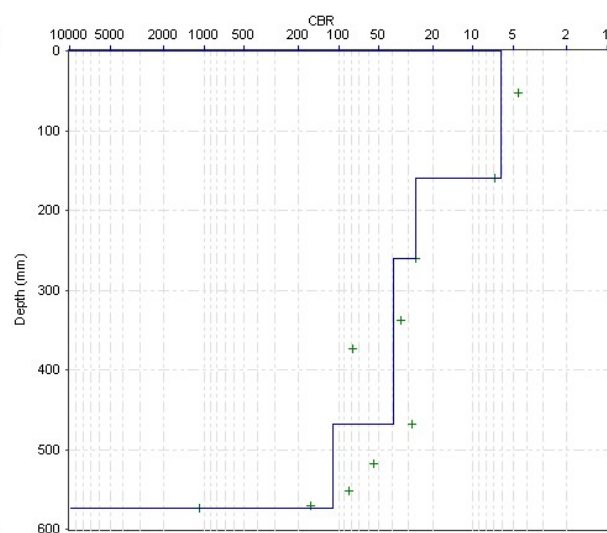
Chainage (km): 2.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 42
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 2.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	40.00	6	160	160	Base	0.02	0.11	0.11	0.11
2	10.00	26	100	260	Base	0.06	0.25	0.25	0.25
3	6.93	39	208	468	Base	0.09	0.71	0.71	0.71
4	2.63	109	105	573	Base	0.14	0.58	0.58	0.58

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.65	1.65	1.65
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.65	1.65	1.65

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

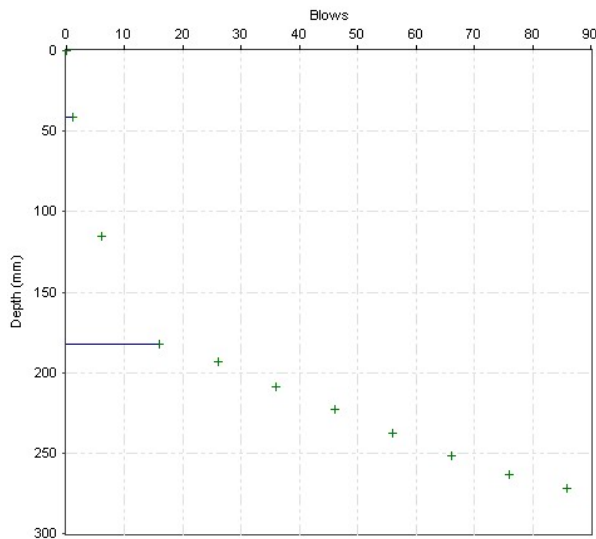
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

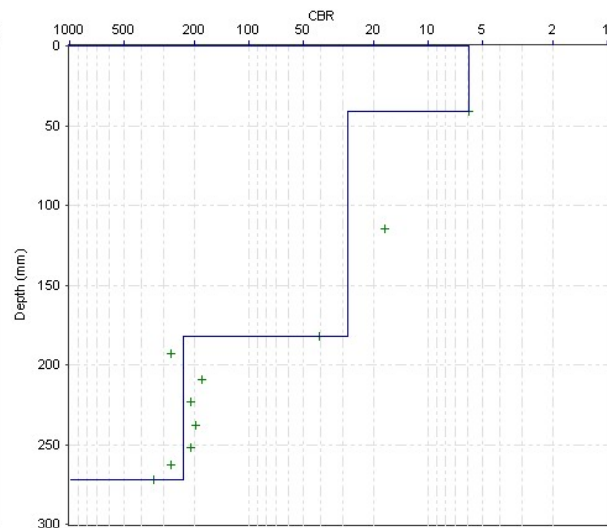
Chainage (km): 3.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 42
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 3.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	41.00	6	41	41	Base	0.02	0.03	0.03	0.03
2	9.40	28	141	182	Base	0.07	0.38	0.38	0.38
3	1.29	232	90	272	Base	0.14	0.51	0.51	0.51

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	0.91	0.91	0.91
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	0.91	0.91	0.91

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

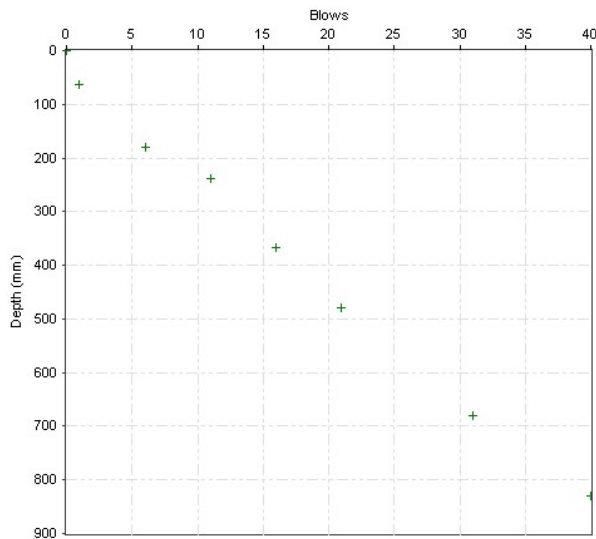
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

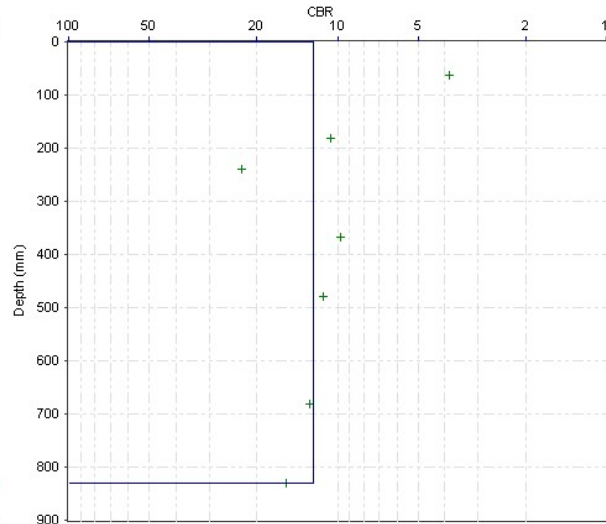
Chainage (km): 4.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 120
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 4.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	20.75	12	830	830	Base	0.03	1.07	1.07	1.07

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.07	1.07	1.07
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.07	1.07	1.07

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

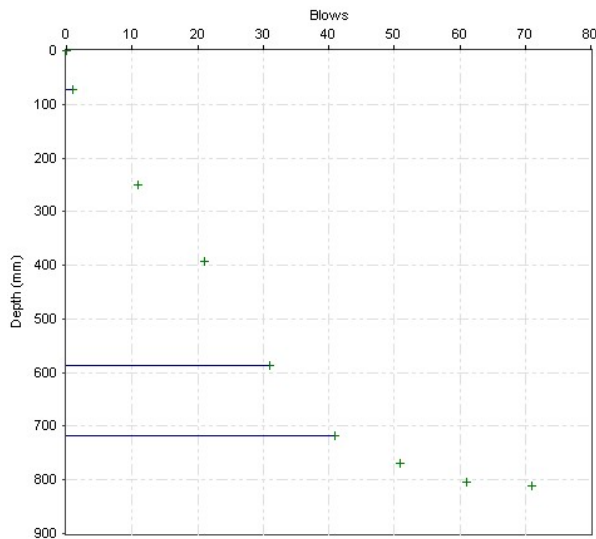
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

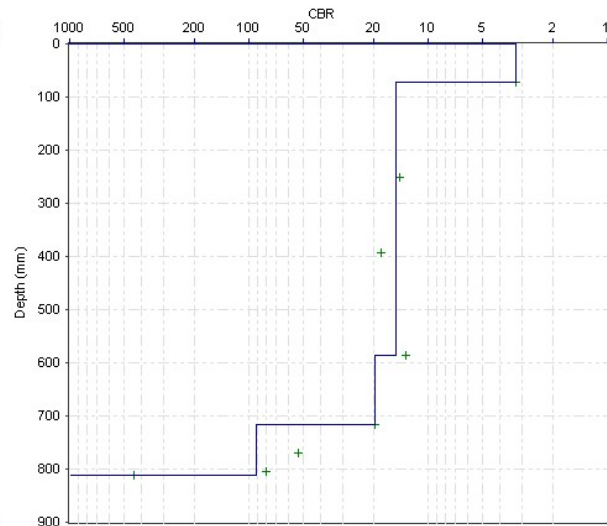
Chainage (km): 5.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 125
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 5.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	73.00	3	73	73	Base	0.01	0.03	0.03	0.03
2	17.10	15	513	586	Base	0.04	0.80	0.80	0.80
3	13.10	20	131	717	Base	0.05	0.26	0.26	0.26
4	3.13	90	94	811	Base	0.14	0.50	0.50	0.50

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.58	1.58	1.58
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.58	1.58	1.58

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

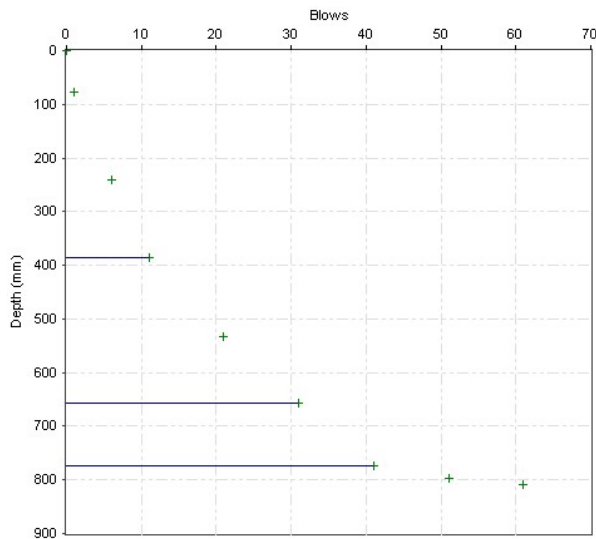
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

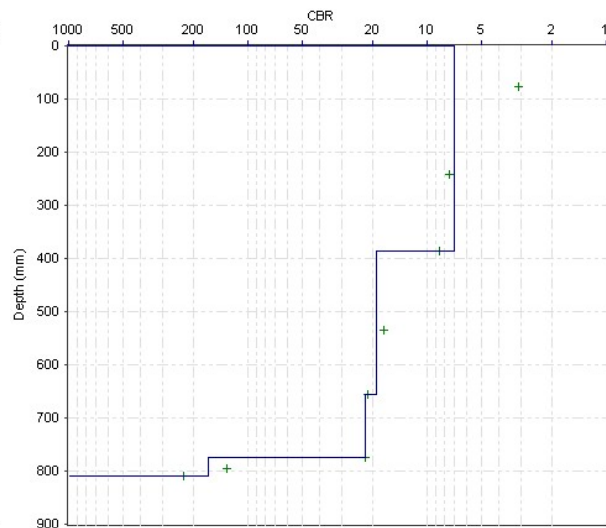
Chainage (km): 6.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 141
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 6.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	35.09	7	386	386	Base	0.02	0.30	0.30	0.30
2	13.50	19	270	656	Base	0.05	0.52	0.52	0.52
3	11.80	22	118	774	Base	0.06	0.26	0.26	0.26
4	1.75	167	35	809	Base	0.14	0.20	0.20	0.20

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.28	1.28	1.28
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.28	1.28	1.28

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

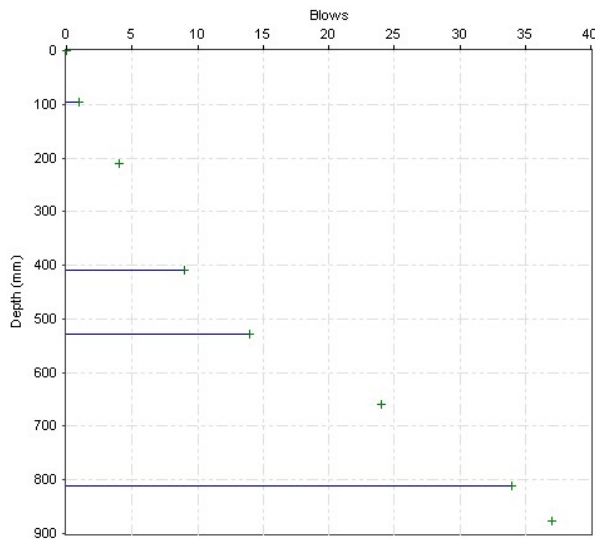
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

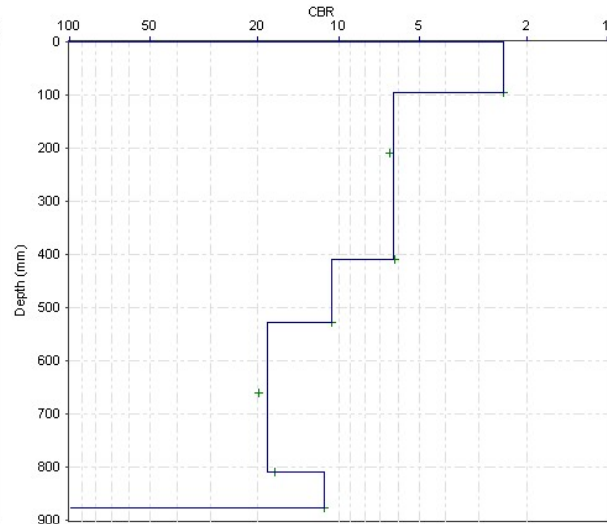
Chainage (km): 7.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 73
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 7.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	96.00	2	96	96	Base	0.01	0.03	0.03	0.03
2	39.13	6	313	409	Base	0.02	0.22	0.22	0.22
3	23.80	11	119	528	Base	0.03	0.13	0.13	0.13
4	14.10	18	282	810	Base	0.05	0.52	0.52	0.52
5	22.33	11	67	877	Base	0.03	0.08	0.08	0.08

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	0.98	0.98	0.98
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	0.98	0.98	0.98

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

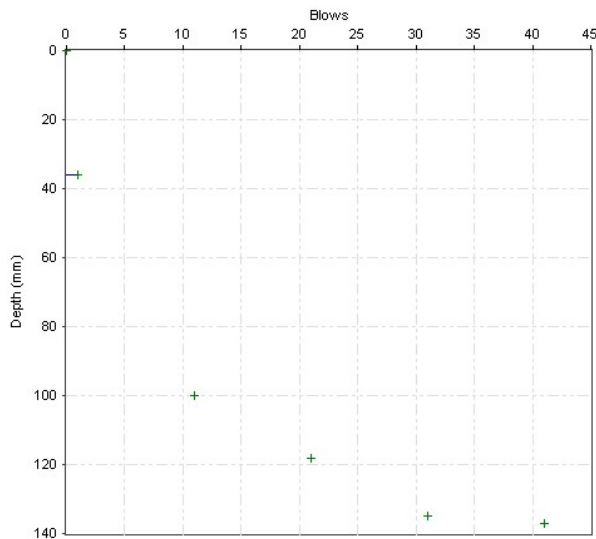
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

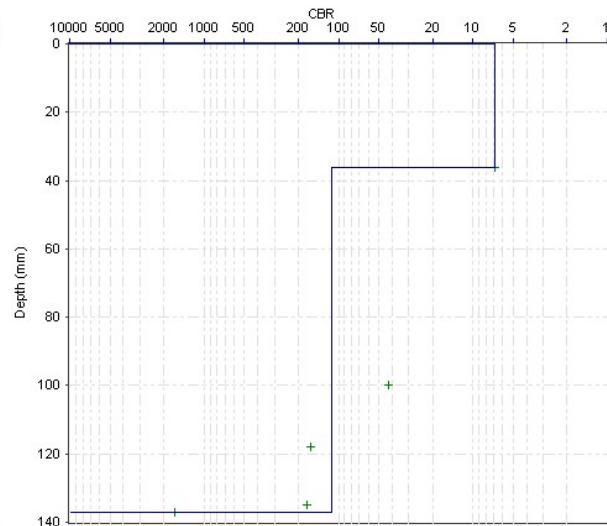
Chainage (km): 8.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 24
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 8.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	36.00	7	36	36	Base	0.02	0.03	0.03	0.03
2	2.53	113	101	137	Base	0.14	0.56	0.56	0.56

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	0.59	0.59	0.59
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	0.59	0.59	0.59

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

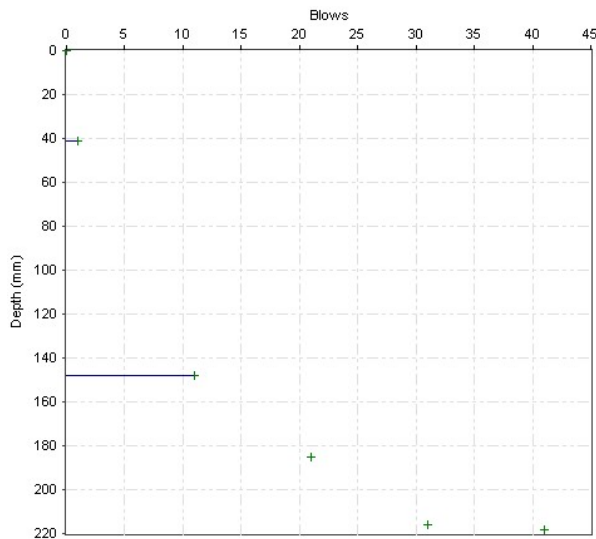
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

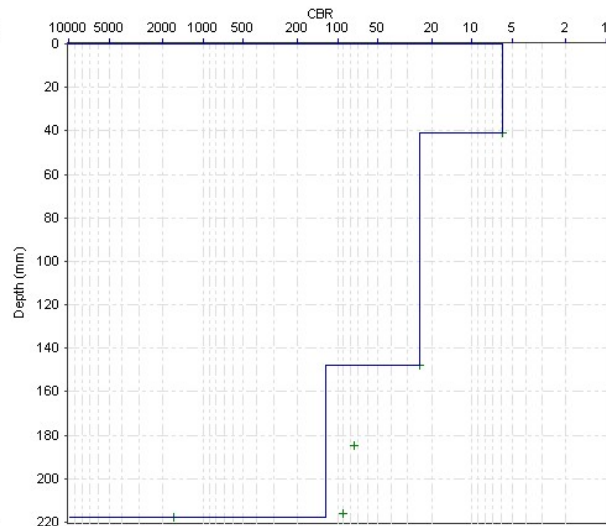
Chainage (km): 9.000
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 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 39
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 9.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	41.00	6	41	41	Base	0.02	0.03	0.03	0.03
2	10.70	25	107	148	Base	0.06	0.25	0.25	0.25
3	2.33	123	70	218	Base	0.14	0.39	0.39	0.39

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	0.68	0.68	0.68
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	0.68	0.68	0.68

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

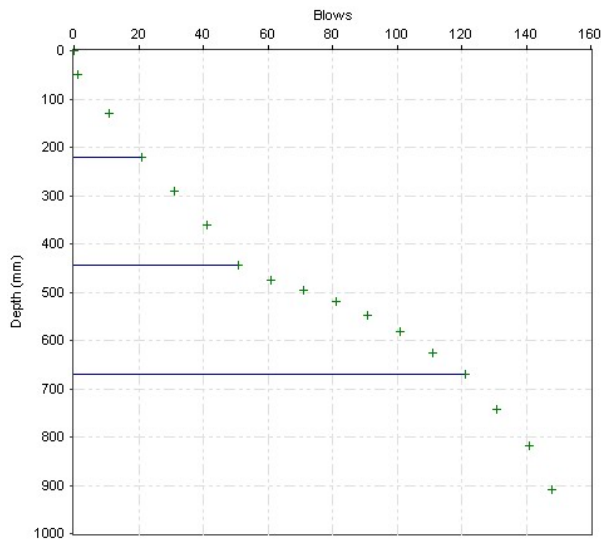
DCP Layer Strength Analysis Report

Project Name: 17760 DCPs

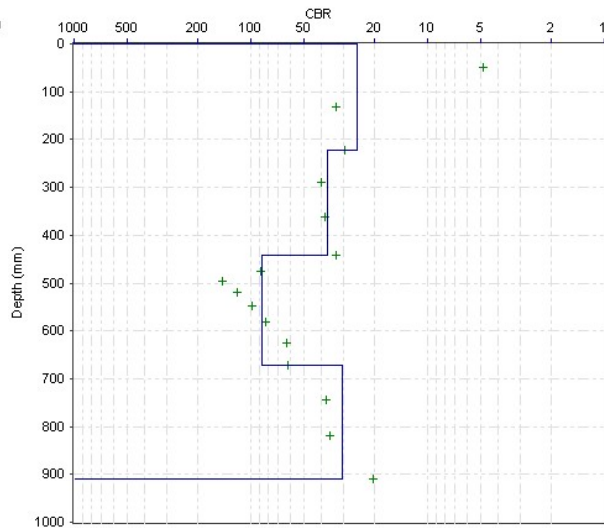
Chainage (km): 10.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 41
 Test Date: 19/07/2019

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 10.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	10.57	25	222	222	Base	0.06	0.53	0.53	0.53
2	7.37	37	221	443	Base	0.08	0.72	0.72	0.72
3	3.26	87	228	671	Base	0.13	1.20	1.20	1.20
4	8.81	30	238	909	Base	0.07	0.67	0.67	0.67

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	3.12	3.12	3.12
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	3.12	3.12	3.12

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Project Name:	Palmer Park Sports Stadium	Project No.	17760	Co-ords:	473889.33E - 173061.77N	Hole Type	DP
Location:	Wokingham Road, Reading RG6 1LF	Level:	48.211m AOD			Scale	1:50
Client:	Reading Borough Council	Dates:	23-07-2019			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
	4	12			
	9	11			
	3				
	2				
	4				
1	6				15
	6				
	5				
	6				
	5				
	6				
	6				
	4				
	3				
2	11	16	26	27	20
			24		
			23		
			24		
		16			
	9				
	5				
3	3				60
	4				
	7				
	8				
	11				
	9				
	7				
	8				
	6				
	6				
4	7				20
	6				
	4				
	5				
	4				
	4				
	3				
	3				
	3				
	3				
5	5	10			25
	11				
	16				
	7				
	7				
		18			
			32		
6					52 110 120
7					
8					
9					
10					
Remarks	Fall Height 750mm		Cone Base Diameter 50.5mm		
	Hammer Weight 64.5kg		Final Depth 5.9m		
	Probe Type DPSH-B		Energy Ratio (Er) 68.22%		

Project Name:	Palmer Park Sports Stadium	Project No.	17760	Co-ords:	473859.02E - 173079.47N	Hole Type	DP
Location:	Wokingham Road, Reading RG6 1LF	Level:	48.143m AOD			Scale	1:50
Client:	Reading Borough Council	Dates:	23-07-2019			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
1	11 13 9 12 15 16 15 16 16 16	17 19	23 24 24 25		0
2	17 20				
3	15 16 13 14 13 13 13 13 11 12 12				0
4	11 11 11 9 8 9 11 12 11 10 11 11 10 11 11 9 10 7 9				
5					5
6					
6		20	26	36	40
7					
8					
9					
10					
Remarks					
Fall Height		750mm	Cone Base Diameter		50.5mm
Hammer Weight		64.5kg	Final Depth		6m
Probe Type		DPSH-B	Energy Ratio (Er)		68.22%
					



Tim Rudkin
Soils Ltd
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 19-10709

Site Reference: Palmer Park Sports Stadium

Project / Job Ref: 17760

Order No: 17760/TR

Sample Receipt Date: 26/07/2019

Sample Scheduled Date: 26/07/2019

Report Issue Number: 1

Reporting Date: 01/08/2019

Authorised by:

A handwritten signature in grey ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate						
DETS Report No: 19-10709	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Palmer Park Sports Stadium	TP / BH No	WS1	BH2	BH2	BH2	
Project / Job Ref: 17760	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	
Order No: 17760/TR	Depth (m)	0.80	3.30	5.80	8.40	
Reporting Date: 01/08/2019	DETS Sample No	424062	424063	424064	424065	

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.8	8.0	7.7	5.4	
Total Sulphate as SO ₄	mg/kg	< 200	NONE	227	219	315	2578	
Total Sulphate as SO ₄	%	< 0.02	NONE	0.02	0.02	0.03	0.26	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	< 10	12	13	1120	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	< 0.01	0.01	0.01	1.12	
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02	< 0.02	1.12	
Ammonium as NH ₄	mg/kg	< 0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	
Ammonium as NH ₄	mg/l	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	14	18	27	30	
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	6.8	9	13.5	14.8	
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	10	< 3	10	< 3	
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	4.8	< 1.5	4.8	< 1.5	
W/S Magnesium	mg/l	< 0.1	NONE	0.9	1.3	2.1	29	

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

Subcontracted analysis (S)



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Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 19-10709	
Soils Ltd	
Site Reference: Palmer Park Sports Stadium	
Project / Job Ref: 17760	
Order No: 17760/TR	
Reporting Date: 01/08/2019	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 424062	WS1	None Supplied	0.80	6.5	Brown sandy clay with stones
^ 424063	BH2	None Supplied	3.30	10.6	Brown sandy clay with stones
^ 424064	BH2	None Supplied	5.80	18.6	Brown loamy clay
^ 424065	BH2	None Supplied	8.40	16.7	Brown loamy sand

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample ^{I/S}
Unsuitable Sample ^{U/S}
^ no sampling date provided; unable to confirm if samples are within acceptable holding times



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate - Methodology & Miscellaneous Information	
DETS Report No: 19-10709	
Soils Ltd	
Site Reference: Palmer Park Sports Stadium	
Project / Job Ref: 17760	
Order No: 17760/TR	
Reporting Date: 01/08/2019	

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



Contract Number: 45151

Client Ref: **17760**

Report Date: **01-08-2019**

Client PO: **17760**

Client **Soils Limited**
Thomas Telford House
Unit 11
Sun Valley Business Park
Winnall Close
Winchester
SO23 0LB

Contract Title: **Palmer Park Sports Stadium**
For the attention of: **Tim Rudkin**

Date Received: **26-07-2019**
Date Commenced: **26-07-2019**
Date Completed: **01-08-2019**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	2
1 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.4 & 5.3 - * UKAS	2
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	3
Saturated Moisture Content of chalk (SMC) BS 1377:1990 - Part 2 : 3.3 - * UKAS	3
Quick Undrained Triaxial Compression test - single specimen at one confining pressure (100mm or 38mm diameter) BS 1377:1990 - Part 7 : 8 - * UKAS	1
Disposal of samples for job	1

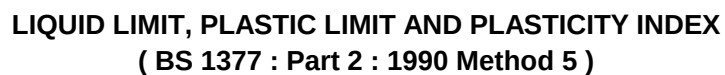
Notes: Observations and Interpretations are outside the UKAS Accreditation
* - denotes test included in laboratory scope of accreditation
- denotes test carried out by approved contractor
@ - denotes non accredited tests

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Approved Signatories:

Emma Sharp (Office Manager) - Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager)
Sean Penn (Administrative/Accounts Assistant) - Shaun Jones (Laboratory manager) - Wayne Honey (Administrative/Quality Assistant)





Contract Number

45151

Site Name

Palmer Park Sports Stadium

Date Tested

30/07/2019

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved





PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number **45151**

Borehole/Pit No. **BH1**

Site Name **Palmer Park Sports Stadium**

Sample No.

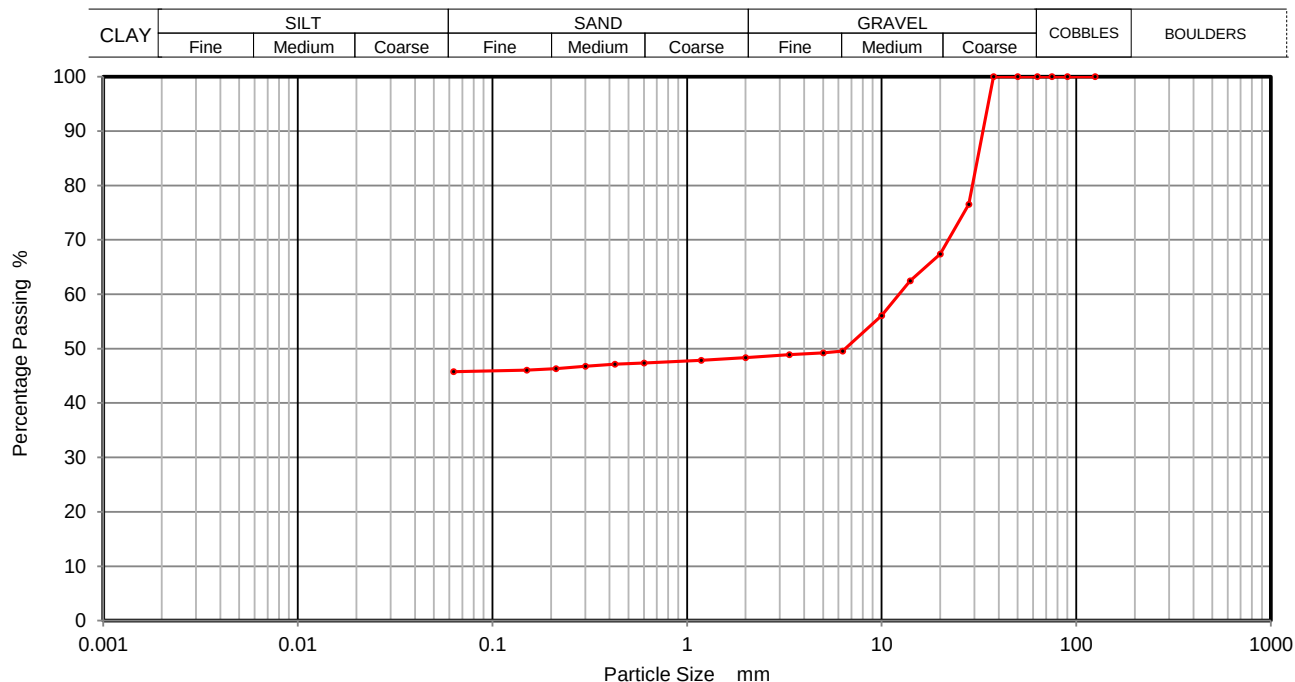
Soil Description **Brown slightly fine to coarse sandy silty/ clayey fine to coarse GRAVEL**

Depth Top **1.50**

Depth Base **2.00**

Date Tested **31/07/2019**

Sample Type **B**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	77		
20	67		
14	62		
10	56		
6.3	50		
5	49		
3.35	49		
2	48		
1.18	48		
0.6	47		
0.425	47		
0.3	47		
0.212	46		
0.15	46		
0.063	46		

Sample Proportions	% dry mass
Cobbles	0
Gravel	52
Sand	2
Silt and Clay	46

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	31/07/2019	Wayne Honey	<i>W. Honey</i>
RO/MH	Approved	01/08/2019	Paul Evans	<i>P. Evans</i>



2788



PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve. Clause 9.2

Contract Number **45151**

Borehole/Pit No. **BH1**

Site Name **Palmer Park Sports Stadium**

Sample No.

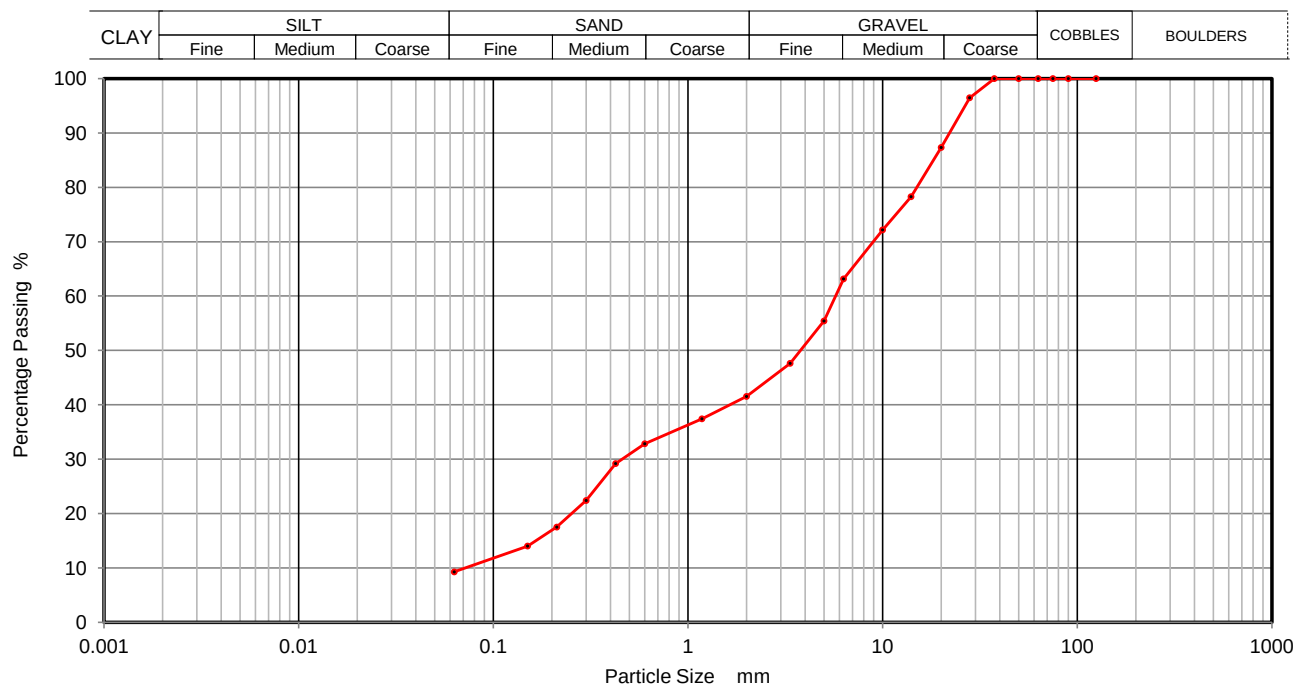
Soil Description **Brown clayey silty sandy fine to coarse GRAVEL**

Depth Top **4.50**

Depth Base **5.00**

Date Tested **02/08/2019**

Sample Type **B**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	96		
20	87		
14	78		
10	72		
6.3	63		
5	55		
3.35	48		
2	42		
1.18	37		
0.6	33		
0.425	29		
0.3	22		
0.212	18		
0.15	14		
0.063	9		

Sample Proportions	% dry mass
Cobbles	0
Gravel	58
Sand	33
Silt and Clay	9

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	04/08/2019	Wayne Honey	<i>W. Honey</i>
RO/MH	Approved	05/08/2019	Paul Evans	<i>P. Evans</i>



2788



PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number **45151**

Borehole/Pit No. **BH1**

Site Name **Palmer Park Sports Stadium**

Sample No.

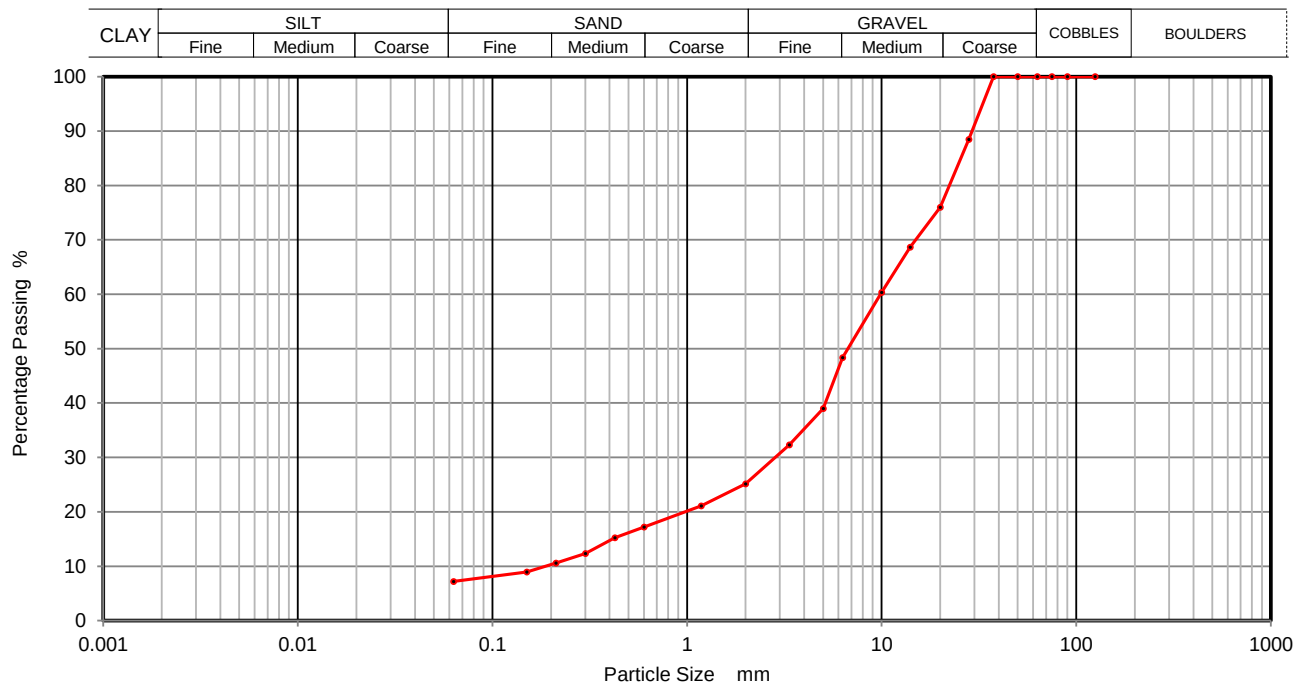
Soil Description **Brown slightly silty/ clayey fine to coarse sandy fine to coarse GRAVEL**

Depth Top **5.50**

Depth Base

Date Tested **31/07/2019**

Sample Type **D**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	88		
20	76		
14	69		
10	60		
6.3	48		
5	39		
3.35	32		
2	25		
1.18	21		
0.6	17		
0.425	15		
0.3	12		
0.212	11		
0.15	9		
0.063	7		

Sample Proportions	% dry mass
Cobbles	0
Gravel	75
Sand	18
Silt and Clay	7

Remarks
Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	31/07/2019	Wayne Honey	<i>W. Honey</i>
RO/MH	Approved	01/08/2019	Paul Evans	<i>P. Evans</i>





PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number **45151**

Borehole/Pit No. **BH1**

Site Name **Palmer Park Sports Stadium**

Sample No.

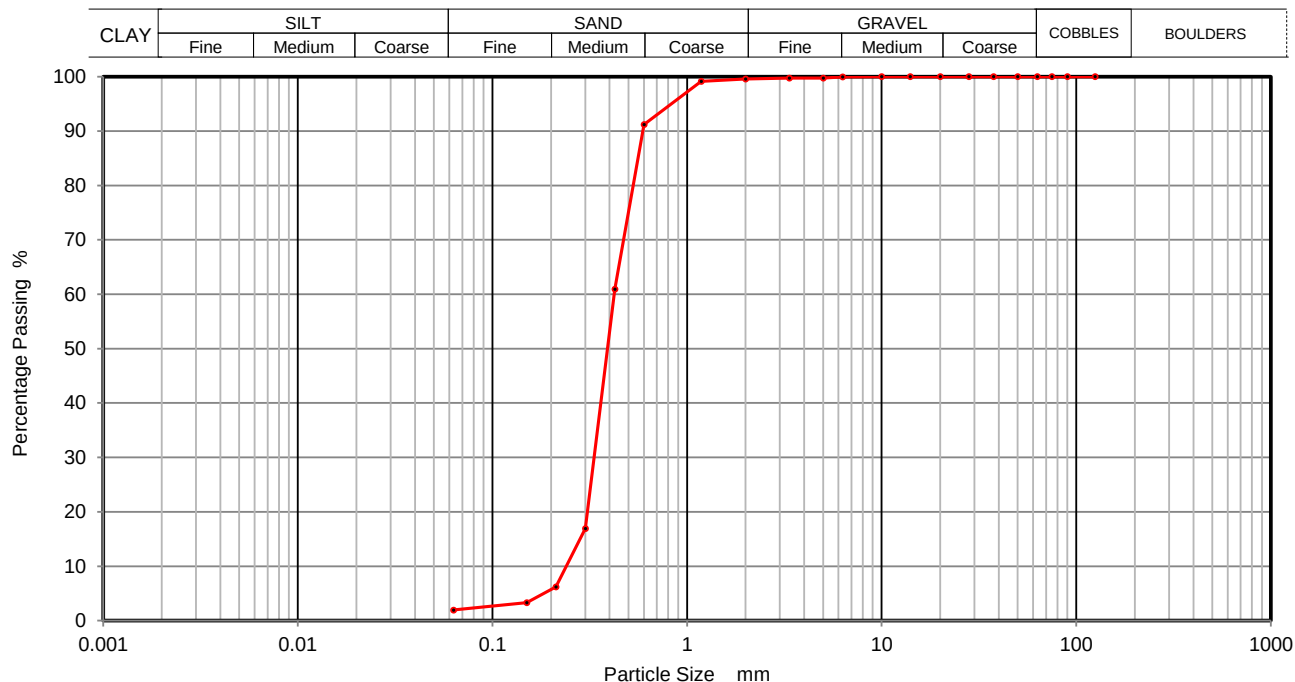
Soil Description **Brown slightly silty/ clayey fine to coarse SAND**

Depth Top **7.50**

Depth Base **8.00**

Date Tested **31/07/2019**

Sample Type **B**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	91		
0.425	61		
0.3	17		
0.212	6		
0.15	3		
0.063	2		

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	98
Silt and Clay	2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	31/07/2019	Wayne Honey	<i>W. Honey</i>
RO/MH	Approved	01/08/2019	Paul Evans	<i>P. Evans</i>



Saturation Moisture Content of Chalk
BS 1377 : Part 2 : 1990 Section 3.3

Contract Number	45151	
Site Name	Palmer Park Sports Stadium	
Date Tested	30/07/2019	

[illegible]

Key	Reported As	Clause
-----	-------------	--------

Moisture Content	%	3.2
Bulk Density	Mg/m ³	7.2
Dry Density	Mg/m ³	7.2
SMC	%	3.3.6

If there is a NON-STANDARD in the remarks next to the reported SMC result this means there was no lump of chalk of sufficient volume (300mL-500mL) present in the samples received to meet the testing requirements of the stated standard.

Operators	Checked	31/07/2019	Emma Sharp	
CJ	Approved	01/08/2019	Paul Evans	



Single Stage Unconsolidated-Undrained Triaxial Test
BS 1377 : 1990 Part 7 : 8

Contract Number 45151

Borehole/Pit No. BH02

Site Name Palmer Park Sports Stadium

Sample No.

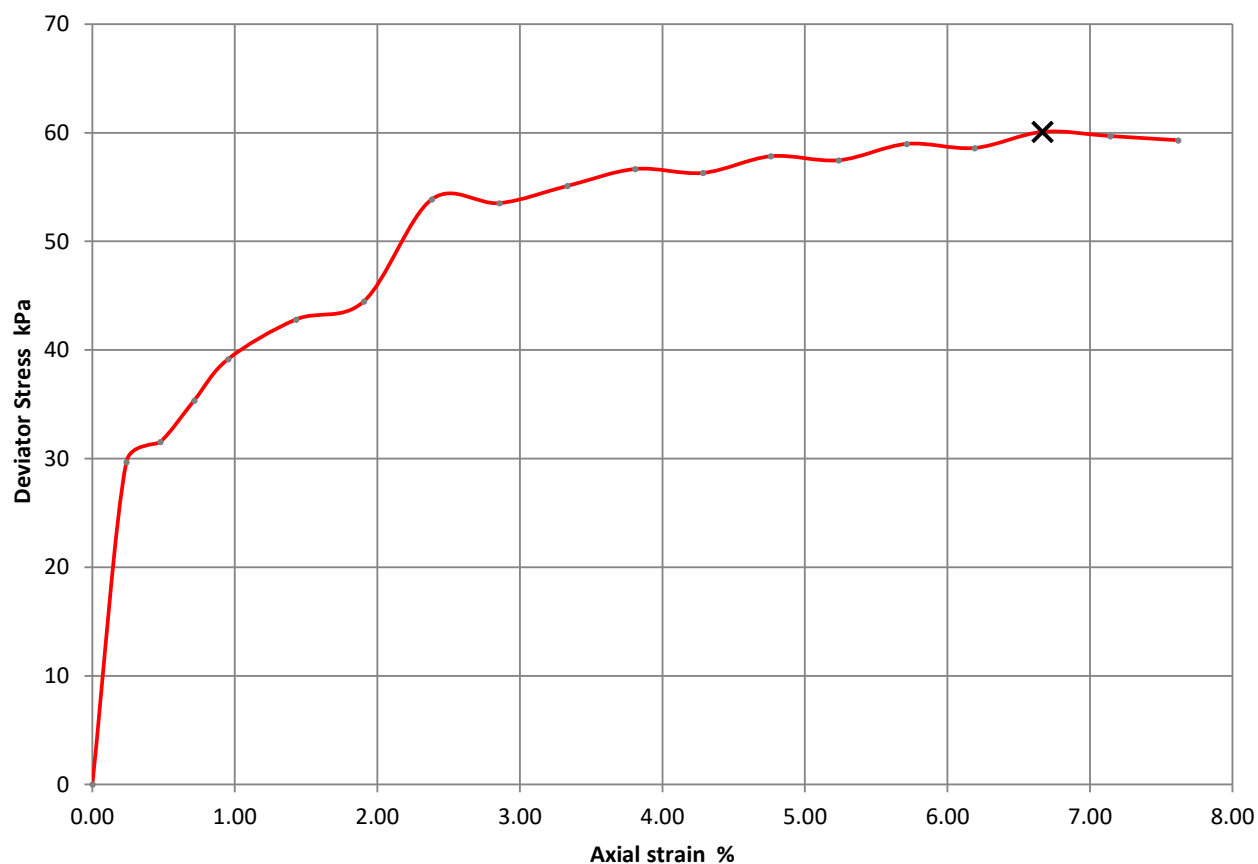
Soil Description Brown silty CLAY

Depth Top (m) 6.00

Depth Base (m) 6.45

Date Tested 30/07/2019

Sample Type U



Moisture Content (%)	24
Bulk Density (Mg/m ³)	1.33
Dry Density (Mg/m ³)	1.08
Specimen Length (mm)	210
Specimen Diameter (mm)	103
Cell Pressure (kPa)	120
Deviator Stress (kPa)	60
Undrained Shear Strength (kPa)	30
Failure Strain (%)	7
Mode Of Failure	Compound
Membrane Used/Thickness	Rubber/0.3mm
Rate of Strain (%/min)	1.43

Specimen Post Test



Sample Split



Checked	31/07/2019	Emma Sharp	
Approved	01/08/2019	Paul Evans	



Appendix C Foundation Design

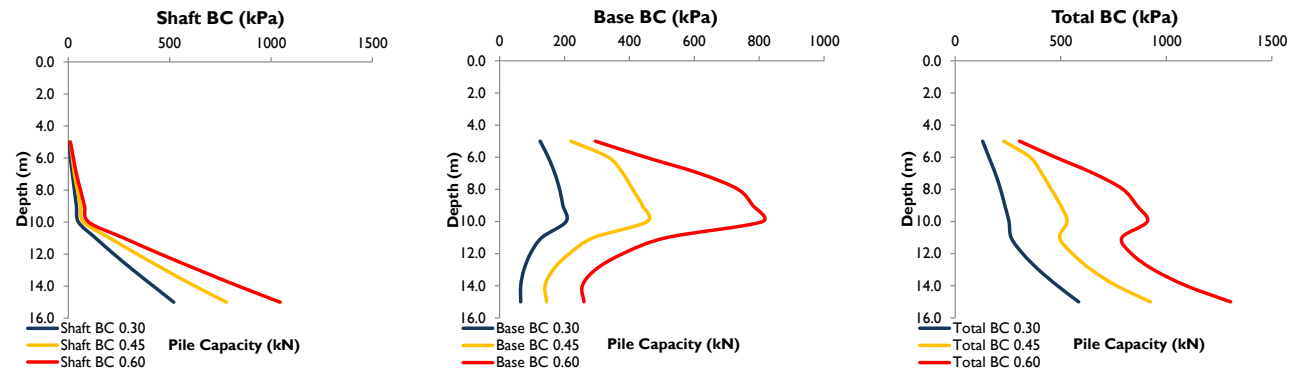
Appendix C.1 Preliminary Pile Design

Preliminary Pile Working Loads

Single Vertically Loaded Pile (kN)

Parameters:	FOS:	Shaft	Base	Alpha Value (α):	0	Maximum no. of layers	2
Name: TR	Clay:	0	0	GW Level: 10	NC Value:	0	
Job No: 17760	Chalk:	1.5	10	Specific Chalk Density:	17		
Date: 15.08.19	Gravel:	3	3	Depth to top of strata:	1.5		

Notes:



Pile Diameter (m):

Pile Depths		0.3			0.45			0.6			Layer
Material	(m bgl)	Shaft	Base	Total	Shaft	Base	Total	Shaft	Base	Total	
Gravel	5.0	5	125	130	10	220	230	10	295	305	1
Gravel	6.0	10	150	160	20	335	355	25	450	475	1
Gravel	7.0	20	170	190	30	380	410	40	615	655	1
Gravel	8.0	30	185	215	45	410	455	60	735	795	1
Gravel	9.0	40	195	235	60	440	500	80	780	860	1
Gravel	10.0	50	205	255	75	455	530	100	810	910	1
Chalk	11.0	135	130	265	205	290	495	275	515	790	2
Chalk	12.0	225	95	320	340	215	555	455	380	835	2
Chalk	13.0	320	75	395	480	165	645	645	295	940	2
Chalk	14.0	420	65	485	625	140	765	840	255	1095	2
Chalk	15.0	520	65	585	780	145	925	1045	260	1305	2

Appendix D Chemical Laboratory Testing

Appendix D.1 Conceptual Site Model

Table D.I.I CSM Revised Pre Testing

Source	Identified Contaminant	Exposure Pathway	Receptor	Initial Assessment from Desk Study and Main Investigation Report Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Made Ground Onsite source of contamination	None	Inhalation of dust	Site Workers/Site Maintenance			None	Soil chemical analysis on Made Ground did not record any determinant concentrations in excess of commercial or POS park end-use screening values.	Soil gas monitoring ongoing.
			End Users			None		
			Off-site Users			None		
	None	Inhalation of Vapour/gases (including Radon)	Site Workers/Site Maintenance			None		
			End Users			None		
			Off-site Users			None		
	None	Ingestion and absorption via direct contact	Site Workers/Site Maintenance			None		
			End Users			None		
	None	Migration via surface runoff	Surface Water			None		
		Migration in solution via groundwater	Surface Water			None		
			Shallow Aquifer			None		
			Deep Aquifer			None		
		Direct contact with construction material	Buried structures			None		
			Buried Services			None		
	None	Migration of gases via permeable soils	Site Workers/Site Maintenance			None		
			End Users			None		
			Off-site Users			None		
			Building and confined spaces			None		

Appendix D.2 Chemical Laboratory Results



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Cross Road
Tadworth
Surrey
KT20 5SR

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t: 01622 850410

DETS Report No: 19-10708

Site Reference: Palmer Park Sports Stadium

Project / Job Ref: 17760

Order No: 17760/TR

Sample Receipt Date: 26/07/2019

Sample Scheduled Date: 26/07/2019

Report Issue Number: 1

Reporting Date: 02/08/2019

Authorised by:

A handwritten signature in grey ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

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Soil Analysis Certificate						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	BH1	BH1	BH1	BH2	BH2
Project / Job Ref: 17760	Additional Refs	J	J&B	J	J	J&B
Order No: 17760/TR	Depth (m)	0.35	1.00	1.20	0.40	0.50 - 1.00
Reporting Date: 02/08/2019	DETS Sample No	424052	424053	424054	424055	424056

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	7.4	7.2	7.5	8.1	8.0
Total Cyanide	mg/kg	< 2	NONE	< 2		< 2	< 2	
Free Cyanide	mg/kg	< 2	NONE	< 2		< 2	< 2	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	20		113	37	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02		0.11	0.04	
Organic Matter	%	< 0.1	MCERTS	1.7	1.4	0.5	1.5	1.1
Arsenic (As)	mg/kg	< 2	MCERTS	14	11	18	13	11
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.3	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	34	16	33	17	17
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	25	15	11	28	19
Lead (Pb)	mg/kg	< 3	MCERTS	58	48	12	59	36
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	17	9	15	15	12
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 2	NONE	38	28	41	31	32
Zinc (Zn)	mg/kg	< 3	MCERTS	87	53	43	114	71
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	WS1	WS1	WS2	WS2	WS2
Project / Job Ref: 17760	Additional Refs	J	J	J	J	J
Order No: 17760/TR	Depth (m)	0.50	0.80	0.20	0.50	0.80
Reporting Date: 02/08/2019	DETS Sample No	424057	424058	424059	424060	424061

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	8.0	8.0	7.1	7.5	7.4
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Free Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	13	< 10	< 10	< 10	< 10
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Organic Matter	%	< 0.1	MCERTS	1.4	1	1.3	1	1.1
Arsenic (As)	mg/kg	< 2	MCERTS	12	10	11	16	17
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.4	0.2	0.3	< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	20	18	10	18	20
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	22	30	11	14	15
Lead (Pb)	mg/kg	< 3	MCERTS	109	100	70	50	59
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	10	9	6	11	12
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 2	NONE	32	30	17	40	41
Zinc (Zn)	mg/kg	< 3	MCERTS	111	61	71	60	63
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	BH1	BH1	BH1	BH2	BH2
Project / Job Ref: 17760	Additional Refs	J	J&B	J	J	J&B
Order No: 17760/TR	Depth (m)	0.35	1.00	1.20	0.40	0.50 - 1.00
Reporting Date: 02/08/2019	DETS Sample No	424052	424053	424054	424055	424056

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	0.11
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.14	1.12	0.16
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.31	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	0.28	0.22	0.29	8.64	1.29
Pyrene	mg/kg	< 0.1	MCERTS	0.27	0.20	0.29	13.90	1.31
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	0.28	0.26	8.44	0.47
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	7.20	0.59
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.34	0.29	0.24	13	1.42
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.17	0.14	0.13	3.75	0.39
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.29	0.26	0.23	10.20	1.14
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.29	0.27	< 0.1	4.74	1.20
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.59	0.17
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.17	0.15	< 0.1	3.63	1.11
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	1.8	1.8	< 1.6	75.6	9.3

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	WS1	WS1	WS2	WS2	WS2
Project / Job Ref: 17760	Additional Refs	J	J	J	J	J
Order No: 17760/TR	Depth (m)	0.50	0.80	0.20	0.50	0.80
Reporting Date: 02/08/2019	DETS Sample No	424057	424058	424059	424060	424061

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.12	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.45	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.15	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.33	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.58	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.63	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	0.12	< 0.1	3.35	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	0.11	< 0.1	3.34	< 0.1	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.46	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.48	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.11	< 0.1	2.43	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.75	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	2.01	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.54	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.21	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.40	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	21.2	< 1.6	< 1.6

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - EPH Texas Banded						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Palmer Park Sports Stadium	TP / BH No	BH1	BH2			
Project / Job Ref: 17760	Additional Refs	J&B	J&B			
Order No: 17760/TR	Depth (m)	1.00	0.50 - 1.00			
Reporting Date: 02/08/2019	DETS Sample No	424053	424056			

Determinand	Unit	RL	Accreditation				
EPH Texas (C6 - C8)	mg/kg	< 0.05	NONE	< 0.05	< 0.05		
EPH Texas (>C8 - C10)	mg/kg	< 1	MCERTS	3	< 1		
EPH Texas (>C10 - C12)	mg/kg	< 1	MCERTS	< 1	< 1		
EPH Texas (>C12 - C16)	mg/kg	< 1	MCERTS	< 1	< 1		
EPH Texas (>C16 - C21)	mg/kg	< 1	MCERTS	3	3		
EPH Texas (>C21 - C40)	mg/kg	< 6	MCERTS	64	65		
EPH Texas (C6 - C40)	mg/kg	< 6	NONE	70	68		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - TPH CWG Banded

DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	BH1	BH1	BH2	WS1	WS1
Project / Job Ref: 17760	Additional Refs	J	J	J	J	J
Order No: 17760/TR	Depth (m)	0.35	1.20	0.40	0.50	0.80
Reporting Date: 02/08/2019	DETS Sample No	424052	424054	424055	424057	424058

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3	< 3	< 3
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	< 3	< 3	< 3
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21	< 21	< 21	< 21
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	21	< 3	< 3
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	144	< 10	< 10
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21	165	< 21	< 21
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42	165	< 42	< 42

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - TPH CWG Banded

DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Palmer Park Sports Stadium	TP / BH No	WS2	WS2	WS2		
Project / Job Ref: 17760	Additional Refs	J	J	J		
Order No: 17760/TR	Depth (m)	0.20	0.50	0.80		
Reporting Date: 02/08/2019	DETS Sample No	424059	424060	424061		

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	7	< 3	< 3		
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	17	< 3	< 3		
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	24	< 21	< 21		
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	4	< 2	< 2		
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	23	< 3	< 3		
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	88	< 10	< 10		
Aromatic (C5 - C35)	mg/kg	< 21	NONE	115	< 21	< 21		
Total >C5 - C35	mg/kg	< 42	NONE	139	< 42	< 42		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	BH1	BH1	BH2	WS1	WS1
Project / Job Ref: 17760	Additional Refs	J	J	J	J	J
Order No: 17760/TR	Depth (m)	0.35	1.20	0.40	0.50	0.80
Reporting Date: 02/08/2019	DETS Sample No	424052	424054	424055	424057	424058

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Palmer Park Sports Stadium	TP / BH No	WS2	WS2	WS2		
Project / Job Ref: 17760	Additional Refs	J	J	J		
Order No: 17760/TR	Depth (m)	0.20	0.50	0.80		
Reporting Date: 02/08/2019	DETS Sample No	424059	424060	424061		

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5		
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - PCB (7 Congeners)						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Palmer Park Sports Stadium	TP / BH No	BH1	BH1	BH2	WS1	WS1
Project / Job Ref: 17760	Additional Refs	J	J	J	J	J
Order No: 17760/TR	Depth (m)	0.35	1.20	0.40	0.50	0.80
Reporting Date: 02/08/2019	DETS Sample No	424052	424054	424055	424057	424058

Determinand	Unit	RL	Accreditation					
PCB Congener 28	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
PCB Congener 52	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
PCB Congener 101	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
PCB Congener 118	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
PCB Congener 138	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
PCB Congener 153	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
PCB Congener 180	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Total PCB (7 Congeners)	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - PCB (7 Congeners)						
DETS Report No: 19-10708	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Palmer Park Sports Stadium	TP / BH No	WS2	WS2	WS2		
Project / Job Ref: 17760	Additional Refs	J	J	J		
Order No: 17760/TR	Depth (m)	0.20	0.50	0.80		
Reporting Date: 02/08/2019	DETS Sample No	424059	424060	424061		

Determinand	Unit	RL	Accreditation					
PCB Congener 28	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
PCB Congener 52	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
PCB Congener 101	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
PCB Congener 118	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
PCB Congener 138	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
PCB Congener 153	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
PCB Congener 180	mg/kg	0.008	NONE	< 0.008	< 0.008	< 0.008		
Total PCB (7 Congeners)	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/2

DETS Report No: 19-10708		Date Sampled	None Supplied			Landfill Waste Acceptance Criteria Limits		
Soils Ltd		Time Sampled	None Supplied					
Site Reference: Palmer Park Sports Stadium		TP / BH No	BH1					
Project / Job Ref: 17760		Additional Refs	J&B					
Order No: 17760/TR		Depth (m)	1.00					
Reporting Date: 02/08/2019		DETS Sample No	424053					
Determinand	Unit	MDL				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
TOC ^{MD}	%	< 0.1	0.8			3%	5%	6%
Loss on Ignition	%	< 0.01	2.20			--	--	10%
BTEX ^{MD}	mg/kg	< 0.05	< 0.05			6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1			1	--	--
Mineral Oil ^{MD}	mg/kg	< 10	< 10			500	--	--
Total PAH ^{MD}	mg/kg	< 1.7	1.8			100	--	--
pH ^{MD}	pH Units	N/a	7.2			--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	1.5			--	To be evaluated	To be evaluated
Eluate Analysis			10:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic ^U		< 0.01			< 0.1	0.5	2	25
Barium ^U		< 0.02			< 0.2	20	100	300
Cadmium ^U		< 0.0005			< 0.005	0.04	1	5
Chromium ^U		< 0.005			< 0.05	0.5	10	70
Copper ^U		< 0.01			< 0.1	2	50	100
Mercury ^U		< 0.0005			< 0.01	0.01	0.2	2
Molybdenum ^U		0.003			0.03	0.5	10	30
Nickel ^U		< 0.007			< 0.07	0.4	10	40
Lead ^U		< 0.005			< 0.05	0.5	10	50
Antimony ^U		< 0.0060			< 0.06	0.06	0.7	5
Selenium ^U		< 0.005			< 0.05	0.1	0.5	7
Zinc ^U		< 0.005			< 0.05	4	50	200
Chloride ^U		< 1			< 10	800	15000	25000
Fluoride ^U		< 0.5			< 5	10	150	500
Sulphate ^U		4			40	1000	20000	50000
TDS		80			800	4000	60000	100000
Phenol Index		< 0.01			< 0.1	1	-	-
DOC		4			39.5	500	800	1000
Leach Test Information								
Sample Mass (kg)		0.10						
Dry Matter (%)		93.8						
Moisture (%)		6.6						
Stage 1								
Volume Eluate L10 (litres)		0.89						

Results are expressed on a dry weight basis, after correction for moisture content where applicable
 Stated limits are for guidance only and DETS Ltd cannot be held responsible for any discrepancies with current legislation
 M Denotes MCERTS accredited test
 U Denotes ISO17025 accredited test

Page 14 of 16



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Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 19-10708	
Soils Ltd	
Site Reference: Palmer Park Sports Stadium	
Project / Job Ref: 17760	
Order No: 17760/TR	
Reporting Date: 02/08/2019	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 424052	BH1	J	0.35	11.1	Brown sandy clay with stones
^ 424053	BH1	J&B	1.00	6.2	Brown sandy clay with stones and concrete
^ 424054	BH1	J	1.20	7.7	Light brown sandy clay with stones
^ 424055	BH2	J	0.40	7.6	Brown sandy clay with stones
^ 424056	BH2	J&B	0.50 - 1.00	9.8	Brown sandy clay with stones
^ 424057	WS1	J	0.50	3.7	Brown loamy sand with stones and brick
^ 424058	WS1	J	0.80	5.6	Brown sandy clay with stones and brick
^ 424059	WS2	J	0.20	3.2	Brown sandy clay with stones and brick
^ 424060	WS2	J	0.50	3.6	Brown sandy gravel with stones
^ 424061	WS2	J	0.80	2.6	Brown sandy gravel with stones

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{1/S}

Unsuitable Sample ^{U/S}

^ no sampling date provided; unable to confirm if samples are within acceptable holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 19-10708

Soils Ltd

Site Reference: Palmer Park Sports Stadium

Project / Job Ref: 17760

Order No: 17760/TR

Reporting Date: 02/08/2019

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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DETS Report No: 19-10935

Site Reference: Palmer Park

Project / Job Ref: 17760

Order No: None Supplied

Sample Receipt Date: 31/07/2019

Sample Scheduled Date: 31/07/2019

Report Issue Number: 1

Reporting Date: 06/08/2019

Authorised by:

A handwritten signature in black ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

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Water Analysis Certificate						
DETS Report No: 19-10935	Date Sampled	25/07/19	25/07/19			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Palmer Park	TP / BH No	BH1	BH2			
Project / Job Ref: 17760	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	None Supplied	None Supplied			
Reporting Date: 06/08/2019	DETS Sample No	424960	424961			

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	ISO17025	7.5	7.7			
Total Cyanide	ug/l	< 5	NONE	< 5	< 5			
Free Cyanide	ug/l	< 5	NONE	< 5	< 5			
Sulphate as SO ₄	mg/l	< 1	ISO17025	18	19			
Total Organic Carbon (TOC)	mg/l	< 0.1	NONE	7	6.5			
Arsenic (dissolved)	ug/l	< 5	ISO17025	< 5	< 5			
Boron (dissolved)	ug/l	< 5	ISO17025	59	104			
Cadmium (dissolved)	ug/l	< 0.4	ISO17025	< 0.4	< 0.4			
Chromium (dissolved)	ug/l	< 5	ISO17025	8	5			
Chromium (hexavalent)	ug/l	< 20	NONE	< 20	< 20			
Copper (dissolved)	ug/l	< 5	ISO17025	< 5	< 5			
Lead (dissolved)	ug/l	< 5	ISO17025	< 5	< 5			
Mercury (dissolved)	ug/l	< 0.05	ISO17025	< 0.05	< 0.05			
Nickel (dissolved)	ug/l	< 5	ISO17025	< 5	< 5			
Selenium (dissolved)	ug/l	< 5	ISO17025	< 5	< 5			
Vanadium (dissolved)	ug/l	< 5	ISO17025	< 5	< 5			
Zinc (dissolved)	ug/l	< 2	ISO17025	< 2	9			
Total Phenols (monohydric)	ug/l	< 10	NONE	< 10	< 10			

Subcontracted analysis ^(S)
Insufficient sample ^{I/S}
Unsuitable Sample ^{U/S}



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Water Analysis Certificate - Speciated PAH

DETS Report No: 19-10935	Date Sampled	25/07/19	25/07/19			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Palmer Park	TP / BH No	BH1	BH2			
Project / Job Ref: 17760	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	None Supplied	None Supplied			
Reporting Date: 06/08/2019	DETS Sample No	424960	424961			

Determinand	Unit	RL	Accreditation				
Naphthalene	ug/l	< 0.01	NONE	< 0.01	0.01		
Acenaphthylene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Acenaphthene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Fluorene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Phenanthrene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Anthracene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Fluoranthene	ug/l	< 0.01	NONE	< 0.01	0.02		
Pyrene	ug/l	< 0.01	NONE	< 0.01	0.02		
Benzo(a)anthracene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Chrysene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Benzo(b)fluoranthene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Benzo(k)fluoranthene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Benzo(a)pyrene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Indeno(1,2,3-cd)pyrene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Dibenz(a,h)anthracene	ug/l	< 0.01	NONE	< 0.01	< 0.01		
Benzo(ghi)perylene	ug/l	< 0.008	NONE	< 0.008	< 0.008		
Total EPA-16 PAHs	ug/l	< 0.01	NONE	< 0.01	0.05		



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Water Analysis Certificate - TPH CWG Banded

DETS Report No: 19-10935	Date Sampled	25/07/19	25/07/19			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Palmer Park	TP / BH No	BH1	BH2			
Project / Job Ref: 17760	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	None Supplied	None Supplied			
Reporting Date: 06/08/2019	DETS Sample No	424960	424961			

Determinand	Unit	RL	Accreditation			
Aliphatic >C5 - C6	ug/l	< 10	NONE	< 10	< 10	
Aliphatic >C6 - C8	ug/l	< 10	NONE	< 10	< 10	
Aliphatic >C8 - C10	ug/l	< 10	NONE	< 10	< 10	
Aliphatic >C10 - C12	ug/l	< 10	NONE	< 10	< 10	
Aliphatic >C12 - C16	ug/l	< 10	NONE	< 10	< 10	
Aliphatic >C16 - C21	ug/l	< 10	NONE	< 10	< 10	
Aliphatic >C21 - C34	ug/l	< 10	NONE	< 10	< 10	
Aliphatic (C5 - C34)	ug/l	< 70	NONE	< 70	< 70	
Aromatic >C5 - C7	ug/l	< 10	NONE	< 10	< 10	
Aromatic >C7 - C8	ug/l	< 10	NONE	< 10	< 10	
Aromatic >C8 - C10	ug/l	< 10	NONE	< 10	< 10	
Aromatic >C10 - C12	ug/l	< 10	NONE	< 10	< 10	
Aromatic >C12 - C16	ug/l	< 10	NONE	< 10	< 10	
Aromatic >C16 - C21	ug/l	< 10	NONE	< 10	< 10	
Aromatic >C21 - C35	ug/l	< 10	NONE	< 10	< 10	
Aromatic (C5 - C35)	ug/l	< 70	NONE	< 70	< 70	
Total >C5 - C35	ug/l	< 140	NONE	< 140	< 140	



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Water Analysis Certificate - BTEX / MTBE						
DETS Report No: 19-10935	Date Sampled	25/07/19	25/07/19			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Palmer Park	TP / BH No	BH1	BH2			
Project / Job Ref: 17760	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	None Supplied	None Supplied			
Reporting Date: 06/08/2019	DETS Sample No	424960	424961			

Determinand	Unit	RL	Accreditation				
Benzene	ug/l	< 1	ISO17025	< 1	< 1		
Toluene	ug/l	< 5	ISO17025	< 5	< 5		
Ethylbenzene	ug/l	< 5	ISO17025	< 5	< 5		
p & m-xylene	ug/l	< 10	ISO17025	< 10	< 10		
o-xylene	ug/l	< 5	ISO17025	< 5	< 5		
MTBE	ug/l	< 10	ISO17025	< 10	< 10		



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Water Analysis Certificate - PCB (7 Congeners)						
DETS Report No: 19-10935	Date Sampled	25/07/19	25/07/19			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Palmer Park	TP / BH No	BH1	BH2			
Project / Job Ref: 17760	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	None Supplied	None Supplied			
Reporting Date: 06/08/2019	DETS Sample No	424960	424961			

Determinand	Unit	RL	Accreditation			
PCB Congener 28	ug/l	< 0.1	NONE	< 0.1	< 0.1	
PCB Congener 52	ug/l	< 0.1	NONE	< 0.1	< 0.1	
PCB Congener 101	ug/l	< 0.1	NONE	< 0.1	< 0.1	
PCB Congener 118	ug/l	< 0.1	NONE	< 0.1	< 0.1	
PCB Congener 138	ug/l	< 0.1	NONE	< 0.1	< 0.1	
PCB Congener 153	ug/l	< 0.1	NONE	< 0.1	< 0.1	
PCB Congener 180	ug/l	< 0.1	NONE	< 0.1	< 0.1	
Total PCB (7 Congeners)	ug/l	< 0.7	NONE	< 0.7	< 0.7	



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Water Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 19-10935

Soils Ltd

Site Reference: Palmer Park

Project / Job Ref: 17760

Order No: None Supplied

Reporting Date: 06/08/2019

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazide followed by	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR detection	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO ₄)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered

Appendix D.3 General Assessment Criteria

HUMAN HEALTH RISK ASSESSMENT

1.1 Introduction

Human Health Generic Quantitative Risk Assessment (GQRA) involves the comparison of contaminant concentrations measured in soil at the site with Generic Assessment Criteria (GAC).

GAC are conservative values adopted to ensure that they are applicable to the majority of possible contaminated site. These values may be published Contaminated Land Exposure Assessment Model (CLEA) derived GAC derived by a third party or the Environment Agency/ DEFRA. It is imperative to the risk assessor to understand the uncertainties and limitations associated with these GAC to ensure that they are used appropriately. Where the adoption of a GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a Detailed Quantitative Risk Assessment (DQRA) may be undertaken to develop site specific values for relevant soil contaminants based on the site specific conditions.

1.2 General Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

1.2.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

- EA Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
 - EA Science Report SC050021/SR3: Updated technical background to the CLEA model.
 - EA CLEA Bulletin (2009).
 - CLEA software version 1.04 (2009)
 - Toxicological reports and SGV technical notes.
-

The CLEA guidance and tools:

1. do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.
 2. do not cover risks to the environment, such as groundwater, ecosystems or buildings.
 3. do not provide a definitive test for telling when human health risks are significant.
 4. are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.
-

1.3 Soil Guideline Values (2009)

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to

chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less than the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

1.4 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published. Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

-
- GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.
-
- SGV reports may give values that differ from the GAC's used in this report.
-
- These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.
-

1.5 Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing.*

1.6 Other Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) are used for example. In the case of Lead, Category 4 screening levels (C4SLs) have replaced the AtRisk Soil SSV.

1.6.1 EIC/AGS/CL: AIRE

The report represents the collaborative effort of risk assessors from 26 EIC and AGS member companies to produce generic assessment criteria (GAC) for soils for human health risk assessment. The project involved the collation and review of physico-chemical data, toxicological data and information on background

exposure for 44 contaminants sometimes encountered on land affected by contamination in the UK and the derivation of GAC for 351 of these using the CLEA model (v1.06). The GAC are intended to complement soil guideline values (SGV) produced by the Environment Agency of England and Wales and the 2nd edition GAC produced by LQM and CIEH (Nathanail et al, 2009). All three sets of assessment criteria have been derived in general accordance with the Environment Agency of England and Wales Contaminated Land Exposure Assessment (CLEA) guidance and thus the combined efforts of these three groups have resulted in a useful set of screening criteria for the assessment of risks to human health from soil contamination for more than 120 potentially contaminative substances.

1.6.2 Category 4 screening levels (C4SLs) (2014)

A new statutory DEFRA guidance recently (i.e. August 2014) published some GACs with a more pragmatic (but still strongly precautionary) approach in their derivation called the Category 4 screening levels (C4SLs). These values provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. They are intended as generic screening values, (ii) they describe a level of risk that whilst above 'minimal' is still 'low' and (iii) they provide a 'higher simple test' for deciding that land is suitable for use and definitely not contaminated. These values were derived for four generic land uses: residential, commercial, allotments, and public open space.

1.6.3 LQM/CIEH Suitable 4 Use Level (S4UL) (2015)

The new S4UL's ((Nathanail et al, 2015), was developed for around 85 substances and are intended to enable a screening assessment of the risks posed by soil quality on development sites. The updated LQM/CIEH GAC publication was developed to accommodate recent developments in the understanding of chemical, toxicological and routine exposure to soil-based contaminants. The S4ULs were:

- based on Health Criteria Values, updated to reflect changes since 2009
- derived for the standard CLEA land uses and the two public open space scenarios developed by Defra SP1010
- developed for ca 85 substances (those previously covered by the LQM/CIEH GAC and the SGV substances);
- Compliant with SR2 and the long standing principle of 'suitable for use' and reflecting changes to exposure parameters produced by Defra SP1010.

For derivation of these Generic Assessment Criteria reference must be made to: Nathanail, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (3rd edition)*. **Land Quality Press**. 2015.

1.7 Standard Land-use Scenarios

The standard land-use scenarios used to develop conceptual exposure models are presented in the following sections:

1.7.1 Residential

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

-
- Critical receptor is a young female child (zero to six years old)
 - Exposure duration is six years.
 - Exposure pathways include direct soil and indoor dust ingestion, consumption of home-grown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
 - Building type is a two-storey small terraced house.
-

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

1.7.2 Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

-
- Critical receptor is a young female child (zero to six years old)
 - Exposure duration is six years.
 - Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
 - There is no building.
-

1.7.3 Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

-
- Critical receptor is a working female adult (aged 16 to 65 years old).
 - Exposure duration is a working lifetime of 49 years.
 - Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
 - Building type is a three-storey office (pre 1970).
-

1.7.4 Public Open Space within Residential Area

The generic scenario refers to any grassed area 0.05 ha and that is close to Housing.

-
- Grassed area of up to 0.05 ha and a considerable proportion of this (up to 50%) may be bare soil
-
- Predominantly used by children for playing and may be used for activities such as a football kick about
-
- Sufficiently close proximity to home for tracking back of soil to occur, thus indoor exposure pathways apply
-
- older children as the critical receptor on basis that they will use site most frequently (Age class 4-9)
-
- ingestion rate 75 mg.day^{-1}
-

1.7.5 Public Open Space Park

This generic scenario refers to any public park that is more than 0.5ha in area:

-
- Public park (>0.5 ha), predominantly grassed and may also contain children's play equipment and border areas of soil containing flowers or shrubs (75% cover)
-
- Female child age classes 1-6
-
- Soil ingestion rate of 50 mg.day^{-1}
-
- Occupancy period outdoors = 2 hours.day^{-1}
-
- Exposure frequency of 170 days.year⁻¹ for age classes 2-18 and 85 days.year⁻¹ for age class 1
-
- Outdoor exposure pathways only (no tracking back).
-

1.8 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a DQRA may be undertaken to develop site specific values for relevant soil contaminants.

-
- Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.
-
- Developing more accurate parameters using site data.
-

1.9 Current Criteria

Table 1 presents the current Generic Assessment Criteria and reference should be made to the original publications if needed.

1.10 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) and Category 4 screening levels (C4SLs) (2014) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CL:AIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CL:AIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots

- A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.
 - Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.
-

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Name	Authority	Date	
			With			Without			Allotments			Commercial			Residential			Park						
			SOM	1.0	2.5	6	1	2.5																6
Type	Contaminants	Species	Year																					
Metals	Antimony		2010					550						7500							EIC/AGS/ CL:AIRE	EIC/AGS/ CL:AIRE	2010	
	Arsenic		2014			37		40			49			640		79		168			C4SL	DEFRA	2014	
			2015			37		40			40			640		79		170			S4UL	LQM/CIEH	2015	
	Beryllium		2015			1.7		1.7			35			12		2.2		63			S4UL	LQM/CIEH	2015	
	Boron		2015			290		11000			45			240000		21000		46000			S4UL	LQM/CIEH	2015	
	Cadmium		2015			11		85			1.9			190		120		532			S4UL	LQM/CIEH	2015	
			2014			26		149			4.9			410		220		880			C4SL	DEFRA	2014	
	Chromium	III	2015			910		910			18000			8600		1500		33000			S4UL	LQM/CIEH	2015	
		VI	2014			21		21			170			49		23		250			C4SL	DEFRA	2014	
		VI	2015			6		6			1.8			33		7.7		220			S4UL	LQM/CIEH	2015	
	Copper		2015			2400		7100			520			68000		12000		44000			S4UL	LQM/CIEH	2015	
	Lead					200		310			80			2330		630		1300			C4SL	DEFRA	2014	
	Mercury	Elemental	2012			1.0		1.0			26			26							SGV	DEFRA	2012	
			2015			1.2		1.2			21			58		16		30			S4UL	LQM/CIEH	2015	
		Inorganic	2012			170		170			80			36000							SGV	DEFRA	2012	
			2015			40		56			19			1100		120		240			S4UL	LQM/CIEH	2015	
		Methyl	2012			11		11			8			410							SGV	DEFRA	2012	
			2015			11		15			6			320		40		68			S4UL	LQM/CIEH	2015	
	Nickel		2012			130		130			230			1800							SGV	DEFRA	2012	
			2015			130		180			53			980		230		800			S4UL	LQM/CIEH	2015	
	Selenium		2012			350		350			120			13000							SGV	DEFRA	2012	
			2015			250		430			88			12000		1100		1800			S4UL	LQM/CIEH	2015	
	Vanadium		2015			410		1200			91			9000		2000		5000			S4UL	LQM/CIEH	2015	
	Zinc		2015			3700		40000			620			730000		81000		170000			S4UL	LQM/CIEH	2015	
BTEX & MTBE	Benzene		2012			0.33		0.33			0.07			95							SGV	DEFRA	2012	
			2014			0.87		3.3			0.18			98		140		230			C4SL	DEFRA	2014	
			2015	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	S4UL	LQM/CIEH	2015
	Toluene		2012			610		610			120			4400							SGV	DEFRA	2012	
			2015	130	290	660	880	1900	3900	22	51	120	65000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015
	Ethylbenzene		2012			350		350			90			2800							SGV	DEFRA	2012	
			2015	47	110	260	83	190	440	16	39	91	4700	13000	27000	24000	24000	25000	17000	22000	27000	S4UL	LQM/CIEH	2015
	Xylenes	o-xylene	2012			250		250			160			2600							SGV	DEFRA	2012	
			2015	60	140	330	88	210	480	28	67	160	6600	15000	33000	41000	42000	43000	17000	24000	33000	S4UL	LQM/CIEH	2015
		m-xylene	2012			240		240			180			3500							SGV	DEFRA	2012	
			2015	59	140	320	82	190	450	31	74	170	6200	14000	31000	41000	42000	43000	17000	24000	32000	S4UL	LQM/CIEH	2015
		p-xylene	2012			230		230			160			3200							SGV	DEFRA	2012	
			2015	56	130	310	79	180	310	29	69	160	5900	14000	30000	41000	42000	43000	17000	23000	31000	S4UL	LQM/CIEH	2015
Petroleum Hydrocarbons Fractions	Aliphatic >C5 - C6		2015	42	78	160	42	78	160	730	1700	3900	3200	5900	12000	570000	590000	600000	95000	130000	180000	S4UL	LQM/CIEH	2015
	Aliphatic >C6 - C8		2015	100	230	530	100	230	530	2300	5600	13000	7800	17000	40000	600000	610000	620000	150000	220000	320000	S4UL	LQM/CIEH	2015
	Aliphatic >C8 - C10		2015	27	65	150	27	65	150	320	770	1700	2000	4800	11000	13000	13000	13000	14000	18000	21000	S4UL	LQM/CIEH	2015
	Aliphatic >C10 - C12		2015	130	330	760	130	330	770	2200	4400	7300	9700	23000	47000	13000	13000	13000	21000	23000	24000	S4UL	LQM/CIEH	2015
	Aliphatic >C12 - C16		2015	1100	2400	4300	1100	2400	4400	11000	13000	13000	59000	82000	90000	13000	13000	13000	25000	25000	26000	S4UL	LQM/CIEH	2015
	Aliphatic >C16 - C35		2015	65000	92000	110000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015
	Aliphatic >C35 - C44		2015	65000	92000	140000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015
	Aromatic >C5 - C7		2015	70	140	300	370	690	1400	13	27	57	26000	46000	86000	56000	56000	56000	76000	84000	92000	S4UL	LQM/CIEH	2015
	Aromatic >C7 - C8		2015	130	290	660	860	1800	3900	22	51	120	56000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015
	Aromatic >C8 - C10		2015	34	83	190	47	110	270	8.6	21	51	3500	8100	17000	5000	5000	5000	7200	8500	9300	S4UL	LQM/CIEH	2015
	Aromatic >C10 - C12		2015	74	180	380	250	590	1200	13	31	74	16000	28000	34000	5000	5000	5000	9200	9700	10000	S4UL	LQM/CIEH	2015
	Aromatic >C12 - C16		2015	140	330	660	1800	2300	2500	23	57	130	36000	37000	38000	5100	5100	5000	10000	10000	10000	S4UL	LQM/CIEH	2015
	Aromatic >C16 - C21		2015	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	S4UL	LQM/CIEH	2015

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)										Name	Authority	Date	
			Allotments						Commercial			Residential						Park							
			With home-grown produce			Without home-grown produce			1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1				2.5
Type	Contaminants	Species	Year	SOM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6			
	Aromatic >C21 - C35		2015		1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aromatic >C34 - C44		2015		1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aliphatic + Aromatic >C44 - C70				1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
Polycyclic Aromatic Hydrocarbons (PAH's) (mg/kg)	Acenaphthene		2015		210	510	1100	3000	4700	6000	34	85	200	84000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Acenaphthylene		2015		170	420	920	2900	4600	6000	28	69	160	83000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Anthracene		2015		2400	5400	11000	31000	35000	37000	380	950	2200	520000	54000	540000	74000	74000	74000	150000	150000	150000	S4UL	LQM/CIEH	2015
	Benzo(a)anthracene		2015		7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	S4UL	LQM/CIEH	2015
	Benzo(a)pyrene		2014				5				5.3			5.7			76			10		21	C4SL	DEFRA	2014
			2015		2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	S4UL	LQM/CIEH	2015
	Benzo(b)fluoranthene		2015		2.6	3.3	3.7	3.9	4.0	4.0	0.99	2.1	3.9	44	44	45	7.1	7.2	7.2	13	15	16	S4UL	LQM/CIEH	2015
	Benzo(ghi)perylene		2015		320	340	250	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	S4UL	LQM/CIEH	2015
	Benzo(k)fluoranthene		2015		77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	S4UL	LQM/CIEH	2015
	Chrysene		2015		15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	S4UL	LQM/CIEH	2015
	Dibenz(a,h)anthracene		2015		0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.43	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	S4UL	LQM/CIEH	2015
	Fluoranthene		2015		280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	6300	6300	6400	S4UL	LQM/CIEH	2015
	Fluorene		2015		170	400	860	2800	3800	4500	27	67	160	63000	68000	71000	9900	9900	9900	20000	20000	20000	S4UL	LQM/CIEH	2015
	Indeno(1,2,3-cd)pyrene		2015		27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	S4UL	LQM/CIEH	2015
	Naphthalene		2015		2.3	5.6	13	2.3	5.6	13	4.1	10	24	190	460	1100	4900	4900	4900	1200	1900	3000	S4UL	LQM/CIEH	2015
	Phenanthrene		2015		95	220	440	1300	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	S4UL	LQM/CIEH	2015
	Pyrene		2015		620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	S4UL	LQM/CIEH	2015
	Coal Tar(Bap as surrogate matter)		2015		0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	S4UL	LQM/CIEH	2015
Chloroalkanes & alkenes	1,2 Dichloroethane		2015		0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	S4UL	LQM/CIEH	2015
	1,1,1 Trichloroethane		2015		8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000	76000	100000	S4UL	LQM/CIEH	2015
	1,1,2,2 Tetrachloroethane		2015		1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	S4UL	LQM/CIEH	2015
	1,1,1,2 Tetrachloroethane		2015		1.2	2.8	6.4	1.5	3.5	8.2	0.79	1.9	4.4	110	250	560	1400	1400	1400	1500	1800	2100	S4UL	LQM/CIEH	2015
	Tetrachloroethene		2015		0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	42	95	1400	1400	1400	810	1100	1500	S4UL	LQM/CIEH	2015
	Tetrachloromethane (Carbon Tetrachloride)		2015		0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	S4UL	LQM/CIEH	2015
	Trichloroethene		2015		0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	S4UL	LQM/CIEH	2015
	Trichloromethane		2015		0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	S4UL	LQM/CIEH	2015
	Vinyl Chloride (chloroethene)		2015		0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	S4UL	LQM/CIEH	2015
	2,4,6 Trinitrotoluene		2015		1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	S4UL	LQM/CIEH	2015
Explosives	RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)		2015		120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000	51000	53000	S4UL	LQM/CIEH	2015
	HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)		2015		5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000	23000	24000	S4UL	LQM/CIEH	2015
	Aldrin		2015		5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	S4UL	LQM/CIEH	2015
Pesticides	Dieldrin		2015		0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	S4UL	LQM/CIEH	2015
	Atrazine		2015		3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	S4UL	LQM/CIEH	2015
	Dichlorvos		2015		0.032	0.066	0.14	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	S4UL	LQM/CIEH	2015
	Alpha - Endosulfan		2015		7.4	18	41	160	280	410	1.2	2.9	6.8	5600	7400	8400	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Beta - Endosulfan		2015		7	17	39	190	320	440	1.1	2.7	6.4	6300	7800	8700	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Alpha -Hexachlorocyclohexanes		2015		0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	S4UL	LQM/CIEH	2015
	Beta -Hexachlorocyclohexanes		2015		0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	S4UL	LQM/CIEH	2015
	Gamma -Hexachlorocyclohexanes		2015		0.06	0.14	0.33	2.9	3.3	3															

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Name	Authority	Date	
			With			Without			Allotments			Commercial			Residential			Park						
			home-grown produce			home-grown produce																		
			SOM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6			
Type	Contaminants	Species	Year																					
Phenols & Chlorophenols	1,2,3,4,-Tetrachlorobenzene		2015	15	36	78	24	56	120	4.4	11	26	1700	3080	4400	830	830	830	1500	1600	1600	S4UL	LQM/CIEH	2015
	1,2,3,5,- Tetrachlobenzene		2015	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49	120	240	78	79	79	110	120	130	S4UL	LQM/CIEH	2015
	1,2,4, 5,- Tetrachlobenzene		2015	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42	72	96	13	13	13	25	26	26	S4UL	LQM/CIEH	2015
	Pentachlrobenzene		2015	5.8	12	22	19	30	38	1.2	3.1	7	640	770	830	100	100	100	190	190	190	S4UL	LQM/CIEH	2015
	Hexachlorobenzene		2015	1.8	3.3	4.9	4.1	5.7	6.7	0.47	1.1	2.5	110	120	120	16	16	16	30	30	30	S4UL	LQM/CIEH	2015
	Phenols		2012			420			420			280			3200							SGV	DEFRA	2012
			2015	120	200	380	440	690	1200	23	42	83	440	690	1300	440	690	1300	440	690	1300	S4UL	LQM/CIEH	2015
	Chlorophenols (4 Congeners)		2015	0.87	2	4.5	94	150	210	0.13	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	S4UL	LQM/CIEH	2015
	Pentachlorophenols		2015	0.22	0.52	1.2	27	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	S4UL	LQM/CIEH	2015
	Others	Carbon Disulphide		2015	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	S4UL	LQM/CIEH
Hexachloro-1,3-Butadiene			2015	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	S4UL	LQM/CIEH	2015
Sum of PCDDs, PCDFs and dioxin-like PCB's.			2012			8			8			8			240							SGV	DEFRA	2012
NOTE																								
Priority		Guideline (mg kg ⁻¹)																						
1		Site Specific Assessment Criteria (SSAC) (Soils Limited)																						
2		2014: Category 4 Screening Level (C4SL) (Contaminated Land: Application in Real Environment (CL:ARE), 2014)																						
3		2012: Soil Guideline Value (SGV) (Environment Agency, 2009)																						
4		2015: Suitable 4 Use Level (S4UL) (Nathanail et al, 2015)																						
For Generic Risk Assessment, the values in Bold have priority																								
Table reviewed February 2018																								

Appendix E Information Provided by the Client



Plamer Park Sports Stadium

Scale: 1:1500

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