Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid

Map date: **1984-1986**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1964
Revised 1986
Edition N/A
Copyright 1986
Levelled 1964

Surveyed 1964
Revised 1984
Edition N/A
Copyright 1984
Levelled 1984

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Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid
Map date: **1987-1992**
Scale: 1:1,250
Printed at: 1:2,000

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Surveyed N/A Revised N/A Edition N/A Copyright 1992 Levelled N/A	Surveyed N/A Revised N/A Edition N/A Copyright 1992 Levelled N/A
Surveyed 1964 Revised 1987 Edition N/A Copyright 1987 Levelled 1964	Surveyed N/A Revised 1991 Edition N/A Copyright 1992 Levelled N/A

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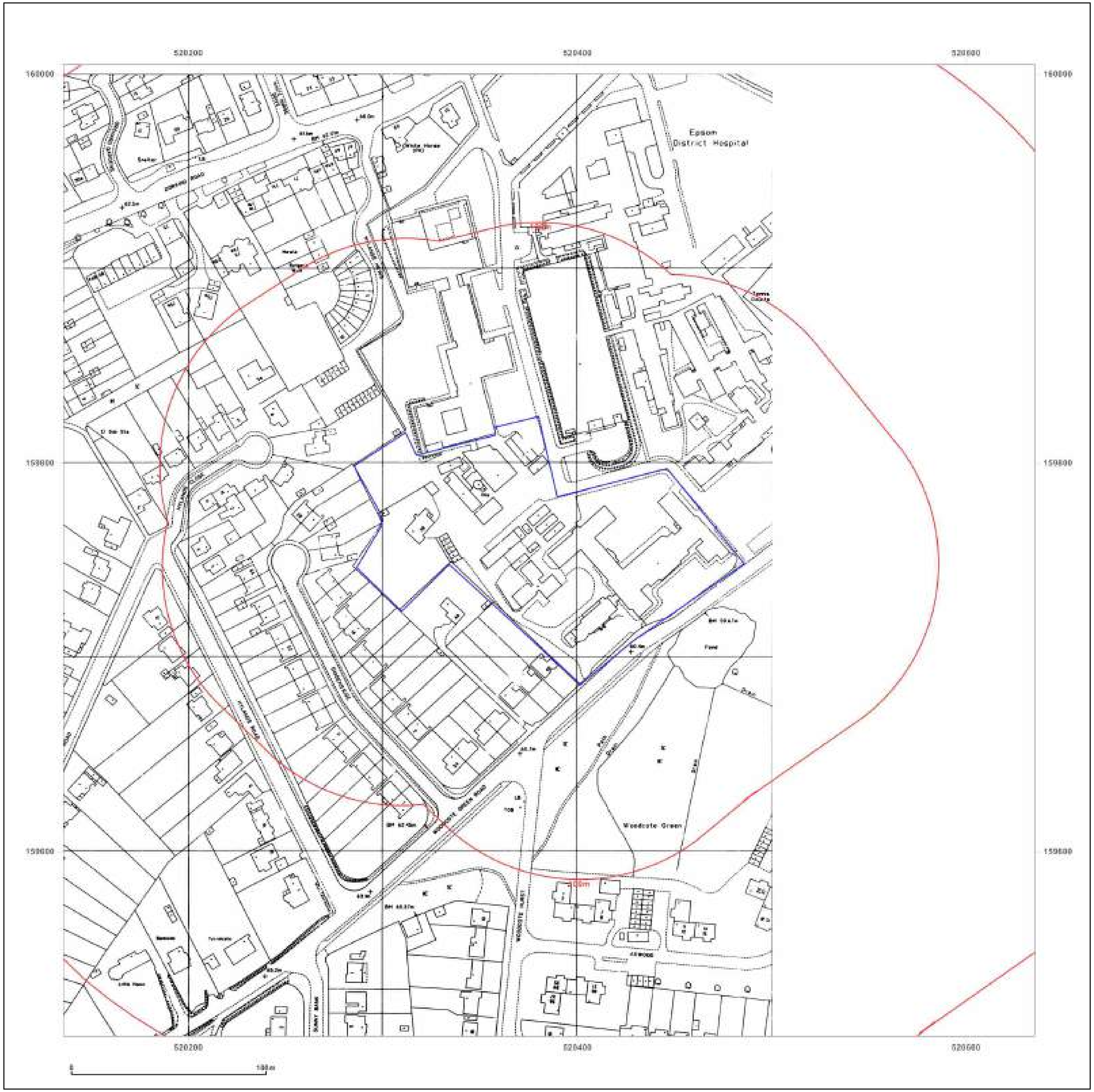

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid

Map date: **1992**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

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Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: LandLine
Map date: **2003**
Scale: 1:1,250
Printed at: 1:1,250

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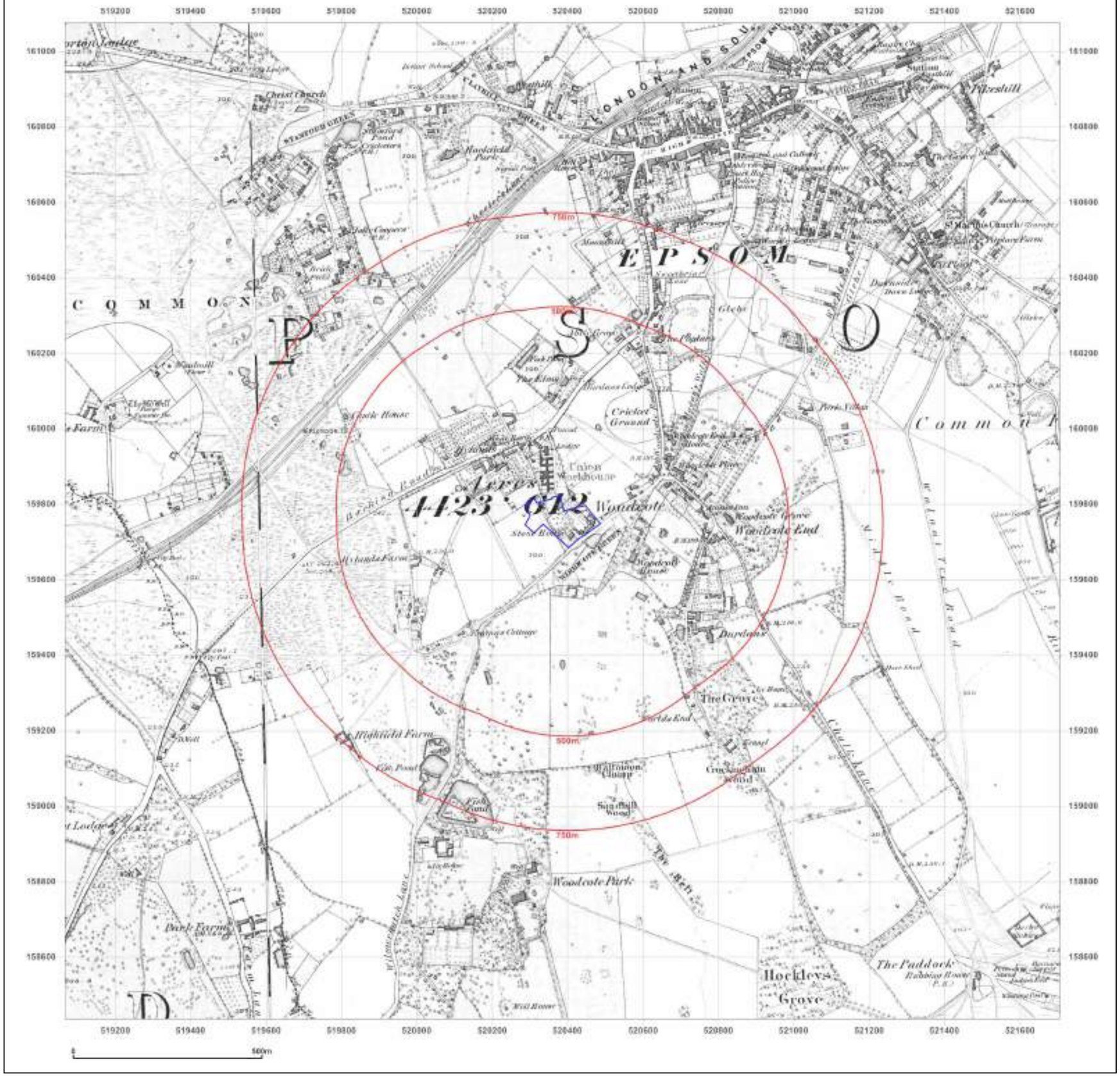
Production date: 23 August 2019

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1866-1869**

Scale: 1:10,560

Printed at: 1:10,560

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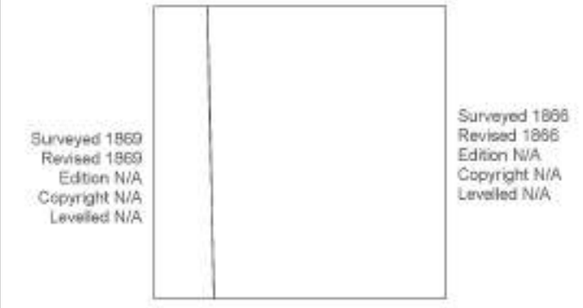

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Map legend available at:
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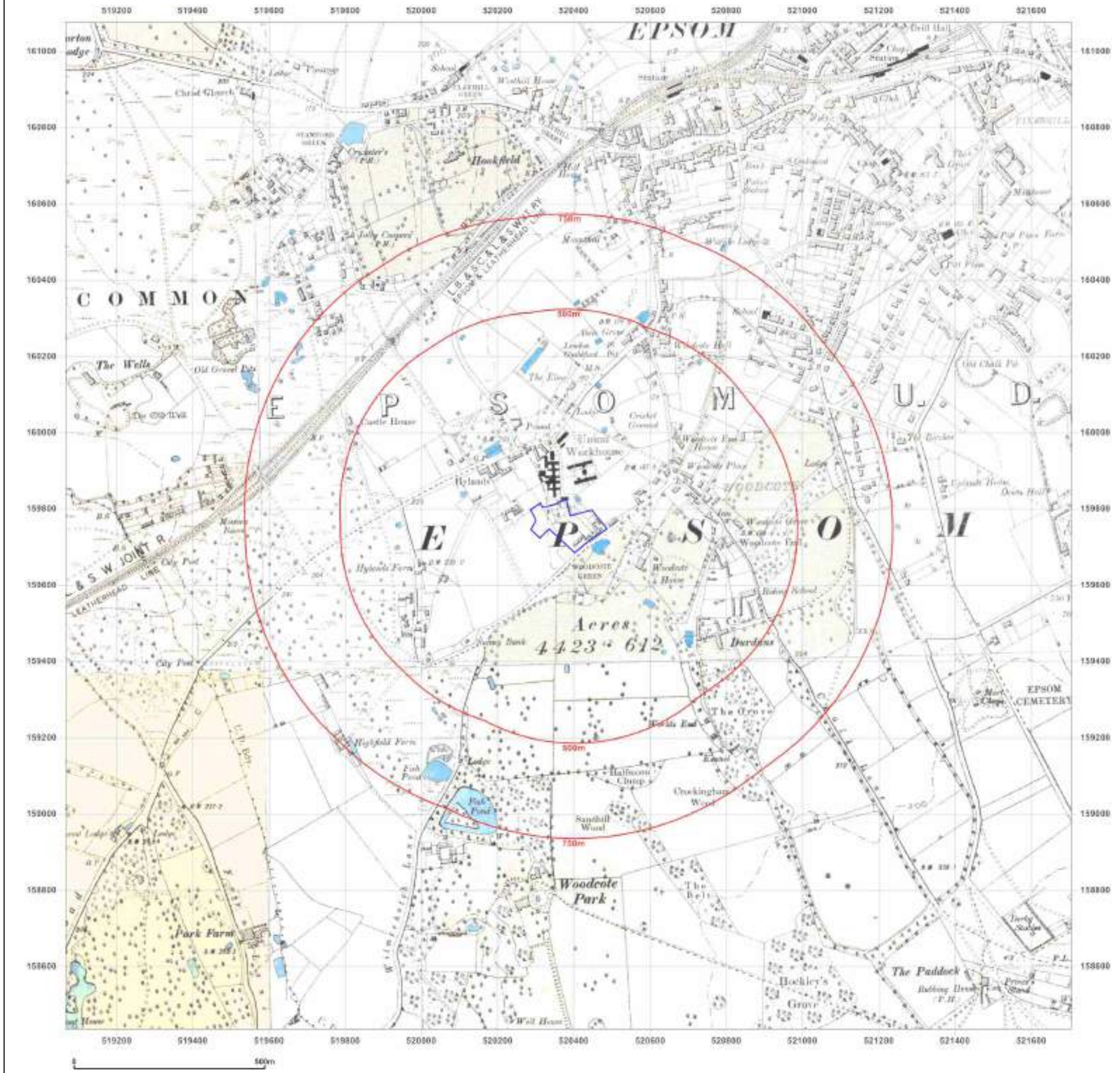

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series
Map date: **1895-1897**
Scale: 1:10,560
Printed at: 1:10,560

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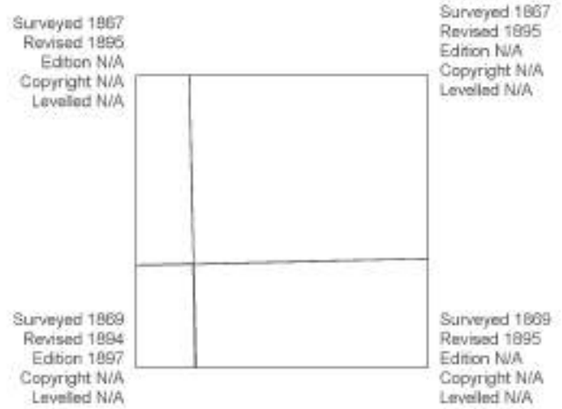

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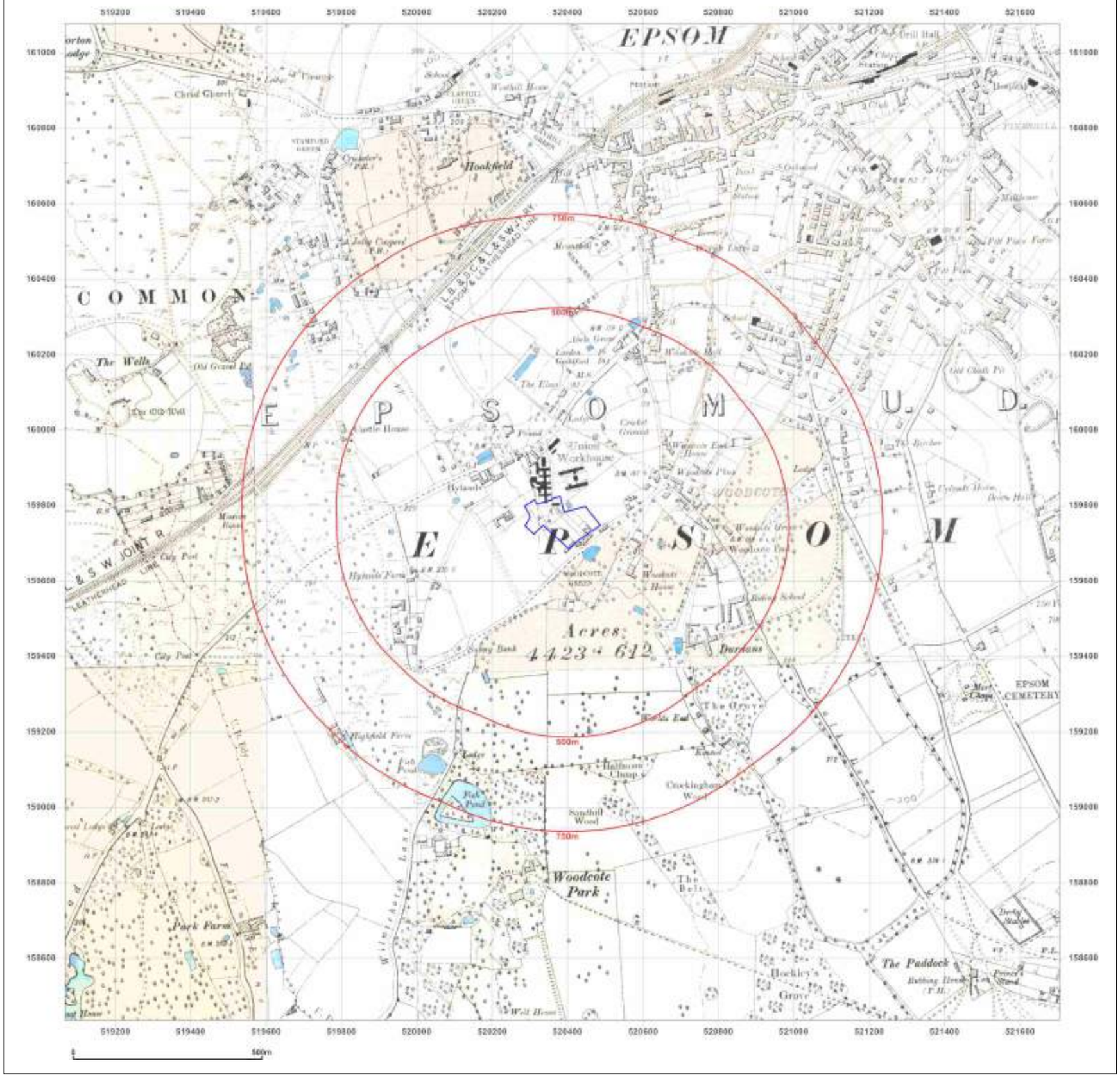

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1896-1897**

Scale: 1:10,560

Printed at: 1:10,560

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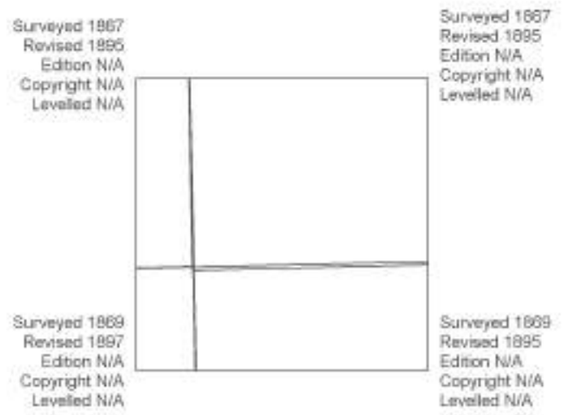

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Map legend available at:
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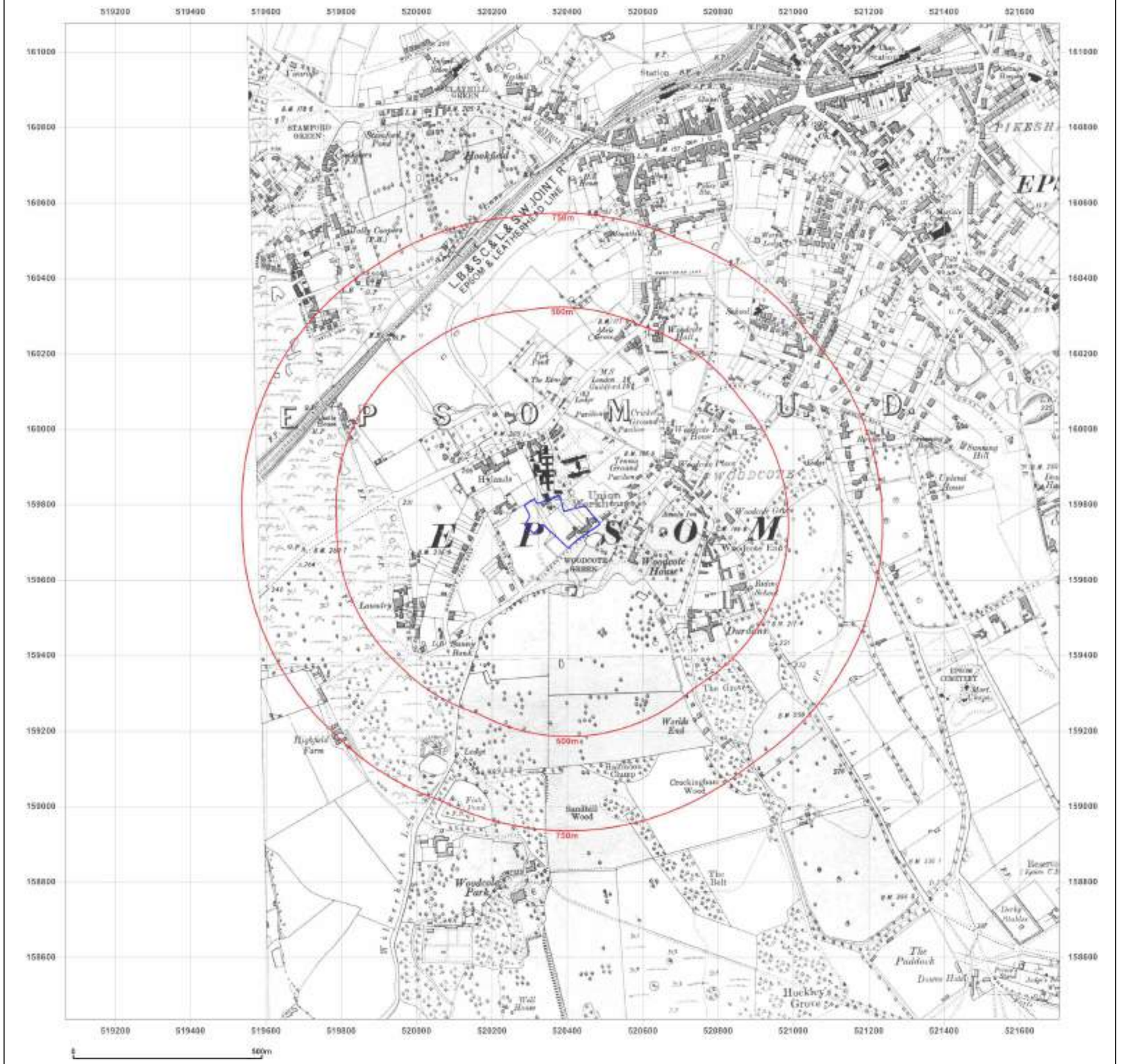

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1912**

Scale: 1:10,560

Printed at: 1:10,560

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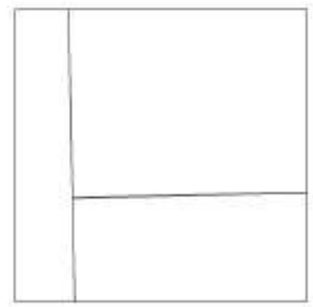

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Production date: 23 August 2019

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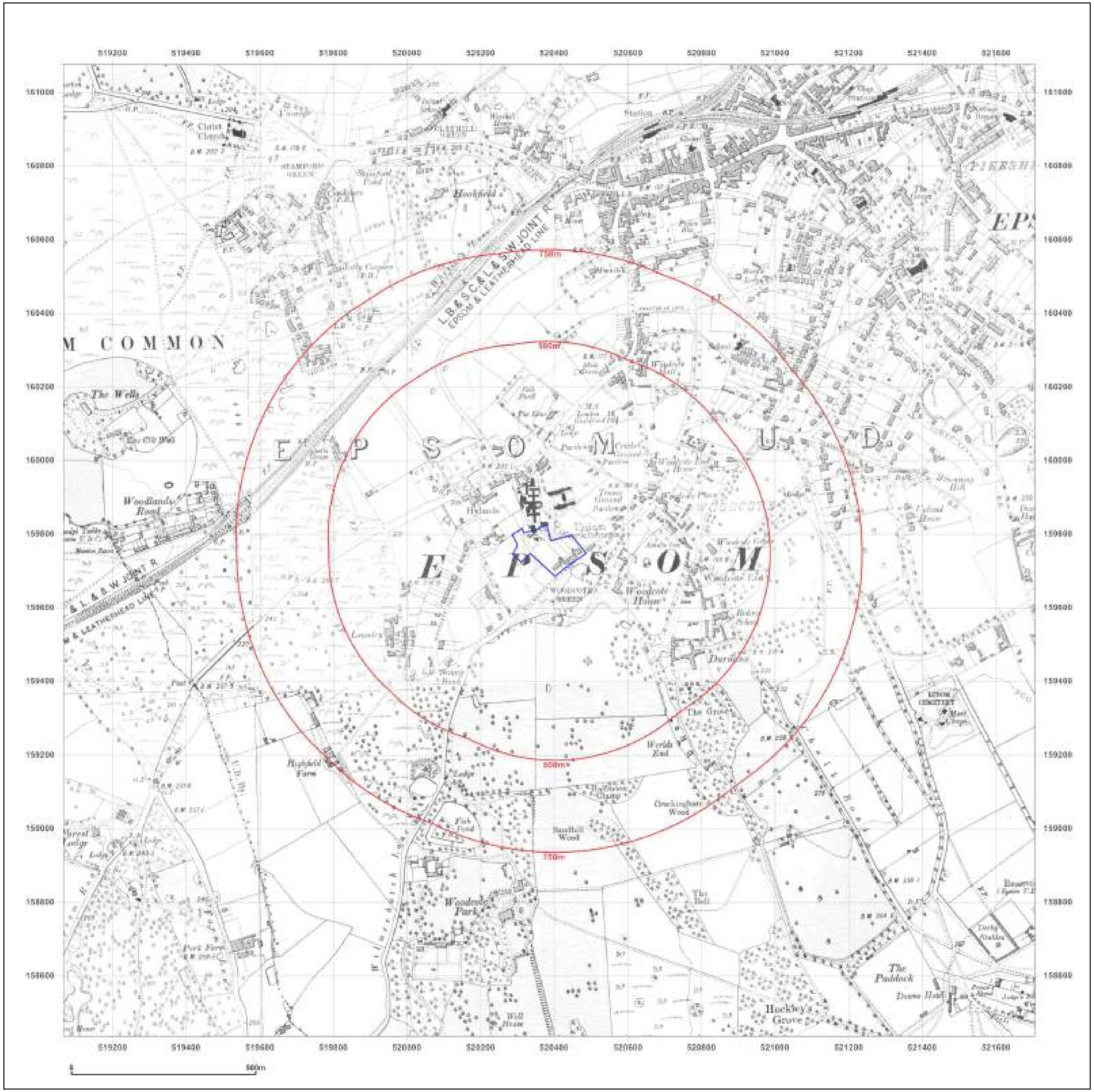

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1912-1915**

Scale: 1:10,560

Printed at: 1:10,560

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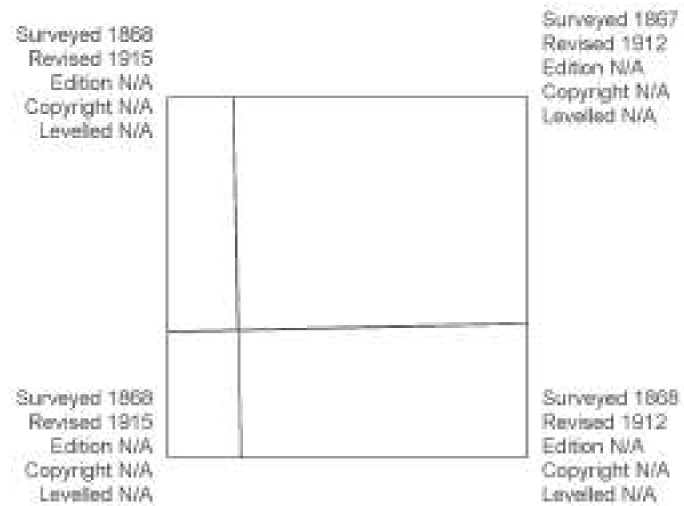

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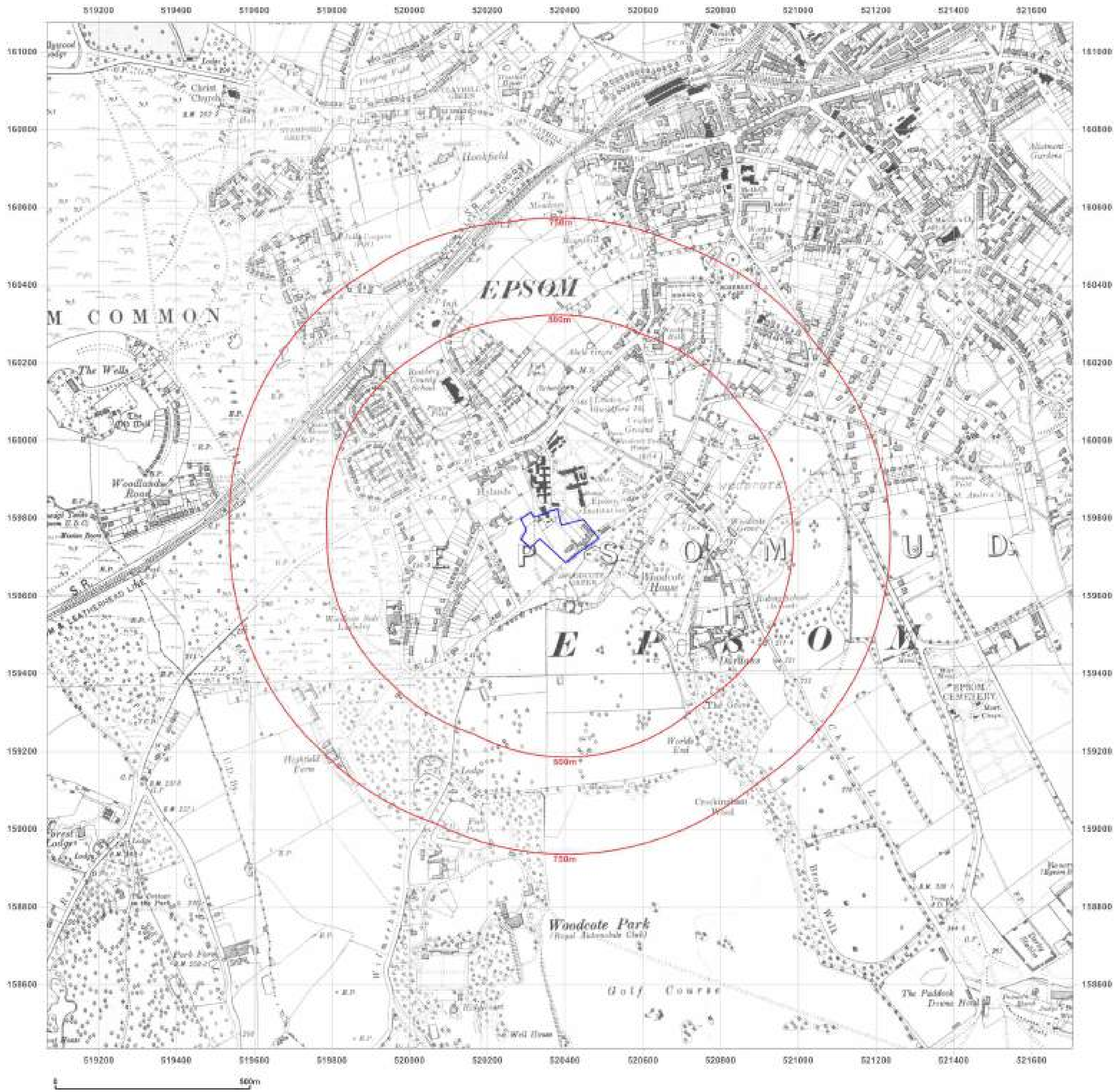
W: www.groundsure.com

Production date: 23 August 2019

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

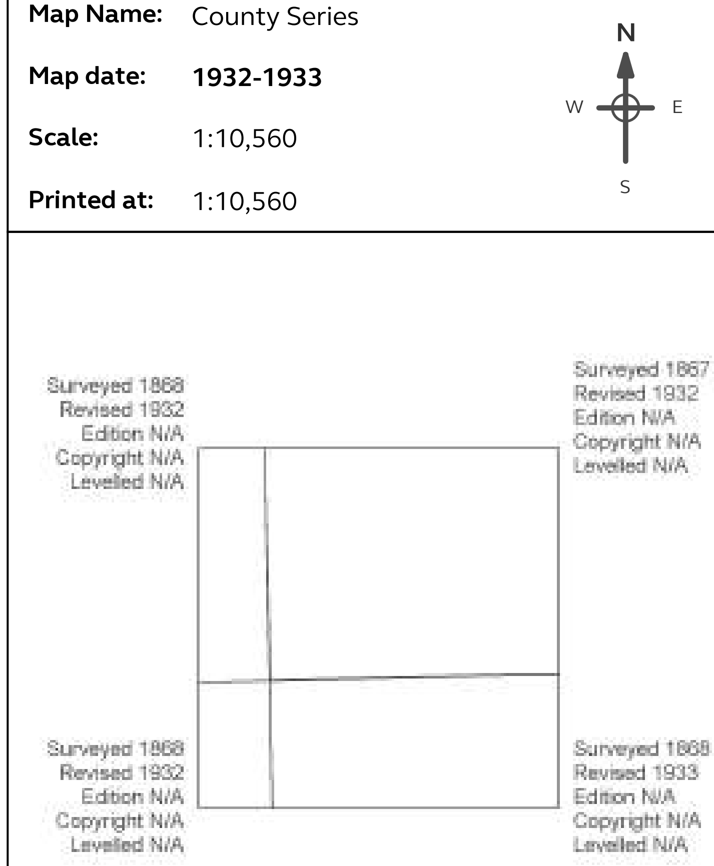
Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1932-1933**

Scale: 1:10,560

Printed at: 1:10,560



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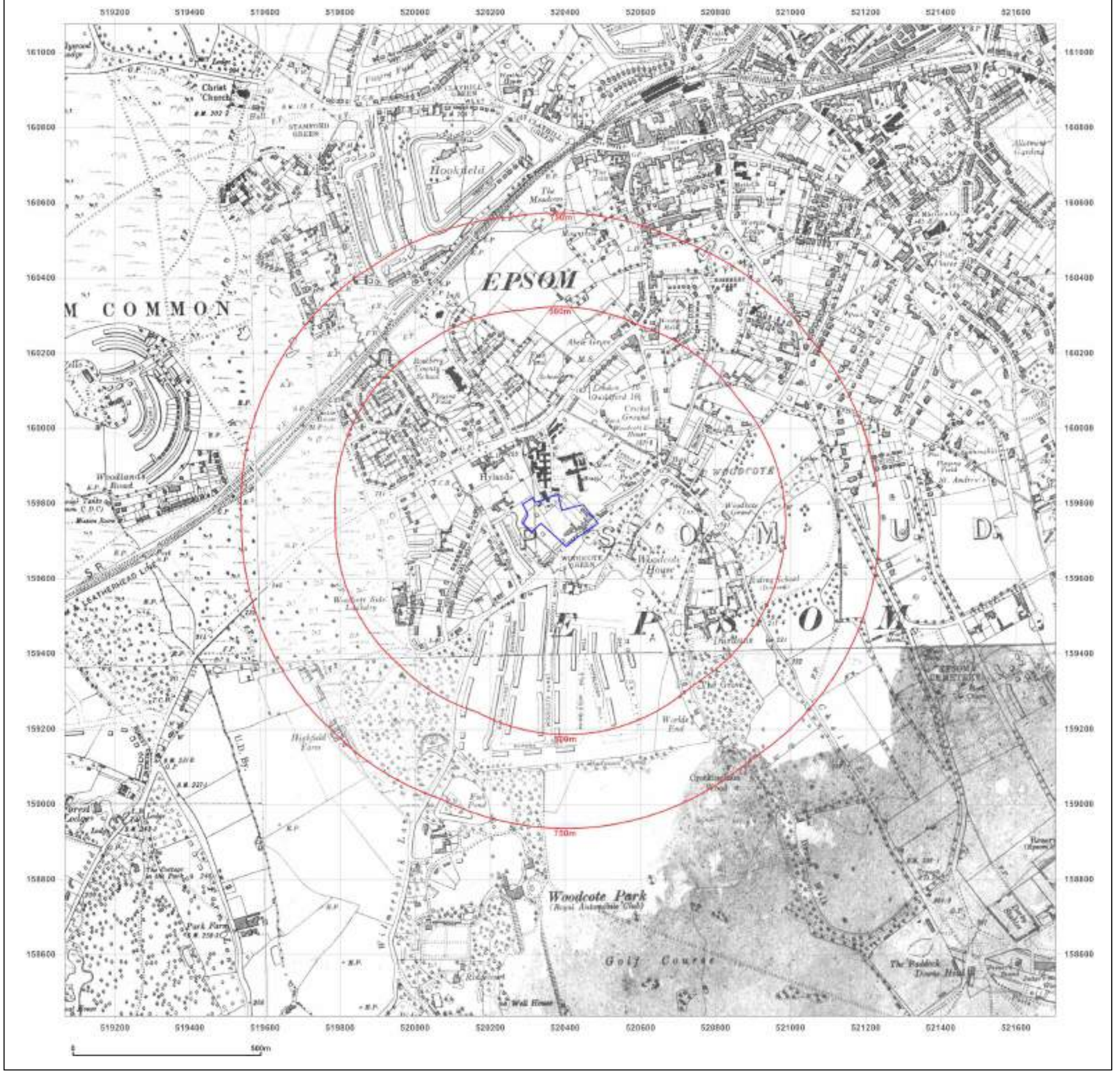
W: www.groundsure.com

Production date: 23 August 2019

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1938**

Scale: 1:10,560

Printed at: 1:10,560

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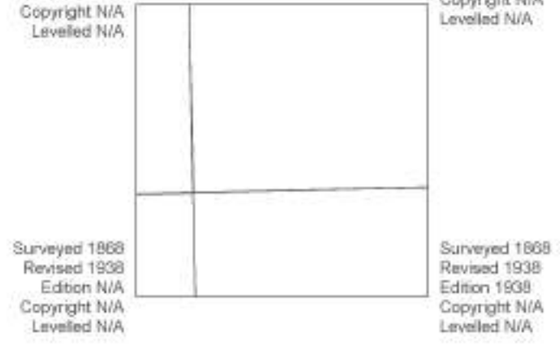

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Production date: 23 August 2019

Map legend available at:
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Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

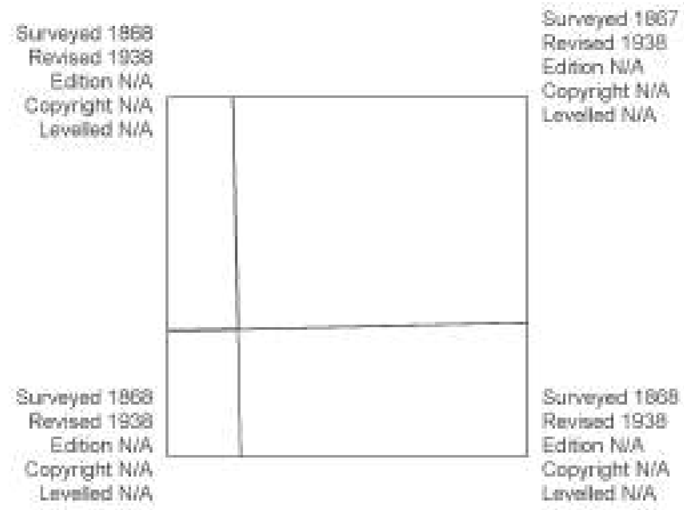
Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: County Series

Map date: **1938**

Scale: 1:10,560

Printed at: 1:10,560



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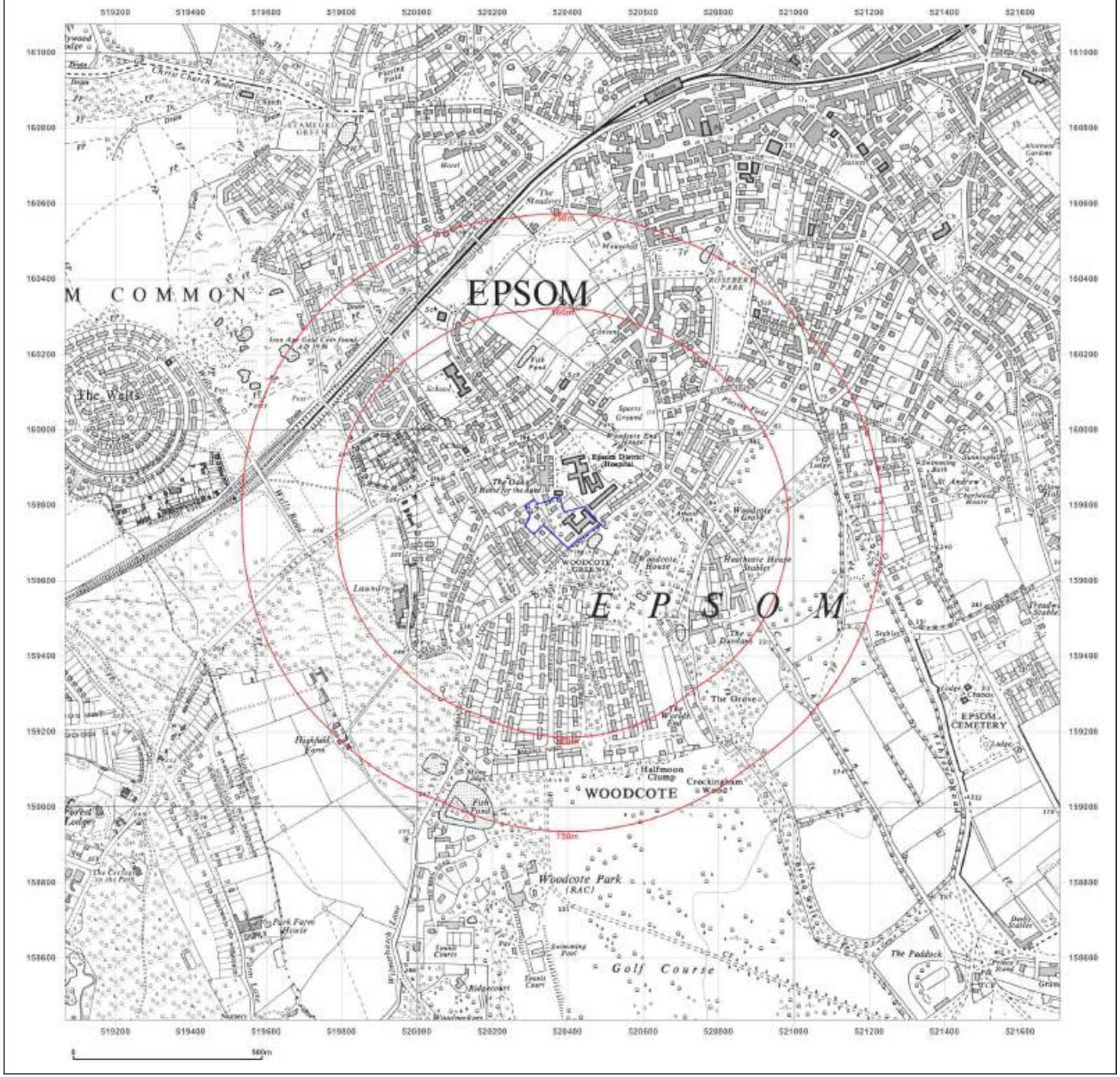
W: www.groundsure.com

Production date: 23 August 2019

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: Provisional
Map date: **1961-1962**
Scale: 1:10,560
Printed at: 1:10,560

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Surveyed N/A
Revised 1961
Edition 1962
Copyright 1962
Levelled N/A

Surveyed 1962
Revised 1962
Edition N/A
Copyright N/A
Levelled N/A

Surveyed N/A
Revised 1959
Edition N/A
Copyright 1961
Levelled N/A

Surveyed 1869
Revised 1955
Edition N/A
Copyright N/A
Levelled N/A

Powered by OS

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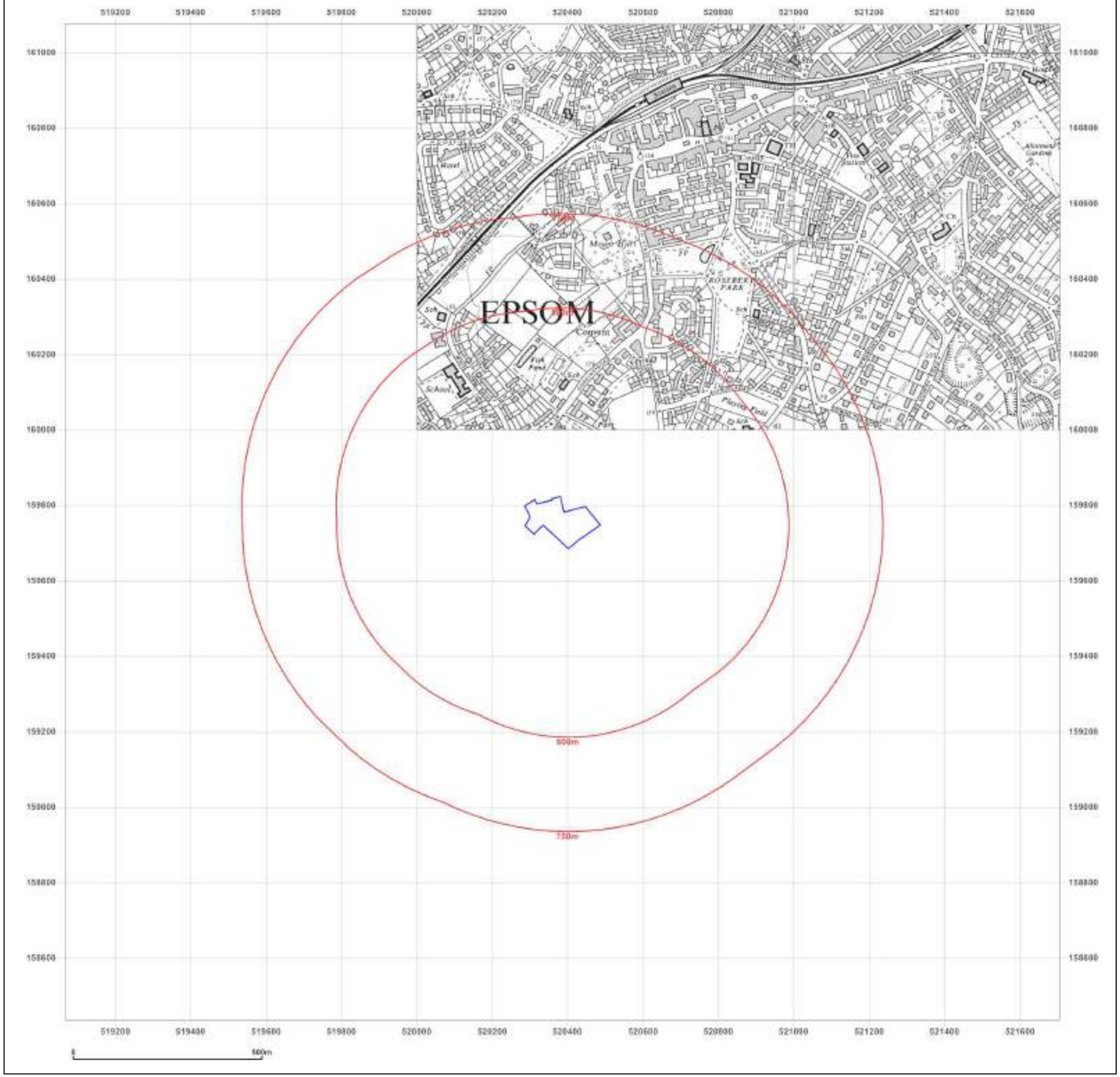
Production date: 23 August 2019

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: Provisional

Map date: **1965**

Scale: 1:10,560

Printed at: 1:10,560

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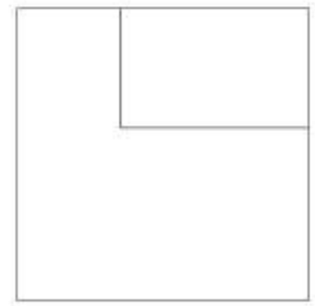
Surveyed 1965
Revised 1965
Edition N/A
Copyright N/A
Levelled N/A



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Production date: 23 August 2019

Map legend available at:
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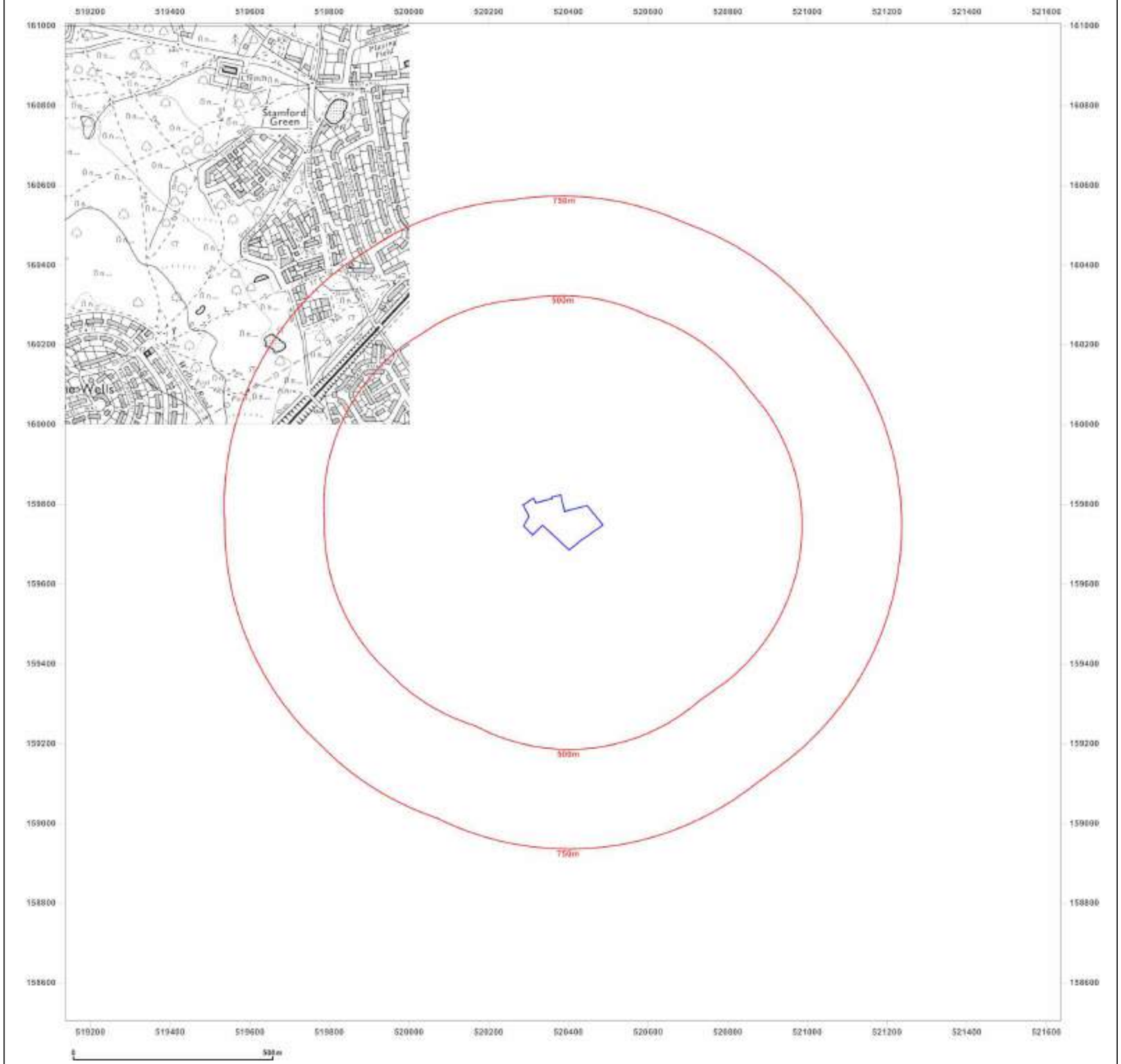

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid
Map date: **1972**
Scale: 1:10,000
Printed at: 1:10,000

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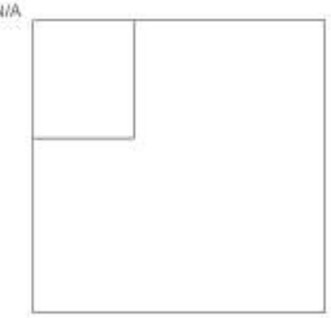
Surveyed 1972
Revised 1972
Edition N/A
Copyright N/A
Levelled N/A



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Map legend available at:
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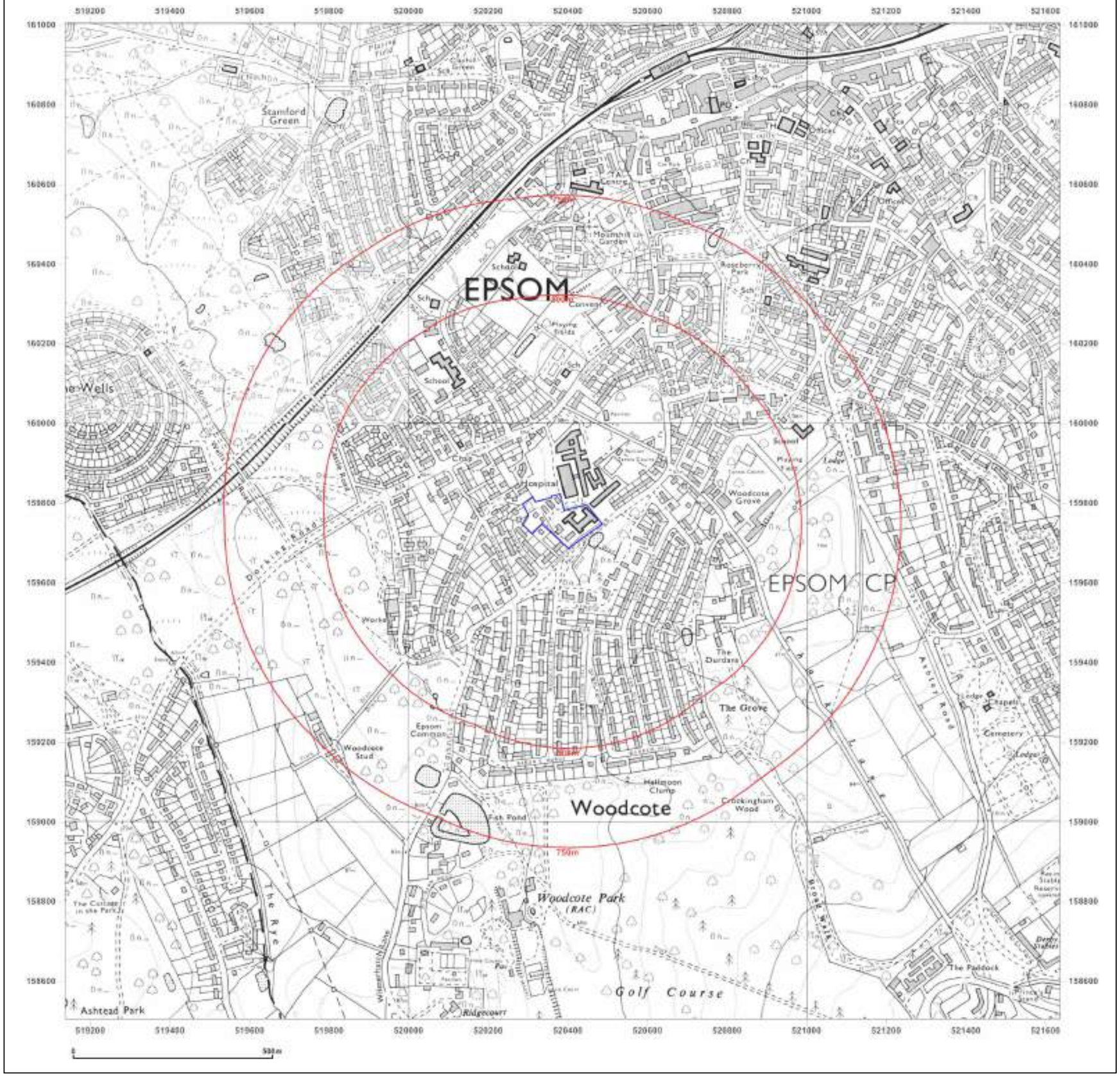

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid

Map date: **1972-1974**

Scale: 1:10,000

Printed at: 1:10,000

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Surveyed 1972
Revised 1972
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1973
Revised 1973
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1973
Revised 1974
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1974
Revised 1974
Edition N/A
Copyright N/A
Levelled N/A

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Map legend available at:
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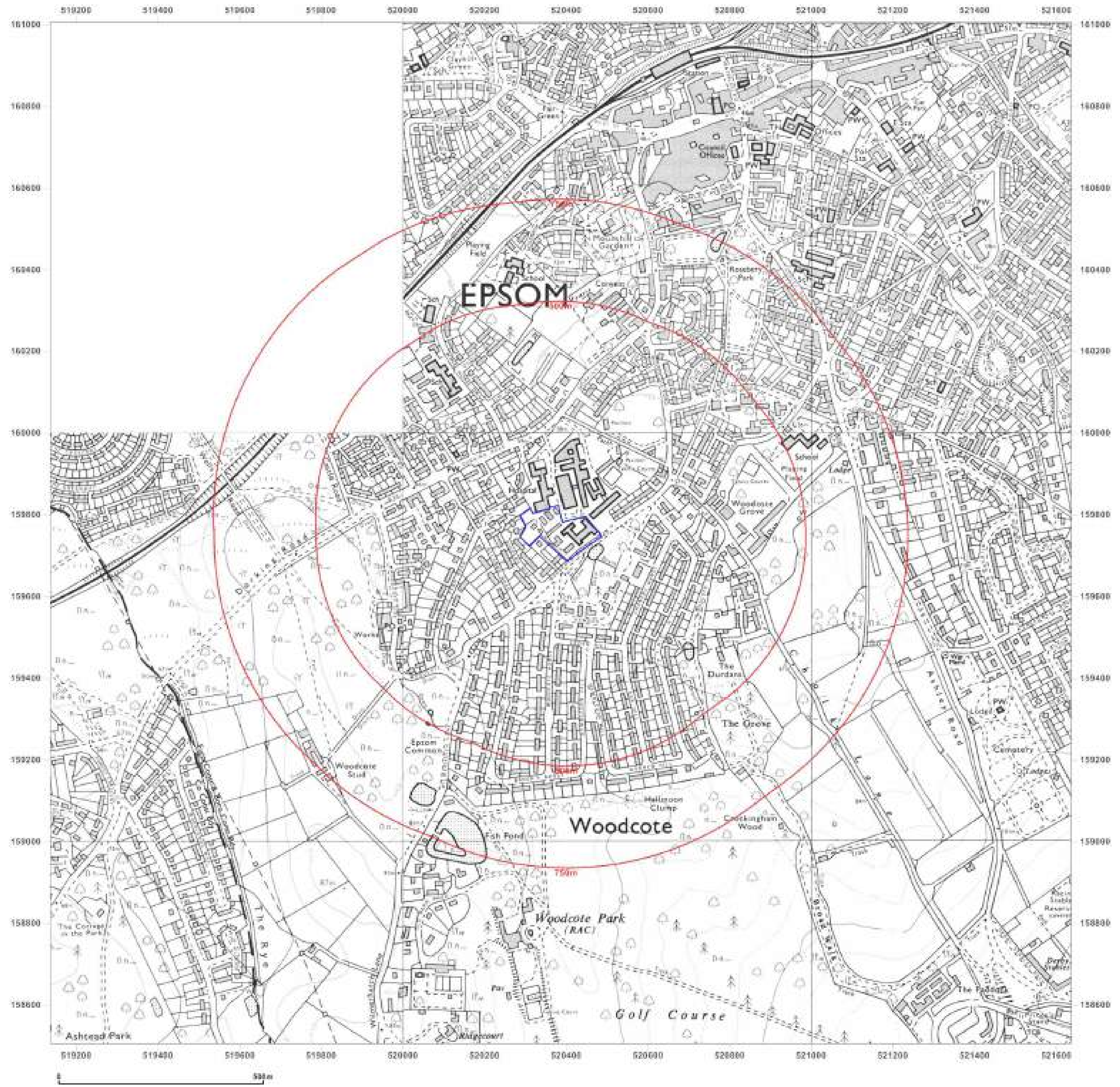

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid

Map date: **1987-1992**

Scale: 1:10,000

Printed at: 1:10,000

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Surveyed 1991
Revised 1992
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1978
Revised 1987
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1981
Revised 1990
Edition N/A
Copyright N/A
Levelled N/A

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Production date: 23 August 2019

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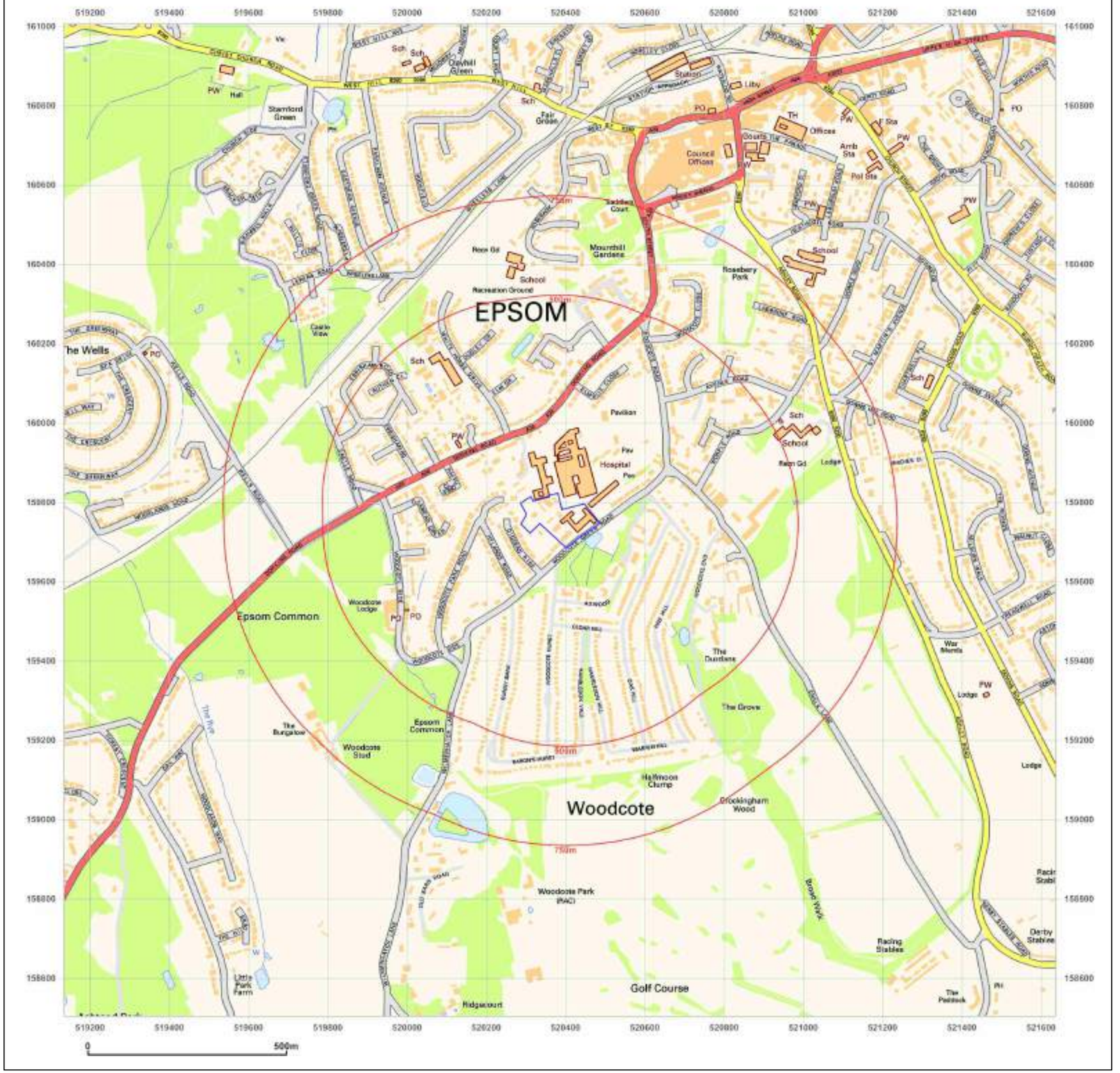

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid
Map date: 2001
Scale: 1:10,000
Printed at: 1:10,000

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2001

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W: www.groundsure.com

Production date: 23 August 2019

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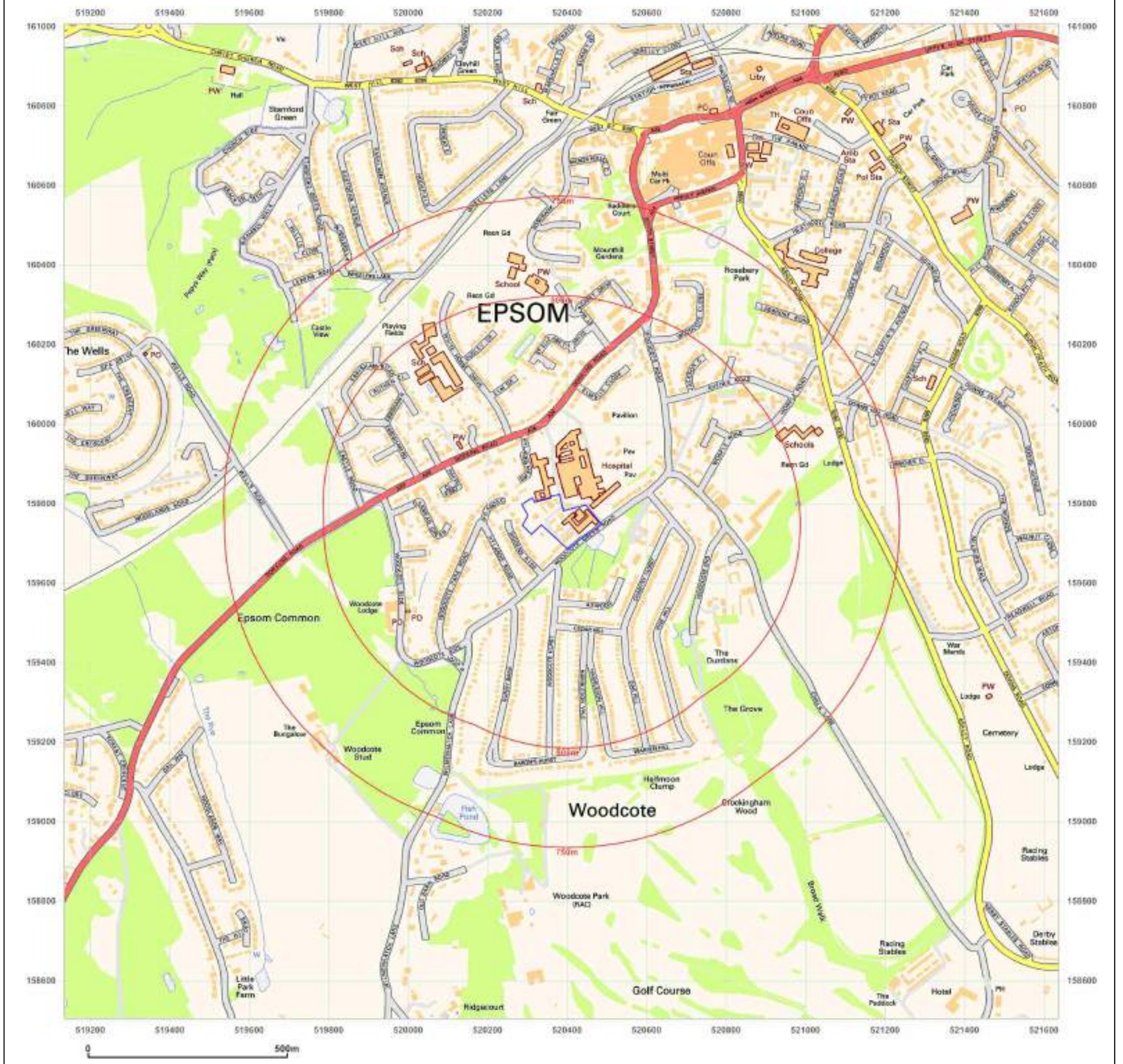

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid
Map date: **2010**
Scale: 1:10,000
Printed at: 1:10,000

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2010

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Production date: 23 August 2019

Map legend available at:
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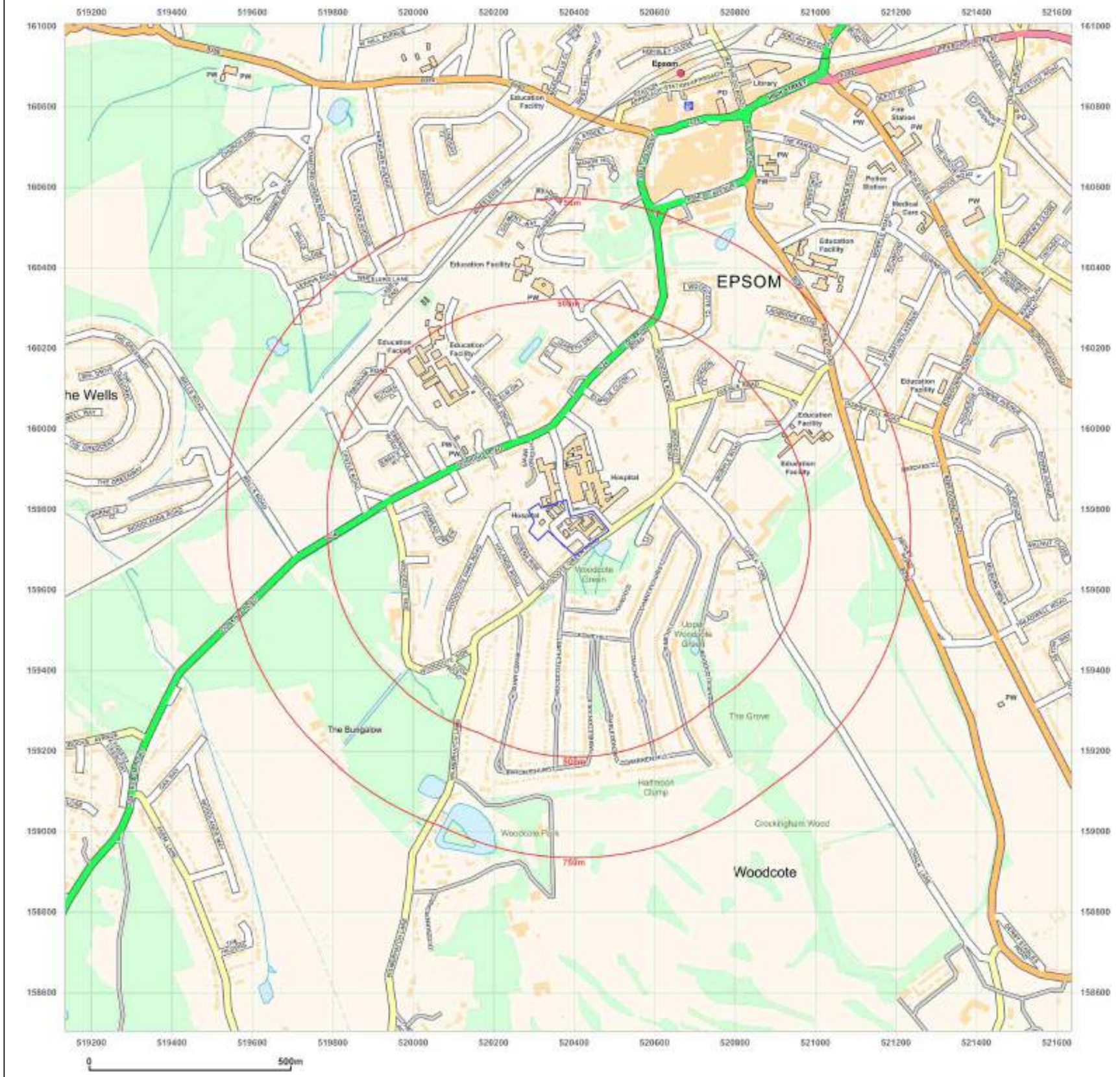

Groundsure INSIGHTS

Site Details:

ROWAN HOUSE, EPSOM GENERAL HOSPITAL, DORKING ROAD, EPSOM, KT18 7EG

Client Ref: Epsom_Hospital_
Report Ref: GS-6266220
Grid Ref: 520385, 159755

Map Name: National Grid
Map date: **2019**
Scale: 1:10,000
Printed at: 1:10,000

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Appendix B

Local Authority Consultation Response

Rosie Holden

From: Freedom of Information <FOIDPA@epsom-ewell.gov.uk>
Sent: 01 November 2019 17:40
To: Rosie Holden
Subject: [External] EIR 093.19 - Contaminated Land Search - RESP

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Ms Holden

I write in reply to your recent Environmental Information request; please find Epsom & Ewell Borough Council's response below:

Request
I am undertaking a preliminary contamination risk assessment for a site in Epsom and would like to include information from any records held by Epsom and Ewell Council. Are you able to provide a contaminated land search report for the site? If so, please advise the cost and the turnaround time of a report. If not, are there any other means by which I can obtain information held by the Council?

Part of the subject site is situated on the Epsom General Hospital complex, which is on our database of potentially contaminated sites (reference 03/00031/CLHIST) due to the fact that various potentially contaminative activities may be carried out at hospitals. We do not hold a contaminated land search for the site.

If you are unhappy with the way the Council has dealt with your request you do have the right to request a review; please contact me in the first instance. If, following the review, you remain dissatisfied, you may ask the Information Commissioner's Office to independently review the matter. The Information Commissioner's Office is an independent body that reports to Parliament. They monitor the Data Protection Act 2018 and the Freedom of Information Act 2000 and ensure organisations fulfil their legal responsibilities under the Acts. Details are available on: https://ico.org.uk/

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Yours sincerely

Elaine Murphy
Legal Secretary
Epsom & Ewell Borough Council
Tel 01372 732144
Fax 01372732111

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-----Original Message-----
From: ContactUs <contactus@epsom-ewell.gov.uk>
Sent: 04 October 2019 16:04
To: Freedom of Information <FOIDPA@epsom-ewell.gov.uk>
Subject: FW: EEBC CRM:04382093 Subject: Contaminated land search

Please see initial email:

Good morning,

I am undertaking a preliminary contamination risk assessment for a site in Epsom and would like to include information from any records held by Epsom and Ewell Council. Are you able to provide a contaminated land search report for the site? If so, please advise the cost and the turnaround time of a report. If not, are there any other means by which I can obtain information held by the Council?

Kind regards,

Rosie Holden
Consultant | Environmental Consulting

-----Original Message-----
From: Rosie Holden <Rosie.Holden@arup.com>
Sent: 04 October 2019 10:38
To: ContactUs <contactus@epsom-ewell.gov.uk>
Subject: RE: EEBC CRM:04382093

Hi Katie,

The site is located at Rowan House Epsom KT18 7DW. A figure showing the site boundary is attached.

Kind regards,

Rosie Holden
Consultant | Environmental Consulting
BSc (Hons), MSc, AMIEnvSc, MCIWEM, FRGS

Arup
13 Fitzroy Street London W1T 4BQ United Kingdom
d: +44 20 7755 5968 m: +4479 6632 4481
www.arup.com
Connect with me on LinkedIn

-----Original Message-----
From: ContactUs <contactus@epsom-ewell.gov.uk>
Sent: 04 October 2019 10:29
To: Rosie Holden <Rosie.Holden@arup.com>
Subject: [External] EEBC CRM:04382093

Dear Miss Holden,

Thank you for your correspondence regarding a contaminated land search.

The information you are requesting would be classed as a freedom of information request , and we will aim to respond to your request no later than 20 working days upon receipt.

Please can you provide us with the site address , so that we can provide you with the correct information.

With regards

Katie Randall
Customer Services
Tel: 01372 732000 Text: 07950 080202
Email: contactus@epsom-ewell.gov.uk<mailto:contactus@epsom-ewell.gov.uk>

Appendix C

Risk assessment methodology

C1 Risk assessment methodology

The potential risks to human health and environmental receptors have been considered in accordance with the current UK approach to contaminated land assessment taking into consideration the available information on the construction and operational phases of the development.

The method for risk evaluation takes into consideration the magnitude of the potential severity of the risk as well as the probability of the risk occurring. The risk characterisations have been assessed based on the qualitative method of interpretation set out in CIRIA guidance C552 [16] and NHBC/EA/CIEH risk classification methodology [17].

The method for risk evaluation involves the classification of the:

- magnitude of the potential consequence (severity) of the risk occurring (refer to Table C1-1); and
- magnitude of the probability (likelihood) of the risk occurring (refer to Table C1-2).

Table C1-1 Classification of consequence

Classification	Definition
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to Environment Agency Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to buildings or property. A short-term risk to an ecosystem, or organism forming part of such ecosystem.
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to Environment Agency Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to Environment Agency Category 3 pollution incident including minimal or short-lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short-lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species

Classification	Definition
	of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.
Minor	No measurable effect on humans. Non-permanent effects to human health, which could easily be prevented by means such as standard personal protective clothing. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.

Table C1-2 Classification of probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible over the short term and likely over the long term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is not certain that such an event would take place.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

Table C1-3 presents the risk assessment matrix and Table C1-4 defines the risk classifications.

Table C1-3 Comparison of consequence against probability

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High likelihood**	Very high risk	High risk	Moderate risk	Low to moderate risk
	Likely	High risk	Moderate risk	Low to moderate risk	Low risk
	Low likelihood	Moderate risk	Low to moderate risk	Low risk	Very low risk
	Unlikely	Low to moderate risk	Low risk	Very low risk	Very low risk

Table C1-4 Risk classifications

Risk classification	Description of risk
Very high	There is a high probability that severe harm could arise to a designated receptor from an identified pollutant linkage at the site without appropriate remediation action, or, there is evidence that severe harm to a designated receptor is currently happening. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.
High	Harm is likely to arise to a designated receptor from an identified pollutant linkage at the site without appropriate remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.
Low	It is possible that harm could arise to a designated receptor from an identified pollutant linkage. It is likely that if any harm was realised, at worst any effects would be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.
Very low	The presence of an identified pollutant linkage does not give rise to the potential to cause harm to a designated receptor. It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

Appendix D

Arcadis Epsom Hospital - Plot 2A Report

ARCADIS Design & Consultancy for natural and built assets

EPSOM HOSPITAL - MAIN HOSPITAL SITE

Phase 2 Geo-Environmental and Geotechnical Assessment Report

OCTOBER 2018

Incorporating

BC HARRIS BUILT ASSET CONSULTANCY

Hyder

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Epsom Hospital - Main Hospital Site

Phase 2 Geo-Environmental and Geotechnical Assessment Report

Author	Andrew Watts 
Checker	Gemma Francis 
Approver	George Flower 
Report No	10020221-ARC-XX-XX-RP-ZZ-0008-01
Date	OCTOBER 2018

VERSION CONTROL

Version	Date	Author	Changes
001	23rd October 2018	AW	Rev 01 for issue

CONTENTS

APPENDICES

1 Introduction

1.1 Terms of Reference

Arcadis Consulting (UK) Limited (Arcadis) was instructed by Epsom and St Helier University Hospitals NHS Trust 'the Client' on 4th July 2018 to undertake to undertake an intrusive site investigation to support the design considerations relating to the re-development of several areas of the 'Main Hospital Site' at Epsom General Hospital, Epsom (the 'Site').

An intrusive ground investigation was recommended to better characterise the potential risk levels, associated with both contamination and geotechnical constraints, and establish a land quality baseline for the site.

1.2 Proposed Development

The proposed development includes a multi-storey car park, connecting footbridge, single or double storey extensions to two buildings, and construction of a three-storey modular building. The use of the Site will remain as a functioning hospital.

The Phase 2 Geo-environmental and Geotechnical Assessment Report herein has been formulated to inform design considerations and to assist with supporting the discharge of future environmental planning conditions associated with the various redevelopment plans. This report provides an assessment of the ground conditions and contaminated land constraints, and provides a quantitative understanding of the land quality in order to better inform the requirement for potential remediation and/or mitigation associated with redevelopment of the site.

It is understood that land adjacent to the site, known as Plot 2A, is to be sold for redevelopment for residential premises. Plot 2A has been assessed separately and is reported in separate documents (Ref. 1 and 2).

It should be noted that this report focuses on the localised areas of proposed development within the overall site.

1.3 Previous Reports

A Phase 1 desk study was completed by Arcadis in August 2018 which is referenced as follows:

- Arcadis Consulting, Epsom Hospital - Main Hospital Site - Phase 1 Geo-Environmental Desk Study, August 2018, Ref: 10020221-ARC-02-XX-RP-ZZ-0001-01 (Ref. 3)

The Phase 1 Desk Study identified some potential sources of contamination which informed the scope of the intrusive investigation.

A separate Factual and Interpretative report was completed in September 2018 for the residential development of Plot 2A with the Epsom Hospital site, the report reference is as follows:

- Epsom Hospital – Plot 2A – Phase 1 Geo-Environmental Desk Study, July 2018, Ref: 10020221-ARC-01-XX-RP-ZZ-0001-01 (Ref. 1)
- Epsom Hospital - Plot 2A - Phase 2 Geo-Environmental and Geotechnical Assessment Report, Ref: 10020221-ARC-XX-XX-RP-ZZ-0007-01, dated September 2018 (Ref. 2)

1.4 Report Objectives

The objectives of this report are to:

- Present the factual information obtained from the intrusive investigation.
- Provide an assessment of whether the potential pollutant linkages identified in the Arcadis desk study (Ref. 3) are likely to be a concern to the development and/or require further assessment/remediation.
- Provide a preliminary assessment of ground conditions to support a geotechnical assessment of potential foundation requirements for the development proposals.

1.5 Limitations

This report has been prepared for Epsom and St Helier University Hospitals NHS Trust in accordance with the terms and conditions of appointment, dated 4th July 2018. Arcadis cannot accept any responsibility for any use of or reliance on the contents of this report by any third party. The copyright of this document shall remain the property of Arcadis.

This report has been compiled from a number of sources, which Arcadis believes to be trustworthy. However, Arcadis is unable to guarantee the accuracy of information provided by others. The report is based on information available at the time of writing. Additional information may become available in the future which may have a bearing on the conclusions of this report and for which Arcadis cannot be held responsible.

Ground investigations by nature only reveal a small percentage of the ground conditions present beneath the site. The possibility of significant variation in ground conditions existing between sampling locations cannot be discounted. Soil borne gas and groundwater conditions are based on observations made at the time of the investigation and during subsequent monitoring visits and may be subject to significant variation due to atmospheric, seasonal or other effects.

Arcadis do not accept liability for any use of the information presented in this report unless it is signed by the author, checker and approver and marked as final.

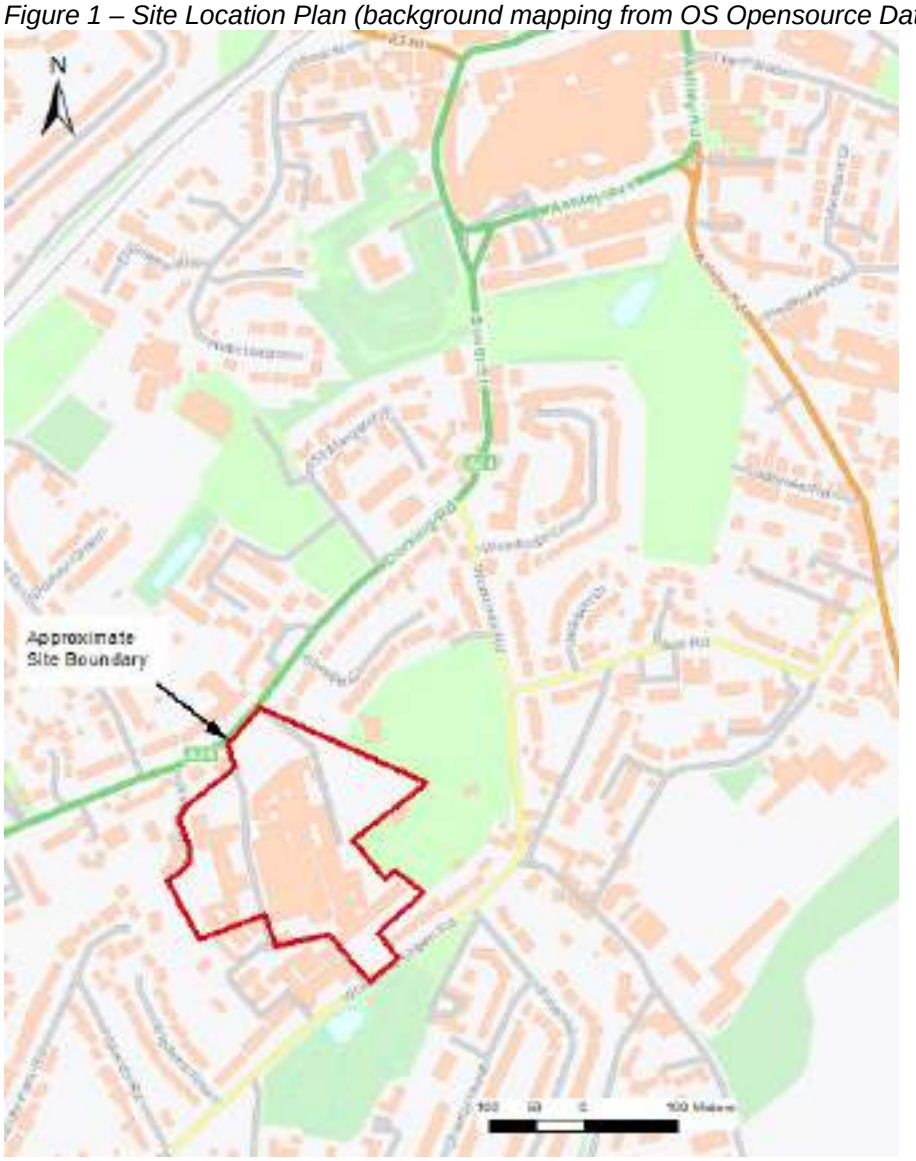
2 Site Setting and Preliminary Conceptual Site Model

The following presents a summary of the site setting and preliminary conceptual model identified in the Arcadis Phase 1 Geo-Environmental Desk Study (Ref. 3).

2.1 Site Location and Description

The site is located approximately 1km south west of the town centre of Epsom, Essex. The Ordnance Survey National Grid Reference for the approximate centre of the site is TQ 204598. The nearest postcode to the site is KT18 7EG. A site location plan is presented in Figure 1.

Figure 1 – Site Location Plan (background mapping from OS Opensource Data)



The overall site comprises the majority of the central and northern part of the Epsom hospital site (an area of approximately 4.56 Ha in size), as shown on Figure 2 (Site Layout Plan).

The site comprises part of an operational hospital facility with associated buildings and infrastructure, including several working hospital wards, offices, portacabins, and associated infrastructure such as generators. Buildings within this part of the site include Langley Wing, Wells Wing, Headley Wing, Woodcote Wing, Denbies Wing, A&E and Day Surgery Unit, Maternity Wing, Bradbury Wing, Ebbisham Ward and Oaks Suite. Car parking areas are present across the site, including the main hospital car park within the north-eastern portion of the site.

Access to the site is via the main hospital entrance off Dorking Road to the north and/or off Woodcote Green Road which borders the site to the south. All access within the site is via minor roads with sufficient breadth for ground investigation drilling rigs.

The site is bounded by residential properties to the north and west. The southern part of Epsom Hospital is adjacent to the south west. To the south and south east there is residential housing and a pond within parkland (known as Woodcote Millennium Green). Epsom Hockey Club and tennis courts are situated adjacent to the east of the site.

The site is generally level with a slight incline towards the west, particularly the soft landscaped area to the west of Langley Wing. The topography of the surrounding area slopes gently down from the south and south west to the north and north east.

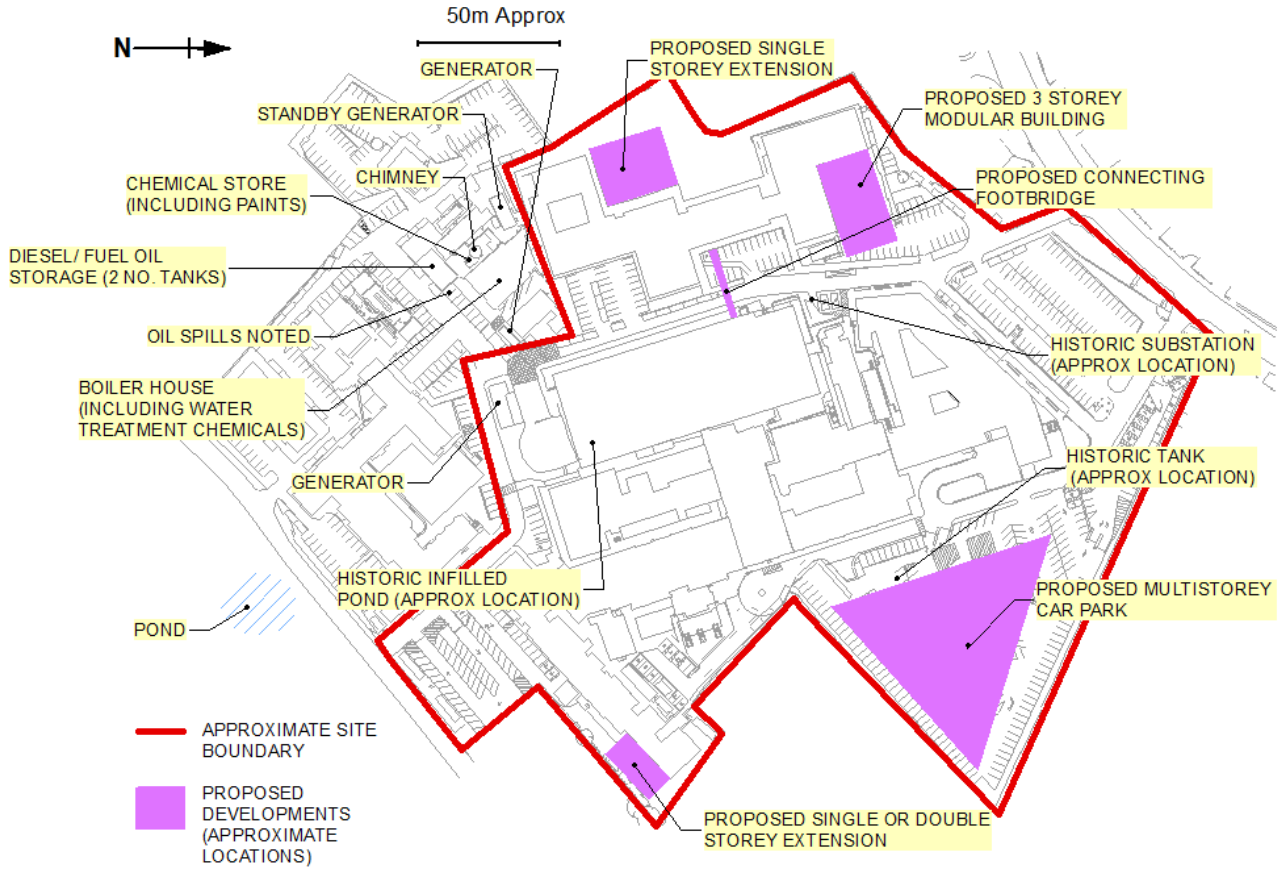
A site walkover survey was undertaken as part of the Phase 1 Desk study (Ref. 3) on 12th July 2018. The notable site uses are presented on Figure 2 and summarised as follows:

- The majority of the site is covered with buildings, concrete hard standing areas and tarmac parking areas with some areas of soft landscaping.
- Large car parking areas are situated within the northern and north-eastern parts of the site.
- Medical Gases Cylinder Store noted along the main access road opposite the main car park.
- Venting pipes observed in the corner of the garden area associated with the former mental health facility (northern part of Langley Wing). This is where the proposed 3 storey modular building is situated. It is understood that this is a gas governor - uninterruptible mains gas supply dedicated for the main boiler house incorporating slam shut downs, regulator/governor to reduce down from high pressure.
- In the vicinity of the proposed single storey extension to the west of Langley Wing, the ground slopes from west to east with levels varying by approximately 1.5m.
- A chimney with standby generator and medical gas [liquid oxygen] containers, chemical store, diesel/fuel-oil store, boiler house and a second generator occupy the land adjacent to the south of the subject hospital site boundary.
- A generator, waste recycling facilities and infectious substances storage containers are situated at the southern end of the subject site.
- Wells Wing (large brick/concrete 1960s approx. 6 storey building) occupies the majority of the central part of the subject site, which houses the hospital mortuary.
- A pond is situated on the other side of Woodcote Green Road, opposite Rowan House (offsite).
- Woodcote Wing is situated in the south-eastern part of the site with a single storey extension proposed at the northern end of the building, the land adjacent to the building is heavily vegetated/overgrown.
- Denbies Wing, A&E, Maternity Wing and Bradbury Wing consist of red-brick buildings constructed in the 1990s.
- Given the age of the majority of the hospital buildings/structures, the potential presence of asbestos containing materials (ACMs) cannot be discounted.
- Numerous underground services were noted across the site associated with water supply, drainage, gas, electricity and telecommunications.

In relation to the potential adjacent “off-site” sources of contamination, the following information has been provided by the Head of Estates (operations) for Epsom & St Helier University Hospitals NHS Trust:

- The boiler water is treated with sodium bisulphite and sodium hydroxide. These chemicals are stored within the Boiler House.
- Other substances stored on site are diesel, paint and liquid oxygen. Paint is stored in the chemical store by the Boiler House.
- The hospital has two 115,547 litre fuel oil storage tanks. Tank No 2 is currently empty. The fuel oil storage is used as the backup fuel for the steam boilers. Additional information, including maintenance requirements, is presented in Appendix E. It is understood that both tanks are situated within the same bunded compound adjacent to the boiler house.

Figure 2 – Current and Proposed layout Plan (background mapping provided by Epsom & St Helier University Hospitals NHS Trust)



2.2 Environmental Setting

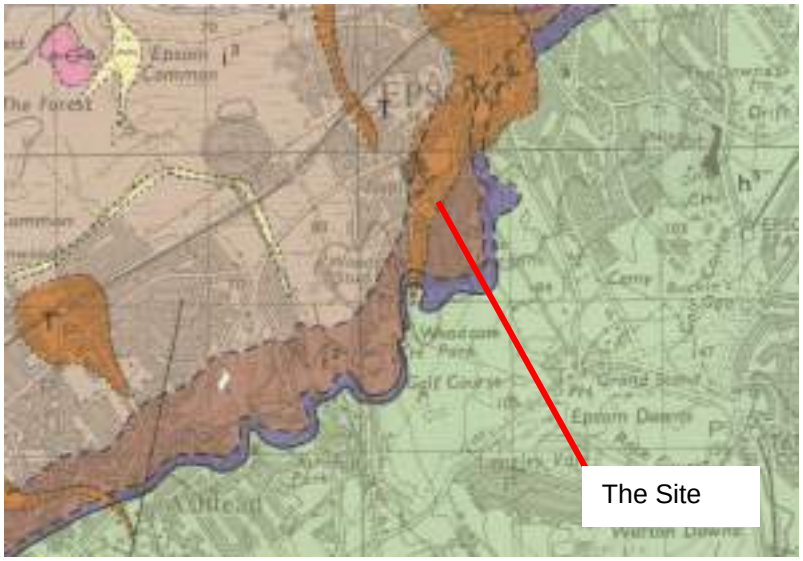
The following section summarises the pertinent information from the Phase 1 Desk Study Report (Ref. 3).

2.2.1 Geology, Hydrogeology and Hydrology

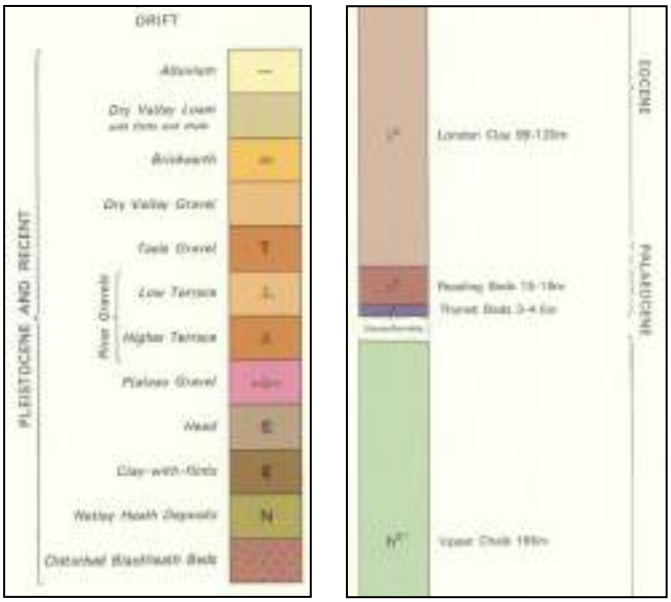
According to the British Geological Survey Geoindex (Ref. 4) and the Envirocheck Geology Datasheet obtained for the Phase 1 Desk Study (Ref. 3) the north western side of the site is underlain by the London Clay Formation, comprising Clay and Silt. The eastern part of the site is underlain by the Lambeth Group formerly known as the Reading Beds, comprising clay, silt and sand. According to the geological cross section lines provided on the published BGS Map sheet of Reigate (Ref. 5) the bedrock (London Clay and Lambeth Group) appears to be dipping gently towards the north west. These strata (London Clay and Lambeth Group) that outcrop on the site are in turn underlain by Thanet Sands and then Chalk, at greater depth.

Superficial deposits directly underlie the majority of the site and cut across the solid geology. These are River Terrace Deposits, comprising sand and gravel which extend northwards from the site. In the north western corner of the site no superficial deposits are indicated to be present. The local geology is displayed on Figure 3.

Figure 3 – Superficial and Solid Geology



Contains British Geological Survey materials © NERC [1978]



No geological fault lines were indicated to be present within 1km of the site.

As the site has previously been developed Made Ground is anticipated.

The Envirocheck Report indicates that the bedrock is a Secondary A aquifer. The River Terrace Deposits are defined as having permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The site is not located within a groundwater Source Protection Zone (SPZ). There are no recorded groundwater abstraction licences within 1km of the site.

The nearest surface water feature is a pond approximately 30m south in Woodcote Green Park. Historical maps indicate the pond has been present sine pre-1871 and several surface ‘drains’ which appear to drain into the pond from the south east and south and appear to be man-made. It is not known whether the pond is man-made, but it does not appear to be connected to a wider stream or river network. The nearest (natural) stream is the Bonesgate Stream, approximately 2.7km north west which flows in a north easterly direction

towards the Hogsmill River. The historical map review has indicated that a pond was present on site and several ponds were present within 250m of the site which have since been infilled. It is not known whether the ponds were natural or man-made.

Based on the topography and the published geological maps, the direction of groundwater flow within the River Terrace Deposits is expected to be towards the north. Groundwater flow within the Lambeth Group is conceived to be more likely to be towards the north west, based on the inferred dip direction of the bedrock.

2.2.2 Site History

The historical map review indicates that prior to being developed into a hospital, the site comprised Epsom Union Workhouse and undeveloped land. The central part of the site was developed into Epsom Hospital by 1934 and has undergone several minor phases of demolition and redevelopment since then. Potential sources of contamination on site include asbestos fibres from various phases of demolition and redevelopment on the site.

There was a small pond on the central part of the site which appears to have been infilled circa 1913. The pond may have been infilled with Made Ground or waste although this is not expected to be significant given its size.

There was an on-site historical tank and electricity substation which are potential sources of hydrocarbon and Polychlorinated Biphenyl (PCB) contamination. There is a current generator adjacent to the south of Wells Wing.

Adjacent to the south and south west is the Plot 2A site of Epsom Hospital which was developed around the same time as the Main site and has also undergone phases of minor redevelopment. There is a chimney, diesel/fuel-oil storage tank, generator, standby generator (oil spills noted), boiler house and chemical store within the Plot 2A site, approximately 5-30m south/ south west which are potential sources of contamination and are directly up hydraulic gradient from the site.

There were historical tanks approximately 30m north east, an electricity substation approximately 45m north east and garages approximately 240m north of the site. These are not considered likely to have significantly impacted the site as they are at a moderate distance and not directly up hydraulic gradient from the site.

2.2.3 Potentially Contaminative Land Uses

Based on the Envirocheck Report obained for the Phase 1 Desk Study (Ref. 3) there are 5no contemporary trade directory entries within 200m of the site (recorded onsite and up to 109m away), relating to hospital's (Epsom General Hospital), cleaning materials and equipment and lighting manufacturers. 2 of these entries are located onsite and relate to the MRI unit and the Orthopaedic centre.

A potentially infilled former pond is located onsite and was infilled around 1913. Another infilled pond is located 11m northeast of the site, and dates back to 1945.

One Part B Authorisation is located 240m northeast of the site and relates to the Woodcote BP Service Station.

There are no current or historic landfill sites within 250m of the subject site.

2.2.4 Radon

According to the Radon Atlas of the UK (Ref. 6) the site is located within a lower probability radon area (less than 1% of homes are estimated to be at or above the Radon Action Level).

No radon protective measures are necessary in the construction of new buildings.

2.2.5 Unexploded Ordnance (UXO)

A map of Unexploded Bomb Risk for the local area was obtained from Zetica which is detailed within the Phase 1 Desk Study (Ref. 3) which shows that the site is within an area of Low London Bombing Density. Low risk areas are those which have seen a bombing density of up to 10 bombs per 1000 acres. No abandoned bombs, UXO finds or strategic targets were identified within 1km of the site.

2.3 Preliminary Conceptual Site Model

Based on the information obtained from Desk Study report, potential pollutant linkages were identified, as detailed in Table 2.1.

Table 2.1 Potential Pollutant Linkages

Potential Contaminant Source	Potential Pathway	Receptor	Likelihood of Pollutant Linkage
On site			
General Made Ground from various phases of demolition and redevelopment of the site. Small infilled pond Historic tank and electricity substation Current generator	Accidental ingestion of contaminants within soil, water and dust. Inhalation of dusts, vapours or hazardous ground gas Dermal contact with contaminants in soil, water and dust	Current and future site users	Unlikely – current and future site users would be unlikely to come into contact with potential contamination as the majority of the site is covered with hardstanding.
			Potential for ground gas is unlikely – Made Ground containing putrescible material that would be capable of generating significant ground gas (methane and carbon dioxide) is not expected to be present.
		Maintenance workers	Likely - future maintenance workers and contractors could be exposed during below ground works such as digging, maintaining services etc. Hydrocarbon vapours may be present.
	Leaching of contaminants from Made Ground and vertical migration into groundwater Horizontal migration of contaminants in groundwater	Secondary A Aquifer (bedrock and superficial deposits) underlying the site Groundwater SPZ down gradient Pond adjacent to the south	Likely – disturbance of soils and general Made Ground during the development could cause increased leaching of potential contaminants, however the provision of hardstanding in the finished development would minimise rainfall derived leaching.

	Direct contact	Buildings	Unlikely – within general Made Ground and soils impact of a degree capable of causing significant impact to the built environment is unlikely to be present. The exception may be drinking water – piped supplies.
Sulphates in the London Clay.	Direct contact	Buildings	Likely - The London Clay underlying the north western side of the site is a potential source of sulphates which can cause aggressive ground conditions for below ground concrete.
Off site			
Potential localised hydrocarbon and solvent contamination from standby generator, diesel/fuel -oil store, boiler house, chemical store and second generator within Plot 2A site). Chemicals used for boiler water treatment and paints (Plot 2A site).	Accidental ingestion of contaminants within soil, water and dust. Home grown produce, if gardens are proposed Inhalation of dusts, vapours or hazardous ground gas Dermal contact with contaminants in soil, water and dust	Current site users	Unlikely – current site users would not likely come into contact with potential contamination as the majority of the site is covered with hardstanding.
		Maintenance workers	Low likelihood that future maintenance workers and contractors could be exposed to contaminants in groundwater that has migrated onto the site (during below ground works such as digging, maintaining services etc).
	Direct contact	Buildings	Low likelihood that gross hydrocarbon with the potential to impact services such as PVC water supply pipes would have migrated beneath the site in groundwater.

3 Site Investigation

3.1 Scope of Works

The ground investigation was designed and undertaken to examine the geo-environmental and geotechnical conditions of the site and provide evidence of its suitability for the proposed land use, and to review the findings of the Phase 1 Desk Study (Ref. 3).

An exploratory hole location plans are included in Appendix A.

3.2 General

Ground investigation works were carried out between 15th and 23rd August 2018. The scope of the ground investigation, including the location, scheduled depth and type of exploratory hole undertaken was determined by Arcadis Consulting Ltd and is summarised in Table 3.1.

Table 3.1 Initial Ground Investigation Scope

Location ID	Hole Type	Scheduled Depth (m)	Requirements
BH103	HTP + CP	15.0	Determine thickness of engineering soils; penetrate 3 m into bedrock; collect representative samples of strata and undertake *in situ* tests. BH103 is positioned in what is believed to be down hydraulic gradient from the key source areas as identified in the Desk Study. It will enable an understanding of the potential extent of any contaminant plume (if present) and hence informing any liability issues that may need to be considered as part of the sale of Plot 2A land.
BH105	HTP + CP	15.0	Determine thickness of engineering soils; penetrate 3 m into bedrock; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed multi-storey car park (probably 6 storeys to take 850 cars). Also targets former tank in this part of the site as shown on historic maps (circa 1896 - 1913), it is not known if this was a former fuel or water tank.
BH106	HTP + CP	15.0	Determine thickness of engineering soils; penetrate 3 m into bedrock; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed connecting footbridge.
BH107	HTP + CP	15.0	Determine thickness of engineering soils; penetrate 3 m into bedrock; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed connecting footbridge.
WS106	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed single storey extension.
WS107	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed single storey extension.

Location ID	Hole Type	Scheduled Depth (m)	Requirements
WS108	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed single storey extension (possibly 2 storey).
WS109	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed multi-storey car park (probably 6 storeys to take 850 cars).
WS110	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed multi-storey car park (probably 6 storeys to take 850 cars).
WS111	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed 3 storey modular building.
WS112	HTP + DS	5.0	Determine thickness of engineering soils; collect representative samples of strata and undertake *in situ* tests. Targeting ground conditions for proposed 3 storey modular building.

Notes: HTP = hand excavated trial pit, CP = cable percussive boring, DS = dynamic sampling.

The investigation works were carried out under the supervision of a suitably experienced ground investigation engineer who undertook the logging and sampling of the exploratory holes and *in situ* testing.

3.3 Exploratory Holes

3.3.1 Exploratory Hole Locations

The co-ordinates and elevations of the exploratory hole locations were obtained by the Arcadis supervising engineer using a Trimble VRS NOW GPRS system; allowing an accuracy of +/-50 mm.

Drawing 10020221-ARC-03-XX-DR-ZZ-0001 presented in Appendix A displays the as-constructed exploratory hole locations while the co-ordinates and elevation of the ground surface at each exploratory hole location are given on the individual logs.

The exploratory hole logs are presented in Appendix C.

3.3.2 Investigation Methodology

Details of the methods of investigation and associated standards adopted are presented in Appendix B; The completed scope of investigation is summarised in Table 3.2. Comments relate to the time of exploratory hole formation, and do not record extended time related behaviour, e.g. of groundwater.

Table 3.2 Summary of Completed Exploratory Holes

Location ID	Hole Type	Start Date	End Date	Final depth (m)	Comment	Termination Reason
BH103	HTP+CP	20/08/2018	20/08/2018	15.00	No groundwater encountered, damp from 14.00 m bgl	Target depth
BH105	HTP+CP	22/08/2018	23/08/2018	15.39	Groundwater encountered at: • 2.50 m bgl, rose to 1.80 m after 20 minutes, • 9.70 m bgl, rose to 6.80 m bgl after 20 minutes; and, • 13.00 m bgl, rose to 12.00 m bgl after 20 minutes.	Target depth (SPT run to 15.39 m bgl)
BH106	HTP+CP	21/08/2018	21/08/2018	15.34	No groundwater encountered	Target depth (SPT run to 15.34 m bgl)
BH107	HTP+CP	20/08/2018	20/08/2018	15.38	No groundwater encountered, slight seepage at 3.20 m bgl	Target depth (SPT run to 15.38 m bgl)
WS106	HTP+DS	15/08/2018	15/08/2018	5.45	No groundwater encountered	Target depth (SPT run to 5.45 m bgl)
WS107	HTP+DS	15/08/2018	15/08/2018	4.38	No groundwater encountered	SPT refusal
WS108	HTP+DS	16/08/2018	16/08/2018	1.50	No groundwater encountered	SPT refusal
WS109	HTP+DS	17/08/2018	17/08/2018	3.38	Groundwater encountered at 2.00 m bgl, rose to 1.50 m bgl after 20 minutes	SPT refusal
WS110	HTP+DS	17/08/2018	17/08/2018	1.58	No groundwater encountered	SPT refusal
WS111	HTP+DS	17/08/2018	17/08/2018	5.45	No groundwater encountered	Target depth (SPT run to 5.45 m bgl)
WS112	HTP+DS	17/08/2018	17/08/2018	2.38	No groundwater encountered	SPT refusal

Notes: HTP = hand excavated trial pit, CP = cable percussive boring, DS = dynamic sampling.

3.3.3 Cable Percussive Boring

Cable percussive boring was completed using Dando D4000 drilling rig equipped with 152 mm casing and tools to undertake boreholes up to 15 m bgl.

Samples of the material recovered in borehole were taken to enable representative laboratory testing. Generally small disturbed samples were taken at each change in stratum and at 0.5 m intervals thereafter in

clay soils; and bulk samples were taken at 1 m intervals where the sand and gravel content of the soil was significant.

Where ground conditions were suitable, open drive tube samples were taken using thin-walled sampling apparatus from the relatively undisturbed material at the base of the borehole.

3.3.4 Dynamic Sampling

Dynamic sampling was completed using a track-mounted sampling rig capable of driving windowless sampling tubes using a mechanical hammer dropped repeatedly from a self-governed height to advance window sample tubes into the ground.

The time to drive the sampling tubes (or number of blows for the mechanical hammer) was recorded together with a description of the recovered materials by the supervising engineer or the lead driller.

Photographs of the materials recovered are presented with the appropriate hole log. To enable a representative photographic record, the samples were split prior to the photograph and subsequently destructively logged.

Due to the method of investigation, the materials recovered within the sampler apparatus were generally disturbed and were assessed as complying with Class 3 to Class 5 of BS EN 22475-2. Sub-samples of the material recovered in the liners were taken to enable representative laboratory testing. Generally small disturbed samples were taken at each change in stratum and at 0.5 m intervals thereafter in clay soils; and small bulk samples were taken at 1 m intervals where the sand and gravel content of the soil was significant.

3.4 In Situ Testing

3.4.1 Standard Penetration Tests

Standard penetration tests (SPT) were carried out as required in the investigation scope and in accordance with the methods given in the standard procedures presented within Appendix C . Generally, tests were undertaken at regular intervals throughout the borehole to provide a profile of the soil's resistance with depth and a disturbed soil samples was recovered from the SPT split-spoon tool or a disturbed sample was taken over the range of the test interval.

The N-values as determined in the field are presented on the borehole logs as uncorrected values that do not take into account the energy losses or efficiency of the automatic trip hammer used to drive the test tool into the ground. The calibration certification for the test devices used in the investigation is presented in Appendix E and a summary of the SPT equipment used at each location is presented in Table 3.3.

Table 3.3 Test Hammer Calibrations

Location ID	SPT Hammer Reference No.	Energy Efficiency Ratio, E_r %	Comment
BH103 and BH107	SEDS8	69	Test date 10/05/2018
BH105 to BH106	SEDS11	71	Test date 27/07/2018
WS101 to WS105	219	78.68	Test date 09/04/2018

3.4.2 VOC Head Space Screening

The presence of Volatile Organic Compounds (VOC) within the ground was determined using a photoionization detector (PID) to detect the 'headspace' vapours emitted by the compounds. The method is applicable to a wide range of compounds that have sufficiently high volatility to be liberated from the soil or water matrix in normal temperature and pressure ranges.

The headspace test was undertaken on the freshly extracted soil core sample at regular intervals typically of 0.5m, by placing a small amount of material into a screw-top glass jar so that the jar was not more than half-full. The jar opening was covered with an aluminium foil sheet and the lid screwed on to form an air-tight seal. The sample and jar were then shaken for about 15 seconds to break-up and disperse the soil before resting the sample for about 5 minutes.

To assess the headspace vapour, the jar lid was removed and the PID probe was inserted through the foil into the headspace area. The PID reading recorded was the highest response observed in the first 10 seconds. The screening results are presented on the relevant exploratory holes logs within Appendix C..

The testing was undertaken using a Mini RAE 3000 PID with a 10.6 eV lamp.

The PID instrument was calibrated regularly throughout the day using Balance Air and Isobutylene Mixture reference gas concentrations.

3.5 Installations and Post-fieldwork Monitoring

3.5.1 Installations

Installations to enable long term monitoring of the site were made in those boreholes selected by Arcadis Design Engineer and the details are summarised in Table 3.4 and are also provided on the relevant borehole logs.

Table 3.4 Summary of Exploratory Hole Installations

Location ID	Installation Type	Response Zone Top m bgl	Response Zone Base m bgl	Comment/limitations
BH103	SP50	14.0	15.0	Flush cover set in 0.50 m concrete 13.50 m bentonite pellet seal to top of response zone 1.00 m pluviated sand filter around response zone to base of hole
BH105	SP50	2.0	3.8	Flush cover set in 0.50 m concrete 1.50 m bentonite pellet seal to top of first response zone 1.80 m pluviated sand filter around first response zone 5.90 m bentonite pellet seal to top of second response zone 0.30 m pluviated sand filter around second response zone 5.39 m bentonite seal to base of hole.
	SP50	9.7	10.0	
BH106	SP50	10.0	15.0	Flush cover set in 0.50 m concrete 9.50 m bentonite pellet seal to top of response zone 5.00 m pluviated sand filter around response zone 0.34 m bgl bentonite pellet seal to base of hole
BH107	SP50	2.0	6.0	Flush cover set in 0.50 m concrete 1.50 m bentonite pellet seal to top of response zone

				4.00 m pluviated sand filter around response zone 9.38 m bgl bentonite pellet seal to base of hole
WS106	SP50	0.5	5.0	Flush cover set in 0.25 m concrete 0.25 m bentonite pellet seal to top of response zone 4.50 m pluviated sand filter around response zone 0.45 m bgl bentonite pellet seal to base of hole
WS107	SP50	0.5	4.0	Flush cover set in 0.25 m concrete 0.25 m bentonite pellet seal to top of response zone 3.50 m pluviated sand filter around response zone 0.38 m bgl bentonite pellet seal to base of hole
WS108	SP50	0.5	1.2	Flush cover set in 0.25 m concrete 0.25 m bentonite pellet seal to top of response zone 0.70 m pluviated sand filter around response zone 0.30 m bgl bentonite pellet seal to base of hole
WS109	-	-	-	No installation as borehole collapsed back up to 1.00m bgl Backfilled with 0.25 m bitumen bound material over 3.13 m arisings to base of hole
WS110	SP50	0.5	1.2	Flush cover set in 0.25 m concrete 0.25 m bentonite pellet seal to top of response zone 0.70 m pluviated sand filter around response zone 0.38 m bgl bentonite pellet seal to base of hole
WS111	SP50	0.5	1.5	Flush cover set in 0.25 m concrete 0.25 m bentonite pellet seal to top of response zone 1.00 m pluviated sand filter around response zone 3.95 m bgl bentonite pellet seal to base of hole
WS112	SP50	1.0	2.0	Flush cover set in 0.25 m concrete 0.75 m bentonite pellet seal to top of response zone 1.00 m pluviated sand filter around response zone 0.38 m bgl bentonite pellet seal to base of hole

Notes: SP50 = 50 mm ID standpipe.

3.5.2 Post-fieldwork Monitoring

Post-field work monitoring was undertaken on separate visits on the 23rd August, 31st August, 13th September, and 28th September 2018. In all, three visits to the site were made to record land gas emissions and while four visits were made to monitor groundwater levels. During the first monitoring visit, the wells were purged by removing three well volumes of groundwater and *in situ* groundwater monitoring and sampling was undertaken. Where installations were purged dry, monitoring and sampling was conducted on groundwater recovered following recharging of groundwater in installations.

The results of the groundwater monitoring are presented within Appendix E.

4 Ground Conditions

4.1 Encountered Geology

The ground conditions generally are consistent with the published geology identified in the Desk Study (Ref. 3), comprising Made Ground overlying River Terrace Deposits, comprising granular material, in turn overlying cohesive materials.

Made Ground was encountered in all exploratory holes.

The River Terrace Deposits were not encountered to the very west of the site (WS106, WS107 & WS111), where Made Ground directly overlies the bedrock formations. SPT N-Value refusal were encountered within WS108 (1.50mbgl), WS109 (3.38mbgl), WS110 (1.58mbgl) and WS112 (2.38mbgl).

The London Clay Formation and the Lambeth Group (bedrock geology) was encountered during the investigation within most of exploratory holes. All positions terminated either within the River Terrace Deposits or the Bedrock. The extent of the London Clay or the Lambeth Group was not proven.

The full engineering logs are presented in within the Appendix C.

A summary of the encountered geological strata is provided in Table 4.1.

Table 4.1 Summary of ground conditions

Stratum	General Description	Depth range encountered (m bgl)	Thickness range of stratum (m)
Bitumen	Bound black bituminous material was identified on the ground surface at BH103, BH106, BH107, WS109, WS110 and WS112.	Ground level – 0.30	0.15 – 0.30
Topsoil	Grass over brown slightly sandy gravelly CLAY with abundant rootlets. Gravel is fine to coarse of flint. Encountered in WS106 & WS107.	Ground level – 0.20	0.10 – 0.20
Astroturf	Astroturf with a membrane and associated subbase was identified at the ground surface in WS111.	Ground level – 0.30	0.30
Made Ground	Brown/grey clayey/silty sandy GRAVEL. Gravel is angular to subrounded of brick, flint, concrete, chalk and mudstone. Occasional cobbles of brick and flint. Occasional low cobble content of brick and concrete. Reddish brown/black gravelly SAND. Gravel is angular to rounded of brick, limestone, wood, flint and concrete. Occasional low cobble content of brick. Very soft to firm brownish grey sandy gravelly CLAY. Gravel is angular to subrounded of brick, concrete, chalk, quartz, sandstone, limestone, ash, clinker and flint. Identified in all exploratory holes.	Ground level – 2.00	1.00 – 2.00

Stratum	General Description	Depth range encountered (m bgl)	Thickness range of stratum (m)
River Terrace Deposits (Granular)	Loose to very dense light brown to grey slightly silty/clayey sandy to very sandy GRAVEL. Gravel is fine to coarse subangular to subrounded of flint, chalk and quartz. Medium dense to very dense orangish brown slightly silty slightly gravelly SAND. Gravel is fine to coarse angular to subangular of flint. Identified in all exploratory holes except WS106, WS107 & WS111.	0.90 – 3.40	1.30 – 2.38
River Terrace Deposits (Cohesive)	Firm orangish brown sandy gravelly CLAY. Gravel is angular to subrounded of flint and quartz. Only encountered in BH105	2.00 – 2.50	0.50
London Clay Formation	Stiff to very stiff slightly sandy to sandy slighty gravelly clay CLAY. Gravel is fine to medium subangular to sub rounded of flint and chalk. Stiff to very Stiff grey slightly sandy CLAY. Occasional laminations of sand. Encountered in WS106, WS107 and BH106 only.	1.00 – 15.00	Not Proven
Lambeth Group (Cohesive)	Firm to very stiff purplish brownish/greenish grey slightly sandy silty CLAY. Soft to firm light grey/greenish grey CLAY. Dense to very dense dark greenish grey clayey SAND.	2.50 – 15.00	Not Proven

4.2 Groundwater

Groundwater strikes observed during drilling were recorded as follows:

- BH103: Damp from 14.00m bgl.
- BH105: Strike at 2.50m bgl in granular River Terrace Deposits, rising to 1.80m bgl after 20 minutes.
- BH105: Strike at 9.70m bgl within Sand of the Lambeth Group, rising to 6.80m bgl after 20 minutes.
- BH105: Strike at 13.00m bgl within Sand of the Lambeth Group, rising to 12.00m bgl after 20 minutes.
- BH107: Slight seepage at 3.20mbgl.
- WS109: Strike at 2.00mbgl within granular River Terrace Deposits, rising to 1.50mbgl after 20 minutes.

Standing groundwater levels were recorded during the three post fieldwork monitoring rounds which are summarised in Table 4.2.

Table 4.2 Summary of groundwater levels from post fieldwork monitoring

Exploratory Position	Response Zone (m bgl)	Geology of Response Zone	Monitored Groundwater Level 23/01/2018 (m bgl)	Monitored Groundwater Level 31/08/2018 (m bgl)	Monitored Groundwater Level 13/09/2018 (m bgl)	Monitored Groundwater Level 28/09/2018 (m bgl)
BH103	14.0 – 15.0	Lambeth Group	1.11	No access to well	No access to well	0.43
BH105 (S)	2.0 – 3.8	River Terrace Deposits/Lambeth Group - Sand	1.50	3.45	3.39	2.28
BH105 (D)	9.7 – 10.0	Lambeth Group – Sand	1.25	3.45	3.40	2.33
BH106	10.0 – 15.0	London Clay	Dry	Dry	Dry	11.15
BH107	2.0 - 6.0	River Terrace Deposits/Lambeth Group	2.25	2.25	2.23	2.21
WS106	0.50 – 5.0	Made Ground/London Clay	1.16	1.16	1.16	1.14
WS107	0.50 – 5.0	Made Ground/London Clay	2.57	2.57	2.57	2.07
WS108	0.50 – 1.20	River Terrace Deposits	Dry	Dry	Dry	Dry
WS109	No Install	N/A	N/A	N/A	N/A	N/A
WS110	0.50 – 1.20	Made Ground/River Terrace Deposits	Well not located	Dry	Dry	Dry
WS111	0.50 – 1.5	Made Ground	Dry	Dry	Dry	1.36
WS112	1.0 – 2.0	River Terrace Deposits	Dry	Dry	Dry	Dry

4.3 Visual and Olfactory Evidence of Contamination

Apart from the components of Made Ground identified above (clinker), no visual or olfactory evidence of contamination was identified during the site investigation.

4.4 Geotechnical Parameters

Geotechnical parameters (preliminary indicative) for each principal stratum type encountered within the exploratory holes are summarised below. These are based on test results or correlation of site observations with published data. It is important that the accompanying notes and previous report are read in detail together with the application of an experienced precautionary approach when using this data to help inform future outline and detailed design and help inform the construction process.

The geotechnical laboratory results are included within Appendix F.

4.4.1 Made Ground

Geotechnical classification tests undertaken on two samples of cohesive Made Ground at a depth of between 0.30m and 0.70mbgl indicated the following;

Table 4.3 Summary of Cohesive Made Ground Classification

Test	Values
Natural Moisture Content	14 - 19
Liquid Limit	32 - 35
Plastic Limit (%)	17 - 20
Plasticity Index (%)	15
Fraction Passing <0.425mm (%)	59 - 61
Modified Plasticity Index (%)	8.85 - 9.15

The classification test results indicate that cohesive samples of Made Ground have a modified plasticity index of between 8.85 - 9.15%, which therefore has a low shrink-swell potential.

Due to the shallow depth of Made Ground deposits at the subject site, widespread representative SPT tests were not undertaken within the stratum.

BRE279 testing was undertaken on one sample of Made Ground at a depth of between 0.70m and 0.90mbgl which recorded a pH value of 7.30, total sulphur content of 0.05%, and an acid soluble sulphate value of 0.08% SO4.

4.4.2 River Terrace Deposits

Geotechnical classification tests undertaken on two samples of cohesive RTDs at a depth of between 2.00m and 3.45mbgl indicated the following;

Table 4.4 Summary of Cohesive River Terrace Deposits Classification

Test	Values
Natural Moisture Content	14 – 17
Liquid Limit	33 – 34
Plastic Limit (%)	19
Plasticity Index (%)	14 – 15

Test	Values
Fraction Passing <0.425mm (%)	50 – 56
Modified Plasticity Index (%)	7 – 8.4

The classification test results indicate that cohesive samples of the River Terrace Deposits have a modified plasticity index ranging from 7% to 8.4%, which therefore has a low shrink-swell potential.

Geotechnical classification tests undertaken on 1 sample of Granular RTDs between 2.00 and 2.50mbgl indicated that soils consisted of silty/clayey very sandy GRAVEL.

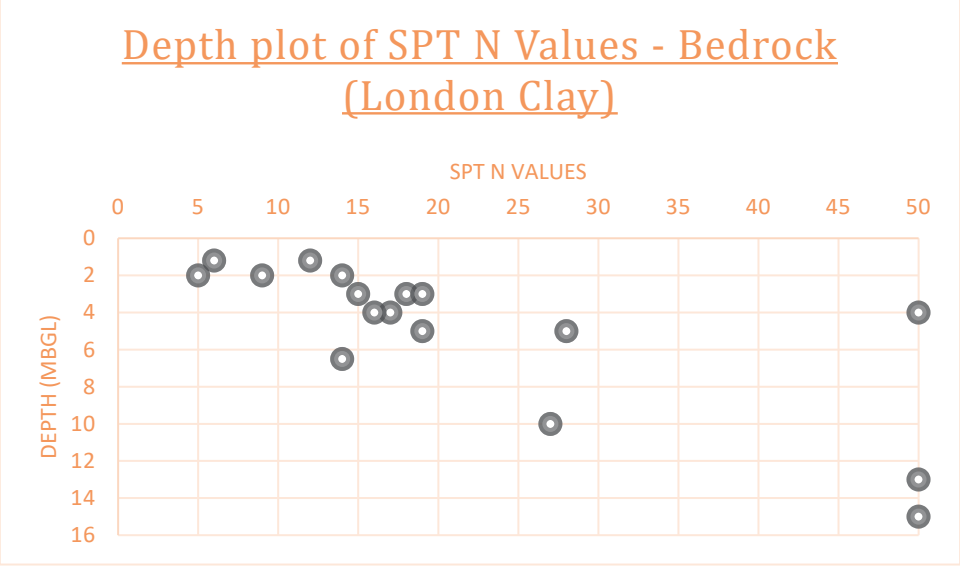
These deposits are, by the nature of deposition, likely to be highly heterogeneous, and variation in lithology should be anticipated both laterally and with depth beyond the locations of each exploratory hole. This natural variation will strongly influence permeability and entry of water into excavations, and stability of excavations, in the presence of groundwater.

SPT testing undertaken within the RTDs ranged between N-values of 3 to 50 indicating loose to very dense relative densities. SPT N-Value refusal were encountered within WS108 (1.50mbgl), WS109 (3.38mbgl), WS110 (1.58mbgl) and WS112 (2.38mbgl). Due to the prevalence of granular strata within the RTDs, representative SPT testing has not been undertaken on the cohesive stratum. The higher values are likely to be skewed (e.g. by presence of gravel).

4.4.3 London Clay

SPT testing undertaken within the London Clay recorded SPT N-values of between 5 to 50 indicating firm to very stiff consistencies. In general, an overall increase in strength with depth was noted within the data set.

Figure 4.1 displays the relationship between depth and the increase in SPT N-value within the London Clay.



Geotechnical classification tests undertaken on 9 samples of the cohesive London Clay Formation at a depth of between 1.20m and 6.60mbgl indicated the following;

Table 4.5 Summary of Cohesive London Clay Classification

Test	Range of Values
Natural Moisture Content	12 – 34
Liquid Limit	33 – 70
Plastic Limit (%)	17 – 26
Plasticity Index (%)	15 – 38
Fraction Passing <0.425mm (%)	60 – 100
Modified Plasticity Index (%)	9.6 – 38

The classification test results indicate that these cohesive samples of the London Clay Formation have a modified plasticity index of 9.6 to 38%, which therefore has a low to medium shrink-swell potential.

Geotechnical classification testing on 1 cohesive sample of the London Clay indicated that the soils consist of slightly gravelly slightly sandy silty Clay.

BRE279 testing was undertaken on two samples of the London Clay at depths of between 1.20m and 4.45mbgl which recorded a pH value range of 7.28 – 7.82, total sulphur content range of 0.12 – 0.14%, and an acid soluble sulphate value range of 0.27 – 0.31% SO4.

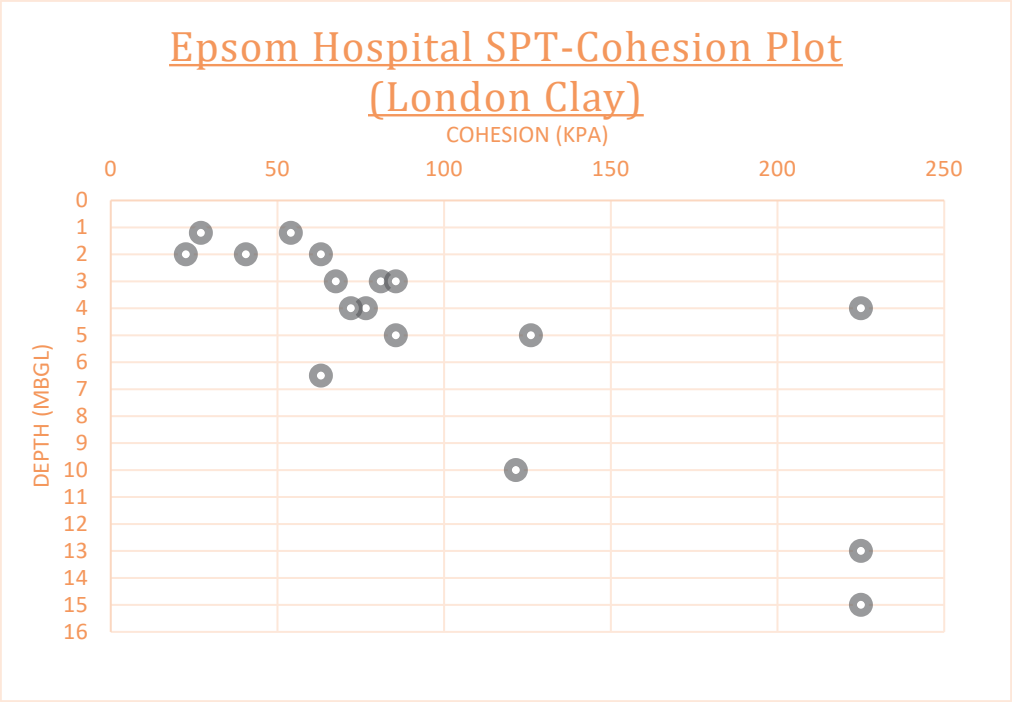
1no “undisturbed” samples was submitted for multi-stage unconsolidated-undrained triaxial tests to determine the undrained shear strength (cohesion) of the material. A summary of the results is presented in Table 4.6.

Table 4.6 Summary of Undrained Triaxial Classification - multistage

Exploratory Hole	Depth	Cell Pressure (kPa)	Undrained Shear Strength (kPa)	Mode of Failure
BH106	5.00 – 5.45	100	115	Compound
		150	121	
		200	120	

The result corresponds to description of stiff clay soil.

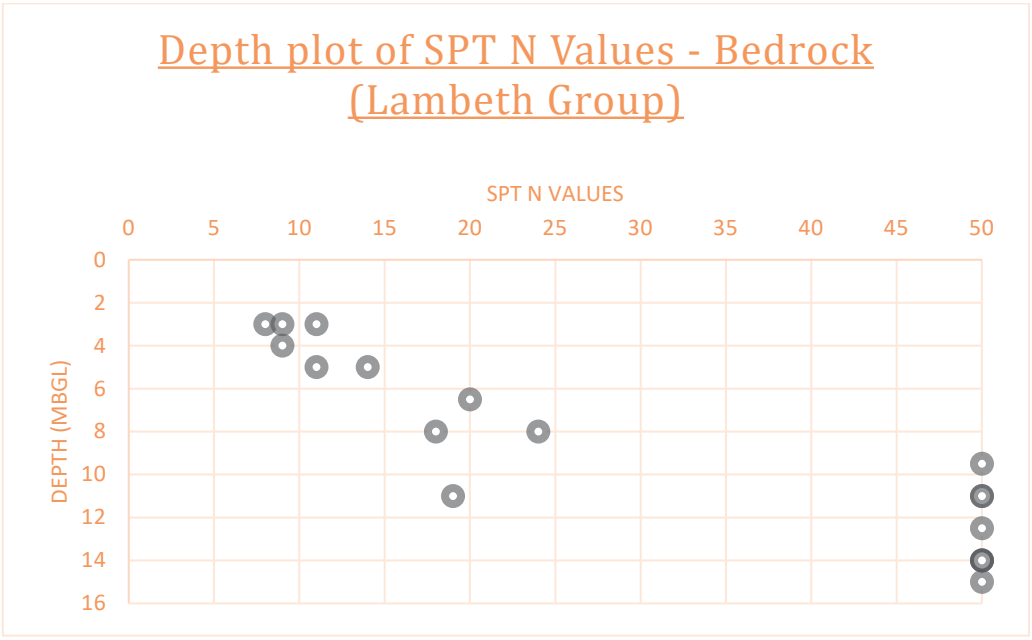
The cohesion/shear strength of the strata has also been estimated based on the relationship between shear strength (Cu), plasticity index and SPT N value (after Stroud, 1975) whereby Cu = f1 N. A mean plasticity index of 30% (obtained from onsite testing) has been used to determine coefficient f1 = 4.5. The cohesion plot is presented in Figure 4.2.



4.4.4 Lambeth Group

SPT testing undertaken within the Lambeth Group recorded SPT N-values of between 9 to 50 indicating stiff to very stiff consistencies. In general, an overall increase in strength with depth was noted within the data set.

Figure 4.3 displays the relationship between depth and the increase in SPT N-value within the Lambeth Group.



Geotechnical classification tests undertaken on 6 samples of the cohesive Lambeth Group at a depth of between 3.00m and 11.10mbgl indicated the following;

Table 4.7 Summary of Cohesive Lambeth Group Classification

Test	Range of Values
Natural Moisture Content	25 – 44
Liquid Limit	41 – 85
Plastic Limit (%)	19 – 37
Plasticity Index (%)	20 – 47
Fraction Passing <0.425mm (%)	100
Modified Plasticity Index (%)	20 – 47

The classification test results indicate that these cohesive samples of the Lambeth Group have a modified plasticity index of 20 to 47%, which therefore has a medium to high shrink-swell potential.

Geotechnical classification testing on 1 cohesive sample of the Lambeth Group indicated that the soils consist of slightly sandy silty Clay.

BRE279 testing was undertaken on three samples of the Lambeth Group at depths of between 3.00m and 4.45mbgl which recorded a pH value range of 6.97 – 7.51, total sulphur content range of 0.11 – 0.19%, and an acid soluble sulphate value range of 0.27 – 0.49% SO4.

Two dry one dimensional consolidation tests were undertaken on cohesive samples of the Lambeth Group, and indicated the following;

Table 4.8 Summary of the One Dimensional Consolidation Testing of the Lambeth Group

Pressure Range (kPa)	Range of Values Mv (M2/MN)	Range of Values Cv (m2/yr)
0 – 100	0.024 - 0.2	18 – 31
100 – 200	0.11 - 0.15	4.6 – 8.9
200 – 400	012 - 0.14	4.1 – 12
400 – 800	0.088 – 0.090	3.1 – 6.9
800 – 1000	0.043 – 0.060	2.1 – 4.3

Particle density - 2.65 Mg/m^3 for tested samples

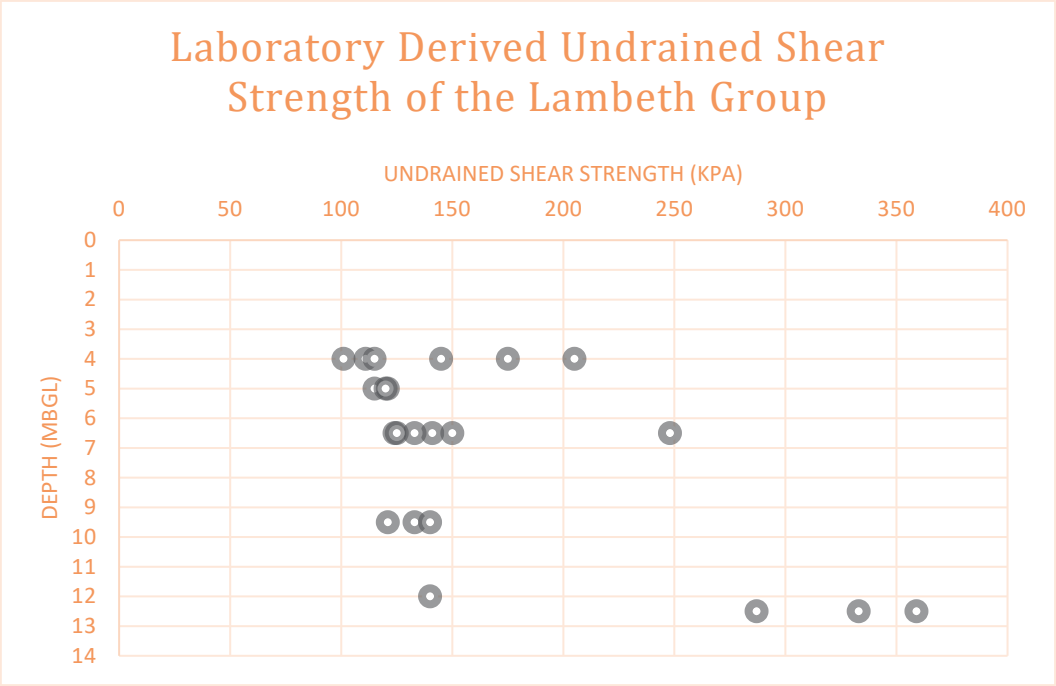
7no “undisturbed” samples were submitted for multi-stage unconsolidated-undrained triaxial tests to determine the undrained shear strength (cohesion) of the material. A summary of the results is presented in Table 4.9.

Table 4.9 Summary of Undrained Triaxial Classification - multistage

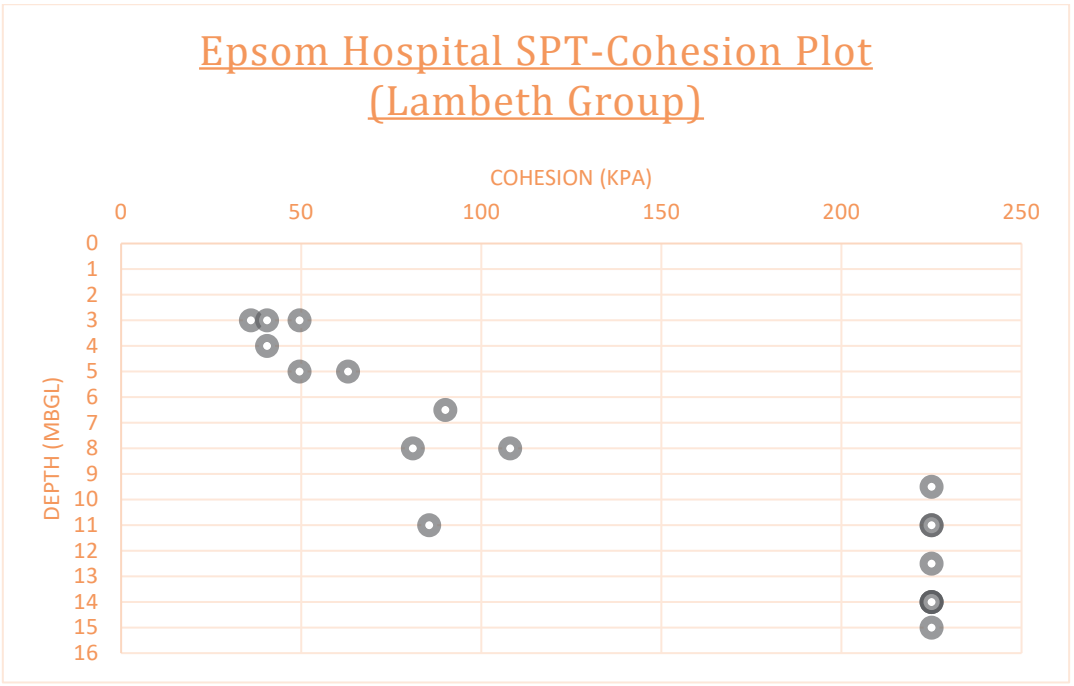
Exploratory Hole	Depth	Cell Pressure (kPa)	Undrained Shear Strength (kPa)	Mode of Failure
BH103	4.00 – 4.45	100	101	Compound
		125	111	
		150	115	

Exploratory Hole	Depth	Cell Pressure (kPa)	Undrained Shear Strength (kPa)	Mode of Failure
BH103	6.50 – 6.95	100	133	Compound
		125	125	
		150	150	
BH105	5.00 – 5.45	100	145	Compound
		150	175	
		200	205	
BH107	4.00 – 4.45	100	108	Compound
		125	116	
		150	120	
BH107	6.50 – 6.95	100	124	Compound
		150	141	
		200	248	
BH107	9.50 – 9.95	175	121	Compound
		225	133	
		275	140	
BH107	12.50 – 12.95	250	287	Compound
		300	333	
		350	359	

The results generally correspond to descriptions of stiff to very stiff clay soils, with an overall increase in strength with depth which is recorded within the depth plot on Figure 4.4.



The cohesion/shear strength of the strata has also been estimated based on the relationship between shear strength (Cu), plasticity index and SPT N value (after Stroud, 1975) whereby Cu = f1 N. A mean plasticity index of 30% (obtained from onsite testing) has been used to determine coefficient f1 = 4.5. The cohesion plot is presented in Figure 4.5.



5 Geo-Environmental Assessment

As part of the intrusive investigation, 20 samples, comprising 18 Made Ground and two natural soil samples (one from the River Terrace Deposits, and one from the London Clay) were selected for chemical testing, in order to determine both the 'baseline' condition of the site and assess whether the potential source areas identified in the Desk Study represent potential risks to human health and controlled waters from the proposed works.

The chemical testing results are presented in Appendix G.

5.1 Soil Screening Values (SSVs)

The chemical data have been compared against the Land Quality Management (LQM) Chartered Institute of Environmental Health (CIEH) Suitable for Use Levels (S4UL) for Human Health Risk Assessment (Ref. 7). In the absence of a S4UL for lead, the CL:AIRE Category 4 Screening Level (C4SL) (Ref. 8) has been adopted.

Considering the form of the proposed development the screening values for a 'Commercial/Industrial' Scenario have been adopted in the assessment.

Contamination risks to construction / maintenance workers are not appraised by chronic (long-term) exposure human health risk assessments and would be addressed under UK employment law, in accordance with the Health and Safety Executive publication entitled "Protection of Workers and the General Public during the Development of Contaminated Land", 1991 (HSG 66) (Ref. 9), the Construction Design and Management (CDM) Regulations (2015) (Ref. 10) and/or any other relevant guidance.

A Soil Organic Matter (SOM) content of 1% has been used in the assessment as a precautionary approach, i.e. soils with a low organic matter content are less able to attenuate organic contaminants and hence this represents a worst-case scenario.

5.2 Tier 1 Screening Assessment

5.2.1 Asbestos

20 samples, comprising 18 Made Ground and two natural samples were screened for the presence of asbestos fibres. Three positive detections were observed within the Made Ground and are detailed within Table 5.1.

Table 5.1 – Asbestos Detections in Made Ground samples

Location	Sample Depth (m)	ACM Detected	Polarised Light Microscpe Result	Asbestos Quantification
WS106	0.30	Loose Fibres	Chrysotile	< 0.001%
BH103	0.50	Loose Fibres	Amosite	< 0.001%
BH105	0.30 – 0.50	Loose Fibres	Chrysotile	< 0.001%

Following quantification, no asbestos concentrations were above the detection limit of 0.001% nor above the hazardous waste concentrations threshold of 0.1% (Ref. 11).

5.2.2 Exceedances of SSVs in Made Ground Samples

Chemical testing including metals and inorganics, phenols, speciated PAH and TPH CWG (including BTEX) were undertaken on 18 Made Ground samples. The exceedances of the SSVs are presented in Table 5.2.

All other determinands tested were either below the relevant SSV or below the laboratory limit of detection.

Table 5.2 – Exceedances of SSVs in Made Ground samples

Determinand	SSV (residential with plant uptake) (mg/kg)	Range of concentrations (mg/kg)	Number of exceedances	Samples exceeding SSV
Benzo(b)fluoranthene	44	<0.05 - 160	2	WS109 0.30 m bgl (160 mg/kg) BH106 0.60 m bgl (74 mg/kg)
Benzo(a)pyrene	35	<0.05 - 130	2	WS109 0.30 m bgl (130 mg/kg) BH106 0.60 m bgl (65 mg/kg)
Dibenz(a,h)anthracene	3.5	<0.05 - 19	2	WS109 0.30 m bgl (19 mg/kg) BH106 0.60 m bgl (7.7 mg/kg)

In addition to the above findings, the pH value measured in BH106 0.60 m (11.7 pH units) is higher than the pH range of a normal soil (6-9 pH units). Whilst this alone does not necessarily indicate contamination it does indicate that soils of an unusually alkaline pH are present. The high pH is consistent with, and may be due to, the presence of concrete noted in the Made Ground in BH106.

No exceedances of the SSV were recorded within either BH103 or BH105, which were emplaced close to potential contaminative sources identified within the Desk Study.

5.2.3 Exceedances of SSVs in Natural Soil Samples

Chemical testing comprising metals and speciated PAH, TPH and phenols was undertaken on two samples of natural soils (one from the River Terrace Deposits, and one from the London Clay).

No exceedances were identified against the relevant screening criteria.

5.3 Controlled Waters Risk Assessment

5.3.1 Water Quality Standards

One round of groundwater sampling was undertaken on 23rd August 2018 from the standpipes installed in BH103, BH105 (dual install), BH107, WS106 and WS107.

To assess the risk to controlled waters, the chemical testing results have been compared against appropriate Water Quality Standards (WQS). The WQS comprise Environmental Quality Standards (EQS) from the Water Framework Directive (Ref. 12) which are considered to be protective of the surface water feature (pond) located 10m south of the site, and UK Drinking Water Standards (DWS) from the Water Supply Water Quality Regulations (Ref. 13) which are considered to be protective of the underlying Secondary A Aquifer.

The EQS for copper, zinc and nickel are based on bioavailability. Site specific Predicted No Effect Concentrations (PNEC) have been calculated for copper, zinc and nickel based on the average measured concentration of calcium (104.5 mg/l), average measured pH of 7.42 pH units and an average measured dissolved organic carbon of 3.5 mg/l. The approach used is set out in the Water Framework Directive UK Technical Advisory Group guidance, Metal Bioavailability Assessment Tool (Ref. 14).

The groundwater chemical data is presented in within Appendix G.

5.3.2 Screening Assessment

The concentration of, phenols, TPH and BTEX were below the laboratory limit of detection in all samples analysed. These are therefore not considered to be contaminants of concern, based on one round of analysis.

The majority of PAH determinands were recorded below the level of detection, however acenaphthene, fluorene and pyrene, for which no GAC have been derived (or the target acceptable risk was not exceeded at theoretical solubility concentration), was detected within BH107 at measured concentrations marginally above the laboratory Method Detection Limit (MDL).

5.3.3 Metals

Minor exceedances of the WQS were identified in a number of samples for metals, as presented in Table 5.3. No exceedances were identified in the sample from WS106.

Table 5.3 – Exceedances of WQS in Groundwater samples

Determinant	EQS (µg/l)	DWS (µg/l)	Samples exceeding EQS/ DWS
Cadmium	0.08	5	WS107 (0.16 µg/l) (EQS) BH107 (0.44 µg/l) (EQS)
Selenium	10	10	BH103 (55 µg/l) (EQS & DWS) BH105 (S) (24 µg/l) (EQS & DWS) BH105 (D) (23 µg/l) (EQS & DWS)

It is unknown whether the overlying Made Ground or an offsite source of contamination is the cause of the elevated concentrations of metals in the groundwater sample. The contamination does appear to be widespread in the groundwater, therefore it may be an isolated hotspot, or perhaps naturally present.

The concentration of metals in the overlying Made Ground does not indicate a significant source of metals.

BH103 and BH105 were emplaced adjacent to potential hydrocarbon sources, which were identified within the Desk Study, no elevated concentrations of hydrocarbons were recorded.

5.4 Ground Gas Risk Assessment

5.4.1 Gas Monitoring Methodology

Three rounds of ground gas monitoring were undertaken on 31st August 2018, 13th September and 28th September 2018 by Arcadis from the monitoring standpipes installed in BH103, BH105 (dual install), BH107, WS106 and WS107.

Concentrations of methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) in %v/v, gas flow in litres per hour (l/h) and hydrogen sulphide (H_2S) and Carbon Monoxide (CO) in parts per million (ppm) were recorded during the monitoring visits using a GFM436 Landfill Gas Analyser.

5.4.2 Atmospheric Pressure

Atmospheric pressure can impact ground gas flow. According to CIRIA C665 Assessing the risks posed by hazardous ground gases to buildings (Ref. 15) "*at falling pressure increased emission rates occur as the gas increases in volume. Rising pressure causes air to flow into the ground, diluting soil gas concentrations. The rate of change in barometric pressure is also important. A swift drop over a small range has the potential to release a greater concentration of gas than a gradual drop over a greater pressure range*".

Atmospheric pressure data for the monitoring period was obtained from the Wunderground Data website (Ref. 16). The data was obtained from a monitoring station at Chessington, located approximately 4km north of the site.

A summary of the atmospheric pressure conditions for each monitoring round is as follows.

- 31st August 2018: Medium and steady atmospheric pressure (1001 – 1000 millibars (mb))
- 13th September 2018: Medium and steady atmospheric pressure (1001 mb)
- 28th September 2018: High and rising atmospheric pressure (1023 – 1028 mb)

5.4.3 Gas Monitoring Results

The full results of the three rounds of gas monitoring are presented in the Appendix E. Table 5.4 presents a summary of the range of gas concentrations from the three monitoring rounds. The maximum concentration of CO_2 and CH_4 are shown and the minimum concentration of O_2, along with the peak and steady gas flow rate. The concentration of H_2S was below the detection limit of the instrument in all locations monitored, so has not been included Table 5.4.

Table 5.4 Summary of gas monitoring results

Borehole Location	Flow Rate range(l/h)	CH_4 range (% v/v)	CO_2 range (% v/v)	O_2 range (% v/v)	CO (ppm)	Groundwater level range (m bgl)
BH103	Peak: 0.0 – 13.0 Steady: 0.0 – 3.0	0.0 – 0.1	0.1 – 2.7	19.4 – 19.5	10	0.43 - 1.11
BH105 (S)	Peak: 0.0 – 0.2 Steady: 0.0 – 0.1	0.0 – 0.1	0.1 – 0.4	2.0 – 20.1	23	1.50 – 3.39
BH105 (D)	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.1	0.1 – 0.4	18.0 – 20.1	6	1.25 – 3.40
BH106	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.1	0.1 – 1.2	14.9 – 20.1	6	Dry – 11.15
BH107	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.1	0.4 – 0.7	19.3 – 20.4	4	2.21 – 2.25
WS106	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 - 0.2	0.4 – 3.1	15.9 – 20.9	5	1.16
WS107	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.2	0.2 – 2.4	19.3 – 20.9	4	2.07 - 2.57

Borehole Location	Flow Rate range(l/h)	CH_4 range (% v/v)	CO_2 range (% v/v)	O_2 range (% v/v)	CO (ppm)	Groundwater level range (m bgl)
WS108	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.2	0.6 – 2.5	17.9 – 21.0	7	Dry
WS110	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.2	0.1 – 0.2	19.1 – 20.1	0	Dry
WS111	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.1	0.4 – 1.9	18.4 – 20.4	4	Dry – 1.36
WS112	Peak: 0.0 – 0.1 Steady: 0.0 – 0.1	0.0 – 0.1	0.1 – 1.0	20.1 – 21.2	3	Dry

During the monitoring visits zero or very low positive rates of flow were measured in the monitoring wells. For the purposes of the assessment a flow rate of 0.1 l/h has been used where flow rates were recorded as zero.

The maximum gas flow rate was <3l/hr, except for a peak flow of 13 l/hr recorded in BH103 on 28th September. The steady gas flow rate is 0.1 to 3.0l/hr. The peak gas flow is likely be the result of pressure build up in the gas pipe as it dropped rapidly from the peak reading. Therefore, the steady gas flow is considered to be more representative of the gas flow from the ground and has been used in the assessment below.

In general the concentration of CO was below the instrument limit of detection, with the exception of the monitoring visit on the 28th September monitoring round, where BH105 (23 ppm) recorded during the maximum concentration. For the purposes of the assessment a worst case of <0.1% was used where no results were recorded.

No significantly elevated concentrations of CO2 or CH4 were recorded within the monitoring wells installed across the subject site.

5.5 Preliminary Gas Hazard Assessment

5.5.1 Methane and Carbon Dioxide

The CO2 and CH4 results from the 3 rounds of gas monitoring have been assessed using current guidance from CIRIA C665 (Ref. 15). Following this approach, the gas concentration and borehole flow rate are used to calculate a Gas Screening Value (GSV) and define a Characteristic Situation (CS). The maximum CH4 and CO2 concentrations and maximum steady gas flow rate have been used in the assessment.

The GSV is calculated using the following equation:

GSV (l/h) = borehole flow rate (l/h) x gas concentration (%v)/100

The following parameters have been used in the equation:

CH_4 (max recorded concentration) = 0.2 % v/v

CO_2 (max recorded concentration) = 3.1 % v/v

Flow Rate (max steady flow rate) 3.0 l/hr

GSV CH_4: 0.2/100 x 3.0 = 0.006 – **CS1 Very Low Risk**

GSV CO_2: 3.1/100 x 3.0 = 0.093 – **CS2 Low Risk**

With reference to BS 8485 *Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* (Ref. 17), if a carbon dioxide concentration greater than 5% v/v is encountered, consideration should be given to assigning a CS2 classification. No exceedances of the CS1/CS2 thresholds have been recorded.

According to the GSV for CO2, BH103 should be classified as Characteristic Situation 2 (Low Risk). This however coincides with elevated groundwater (0.43mbgl) which is inside the upper most plain section of pipework which has created a head of pressure which has likely given rise to an anomalous flow rate reading. According to RB17, a pragmatic approach to ground gas risk assessment (Ref 18), this piece of data is not reliable. In all other respects, and as no elevated concentrations of Carbon Dioxide or Methane or elevated flow rates have been recorded, the site should therefore be classified as Characteristic Situation 1. This is consistent with the conceptual site model, where no source of ground gas, capable of higher rates of volume generation, are present.

No gas protection measures are deemed necessary for structures at the subject site.

5.5.2 Carbon Monoxide

The CO concentrations recorded during the 28th September monitoring round have been compared against the 30ppm Health and Safety Executive (HSE) Workplace Exposure Limits (WEL) for an 8 hour (long term) exposure period (Ref. 19). The concentration recorded in BH105 (up to 23 ppm) does not exceed the 8 hour WEL. As such no further action is required.

6 Other Development Considerations

6.1 Material Management

In the case of managing soil movements or earthworks it is important to also manage the intention to re-use materials, if a genuine need for the materials exists.

This will help avoid unnecessary additional regulation that can sometimes arise from a “waste management” perspective.

Providing materials are suitable for use, both chemically and geotechnically, and that re-use is certain, arisings do not need to enter the waste regulation system. This process is managed via development of a Materials Management Plan (MMP) in line with the CL:AIRE Code of Practice.

If certain materials do require regulation, it is important to note that waste exemptions have changed significantly in recent years and there are now strict limitations on the quantity of soil that can be used and the thickness to which it can be deposited. The use of a waste permit could stigmatise the site for future conveyance. It is on this basis that we would recommend the development of the MMP.

The MMP once drafted must be reviewed together with the approved site investigation and remediation documents by a Qualified Person, with their Declaration being issued to the Environment Agency; ultimately allowing the development to go ahead under a self-regulation approach.

The development of an MMP will require a “Cut and Fill” model or a detailed materials management strategy to identify the sources of and destinations for site-won materials.

6.2 Excess Arisings

On the basis of the current information it is likely that if materials became excess to requirements, the majority of the natural soils would likely classify as “Inert” for landfill disposal. Owning to the likely presence of organic matter within the topsoil, it should be separated from other natural arisings and appropriately classified. Made Ground would likely be classifiable as Stable Non-Reactive waste, or Hazardous waste, should any further asbestos findings above 0.1% be encountered.

An appropriate waste classification can only be undertaken on the material due to be disposed. Further chemical testing should be completed prior to making disposal arrangements. In all cases where excess soils require off-site disposal, the materials need to be managed under the appropriate waste legislation and consideration given to any remedial techniques that could be used to improve the soil.

For Inert Waste and Hazardous Waste disposal, an allowance will need to be made for adequate Waste Acceptance Criteria (WAC) testing with appropriate consideration of the additional time and cost associated with this.

6.3 Health, Safety & Environment

Whilst few samples tested were found to have contamination at concentrations of regulatory concern, there remains a low potential for more-significantly impacted soils to be encountered; consideration should therefore be given to the level of PPE that should be provided to future site operatives. A watching brief should be established.

All work on site should be conducted in accordance with appropriate Health and Safety guidance, with particular reference to HSG66 (HSE, 1991) (Ref. 9).

Care should be taken to minimise the risk of potentially contaminative incidents occurring during redevelopment. Good working practices should be adopted during construction works in order to minimise the risk of contamination occurring as a result of spillage or leakage of fuels, oils or chemicals stored or used at the site during re-development. All such materials should be sited on an impervious base within a bund and should be adequately secured. Particular care should be taken to prevent fuel, oils or other mobile contamination sources from entering any surface water drains at the site.

Throughout all redevelopment works, due regard should be given to potential detrimental effects on the surroundings including noise, vibration, odour and dust.

6.4 Built Environment Risk Assessment

There are currently no (fully adopted) national Standards for the protection of potable water supply pipes in potentially contaminated ground. However, the UKWIR has published guidance in this respect and site testing should be undertaken with due recognition of this guidance.

On the basis of the ground conditions encountered, and due to the fact that no gross hydrocarbon contamination was encountered during the intrusive investigation it is unlikely that specific protection measures may be required for potable water supply for the development. It is recommended that consultation is undertaken with the local supplier to confirm this and a Water Pipeline Risk Assessment undertaken.

A CS1(very low risk) with respect to ground gas has been identified at the site. Therefore, it is considered unlikely that ground gas ingress into confined spaces could cause an explosive risk.

7 Conceptual Model – Pollutant Linkages

Based on the assessment of soil, groundwater and gas monitoring data, the potential contaminant linkages identified in the Phase 1 Desk Study have been updated in accordance with CIRIA Guidance C552 (Ref. 20), taking into consideration the proposed use of the site as a number of developments and upgrades to the Epsom General Hospital.

7.1 Risk Assessment Methodology

Risk assessment is the process of collating known information on a hazard or set of hazards (to determine the potential severity of any impact) along with details on the likelihood of impact on detailed receptors. Risks are generally managed by isolating the sensitive receptor or by intercepting or interrupting the exposure pathway, thus no pollutant linkages are formed and there is no risk. The following risk assessment focuses on the potential contaminants identified on the site in the context of the proposed development of the site.

CIRIA guidance C552 (Ref. 20) states that the designation of risk is based upon a consideration of both:

- The likelihood of an event (probability) (takes into account both the presence of the hazard and the receptor and the integrity of the pathway).
- The severity of the potential consequence (takes into account both the potential severity of the hazard and the sensitivity of the receptor).

Under such a classification system the following categorisation of risk has been developed and the terminology adopted as presented in Table 7.1. Further risk assessment information is presented in Appendix H.

Table 7.1 Summary of Risk likelihood categories

Term	Description
Very High Risk	There is a high probability that significant harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High Risk	Significant Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
Moderate Risk	It is possible that without appropriate remedial action, harm could arise to a designated receptor but it is relatively unlikely that any such harm would be severe and if any harm were to occur, it is likely that such harm would be relatively mild.
Low Risk	It is possible that significant harm could arise to a designated receptor from an identified hazard but it is likely that at worst this harm if realised would normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

7.2 Contaminant Sources

The following determinants have been identified as contaminants of concern:

Soils / Made Ground

- Asbestos fibres (loose chrysotile and amosite) were visually identified in WS106 0.30m, BH103 0.5 m and BH105 0.30-0.50m (Made Ground) out of 20 samples analysed. When quantified, all positive detections were found to be below the level of detection (0.001%), and as such is not considered to pose a risk to end-users of the site, or to construction/maintenance workers. Due to the inherent variability Made Ground deposits, it is possible that there may be further asbestos fibres present on site, especially in

areas where demolition has occurred – i.e. former buildings associated with the hospital and the former Epsom Work House which once resided onsite.

- Exceedances of the SSV for PAH compounds in two samples of Made Ground (BH106 0.60m & WS109 0.30m). Both exploratory holes are in the location of the car parking where localised spillages/leaks could have occurred historically.
- Made Ground of unusually alkaline pH was identified in BH106 0.50m which is a potential irritant risk, however this is likely to be associated with the presence of concrete in the sample and is not considered to pose a risk to future site users.
- An aggressive chemical environment for concrete is likely to be present, based on 5 BRE279 testing results.

Ground Gas

- Characteristic situation 1 – very low risk for methane and carbon dioxide across the site, no protection measures deemed necessary.

Groundwater

- Exceedances of the WQS for metals (Cadmium and Selenium) identified in several groundwater samples. The source of the elevated concentration of metals is unknown but could be from the overlying Made Ground or from an offsite upgradient source.
- The risk of vapour inhalation from groundwater is considered to be lowkely and has not been considered further in the assessment.

7.3 Pathways and Receptors

Potential pathways are the routes that link the receptor to the contamination. The potential pathways and receptors are provided in Table 7.2.

Table 7.2 Potential contaminant pathways and receptors

Receptors	Pathways
Human Health Future site users Maintenance workers and contractors	Direct contact (dermal), accidental ingestion Accumulation of gas in a confined space leading to asphyxiation
Controlled Waters	Vertical migration of contaminants from Made Ground Horizontal migration of contaminants into surface water
The Built Environment	Direct contact with buildings and services

7.4 Contaminant Linkages – Conceptual Model

The conceptual site model has been derived from the contaminants identified from the site investigation and assessment and the identified receptors and pathways.

Table 7.3 provides an assessment of each identified contaminant linkage (CL) to establish the potential risk to the sensitive receptors. The proposed development of a single and two storey houses with private gardens has been taken into consideration and the risk assessment has been developed based on this specific redevelopment and land use scenario.

Table 7.3 Contaminant Linkages

CL No.	Source	Pathway	Receptor	Hazard Severity	Likelihood	Potential Risk and Mitigated Risk	Mitigation/ remedial action or further assessment
CL1	Exceedances of SSVs PAHs	Direct contact, accidental ingestion	Future site users, visitors, maintenance workers and contractors	Medium	Likely – exposure could occur during activities construction and maintenance works Reduced to low likelihood with mitigation	Moderate Reduced to low with mitigation	The driving exposure pathways for PAH comprise direct exposure pathways including soil ingestion/inhalation and dermal contact. Therefore, in areas with buildings/external hard-standing or similar, no such potential pollution linkage would exist, and hence no specific remedial measures would be required. However, in the areas of soft landscaping/communal garden areas, the potential contamination linkage will need to be broken by capping with a suitable thickness of uncontaminated cover soils.
CL2	Exceedances of WQS for metals in site-wide groundwater samples	Vertical migration of contaminants from Made Ground Horizontal migration of contaminants into surface water	Underlying Secondary A Aquifer Pond to the south of the site	Medium	Low likelihood of the works causing an increase in metals concentrations in groundwater Reduced to unlikely with mitigation	Moderate/ low Reduced to low with mitigation	Further groundwater monitoring would be prudent to provide better understanding/certainty of groundwater conditions, However the recorded concentrations are minor when compared to the stringent WQS, and the site lies beyond a SPZ. Undertake good material management practices during construction such as covering stockpiles to minimise leaching Provision of hardstanding for roads and parking areas will minimise leaching.

Epsom Hospital - Main Hospital Site

CL No.	Source	Pathway	Receptor	Hazard Severity	Likelihood	Potential Risk and Mitigated Risk	Mitigation/ remedial action or further assessment
CL3	Sulphates and pH	Direct Contact	Buildings, foundations and services	Medium	Likely – building foundations may encounter ground with elevated sulphates Reduced to unlikely with mitigation	Moderate/ low Reduced to low with mitigation	Select an appropriate design classification of concrete classification. Design Sulphate Class (DS) of DS-2 and an Aggressive Chemical Environment for Concrete Class (AC) of AC- 2.

7.5 Contaminant Linkages – Pollutant Linkages Discussion

Concentrations above the appropriate SSVs for PAHs (BH106 & WS109) within Made Ground deposits obtained during the intrusive investigation.

The results are not indicative of gross site wide contamination. The driving exposure pathways for the PAHs comprise direct exposure pathways including soil ingestion/inhalation and dermal contact. Therefore, in areas with buildings/external hard-standing or similar, no such potential pollution linkage would exist, and hence no specific remedial measures would be required.

BH106 is the location of a proposed footbridge and the surrounding area is covered with hardstanding roads and car parking, while WS109 is at the location of the proposed multi-storey car park. In both instances the hardstanding should be sufficient to sever the contamination pathway.

However, should the design proposals change, within any affected general landscaping areas the potential contamination linkage will need to be broken, either by physical excavation of these materials, or by capping with a suitable thickness of uncontaminated cover soils.

Minor Cadmium and Selenium exceedances of the WQS have been recorded within the groundwater samples (only marginally above the stringent WQS criteria). These are minor and possibly background concentrations. The site is not within a Source Protection Zone (SPZ) and no groundwater abstractions are within influencing distance of the site. Therefore, the risk to Controlled Water is deemed low.

Design Sulphate Class (DS) of DS-2 and an Aggressive Chemical Environment for Concrete Class (AC) of AC- 2 is recommended for the site.

In order to satisfy and enable the discharge of the likely future relevant Planning Conditions (including pre-commencement conditions), it is recommended that the findings of this report (with respect to contamination) be formalised in a development-specific Remediation Statement (detailing the development scheme and most appropriate remedial option) and be submitted to the Local Planning Authority for their approval.

8 Geotechnical Assessment

8.1 General

The proposed development plans include a multi-storey car park, connecting footbridge, single or double storey extensions to two buildings, and construction of a three-storey modular building. The use of the Site will remain as a working hospital.

The proposed site/formation level, settlement tolerance criteria and structural loadings have not been provided and will need to be considered during detailed design. It is assumed that the site levels will remain unchanged for the assessment. The following assessment and recommendation are for guidance and will need to be reviewed when design details are available.

8.2 Ground Conditions

The ground conditions generally confirm the published geology identified in the Desk Study (Ref. 3), comprising Made Ground overlying River Terrace Deposits, comprising granular material. Made Ground was encountered within every exploratory hole.

The River Terrace Deposits were not encountered to the very west of the site (WS106, WS107 & WS111), where Made Ground directly overlies the bedrock formations. SPT N-Value refusal were encountered within WS108 (1.50mbgl), WS109 (3.38mbgl), WS110 (1.58mbgl) and WS112 (2.38mbgl).

The London Clay Formation and the Lambeth Group (bedrock) was encountered during the investigation within the majority of exploratory holes. All positions terminated either within the River Terrace Deposits or the Bedrock. The extent of the London Clay or the Lambeth Group was not proven.

8.3 Obstructions

Historical mapping indicates that the Epsom Union Workhouse, and former structures associated with the Epsom General Hospital once resided onsite, which have been demolished. No evidence of buried structures or services was encountered during the site investigation, however there is potential for buried structures or foundations and deeper Made Ground to be present locally.

Obstructions may require removal where they may influence future development including foundations, pavements and services as they may act as a hard spot creating differential settlement issues.

8.4 Foundations

This assessment has been split to consider the broad development options.

8.4.1 Area A – Multi-storey Car Park & Connecting Footbridge

Proposed structural loads have not been provided for car park or connecting bridge. Three exploratory holes are present within the Car Park area (BH105, WS109 & WS110), while two exploratory holes are pertinent for the connecting footbridge (BH106 & BH107).

Multi-storey - Ground Conditions: Made Ground between depths of 0.90 and 1.00mbgl, with River Terrace Deposits encountered between 1.00m and 3.80mbgl, basal unit encountered Lambeth Group (Clay & Sand) to 15.00mbgl. Groundwater entries of between 2.00m and 2.50mbgl within the River Terrace Deposits.

Footbridge – Ground Conditions: Made Ground between depths of 1.70 and 2.00mbgl, with River Terrace Deposits encountered between 1.70m and 3.40mbgl, basal unit encountered London Clay (Clay) to 15.00mbgl. Groundwater not encountered during investigation works but groundwater was monitoring at a depth of between 2.21m and 2.25mbgl within the River Terrace Deposits.

Made Ground soils are not considered to be a suitable founding stratum. Due to the variable depth range that the River Terrace Deposits have been encountered, and likely shallow ingress of water within any shallow foundation excavations, the likely significant loadings required for both the multi-storey car park, and the proposed footbridge, a piled foundation solution is recommended.

The target founding stratum will ideally be the London Clay Formation or the Lambeth Group due to their fairly uniform properties and the increase in strength with depth which has been recorded typically across the site. It is envisaged that a pile design will be able to utilise both end bearing and shaft friction properties.

8.4.2 Area B – 3 Storey Modular Building

Proposed structural loads have not been provided for the 3-storey modular building. Two exploratory holes are present within this area (WS111 & WS112).

The shallow deposits (i.e. less than 2m) within this area are variable, which include Made Ground to depths of between 1.00m and 1.50mbgl, River Terrace Deposits only in WS122 between 1.00m and 2.38mbgl and London Clay deposits from 1.50m to 5.45mbgl in WS112. Groundwater was not encountered during the intrusive investigation or during the monitoring period.

Made Ground is generally not a suitable founding stratum due to its inherent variability. A number of foundation solutions are deemed viable. Should light to moderate loadings be required then a shallow foundation solution may be viable. Raft foundations would help to avoid any differential settlement considering the variable geology which has been encountered.

For more substantial loadings then mini-piles or vibrostone or concrete columns would be me more suitable as a founding solution. The subsequent foundations should be 'rafted strips', to avoid any differential settlement.

8.4.3 Area C – Single Storey Extension

Proposed structural loads have not been provided but are anticipated to be in the order of <50kPa for the single storey extension. One exploratory hole is present within this area (WS108).

Made Ground was encountered to a depth of 0.40mbgl, while the underlying River Terrace Deposits were encountered to a depth of 1.50mbgl where an SPT N-Value refusal (50) was recorded. No groundwater entries were recorded during the intrusive investigation or during the monitoring period.

Based upon the ground conditions encountered shallow strip foundations are likely to be a suitable foundation solution for light to moderately loaded structures. This is on the assumption that the River Terrace Deposits are laterally continuous within this area.

For indication purposes the River Terrace Deposits (very dense granular strata) are likely to provide an appropriate allowable bearing capacity a depth of 1.20m bgl. Foundations should be extended 300mm below loose materials such as this to more competent dense materials.

Foundations should be within consistent strata to reduce the risk of differential settlement and a suitably qualified geotechnical engineer should confirm the ground conditions on site during the works. This is important as the River Terrace Deposits are not laterally continuous beneath the subject site.

8.4.4 Area D – Single Storey Extension

Proposed structural loads have not been provided for the single storey extension. Two exploratory holes are present within this area (WS106 & WS107).

Made Ground deposits were encountered to a depth of 1.00mbgl, overlying London Clay to 5.45mbgl. No River terrace Deposits were encountered. Groundwater entries were not recorded during the intrusive investigation, however during the monitoring period levels were observed between 1.14m and 2.57mbgl.

Based upon the ground conditions encountered shallow strip or pad foundations are likely to be a suitable foundation solution for light to moderately loaded structures.

For indication purposes the firm to stiff clay deposits of the London Clay are likely to provide an appropriate allowable bearing capacity at a depth of 1.2m bgl within stiff to very stiff clays. In general an increase in strength with depth was observed within the London Clay Deposits, if soft spots are encountered foundations should be taken deeper to more competent stiff materials.

Foundations should be within consistent strata to reduce the risk of differential settlement and a suitably qualified geotechnical engineer should confirm the ground conditions on site during the works.

8.5 Foundations – General Comments

Consideration will need to be given to future tree planting and the proximity of trees to foundations with regard to the low to high plasticity of the cohesive subsoils in accordance with NHBC guidance Chapter 4.2.

Detailed pile designs (in terms of pile type, depths, and method of installation) would be dependent upon the required working loads and should be undertaken in conjunction with a reputable, specialist, piling contractor; ideally with local experience.

Low level contamination has been encountered on site, as such piling works should adhere to the EA guidance on piling through contaminated soils, so as to prevent any mobilisation of contamination into underlying natural soils.

Any piling works should adhere to the EA guidance on piling through contaminated soils, so as to prevent any mobilisation of contamination into underlying natural soils. Furthermore piling may create migration pathways for hazardous ground gases, which have been identified at the subject site.

Where new structures are extensions to existing structures, or bridging between two existing structures, the choice and detailed design of foundation system will need to take into account the likely relative movements between the existing and new-build, and also the movement induced on the existing structure by temporary works or the newly applied loadings.

8.6 Ground Floor Slabs

The shallow deposits are variable and comprise Made Ground, River Terrace Deposits and the London Clay/Lambeth Group.

In accordance with NHBC guidance 5.1 “substructure and ground bearing floors”, shrinkable soil, expansive materials or other unstable soils may require suspended floor construction. Shrinkable soils are classified as those containing more than 35% fine particles (silt and clay) and have a modified Plasticity Index of 40% or greater (see NHBC Chapters 4.2 ‘Building near trees’ (each section) and 5.2 ‘Suspended ground floors’ (each section)).

The site soils therefore do meet this criteria of “shrinkable soil”, and the shallow soils are found to be variable, hence suspended ground floors are likely to be required to avoid problems of heave and shrinkage settlements.

Furthermore, due to the variability in geology suspended floor slabs also recommended.

8.7 Excavations

It is likely that the majority of the overlying Made Ground, cohesive River Terrace Deposits and the London Clay/Lambeth Group could be easily excavated using a conventional backhoe excavator. However due to the dense nature and depth of the granular River Terrace Deposits some hard digging or ripping may be required at depth. Due to the presence of fine granular material in places, some temporary support or battering back may be required for deep excavations.

Groundwater has been indicated to be present from 1.11mbgl, so excavations may be prone to groundwater ingress and subsequent collapse, unless dewatering methods such as sumps are used. Trench support and battering may also be required.

8.8 Pavement and Road Design

Areas of hardstanding and car parking are proposed at the site.

No *in situ* California Bearing Ratio (CBR) tests were undertaken as part of the investigation.

It is recommended that testing be undertaken during earthworks at the proposed formation level. It is anticipated that a CBR in the order of 2% will be achievable in this material pending further testing. Any topsoil should be removed prior to construction. The subgrade material will be frost susceptible and full pavement thickness will be required.

8.9 Aggressive Chemical Environment for Below Ground Concrete

With reference to guidance outlined within BRE document SD1 “Concrete in aggressive ground” (2005) (Ref. 21), the test results returned for sulphate and pH values across the site correspond to a Design Sulphate Class (DS) of DS-2 and an Aggressive Chemical Environment for Concrete Class (AC) of AC- 2.

The London Clay is in places known to be pyritic. From SD1 utilising the methodology stated within section C5.1.2, 5 samples were analysed for BRE 279. None of the samples were deemed to contain pyrite. As a precautionary approach the Design Sulphate value has been selected due to the total potential sulphate content.

9 Conclusions and Recommendations

9.1 Geo-Environmental

An intrusive ground investigation was undertaken to investigate and assess areas of potential concern identified in the Arcadis Desk Study Report (Ref. 3) and to provide preliminary geotechnical advice on ground parameters to inform design of proposed developments.

9.1.1 Human Health

- Asbestos fibres were identified in three samples (however following quantification, none were found to be above the laboratory level of detection) and exceedances of the SSV were identified for PAHs in two samples of Made Ground.
- The results are not indicative of gross site wide contamination. The driving exposure pathways for the PAHs comprises direct exposure including soil ingestion/inhalation and dermal contact. Therefore, in areas with buildings/external hard-standing or similar, no such potential pollution linkage would exist, and hence no specific remedial measures would be required.
- BH106 is the location of a proposed footbridge and the surrounding area is covered with hardstanding, while WS109 is at the location of the proposed multi-storey car park. In both instances the hardstanding should be sufficient to sever the contamination pathway. However, should the design proposals change, within any affected general landscaping areas the potential contamination linkage will need to be broken, either by physical excavation of these materials, or by capping with a suitable thickness of uncontaminated cover soils. Early consultation with regulatory bodies will be key in taking the site forward for development.
- Gas concentrations and flow rates recorded at the subject site indicate that the site is classified as Characteristic Situation 1, as such no special protection measures are likely to be required within the proposed structures.
- In order to satisfy and enable the discharge of the likely future relevant Planning Conditions (including pre-commencement conditions), it is recommended that the findings of this report (with respect to contamination), be submitted to the Local Planning Authority for their approval.

9.1.2 Controlled Waters

- Minor exceedances of the WQS were identified in a number of samples for metals.
- Minor Cadmium and Selenium exceedances of the WQS have been recorded within the groundwater samples, however these are minor and most probably representative of background concentrations. The site does not lie within a Source Protection Zone (SPZ) and no groundwater abstractions are within influencing distance of the site. Therefore, the risk to Controlled Waters is deemed low.

9.2 Geotechnical

Based on the results of the intrusive investigation, geotechnical laboratory testing and *in situ* testing the following indicative geotechnical conclusions and recommendations have been made;

- Area A - Car Park and Foot Bridge: A piled foundation solution is recommended, the target founding stratum will ideally be the London Clay Formation or the Lambeth Group due to their fairly uniform properties and the increase in strength with depth which has been recorded typically across the site. It is envisaged that a pile design will be able to utilise both end bearing and shaft friction properties.
- Area B - 3 Storey Modular Building: Should light to moderate loadings be required then a shallow foundation solution may be viable. Raft foundations would help to avoid any differential settlement considering the variable geology which has been encountered. For more substantial loadings then mini-piles or vibrostone columns would be me more suitable as a founding solution.
- Area C & D - Single Storey Extensions: Based upon the ground conditions encountered shallow strip or pad foundations are likely to be a suitable foundation solution for light to moderately loaded structures.

- Detailed geotechnical design should be undertaken when the loading and settlement criteria are available.
- Due to the variable geology encountered and potentially shrinkable soils, suspended floor slabs are recommended.
- In deep excavations, excavations may be prone to collapse, trench support may be required. Sump pumping may be required if groundwater ingress is encountered.
- An aggressive chemical environment for concrete is thought to be present within the London Clay and Lambeth Group. Below ground concrete should be designed to meet the specifications of DS2, AC2.
- Where new structures are extensions to existing structures, or bridging between two existing structures, the choice and detailed design of foundations will need to take into account the likely relative movements between the existing and new-build, and also the movement induced on the existing structure by temporary works or the newly applied loadings.

10 References

1.) Arcadis Consulting, Epsom Hospital – Plot 2A Phase1 Geo-Environmental Desk Study, July 2018.

2.) Arcadis Consulting, Epsom Hospital – Plot 2A Phase 2 Geo-Environmental and Geotechnical Assessment Report, September 2018.

3.) Arcadis Consulting, Epsom Hospital – Main Hospital Site Phase 1 Geo-Environmental Desk Study, August 2018.

4.) British Geological Survey, Geoindex Website [online] http://www.bgs.ac.uk/geoindex/, accessed September 2018.

5.) BGS Map Sheet of Reigate.

6.) Public Health England UK Map of Radon [online]. Available at: http://www.ukradon.org/information/ukmaps, accessed September 2018.

7.) Land Quality Management/ Chartered Institute of Environmental Health S4ULs for Human Health Risk Assessment, Land Quality Press, Nottingham. “Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3223. All rights reserved.

8.) Contaminated Land: Applications in Real Environments (CL:AIRE), 2014. Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - SP1010.

9.) Health & Safety Executive, Health & Safety Guidance 66, Protection of workers and the general public during the development of contaminated land, 1991.

10.) Construction Design and Management (CDM) Regulations 2015.

11.) Health & Safety Executive, Health & Safety Guidance EM9, Disposal of Asbestos Waste, 2001.

12.) The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

13.) The Water Supply (Water Quality) Regulations 2016. SI 2016/614.

14.) Water Framework Directive UK Technical Advisory Group, River and Lake Assessment Method, Specific Pollutants (Metals) Metal Bioavailability Assessment Tool (M-BAT). July 2014.

15.) CIRIA C665. Assessing the risks posed by hazardous ground gases to buildings. 2005.

16.) Wunderground historic weather data [online]. Available at: https://www.wunderground.com/, Accessed September 2018.

17.) British Standard BS8485:2015. Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

18.) CL:AIRE, Research Bulletin 17, A Pragmatic Approach to Ground Gas Risk Assessment, November 2012.

19.) Health and Safety Executive (HSE), EH40/2005 Workplace Exposure Limits, 2nd Edition, 2011.

20.) CIRIA C552 – Contaminated Land Risk Assessment – A guide to good practice. 2001.

21.) BRE Special Digest 1:2005, Concrete in Aggressive Ground.

APPENDIX A - Exploratory Hole Location Plan

N

WS109
WS110
WS112
WS111
BH105
MAIN HOSPITAL SITE
BH106
BH107
WS107
WS106
WS108
BH103
WS103
WS102
BH101
BH102
WS105
PLOT 2A SITE
WS101
BH104
WS104

0 25 50 100 Meters

1:1,300

TOPOHGRAPHICAL SURVEY DATA PROVIDED BY EPSOM AND ST HELIER UNIVERSITY HOSPITALS NHS TRUST

LEGEND

EXPLORATORY HOLE LOCATIONS

BH

WS

Type

MAIN SITE BOUNDARY (APPROX.)

PLOT 2A BOUNDARY (APPROX.)

Rev	Date	Description	Drawn	Check	Approv
01	10/9/18	1ST ISSUE	FW	GF	GF

Client

EPSOM AND ST HELIER UNIVERSITY HOSPITALS NHS TRUST

ARCADIS

Registered office:
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TITLE:

EPSOM HOSPITAL EXPLORATORY HOLE LOCATION PLAN

Designed	F.W	Date 10SEP18	Signed
Drawn	F.W	Date 10SEP18	Signed
Checked	G.F	Date 10SEP18	Signed
Approved	G.F	Date 10SEP18	Signed
Scale:	1:1,300	Datum:	AOD
Original Size:	A3	Grid:	OS
Suitability Code:	Sx	Project Number:	10020221

Suitability Description:

Suitability Descrption

Suitability description comment

Drawing Number: 10020221-ARC-03-XX-DR-ZZ-0001

Revision: 01

50mm on Original

Print Date: 09-10-18 11:38:46

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APPENDIX B - Standard Procedures

C0 General Principles

This ground investigation was undertaken in general accordance with the principles of BS EN 1997-1 [1] and BS EN 1997-2 [2] and the advice given in BS5930:2015 [8], which, provides complimentary guidance on the application of the primary standards. Where the requirements of the ground investigation specification differ from these primary standards, the investigation methodology was adapted as required and specific notes regarding methods and techniques employed were made in the appropriate report sections.

C1 Buried Services

Service clearance was undertaken in accordance with Arcadis' common operating practice COP SA1. This document details the methods and safe working practices used to undertake excavations safely. Prior to breaking ground, services plans were consulted and the area scanned using a Cable Avoidance Tool (CAT) with detected signals marked on the ground. For all investigation positions, other than for machine excavated trial pits, hand excavated inspection pits are completed to 1.20 m bgl prior to the use of drilling and boring plant.

C2 Sampling requirements

The selection of sample types and sampling techniques has been chosen to take account of the soil fabric, size and quality of sample required based on whether the soils mass properties or the intact material properties of the ground are to be determined in subsequent laboratory tests. BS EN ISO 22475-1 [4] describes three generic sample groups that are:

a. Sampling by drilling. Generally a disturbed sample recovered from the drilling tool or digging equipment, typically meeting Class 3 to Class 5 requirements, with the recovered material being stored in bulk bags or sealed jar or tub containers.
b. Sampling by sampler. Typically referred to as open tube or drive sampling in which a tube with a sharp cutting edge is driven into the ground either by static thrust or dynamically driven to give a relatively undisturbed sample of Class 1 or Class 2 but may result in a Class 3 sample.
c. Block sampling. Cylindrical large diameter samples or cuboid hand-cut samples usually relatively undisturbed Class 1 and Class 2.

The open-tube sampling equipment used on the site was of a type and design that conformed to BS EN ISO 22475-1. For the purpose of this ground investigation block sampling was not required.

Generally samples were assessed on site and any unexpected deterioration in sample quality was reported to the ground engineer by the lead drilling technician.

Sufficient and representative samples were taken to allow the geo-mechanical properties of the ground to be adequately characterised and to enable the sequence of soil strata to be described by an engineering geologist or geotechnical engineer.

Where samples have been taken for chemical tests the drilling method attempted to adopt dry drilling over the sampling range that generally was achieved by the use of drill casing to separate and isolate the upper soil layers and exclude groundwater. Cross-contamination was further reduced by regular cleaning of sampling tools. Sample integrity was maintained by sealing samples immediately on collection and storing the samples in a temperature controlled cool box. Samples were despatched from the site at the end of the shift on which they were collected or as required in the project specification. Details of best practice storage, preservation and decontamination measures undertaken are given below:

Task	Soil	Groundwater	Ground Gas
Storage	Glass jars and vials supplied by the laboratory were used for the collection of soil samples to be	Glass vials supplied by the laboratory were used for the collection of samples to be analysed for volatile	1.4L Canisters supplied by the laboratory.

	analysed for volatile compounds. Plastic one-litre tubs were used to collect soil samples for metals analysis.	compounds. Samples to be analysed for lower volatility compounds were stored in laboratory prepared glass bottles.	
Preservation	Filling of sample containers as far as practicable to minimise headspace and low storage temperature to minimise the potential for volatilisation and biodegradation of petroleum hydrocarbon compounds prior to analysis.		Not required.
Decontamination	Disposable gloves were worn and changed between sample collection to prevent cross-contamination.	Groundwater samples were collected using dedicated disposable tubing / bailers, that were changed between monitoring well locations in order to prevent cross-contamination.	Disposable gloves were worn and changed between sample collection to prevent cross contamination.
Transport	Samples stored in dedicated sample boxes provided by the laboratory. Sample details and analytical requests were recorded on the laboratory chain of custody form included with samples, prior to dispatching to laboratory for analysis. Samples were dispatched to the laboratory on the day of sampling.		

C3 Sample description

Sample description was undertaken by the Arcadis site geologist in accordance with BS 5930: 2015. The descriptions of the individual samples were used to identify the sequence of strata at the exploratory hole location and from which representative exploratory hole logs were drawn.

C4 In situ testing

In situ geotechnical tests were undertaken taking account of the investigation scope and requirement to attain the appropriate parameters required in the geotechnical design. The tests were undertaken in accordance with the requirements of the relevant parts of BS EN ISO 22476 [5, 6, 7] and other methods as follows:

Dynamic probing

Dynamic probes were undertaken in general accordance with BS EN ISO 22476-2, BS EN 1997-2 and the national annex to BS EN 1997. The tests were generally made using the super-heavy DPSH-B configuration of the apparatus, however, it should be noted that the basis for selection of the type of dynamic probe should be a consideration of the driving energy in relation to the type of ground conditions anticipated at the site.

Where adequate correlation with borehole data is available an interpretation of the estimated soil type may be made, however, it should be noted that probing can give unreliable results in mixed soils.

Standard penetration testing

Standard penetration tests were carried out in accordance with BS EN ISO 22476-3, BS EN 1997-2 and the national Annex to BS EN 1997-2. The test records are presented on the borehole logs as blow counts for each increment with the N-value as the total number of blows of the four main test increments.

Where the N-value exceeds a total of 50 blows, the test reports the penetration in millimetres for the last test increment recorded, and the N value is indicated as greater than 50,

e.g. 4,5/12,14,18, 6 for 10 mm

indicates that the seating blows (4 and 5) were completed and that the test terminated in the 4th increment after penetrating 10 mm.

Where the seating blows exceeded 25 blows for less than 150 mm; the test was stopped and the rods remarked after which, the main drive was continued. The test is then reported as the number of blows in each seating drive for the recorded penetration with the results of the main drive given as above,

e.g. 14/11 for 45 mm/12,14,16, 8 for 10 mm.

In certain circumstances where groundwater in-flow may affect the test, particularly in fine sand or silt, low SPT blow counts may be recorded. Where the SPT blow count was very low, N values of 5 or less, the test

was, at the discretion of the site engineer, continued for a further 300 mm, recording blows for each 75 mm increment. **This is not** a standard penetration test value, it does however give an indication of potential disturbance to the ground.

California Bearing Ratio

In situ California Bearing Ratio (CBR) tests were carried out in general accordance with the requirements of BS 1977-9:1990, 4.3 [10]. The CBR is a strength test that is generally concerned with pavement design and the control of pavement sub grade construction, as such it is a test that is most suited to soils with a maximum particle size not exceeding 20 mm.

TRL Dynamic cone penetrometer

The TRL DCP is a device developed by the TRL to assess the California Bearing Ratio of road sub-base by correlation. As such the device was developed for use in a limited range of soil types. The test has no formal standard the test methodology and its use is discussed in TRL report PR IN 277-04 [11].

C5 Data transfer format

The data collated during the ground investigation has been organised and managed using the “AGS data format” that allows data transfer between different disciplines and organisations in accordance with BS 8574 [9].

C6 References

1. BS EN 1997-1. 2004. Eurocode 7: Geotechnical Design. Part 1 General Rules. British Standards Institution, 2013 (revised text).
2. BS EN 1997-2. 2007. Eurocode 7: Geotechnical Design. Part 2 Ground Investigation and testing. British Standards Institution, 2010 (revised text).
3. BS EN ISO 22282-1:2012. Geotechnical investigation and testing – Geohydraulic testing. Part 1: General Rules. British Standards Institution.
4. BS EN ISO 22475-1. Geotechnical investigation and testing – Sampling methods and groundwater measurements – Part 1 Technical principles for execution.
5. BS EN ISO 22476-1:2015. Geotechnical investigation and testing – Field testing – Part 1: Electrical cone and piezocone test. British Standards Institution
6. BS EN ISO 22476-2. Geotechnical investigation and testing – Field testing – Part 2: Dynamic Probing. British Standards Institution
7. BS EN ISO 22476-3 2005. Geotechnical investigation and testing – Field testing – Part 3: Standard penetration test. British Standards Institution
8. BS 5930: 2015. Code of practice for ground investigation. British Standards Institution.
9. BS 8574. Code of practice for the management of geotechnical data for ground engineering projects.
10. BS 1377-9. 1990. Methods of test for soils for civil engineering purposes. Part 9: In-situ tests. British Standards Institution.
11. TRL. 2004. Dynamic cone penetrometer tests and analysis. TRL Technical Report PR IN 277-04. Transport Research Laboratory, Crowthorne, England.

APPENDIX C - Exploratory Hole Logs

Key to Exploratory Hole Symbols and Abbreviations

SAMPLE TYPES

B	Bulk disturbed sample	ES	Environmental soil sample	U	Undisturbed sample
C	Core sample	EW	Environmental water sample	UT	Undisturbed thin wall sample
CBR-D	Disturbed sample from CBR test area	G	Gas sample	W	Water sample
CBR-U	Undisturbed sample from CBR test area	L	Liner sample		
D	Small disturbed sample	SPT	SPT split spoon sample		

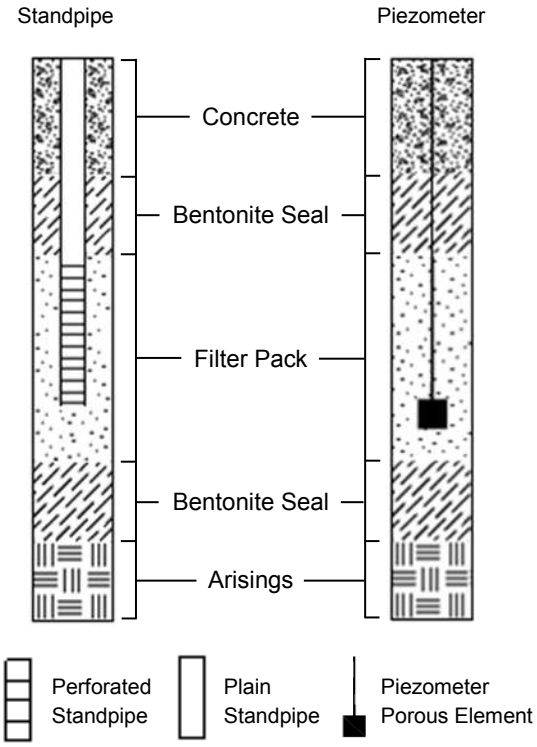
IN-SITU TESTING

SPTs	Standard Penetration Test (using a split spoon sampler)
SPTc	Standard Penetration Test (using a solid 60 degree cone)
N	Recorded SPT 'N' Value *
-/-	Blows/Penetration (mm) after seating blows totalling 150 mm
MX	Mexi Probe Test (records CBR as %)
HV	Hand Shear Vane Test (undrained shear strength quoted in kPa)
PP	Pocket Penetrometer Test (kg/m^3)
( )	Denotes residual test value
PID	Photo Ionisation Detector (ppm) *
Kf/Kr	Permeability Test (f = falling head, r = rising head quoted in ms^{-1})
HPD	High Pressure Dilatometer Test (pressure meter)
PKR	Packer / Lugeon Permeability Test
CBR	California Bearing Ratio Test

ROTARY CORE DETAILS

TCR	Total Core Recovery, %
SCR	Solid Core Recovery, %
RQD	Rock Quality Designation (% of intact core >100 mm)
FI	Fracture Spacing (average fracture spacing; in mm, over indicated length of core) * *
NI	Non-Intact Core
AZCL	Assumed Zone of Core Loss

INSTALLATION & BACKFILL DETAILS



GROUNDWATER

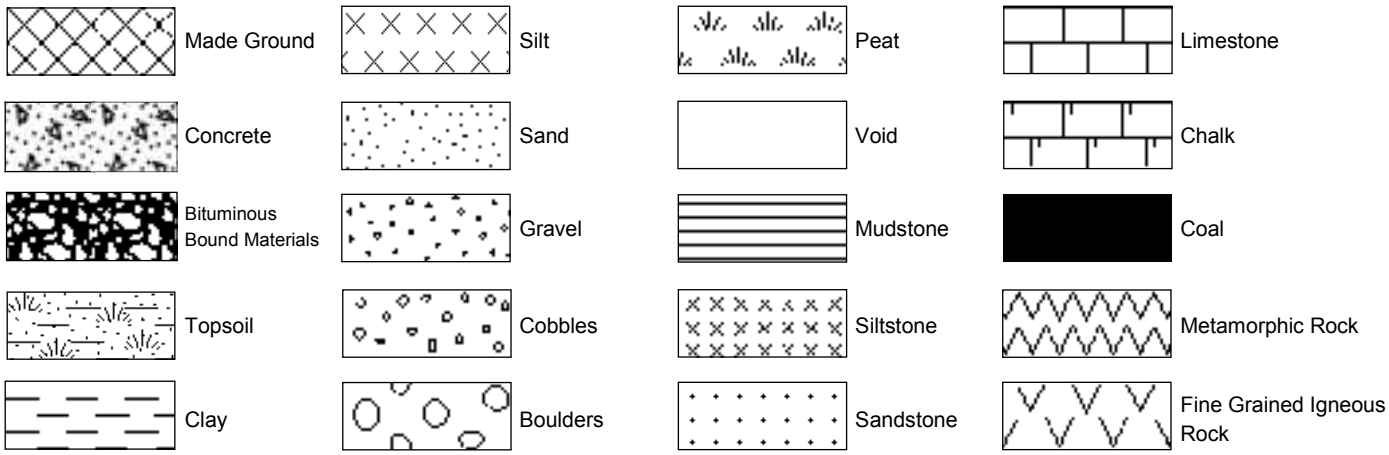
Groundwater strike

Standing water level after 20 minutes; 1st, 2nd etc (number denotes level order)

STRATUM BOUNDARIES

Unit boundary

STRATA LEGENDS - Note: Composite strata types are shown by combining symbols



* Where a single value is quoted this is the uncorrected 'N' value for a full 300 mm test drive following a seating drive of 150mm. Where the full test drive penetration is not achieved the number of blows is quoted for the penetration below the test total of 300mm, e.g.: 50/75.

* * The minimum, average and maximum are shown e.g. 5/45/125.

ARCADIS Percussive Borehole Log

BH103

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.23**	**20/08/2018**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Epsom and St. Helier University Hospitals NHS Trust	**520376.54**	**159824.13**	**20/08/2018**	**Sheet 1 of 2**

SAMPLES Depth	SAMPLES Type/ No.	TESTS Depth	TESTS Type/ No.	TESTS Results	Water Strikes	PROGRESS Date Time	PROGRESS Casing Water	STRATA Description	STRATA Legend	Depth (Thickness)	Level	Install/ Backfill
						20/08/2018 08:00		MADE GROUND: Bitumen bound material		(0.15) 0.15	59.08	
								MADE GROUND: Reddish brown sandy GRAVEL. Gravel is angular and subangular fine to coarse red brick.		(0.35) 0.50	58.73	
0.50 - 1.00	B1	0.50	PID	<1ppm				MADE GROUND: Very soft to soft dark brownish grey sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse red brick, concrete, sandstone, limestone and flint.				
0.50 - 1.00	ES2	0.50	PID	<1ppm						(0.70) 1.20	58.03	
1.20 - 1.70	B3	1.20	SPT(C)	N=17 (2,3/4,4,4,5)				Medium dense orangish brown slightly clayey sandy GRAVEL. Gravel is angular to subrounded fine to coarse flint and chalk [RIVER TERRACE DEPOSITS]				
1.20 - 1.70	ES4	1.20	PID	<1ppm						(1.40) 2.60	56.63	
2.00 - 2.10	D5	2.00	SPT(C)	N=13 (2,2/3,4,3,3)				Soft light greyish brown CLAY. [LAMBETH GROUP]				
2.00 - 2.50	B6									(0.80) 3.40	55.83	
3.00 - 3.10	D7	3.00	SPT(S)	N=8 (1,1/2,2,2,2)				Soft to firm dark greyish black CLAY. [LAMBETH GROUP]				
4.00 - 4.10	D9			Ublow=40								
4.00 - 4.45	U8									(2.00) 5.40	53.83	
4.50 - 4.60	D10											
5.00 - 5.10	D11	5.00	SPT(S)	N=14 (1,2/3,3,4,4)				Firm light grey CLAY. [LAMBETH GROUP]				
5.00 - 5.50	B12									(0.90) 6.30	52.93	
6.00 - 6.10	D13							Firm dark grey occasionally mottled light green CLAY. [LAMBETH GROUP]				
6.50 - 6.95	U14			Ublow=60						(1.20) 7.50	51.73	
7.00 - 7.10	D15							Stiff to very stiff light grey to purplish brown CLAY. [LAMBETH GROUP]				
8.00 - 8.10	D16	8.00	SPT(S)	N=24 (3,4/5,6,6,7)								
9.00 - 9.10	D17											
9.50 - 9.95	U18			Ublow=80								
10.00 - 10.10	D19											

DRILLING TECHNIQUE

From	To	Type
0.00	1.20	Inspection Pit
1.20	15.00	Cable Percussion

CHISELLING

Hard Strata From	Hard Strata To	Duration

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth
300	1.20	152	3.00
152	3.00		
140	15.00		

WATER ADDED

From	To	Volume (ltr)

Remarks

Borehole terminated at target depth of 15.00 m bgl.
No groundwater encountered, damp from 14.00 m bgl.
Installations: 0.00 m - 14.00 m plain 50 mm ID standpipe piezometer, 14.00 m - 15.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.50 m concrete, 13.50 m bentonite pellet seal to top of response zone, 1.00 m pluviated sand filter around response zone to base of hole.
No evidence of contamination noted.

Termination Depth: 15.00m

Arcadis Cymru House St Mellons Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Percussive Borehole Log

BH103

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.23**	**20/08/2018**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Epsom and St. Helier University Hospitals NHS Trust	**520376.54**	**159824.13**	**20/08/2018**	**Sheet 2 of 2**

SAMPLES		TESTS			Water Strikes	PROGRESS		STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Date Time	Casing Water	Description	Legend			
								Stiff to very stiff light grey to purplish brown CLAY. [LAMBETH GROUP]				
11.00 - 11.10	D20	11.00	SPT(S)	N>50 (7,11/14,21,15 for 50mm)						(5.70)		
12.00 - 12.10	D21											
12.50 - 12.95	U22			Ublow=100								
13.00 - 13.10	D23											
								Very stiff greenish grey sandy CLAY. [LAMBETH GROUP]		13.20	46.03	
14.00 - 14.10	D24	14.00	SPT(S)	N>50 (8,17/33,17 for 45mm)						(1.80)		
15.00	D25					20/08/2018 16:00	3.00			15.00	44.23	

DRILLING TECHNIQUE			CHISELLING			WATER OBSERVATIONS						HOLE/CASING DIAMETER				WATER ADDED		
From	To	Type	Hard Strata From	Hard Strata To	Duration	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Volume (ltr)
0.00	1.20	Inspection Pit										300	1.20	152	3.00			
1.20	15.00	Cable Percussion										152	3.00					
												140	15.00					

Remarks

Borehole terminated at target depth of 15.00 m bgl.
No groundwater encountered, damp from 14.00 m bgl.
Installations: 0.00 m - 14.00 m plain 50 mm ID standpipe piezometer, 14.00 m - 15.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.50 m concrete, 13.50 m bentonite pellet seal to top of response zone, 1.00 m pluviated sand filter around response zone to base of hole.
No evidence of contamination noted.

Termination Depth: 15.00m

Arcadis Cymru House
St Mellons Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Percussive Borehole Log

BH105

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**57.07**	**22/08/2018**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Epsom and St. Helier University Hospitals NHS Trust	**520494.59**	**159932.65**	**23/08/2018**	**Sheet 1 of 2**

SAMPLES Depth	SAMPLES Type/ No.	TESTS Depth	TESTS Type/ No.	TESTS Results	Water Strikes	PROGRESS Date Time	PROGRESS Casing Water	STRATA Description	STRATA Legend	Depth (Thickness)	Level	Install/ Backfill
0.00 - 0.10	D2	0.00	PID	<1ppm		22/08/2018 08:00		MADE GROUND: Bitumen bound material.		0.10	56.97	
0.00 - 0.10	ES1	0.10	PID	<1ppm						(0.20)		
0.10 - 0.30	D4	0.30	PID	<1ppm				MADE GROUND: Dark reddish brown gravelly fine to coarse SAND. Gravel is angular and subangular fine to coarse red brick and concrete.		0.30	56.77	
0.10 - 0.30	ES3									(0.20)		
0.30 - 0.50	D6	0.50	PID	<1ppm						0.50	56.57	
0.30 - 0.50	ES5							MADE GROUND: Soft black slightly sandy slightly gravelly CLAY. Gravel is subangular and subrounded fine to coarse red brick, concrete and limestone.		(0.40)		
0.50 - 0.70	B8											
0.50 - 0.70	ES7							Slight organic odour from 0.30 m to 0.50 m bgl.		0.90	56.17	
0.90 - 1.00	D9											
1.00 - 1.20	B11	1.00	PID	<1ppm				MADE GROUND: Soft dark grey slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse red brick, concrete, mudstone, ash and clinker.				
1.00 - 1.20	ES10											
1.20 - 1.50	B12	1.20	SPT(C)	N=29 (3,5/5,7,7,10)						(1.10)		
								Medium dense orangish brown very sandy GRAVEL. Gravel is angular to subrounded fine to coarse flint and quartz. [RIVER TERRACE DEPOSITS]				
1.90 - 2.00	D13											
2.00 - 2.45	D14	2.00	SPT(C)	N=10 (2,3/2,2,3,3)						2.00	55.07	
2.00 - 2.50	B15							Firm orangish brown slightly sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse flint and quartz. [RIVER TERRACE DEPOSITS]		(0.50)		
2.50 - 2.60	D16									2.50	54.57	
								Medium dense light greenish grey fine silty SAND. [LAMBETH GROUP]				
3.00 - 3.45	D17	3.00	SPT(S)	N=11 (1,2/2,3,3,3)	1.80							
3.00 - 3.50	B18									(1.30)		
3.80 - 3.90	D19									3.80	53.27	
4.00 - 4.45	D20	4.00	SPT(S)	N=9 (1,1/2,2,2,3)	3.70			Firm dark grey slightly sandy CLAY. [LAMBETH GROUP]				
										(1.20)		
5.00 - 5.10	D21			Ublow=60						5.00	52.07	
5.00 - 5.45	U22							Firm to stiff light grey to reddish purplish brown CLAY. [LAMBETH GROUP]				
5.50 - 5.60	D23											
6.50 - 6.95	D24	6.50	SPT(S)	N=20 (2,3/4,4,6,6)								
										(4.70)		
7.50 - 7.60	D25											
8.00 - 8.45	U26			Ublow=120								
8.45 - 8.50	D27											
9.50 - 9.95	D28	9.50	SPT(S)	N>50 (4,10/25,25 for 15mm)						9.70	47.37	
								Dense to very dense greenish grey fine to medium SAND. [LAMBETH GROUP]		(0.30)		
10.00 - 10.10	D29									10.00	47.07	

DRILLING TECHNIQUE

From	To	Type
0.00	1.20	Inspection Pit
1.20	15.39	Cable Percussion

CHISELLING

Hard Strata From	Hard Strata To	Duration

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed
22/08/2018 09:20	2.50	20	1.80	2.40	3.80
22/08/2018 11:40	9.70	20	12.00	3.90	
23/08/2018 14:00	13.00	20	6.80	11.50	

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth
300	1.20	152	15.00
152	15.00		
45	15.39		

WATER ADDED

From	To	Volume (ltr)

Remarks

Borehole terminated at target depth of 15.00 m bgl, with SPT run to 15.39m bgl.
Groundwater encountered at 2.50 m bgl (rose to 1.80 m after 20 minutes), 9.70 m bgl (rose to 6.80 m bgl after 20 minutes) and 13.00 m bgl (rose to 12.00 m bgl after 20 minutes). Installations: Shallow = 0.00 m - 2.00 m plain 50 mm ID standpipe piezometer, 2.00 m - 3.80 m slotted 50 mm ID standpipe piezometer. Deep = 0.00 m - 9.70 m 50 mm ID standpipe piezometer, 9.70 m - 10.00 m slotted 50 mm ID standpipe piezometer. Backfill: Flush cover set in 0.50 m concrete, 1.50 m bentonite pellet seal to top of first response zone, 1.80 m pluviated sand filter around first response zone, 5.90 m bentonite pellet seal to top of second response zone, 0.30 m pluviated sand filter around second response zone, 5.39 m bentonite seal to base of hole. No evidence of contamination noted.

Termination Depth: 15.39m

AGS Arcadis Cymru House St Mellons Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Percussive Borehole Log

BH105

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**57.07**	**22/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520494.59**	**159932.65**	**23/08/2018**	**Sheet 2 of 2**

SAMPLES Depth	SAMPLES Type/ No.	TESTS Depth	TESTS Type/ No.	TESTS Results	Water Strikes	PROGRESS Date Time	PROGRESS Casing Water	STRATA Description	STRATA Legend	Depth (Thickness)	Level	Install/ Backfill
								Stiff brown to grey slightly sandy CLAY. [LAMBETH GROUP]		(0.50)		
10.50 - 10.60	D30							Dense to very dense greenish grey to light brown very clayey fine to medium SAND. [LAMBETH GROUP]		10.50	46.57	
11.00 - 11.10	D31	11.00	SPT(S)	N>50 (9,12/15,16,19 for 70mm)	9.00	22/08/2018 17:00	10.00 3.30			(0.80)		
						23/08/2018 07:00	10.00 9.00			11.30	45.77	
								Dense to very dense dark greenish grey to light brown very clayey fine to medium SAND. [LAMBETH GROUP]		(0.90)		
12.20 - 12.30	D32									12.20	44.87	
		12.50	SPT(S)	N>50 (7,9/11,17 for 55mm)	12.10			Dense to very dense dark greenish grey to light brown occasionally white very clayey fine to medium SAND. [LAMBETH GROUP] Pockets of white calcrete crystals from12.20 m to 13.00 m bgl.		(0.80)		
13.00 - 13.10	D33							Dense to very dense greenish grey fine to medium SAND. [LAMBETH GROUP]		13.00	44.07	
13.50 - 13.70	B34									(0.90)		
13.90 - 14.00	D35									13.90	43.17	
14.00 - 14.45	D36	14.00	SPT(S)	N>50 (3,6/9,11,15,15 for 40mm)	13.00			Dense to very dense greenish grey very clayey fine to medium SAND. [LAMBETH GROUP]		(1.49)		
15.00 - 15.39	D37	15.00	SPT(S)	N>50 (2,8/10,15,20,5 for 10mm)	14.00							
						23/08/2018 15:00	15.39 14.00			15.39	41.68	

DRILLING TECHNIQUE

From	To	Type
0.00	1.20	Inspection Pit
1.20	15.39	Cable Percussion

CHISELLING

Hard Strata From	Hard Strata To	Duration

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed
22/08/2018 09:20	2.50	20	1.80	2.40	3.80
22/08/2018 11:40	9.70	20	12.00	3.90	
23/08/2018 14:00	13.00	20	6.80	11.50	

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth
300	1.20	152	15.00
152	15.00		
45	15.39		

WATER ADDED

From	To	Volume (ltr)

Remarks

Borehole terminated at target depth of 15.00 m bgl, with SPT run to 15.39m bgl.
Groundwater encountered at 2.50 m bgl (rose to 1.80 m after 20 minutes), 9.70 m bgl (rose to 6.80 m bgl after 20 minutes) and 13.00 m bgl (rose to 12.00 m bgl after 20 minutes). Installations: Shallow = 0.00 m - 2.00 m plain 50 mm ID standpipe piezometer, 2.00 m - 3.80 m slotted 50 mm ID standpipe piezometer. Deep = 0.00 m - 9.70 m 50 mm ID standpipe piezometer, 9.70 m - 10.00 m slotted 50 mm ID standpipe piezometer. Backfill: Flush cover set in 0.50 m concrete, 1.50 m bentonite pellet seal to top of first response zone, 1.80 m pluviated sand filter around first response zone, 5.90 m bentonite pellet seal to top of second response zone, 0.30 m pluviated sand filter around second response zone, 5.39 m bentonite seal to base of hole. No evidence of contamination noted.

Termination Depth: 15.39m

Arcadis Cymru House St Mellons Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Percussive Borehole Log

BH106

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.24**	**21/08/2018**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Epsom and St. Helier University Hospitals NHS Trust	**520356.88**	**159871.47**	**21/08/2018**	**Sheet 1 of 2**

SAMPLES Depth	SAMPLES Type/ No.	TESTS Depth	TESTS Type/ No.	TESTS Results	Water Strikes	PROGRESS Date Time	PROGRESS Casing Water	STRATA Description	STRATA Legend	Depth (Thickness)	Level	Install/ Backfill
0.15 - 0.25	D1					21/08/2018 08:00		MADE GROUND: Bitumen bound material.		(0.15)	59.09	
0.25 - 0.50	D2	0.25	PID	<1ppm				MADE GROUND: Dark orangish brown gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse red brick, concrete and flint.		0.15 0.25 (0.25)	58.99	
0.25 - 0.50	ES3											
0.50 - 0.70	B5									0.50	58.74	
0.50 - 0.70	D4	0.60	PID	<1ppm				MADE GROUND: Dark grey to black gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse red brick, wood and concrete.		(0.50)		
0.60 - 0.70	ES6											
1.00 - 1.20	B7							MADE GROUND: Soft grey slightly sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse flint, red brick, ash and clinker.		1.00	58.24	
1.10 - 1.20	ES8	1.10	PID	<1ppm								
1.20 - 1.60	B9	1.20	SPT(C)	N=29 (3,4/5,6,8,10)								
								MADE GROUND: Dark orangish brown gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse red brick and flint.		(0.70)		
1.70 - 1.80	D10									1.70	57.54	
								Dense dark brown very clayey sandy GRAVEL. Gravel is angular to subrounded fine to coarse flint. [RIVER TERRACE DEPOSITS]				
2.00 - 2.10	ES12	2.00	SPT(C)	N=47								
2.00 - 2.50	B11	2.00	PID	(10,13/13,8,12,14) <1ppm						(1.00)		
2.70 - 2.80	D13									2.70	56.54	
								Loose to medium dense dark orangish brown clayey sandy GRAVEL. Gravel is angular to subrounded fine to coarse flint. [RIVER TERRACE DEPOSITS]		(0.30)		
3.00 - 3.40	B14	3.00	SPT(C)	N=10 (1,2/2,2,2,4)						3.00	56.24	
								Firm reddish brown to light grey silty CLAY. [LONDON CLAY FORMATION]				
3.40 - 3.50	D15											
4.00 - 4.45	D16									(2.50)		
5.00 - 5.10	D17			Ublow=50								
5.00 - 5.45	U18											
5.50 - 5.60	D19							Firm grey sandy silty CLAY. [LONDON CLAY FORMATION]		5.50	53.74	
										(1.00)		
6.50 - 6.60	D20	6.50	SPT(S)	N=14 (2,2/3,3,4,4)				Firm to stiff dark grey and occasionally black silty CLAY. [LONDON CLAY FORMATION]		6.50	52.74	
7.50 - 7.60	D21											
8.00 - 8.50	B22									(4.50)		
8.50 - 8.95	U23			Ublow=100								
9.00 - 9.10	D24											
10.00 - 10.45	D25	10.00	SPT(S)	N=27 (2,4/6,6,7,8)								

DRILLING TECHNIQUE From	To	Type	CHISELLING Hard Strata From	To	Duration	WATER OBSERVATIONS Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	HOLE/CASING DIAMETER Hole Dia.	Depth	Casing Dia.	Depth	WATER ADDED From	To	Volume (ltr)
0.00	1.20	Inspection Pit										300	1.20	152	3.50			
1.20	15.34	Cable Percussion										152 140 45	3.50 15.00 15.34					

Remarks

Borehole terminated at target depth of 15.00 m bgl, with SPT run to 15.34 m bgl.
No groundwater encountered.
Installations: 0.00 m - 10.00 m plain 50 mm ID standpipe piezometer, 10.00 m - 15.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.50 m concrete, 9.50 m bentonite pellet seal to top of response zone, 5.00 m pluviated sand filter around response zone, 0.34 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 15.34m

Arcadis Cymru House St Mellons Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Percussive Borehole Log

BH106

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.24**	**21/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520356.88**	**159871.47**	**21/08/2018**	**Sheet 2 of 2**

SAMPLES Depth	SAMPLES Type/ No.	TESTS Depth	TESTS Type/ No.	TESTS Results	Water Strikes	PROGRESS Date Time	PROGRESS Casing Water	STRATA Description	STRATA Legend	Depth (Thickness)	Level	Install/ Backfill
								Firm to stiff dark grey and occasionally black silty CLAY. [LONDON CLAY FORMATION]				
11.00 - 11.10	D26									11.00	48.24	
								Stiff reddish brown to light grey occasionally purple CLAY. [LONDON CLAY FORMATION]				
11.50 - 11.90	U27			Ublow=100								
11.90 - 12.00	D28									(3.00)		
13.00 - 13.45	D29	13.00	SPT(S)	N>50 (4,6/10,11,15,14 for 50mm)								
14.00 - 14.10	D30							Stiff reddish brown to greenish grey slightly sandy CLAY. [LONDON CLAY FORMATION]		14.00	45.24	
14.50 - 14.87	U31			Ublow=120						(1.34)		
14.80 - 14.90	D32											
15.00 - 15.34	D33	15.00	SPT(S)	N>50 (7,12/15,19,16 for 35mm)								
						21/08/2018 16:00	3.50			15.34	43.90	

DRILLING TECHNIQUE

From	To	Type
0.00	1.20	Inspection Pit
1.20	15.34	Cable Percussion

CHISELLING

Hard Strata From	Hard Strata To	Duration

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth
300	1.20	152	3.50
152	3.50		
140	15.00		
45	15.34		

WATER ADDED

From	To	Volume (ltr)

Remarks

Borehole terminated at target depth of 15.00 m bgl, with SPT run to 15.34 m bgl.
No groundwater encountered.
Installations: 0.00 m - 10.00 m plain 50 mm ID standpipe piezometer, 10.00 m - 15.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.50 m concrete, 9.50 m bentonite pellet seal to top of response zone, 5.00 m pluviated sand filter around response zone, 0.34 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 15.34m

ARCADIS Percussive Borehole Log

BH107

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.24**	**20/08/2018**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Epsom and St. Helier University Hospitals NHS Trust	**520372.86**	**159874.03**	**20/08/2018**	**Sheet 1 of 2**

SAMPLES Depth	SAMPLES Type/ No.	TESTS Depth	TESTS Type/ No.	TESTS Results	Water Strikes	PROGRESS Date Time	PROGRESS Casing Water	STRATA Description	STRATA Legend	Depth (Thickness)	Level	Install/ Backfill
						20/08/2018 08:00		MADE GROUND: Bitumen bound material		(0.15) 0.15	59.09	
								MADE GROUND: Light grey GRAVEL . Gravel is angular and subangular fine to coarse concrete.		(0.25) 0.40	58.84	
0.50 - 1.00	B1	0.50	PID	<1ppm				MADE GROUND: Dark reddish brown gravelly medium to coarse SAND with low cobble content. Gravel is angular to subrounded fine to coarse red brick and concrete. Cobbles are subangular red brick.				
0.50 - 1.00	ES2									(0.80)		
1.00 - 1.20	ES3	1.00	PID	<1ppm								
1.20 - 1.70	B4	1.20	SPT(C)	N=12 (1,2/3,3,3,3)				MADE GROUND: Firm brown slightly sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse flint and red brick.		1.20	58.04	
1.50 - 1.60	ES5	1.50	PID	<1ppm						(0.80)		
2.00 - 2.10	D6	2.00	SPT(C)	N=18 (4,4/6,4,3,5)				Loose to medium dense dark orangish brown very clayey very sandy GRAVEL. Gravel is angular to subrounded fine to coarse flint. [RIVER TERRACE DEPOSITS]		2.00	57.24	
2.00 - 2.50	B7	2.10	PID	<1ppm								
2.10 - 2.20	ES8									(1.30)		
3.00 - 3.10	D9	3.00	SPT(C)	N=9 (2,1/1,2,3,3)								
3.00 - 3.50	B10											
								Firm reddish brown CLAY. [LAMBETH GROUP]		3.30	55.94	
4.00 - 4.10	D11			Ublow=40						(1.20)		
4.00 - 4.45	U12											
4.50 - 4.60	D13							Soft to firm light greenish grey slightly sandy silty CLAY. [LAMBETH GROUP]		4.50	54.74	
5.00 - 5.10	D14	5.00	SPT(S)	N=11 (1,2/2,2,3,4)						(0.80)		
								Firm dark grey to black silty CLAY. [LAMBETH GROUP]		5.30	53.94	
6.00 - 6.10	D15									(0.70)		
								Firm purplish grey silty CLAY. [LAMBETH GROUP]		6.00	53.24	
6.50 - 6.95	U16			Ublow=50								
7.00 - 7.10	D17									(2.00)		
8.00 - 8.10	D18	8.00	SPT(S)	N=18 (2,3/3,4,5,6)				Stiff purplish grey silty CLAY. [LAMBETH GROUP]		8.00	51.24	
9.00 - 9.10	D19									(3.40)		
9.50 - 9.95	U20			Ublow=50								
10.00 - 10.10	D21											

DRILLING TECHNIQUE

From	To	Type
0.00	1.20	Inspection Pit
1.20	15.38	Cable Percussion

CHISELLING

Hard Strata From	Hard Strata To	Duration

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth
300	1.20	152	4.00
152	4.00		
140	15.00		
45	15.38		

WATER ADDED

From	To	Volume (ltr)

Remarks

Borehole terminated at target depth of 15.00 m bgl, with SPT run to 15.38 m bgl.
No groundwater encountered, slight seepage at 3.20 m bgl.
Installations: 0.00 m - 2.00 m plain 50 mm ID standpipe piezometer, 2.00 m - 6.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.50 m concrete, 1.50 m bentonite pellet seal to top of response zone, 4.00 m pluviated sand filter around response zone, 9.38 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 15.38m

Arcadis Cymru House St Mellons Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Percussive Borehole Log

BH107

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.24**	**20/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520372.86**	**159874.03**	**20/08/2018**	**Sheet 2 of 2**

SAMPLES		TESTS			Water Strikes	PROGRESS		STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Date Time	Casing Water	Description	Legend			
								Stiff purplish grey silty CLAY. [LAMBETH GROUP]				
11.00 - 11.10	D22	11.00	SPT(S)	N=19 (2,3/4,4,5,6)								
										11.40	47.84	
								Stiff purplish brown to bluish grey CLAY. [LAMBETH GROUP]				
12.00 - 12.10	D23									(1.50)		
12.50 - 12.95	U24			Ublow=100								
										12.90	46.34	
13.00 - 13.10	D25							Stiff to very stiff greenish grey slightly sandy CLAY. [LAMBETH GROUP]				
14.00 - 14.10	D26	14.00	SPT(S)	N>50 (4,7/11,13,14,12 for 50mm)						(2.48)		
15.00 - 15.38	D27	15.00	SPT(S)	N>50 (7,11/13,14,18,5 for 10mm)								
						20/08/2018 16:00	4.00			15.38	43.86	

DRILLING TECHNIQUE			CHISELLING			WATER OBSERVATIONS						HOLE/CASING DIAMETER				WATER ADDED		
From	To	Type	Hard Strata From	Hard Strata To	Duration	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Volume (ltr)
0.00	1.20	Inspection Pit										300	1.20	152	4.00			
1.20	15.38	Cable Percussion										152	4.00					
												140	15.00					
												45	15.38					

Remarks

Borehole terminated at target depth of 15.00 m bgl, with SPT run to 15.38 m bgl.
No groundwater encountered, slight seepage at 3.20 m bgl.
Installations: 0.00 m - 2.00 m plain 50 mm ID standpipe piezometer, 2.00 m - 6.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.50 m concrete, 1.50 m bentonite pellet seal to top of response zone, 4.00 m pluviated sand filter around response zone, 9.38 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 15.38m

Arcadis Cymru House
St Mellons Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Dando 4000	**Arcadis Consulting (UK) Ltd**	**MW**	**IP**

ARCADIS Dynamic Sample Log

WS106

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**61.10**	**15/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520311.41**	**159846.20**	**15/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Grass over brown slightly sandy gravelly CLAY with abundant rootlets. Gravel is angular fine to coarse flint (TOP SOIL).		0.10	61.00	
0.30 - 0.50 0.30 - 0.50	B2 ES1	0.30	PID	<1ppm		MADE GROUND: Brown slightly silty sandy GRAVEL with low cobble content. Gravel is angular and subangular fine to coarse flint, brick and concrete. Cobbles are angular brick and concrete.		(0.90)		
0.70 - 0.90 0.70 - 0.90	B3 ES4	0.70	PID	<1ppm		Becoming very sandy from 0.60 m to 1.00 m bgl.		1.00	60.10	
1.20 - 1.65 1.20 - 2.00	D10 I6	1.20	SPT(S)	N=12 (1,2/2,3,4,3)	Dry	Firm greyish brown slightly sandy CLAY [LONDON CLAY FORMATION]				
1.50 - 1.60	ES5	1.50	PID	<1ppm						
2.00 - 2.45 2.00 - 3.00	D11 I7	2.00	SPT(S)	N=9 (1,2/2,2,2,3)	Dry			(3.00)		
3.00 - 3.45 3.00 - 4.00	D12 I8	3.00	SPT(S)	N=18 (2,3/4,4,5,5)	Dry	Becoming stiff from 3.00 m bgl.				
4.00 - 4.45 4.00 - 5.00	D13 I9	4.00	SPT(S)	N=17 (3,2/4,4,4,5)	Dry	Stiff dark grey slightly sandy very silty CLAY with frequent laminations of fine to medium sand. [LONDON CLAY FORMATION]		4.00 (0.80)	57.10	
5.00 - 5.45	D14	5.00	SPT(S)	N=28 (5,5/5,7,8,8)	Dry	Stiff dark brownish grey slightly sandy CLAY. [LONDON CLAY FORMATION]		4.80 (0.65)	56.30	
								5.45	55.65	

DRILLING TECHNIQUE			WATER OBSERVATIONS						HOLE/CASING DIAMETER				BACKFILL		
From	To	Technique	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	Top	Base	Backfill
0.00	1.20	Inspection Pit							300	1.20			0.00	0.25	Concrete
1.20	5.45	Window Sample							87	2.00			0.25	0.50	Bentonite
									77	3.00			0.50	5.00	Gravel
									67	5.00			5.00	5.45	Bentonite

Remarks

Borehole terminated at target depth of 5.00 m bgl, with SPT run to 5.45 m bgl.
No groundwater encountered.
Installation: 0.00 m - 0.50 m plain 50 mm ID standpipe piezometer, 0.50 m - 5.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.25 m concrete, 0.25 m bentonite pellet seal to top of response zone, 4.50 m pluviated sand filter around response zone, 0.45 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 5.45m

AGS Arcadis Cymru House St. Mellon's Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

ARCADIS Dynamic Sample Log

WS107

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**60.04**	**15/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520323.84**	**159864.64**	**15/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Grass over brown slightly sandy gravelly CLAY with abundant rootlets. Gravel is angular fine to coarse flint (TOP SOIL).		(0.20) 0.20	59.84	
0.30 - 0.50 0.30 - 0.50	B2 ES1	0.30	PID	<1ppm		MADE GROUND: Brown slightly silty sandy GRAVEL with low cobble content. Gravel is angular and subangular fine to coarse flint, brick and concrete. Cobbles are angular brick and concrete.		(0.80)		
0.70 - 0.90 0.70 - 0.90	B4 ES3	0.70	PID	<1ppm		Rebar fragments at 0.35 m bgl. Becoming very sandy from 0.60 m bgl.		1.00	59.04	
1.20 - 1.30 1.20 - 1.65 1.20 - 2.00	ES5 D9 I6	1.20 1.20	SPT(S) PID	N=6 (2,1/1,2,2,1) 1ppm	Dry	Soft to firm greyish brown slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse flint and chalk. [LONDON CLAY FORMATION]				
2.00 - 2.45 2.00 - 3.00	D10 I7	2.00	SPT(S)	N=14 (2,2/3,3,4,4)	Dry			(2.00)		
3.00 - 3.45 3.00 - 4.00	D11 I8	3.00	SPT(S)	N=19 (3,4/4,4,5,6)	Dry	Stiff greyish brown slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse flint and chalk. [LONDON CLAY FORMATION]		3.00	57.04	
4.00 - 4.38	D12	4.00	SPT(S)	N>50 (6,7/16,16,17,1 for 10mm)	Dry			(1.38)		
								4.38	55.66	

DRILLING TECHNIQUE			WATER OBSERVATIONS						HOLE/CASING DIAMETER				BACKFILL		
From	To	Technique	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	Top	Base	Backfill
0.00	1.20	Inspection Pit							300	1.20			0.00	0.25	Concrete
1.20	4.38	Window Sample							87	2.00			0.25	0.50	Bentonite
									77	3.00			0.50	4.00	Gravel
									67	4.00			4.00	4.38	Bentonite

Remarks

Borehole terminated at 4.38 m bgl due to SPT refusal.
No groundwater encountered.
Installation: 0.00 m - 0.50 m plain 50 mm ID standpipe piezometer, 0.50 m - 4.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.25 m concrete, 0.25 m bentonite pellet seal to top of response zone, 3.50 m pluviated sand filter around response zone, 0.38 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 4.38m

AGS Arcadis Cymru House St. Mellon's Business Park Cardiff CF3 0EY

Unless otherwise stated: Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

ARCADIS Dynamic Sample Log

WS108

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**57.74**	**16/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520539.87**	**159843.90**	**16/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA				
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend	Depth (Thickness)	Level	Install/ Backfill
0.20 - 0.40	ES1	0.20	PID	<1ppm		MADE GROUND: Grass over brown slightly sandy gravelly CLAY with abundant rootlets. Gravel is angular from fine to coarse gravelly flint (TOP SOIL).		(0.20) 0.20	57.54	
0.50 - 0.70	B2					MADE GROUND: Brown slightly silty sandy GRAVEL with low cobble content. Gravel is angular and subangular fine to coarse flint, brick and concrete. Cobbles are angular brick and concrete.		(0.20) 0.40	57.34	
0.70 - 0.90	ES3	0.70	PID	<1ppm		Rebar fragments at 0.35 m bgl.				
		1.20	SPT(S)	N>50 (13,16/16,16,2 for 10mm)	Dry	Very dense grey sandy angular fine to coarse GRAVEL of flint and chalk. [RIVER TERRACE DEPOSITS]		(1.10)		
								1.50	56.24	

DRILLING TECHNIQUE			WATER OBSERVATIONS						HOLE/CASING DIAMETER				BACKFILL		
From	To	Technique	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	Top	Base	Backfill
0.00	1.20	Inspection Pit							300	1.20			0.00	0.25	Concrete
1.20	1.50	Window Sample							45	1.50			0.25	0.50	Bentonite
													0.50	1.20	Gravel
													1.20	1.50	Bentonite

Remarks

Borehole terminated at 1.50 m bgl due to SPT refusal.
No groundwater encountered.
Installation: 0.00 m - 0.50 m plain 50 mm ID standpipe piezometer, 0.50 m - 1.20 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.25 m concrete, 0.25 m bentonite pellet seal to top of response zone, 0.70 m pluviated sand filter around response zone, 0.30 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 1.50m

Arcadis Cymru House
St. Mellon's Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

ARCADIS Dynamic Sample Log

WS109

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**56.54**	**17/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520468.13**	**159993.24**	**17/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Grey bitumen bound material.		0.10	56.44	
						MADE GROUND: Black bitumen bound material.		0.20	56.34	
0.30 - 0.50	B2	0.30	PID	<1ppm		MADE GROUND: Dark brown very gravelly CLAY. Gravel is angular fine to coarse red brick, concrete and flint.		(0.30)		
0.30 - 0.50	ES1							0.50	56.04	
0.70 - 0.90	B4	0.70	PID	<1ppm		MADE GROUND: Dark grey brown slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse chalk, quartz and red brick.		(0.50)		
0.70 - 0.90	ES3							1.00	55.54	
1.10 - 1.20	ES5	1.10	PID	<1ppm						
1.20 - 2.00	I6	1.20	SPT(S)	N=21 (8,4/5,5,6,5)	Dry	Medium dense light brownish grey very sandy GRAVEL. Gravel is angular fine to coarse flint. [RIVER TERRACE DEPOSITS]		(1.00)		
2.00 - 3.00	B7	2.00	SPT(S)	N=22 (7,6/9,4,4,5)	2.00	Medium dense to dense orangish brown slightly silty slightly gravelly SAND. Gravel is angular fine to coarse flint. [RIVER TERRACE DEPOSITS]		2.00	54.54	
		3.00	SPT(S)	N>50 (9,15/17,16,17,0 for 0mm)	2.00			(1.38)		
								3.38	53.16	

DRILLING TECHNIQUE			WATER OBSERVATIONS						HOLE/CASING DIAMETER				BACKFILL		
From	To	Technique	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	Top	Base	Backfill
0.00	1.20	Inspection Pit	17/08/2018 12:00	2.00	20	1.50			300	1.20			0.00	0.25	Tarmac
1.20	3.38	Window Sample							87	2.00			0.25	3.38	Arisings
									77	3.00					
									45	3.38					

Remarks

Borehole terminated at 3.38 m bgl due to SPT refusal.
Groundwater encountered at 2.00 m bgl, rose to 1.50 m bgl after 20 minutes.
Borehole collapsed back up to 1.00m bgl, no installation.
Backfill: 0.25 m bitumen bound material, 3.13 m arisings to base of hole.
No evidence of contamination noted.

Termination Depth: 3.38m

Arcadis Cymru House
St. Mellon's Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

ARCADIS Dynamic Sample Log

WS110

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**56.46**	**17/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520501.79**	**159981.96**	**17/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
0.20 - 0.30 0.30 - 0.50	ES1 B2	0.20	PID	<1ppm		MADE GROUND: Grey bitumen bound material. MADE GROUND: Brown slightly silty sandy GRAVEL with rare pockets of orangish brown slightly silty sand. Gravel is angular fine to coarse red brick, flint and concrete.		0.10 (0.90)	56.36	
0.70 - 0.80	ES3	0.70	PID	<1ppm						
1.10 - 1.20	ES4	1.10 1.20	PID SPT(S)	<1ppm N>50 (10,11/14,16,20,0 for 0mm)	Dry	Medium dense to dense light brownish grey very sandy GRAVEL. Gravel is angular fine to coarse flint. [RIVER TERRACE DEPOSITS]		1.00 (0.58) 1.58	55.46 54.88	

DRILLING TECHNIQUE			WATER OBSERVATIONS						HOLE/CASING DIAMETER				BACKFILL		
From	To	Technique	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	Top	Base	Backfill
0.00 1.20	1.20 1.58	Inspection Pit Window Sample							300 45	1.20 1.58			0.00 0.25 0.50 1.20	0.25 0.50 1.20 1.58	Concrete Bentonite Gravel Bentonite

Remarks

Borehole terminated at 1.58 m bgl due to SPT refusal.
No groundwater encountered.
Installation: 0.00 m - 0.50 m plain 50 mm ID standpipe piezometer, 0.50 m - 1.20 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.25 m concrete, 0.25 m bentonite pellet seal to top of response zone, 0.70 m pluviated sand filter around response zone, 0.38 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 1.58m

Arcadis Cymru House
St. Mellon's Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

ARCADIS Dynamic Sample Log

WS111

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.46**	**17/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520334.60**	**159922.15**	**17/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA				
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend	Depth (Thickness)	Level	Install/ Backfill
0.20 - 0.30	ES1	0.20	PID	<1ppm		MADE GROUND: Astro-turf with sub-base and membrane.		0.10	59.36	
						MADE GROUND: Dark brown very clayey SILT.		(0.20)		
0.40 - 0.60	B2					MADE GROUND: Firm dark brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse brick and concrete.		0.30	59.16	
0.70 - 0.80	ES3	0.70	PID	<1ppm				(1.20)		
1.20 - 2.00	I5	1.20	SPT(S)	N=9 (2,2/3,2,2,2)	Dry					
1.60 - 1.70	ES4	1.60	PID	<1ppm		Soft to firm grey mottled brown slightly sandy CLAY. [LONDON CLAY FORMATION]		1.50	57.96	
2.00 - 3.00	I6	2.00	SPT(S)	N=5 (1,1/1,1,1,2)	Dry			(1.50)		
3.00 - 4.00	I7	3.00	SPT(S)	N=15 (2,3/4,4,3,4)	Dry	Stiff grey mottled brown slightly sandy CLAY. [LONDON CLAY FORMATION]		3.00	56.46	
4.00 - 5.00	I8	4.00	SPT(S)	N=16 (3,2/4,4,4,4)	Dry			(1.40)		
		5.00	SPT(S)	N=19 (4,4/5,5,4,5)	Dry	Stiff dark grey slightly sandy very silty CLAY. [LONDON CLAY FORMATION] Lens of orangish brown silty sand at 4.45 m bgl.		4.40	55.06	
								(1.05)		
								5.45	54.01	

DRILLING TECHNIQUE		
From	To	Technique
0.00	1.20	Inspection Pit
1.20	5.45	Window Sample

WATER OBSERVATIONS					
Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed

HOLE/CASING DIAMETER			
Hole Dia.	Depth	Casing Dia.	Depth
300	1.20		
87	2.00		
77	3.00		
67	5.00		

BACKFILL		
Top	Base	Backfill
0.00	0.25	Concrete
0.25	0.50	Bentonite
0.50	1.50	Gravel
1.50	5.45	Bentonite

Remarks

Borehole terminated at target depth of 5.00 m bgl, with SPT run to 5.45 m bgl.
No groundwater encountered.
Installation: 0.00 m - 0.50 m plain 50 mm ID standpipe piezometer, 0.50 m - 1.50 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.25 m concrete, 0.25 m bentonite pellet seal to top of response zone, 1.00 m pluviated sand filter around response zone, 3.95 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 5.45m

Arcadis Cymru House
St. Mellon's Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

ARCADIS Dynamic Sample Log

WS112

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Epsom Hospital - Main Hospital Site	**10020221**	**59.06**	**17/08/2018**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Epsom and St. Helier University Hospitals NHS Trust	**520354.54**	**159939.75**	**17/08/2018**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Grey bitumen bound material.		0.10	58.96	
						MADE GROUND: Black bitumen bound material.		(0.20) 0.30	58.76	
0.40 - 0.70	B2	0.40	PID	<1ppm		MADE GROUND: Brown slightly silty sandy GRAVEL with low cobble content. Gravel is angular and subangular fine to coarse brick, concrete and flint. Cobbles are angular brick and concrete.		(0.70)		
0.40 - 0.70	ES1									
0.80 - 0.90	ES3	0.80	PID	<1ppm				1.00	58.06	
1.20 - 1.65	ES4	1.20	SPT(S)	N=3 (1,0/1,0,1,1)	Dry	Loose becoming dense brown slightly clayey sandy GRAVEL. Gravel is angular and subangular fine to coarse chalk, flint and quartz. [RIVER TERRACE DEPOSITS]		(1.38)		
		1.20	PID	<1ppm						
		2.00	SPT(S)	N>50 (8,14/14,16,20,0 for 0mm)	Dry			2.38	56.68	

DRILLING TECHNIQUE			WATER OBSERVATIONS						HOLE/CASING DIAMETER				BACKFILL		
From	To	Technique	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	Top	Base	Backfill
0.00	1.20	Inspection Pit							300	1.20			0.00	0.25	Concrete
1.20	2.38	Window Sample							87	2.00			0.25	1.00	Bentonite
									45	2.38			1.00	2.00	Gravel
													2.00	2.38	Bentonite

Remarks

Borehole terminated at 2.38 m bgl due to SPT refusal.
No groundwater encountered.
Installation: 0.00 m - 1.00 m plain 50 mm ID standpipe piezometer, 1.00 m - 2.00 m slotted 50 mm ID standpipe piezometer.
Backfill: Flush cover set in 0.25 m concrete, 0.75 m bentonite pellet seal to top of response zone, 1.00 m pluviated sand filter around response zone, 0.38 m bgl bentonite pellet seal to base of hole.
No evidence of contamination noted.

Termination Depth: 2.38m

Arcadis Cymru House
St. Mellon's Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter(mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Yellow Dart	**Arcadis Consulting (UK) Ltd**	**SS**	**IP**

Window Sample Photography Sheet WS106

Project	Job No	Ground Level (mAOD)	Start Date
Epsom Hospital – Main Hospital Site	**10020221**	**61.10**	**15/08/2018**
Client	Easting (OS mE)	Northing (OS mN)	End Date
Epsom and St. Helier University Hospitals NHS Trust	**520311.41**	**159846.20**	**15/08/2018**

WS106 – 1.20 m – 5.00 m bgl

Arcadis Cymru House
St Mellons Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used: **Yellow Dart**

Logged By: **SAS**

Checked By: **IP**

Window Sample Photography Sheet WS107

Project	Job No	Ground Level (mAOD)	Start Date
Epsom Hospital – Main Hospital Site	**10020221**	**60.04**	**15/08/2018**
Client	Easting (OS mE)	Northing (OS mN)	End Date
Epsom and St. Helier University Hospitals NHS Trust	**520323.84**	**159864.64**	**15/08/2018**

WS107 – 1.20 m – 4.00 m bgl

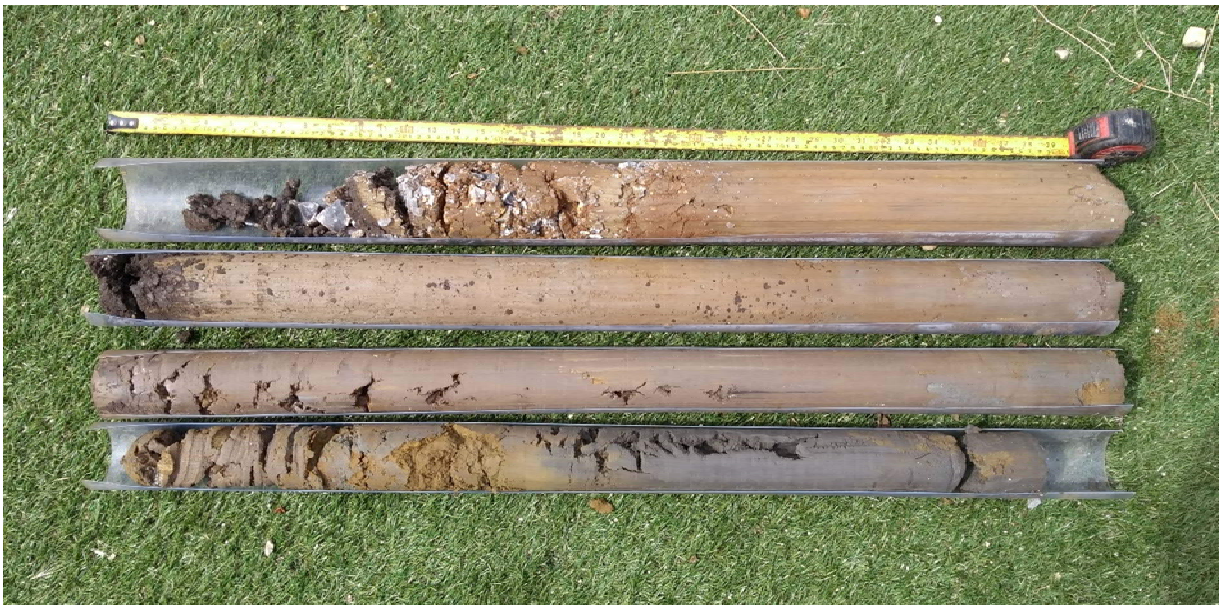
Window Sample Photography Sheet WS109

Project	Job No	Ground Level (mAOD)	Start Date
Epsom Hospital – Main Hospital Site	**10020221**	**56.54**	**17/08/2018**
Client	Easting (OS mE)	Northing (OS mN)	End Date
Epsom and St. Helier University Hospitals NHS Trust	**520468.13**	**159993.24**	**17/08/2018**

WS109 – 1.20 m – 3.00 m bgl

Window Sample Photography Sheet WS111

Project	Job No	Ground Level (mAOD)	Start Date
Epsom Hospital – Main Hospital Site	**10020221**	**59.46**	**15/08/2018**
Client	Easting (OS mE)	Northing (OS mN)	End Date
Epsom and St. Helier University Hospitals NHS Trust	**520334.60**	**159922.15**	**15/08/2018**



WS111 – 1.20 m – 5.00 m bgl

Window Sample Photography Sheet WS112

Project	Job No	Ground Level (mAOD)	Start Date
Epsom Hospital – Main Hospital Site	**10020221**	**59.06**	**15/08/2018**
Client	Easting (OS mE)	Northing (OS mN)	End Date
Epsom and St. Helier University Hospitals NHS Trust	**520354.54**	**159939.75**	**15/08/2018**

WS112 – 1.20 m – 2.00 m bgl

Arcadis Cymru House
St Mellons Business Park
Cardiff
CF3 0EY

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used: **Yellow Dart**

Logged By: **SAS**

Checked By: **IP**

APPENDIX D - Certification of Field Apparatus

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Neil Burrows
Southern Testing Laboratories
Unit 11
Charlwoods Road
East Grinstead
RH19 2HU

SPT Hammer Ref:	SEDS8
Test Date:	10/05/2018
Report Date:	15/05/2018
File Name:	SEDS8.spt
Test Operator:	N P BURROWS

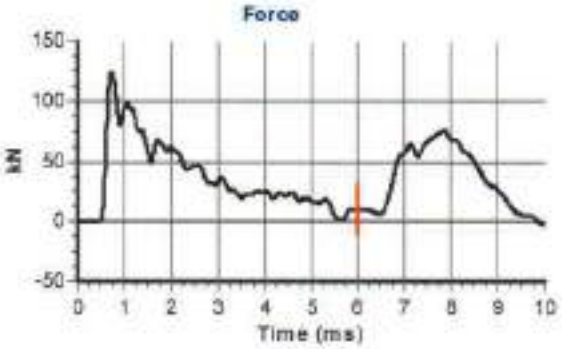
Instrumented Rod Data

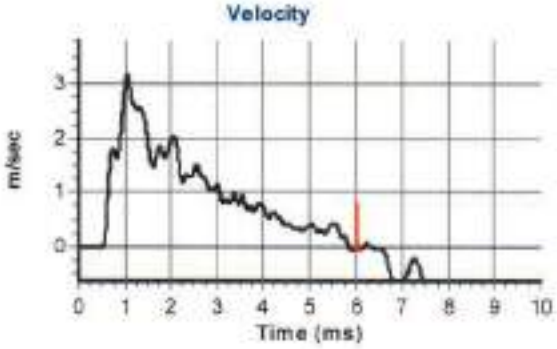
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

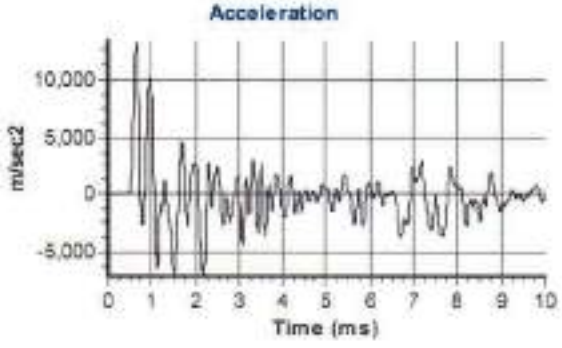
SPT Hammer Information

Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	14.5

Comments / Location
CHARLWOODS







Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	329

Energy Ratio E_r (%): **69**

Signed: N P Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Neil Burrows
Southern Testing Laboratories
Unit 11
Charlwoods Road
East Grinstead
RH19 2HU

SPT Hammer Ref:	SEDS11
Test Date:	27/07/2018
Report Date:	27/07/2018
File Name:	SEDS11.spt
Test Operator:	N P BURROWS

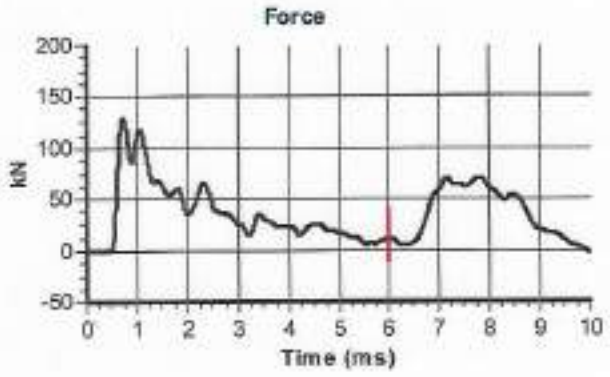
Instrumented Rod Data

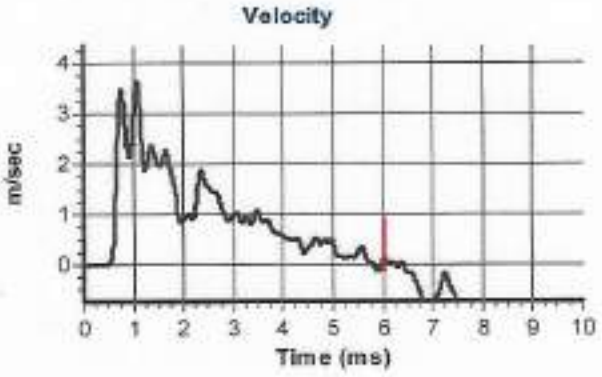
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

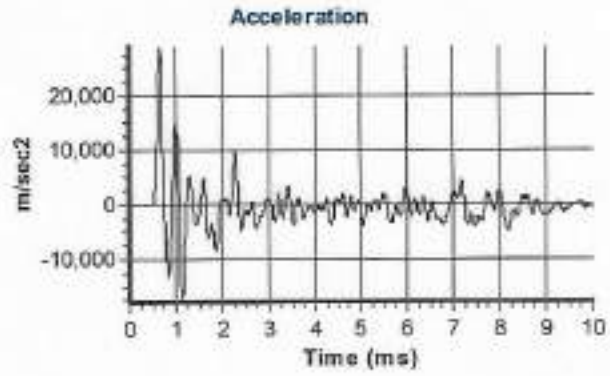
SPT Hammer Information

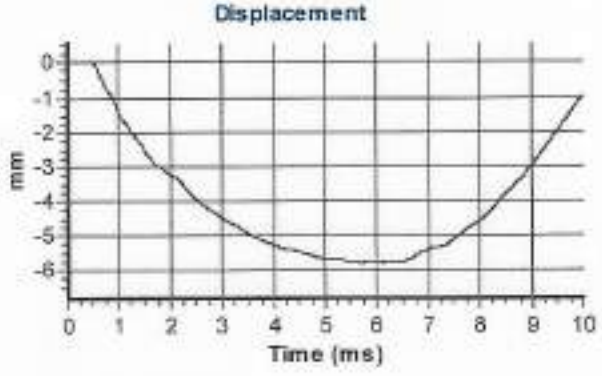
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	14.5

Comments / Location
CHARLWOODS









Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	336

Energy Ratio E_r (%): 71

N P Burrows

Signed: N P Burrows
Title: Field Operations Manager

SPT Calibration Report

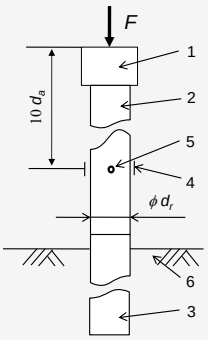
www.equipegroup.com

Hammer Energy Measurement Report

Type of Hammer		DART
Client		GSTL
Test No		EQU2067
Test Depth (m)		8.70
Mass of hammer	m =	63.5kg
Falling height	h =	0.76m
E_{theor} =	$m \times g \times h$ =	473J

Characteristics of the instrumented rod

Diameter	d_r =	0.052 m
Length of instrumented rod		0.558 m
Area	A =	11.61 cm²
Modulus	E_a =	206843 MPa



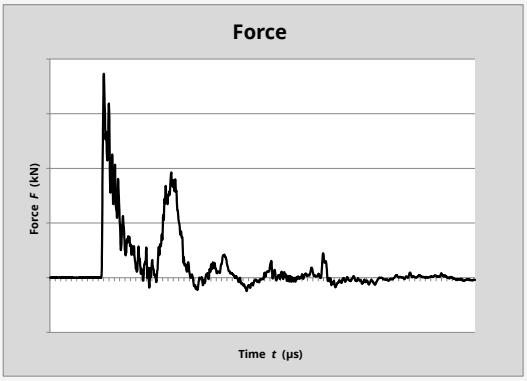
Key

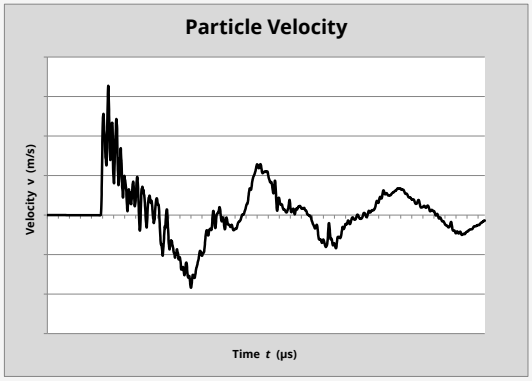
1 Anvil
2 Part of instrumented rod
3 Drive Rod
4 Strain Gauge
5 Accelerometer
6 Ground

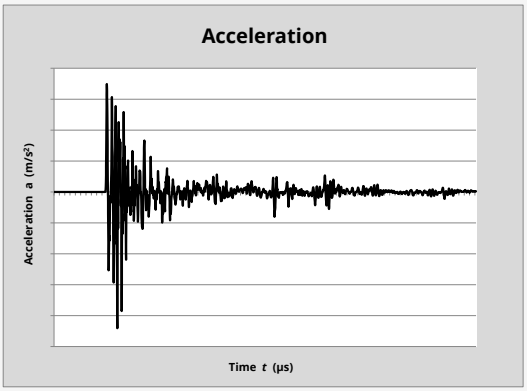
F Force
d_r Diameter of rod

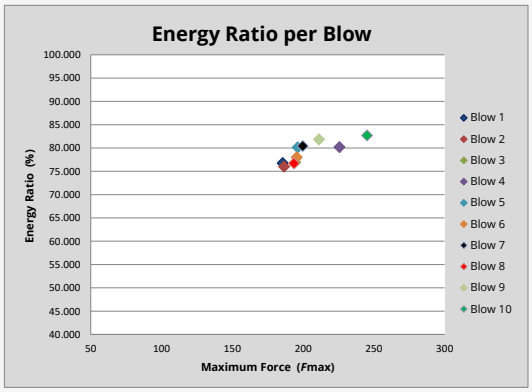
Fig. B.1 and B.2
BS EN ISO 22476-3 : 2005 + A1 : 2011

DATE OF TEST	VALID UNTIL	HAMMER ID
09/04/2018	09/04/2019	219









Observations:
1.

E_{meas} =	**0.372**	kN-m
E_{theor} =	**0.473**	kN-m

Energy Ratio = $\frac{E_{meas}}{E_{theor}}$ (E_r) **78.68%**

Equipe SPT Analyzer Operators: AF

Prepared by: **Checked by:** **Date:** 11/04/2018

 Equipe Group, The Paddocks, Home Farm Offices, The Upton Estate, Banbury, Oxfordshire, OX15 6HU
Tel: +44 (0)1295 670990 Fax: +44 (0)1295 678232 Email: info@equipegroup.com

APPENDIX E - Monitoring Data

Ground and Groundwater Elevations												
Monitoring Well	Surface Elevation (m AOD)	pH	Temp.	Conductivity	ORP	Dissolved Oxygen	Depth to LNAPL	Thickness of LNAPL	Comments	Depth to Groundwater	Depth to Base	Groundwater Elevation
			(°C)	(mS/cm)	mV	(mg/l)	(m bgl)	(mm)		(m bgl)	(m bgl)	(mAOD)
23-Aug-18												
BH103	59.23	7.38	17.57	1775	62.4	1.29	-	-	Clear, colourless	1.11	14.03	58.12
BH105 (S)	57.07		GRAB SAMPLE				-	-	Cloudy, dark brown	1.50	3.00	55.57
BH105 (D)	57.07		GRAB SAMPLE				-	-	Cloudy, dark brown	1.25	10.00	55.82
BH106	59.24		NO GROUNDWATER ENCOUNTERED				-	-	-	DRY	14.97	N/A
BH107	59.24		GRAB SAMPLE				-	-	Cloudy, dark brown	2.25	5.97	57.00
WS106	61.10		GRAB SAMPLE				-	-	Cloudy, dark brown	1.16	4.92	59.94
WS107	60.04		GRAB SAMPLE				-	-	Cloudy, dark brown	2.57	3.92	57.47
WS108	57.74		NO GROUNDWATER ENCOUNTERED				-	-	-	DRY	1.05	N/A
WS109	56.54		NO WELL INSTALLATION				-	-	-	-	-	N/A
WS110	56.46		UNABLE TO LOCATE MONITORING WELL				-	-	-	-	-	N/A
WS111	56.46		NO GROUNDWATER ENCOUNTERED				-	-	-	DRY	1.40	N/A
WS112	59.06		NO GROUNDWATER ENCOUNTERED				-	-	-	DRY	2.05	N/A

Notes:

m bgl	Metres below ground level
m AOD	Metres Above Ordnance Datum
-	No LNAPL encountered
LNAPL	Light Non-Aqueous Phase Liquid

ARCADIS

Project:	Epsom Hospital - Main Hospital Site		
Job Number:	10020221	Date:	31/08/2018

Weather:		Overcast with bright spells
Engineer:		SAS

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Temp. (°C)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Surface Elevation (m AOD)	Depth to Water (m)	Depth to base (m)	Groundwater Elevation	Comments (all readings from GL, note datum height if different)
AMB	31/08/2018 0900	1010	16	N/A	N/A	N/A	0.0	0.0	0.1	20.4	0.0	0.0	0.0	0.0	N/A	N/A	N/A	N/A	N/A	
BH103	31/08/2018 1100	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial										59.23	N/A	N/A	N/A	Unable to be recorded due to patient's car being parked over installation cover
						30														
						60														
						90														
						120														
						150														
						180														
BH105 (S)	31/08/2018 1110	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						57.07	3.45	3.66	53.62	
						30	0		0.1	19.1										
						60	0		0.1	19.1										
						90	0.1		0.2	19.1										
						120	0.1		0.2	19.1										
						150	0.1		0.2	19.1										
						180	0.1		0.2	19.1										
BH105 (D)	31/08/2018 1120	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						57.07	3.45	9.98	53.62	
						30	0		0.1	19.1										
						60	0		0.1	19.1										
						90	0.1		0.2	19.1										
						120	0.1		0.2	19.1										
						150	0.1		0.2	19.1										
						180	0.1		0.2	19.1										
BH106	31/08/2018 1130	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						59.24	Dry	14.97	N/A	
						30	0		0.1	19.3										
						60	0.1		0.1	19.3										
						90	0.1		0.1	19.3										
						120	0.1		0.1	19.3										
						150	0.1		0.2	19.3										
						180	0.1		0.2	19.3										
BH107	31/08/2018 1140	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.4						59.24	2.25	5.95	56.99	
						30	0.1		0.5	19.3										
						60	0.1		0.7	19.6										
						90	0.1		0.7	19.6										
						120	0.1		0.7	19.6										
						150	0.1		0.7	19.6										
						180	0.1		0.7	19.6										

ARCADIS

Project:	Epsom Hospital - Main Hospital Site		
Job Number:	10020221	Date:	31/08/2018

Weather:		Overcast with bright spells
Engineer:		SAS

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Temp. (°C)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Surface Elevation (m AOD)	Depth to water (m)	Depth to base (m)	Groundwater Elevation	Comments (all readings from GL, note datum height if different)
WS106	31/08/2018 1150	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		1.1	16.5						61.10	1.16	4.92	59.94	
						30	0		2.8	15.9										
						60	0.1		2.9	15.9										
						90	0.1		3.1	15.9										
						120	0.1		3.1	15.9										
						150	0.2		3.1	15.9										
						180	0.2		3.1	15.9										
WS107	31/08/2018 1200	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		1.2	20.1						60.04	2.57	3.92	57.47	
						30	0		1.7	19.9										
						60	0.1		2.1	19.3										
						90	0.1		2.1	19.3										
						120	0.1		2.4	19.3										
						150	0.2		2.4	19.3										
						180	0.2		2.4	19.3										
WS108	31/08/2018 1210	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		2.1	20.1						57.74	Dry	1.05	N/A	
						30	0		2.5	18.6										
						60	0.1		2.5	17.9										
						90	0.1		2.5	17.9										
						120	0.1		2.5	17.9										
						150	0.2		2.5	17.9										
						180	0.2		2.5	17.9										
WS110	31/08/2018 1220	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						56.46	Dry	1.12	N/A	
						30	0		0.1	19.1										
						60	0		0.1	19.1										
						90	0.1		0.2	19.1										
						120	0.1		0.2	19.1										
						150	0.1		0.2	19.1										
						180	0.1		0.2	19.1										
WS111	31/08/2018 1230	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.4						59.46	Dry	1.45	N/A	
						30	0.1		0.5	18.8										
						60	0.1		1.9	18.4										
						90	0.1		1.9	18.4										
						120	0.1		1.9	18.4										
						150	0.1		1.9	18.4										
						180	0.1		1.9	18.4										
WS112	31/08/2018 1240	1021	16	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.4						59.06	Dry	2.05	N/A	
						30	0		0.2	20.3										
						60	0.1		0.2	20.1										
						90	0.1		0.2	20.1										
						120	0.1		0.2	20.1										
						150	0.1		0.2	20.1										
						180	0.1		0.2	20.1										

ARCADIS

Project:	Epsom Hospital - Main Hospital Site		
Job Number:	10020221	Date:	13/09/2018

Weather:		Overcast with bright spells
Engineer:		SC

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Temp. (°C)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Surface Elevation (m AOD)	Depth to Water (m)	Depth to base (m)	Groundwater Elevation	Comments (all readings from GL, note datum height if different)
AMB	13/9/18 1350	1018	16	N/A	N/A	N/A	0.0	0.0	0.1	20.4	0.0	0.0	0.0	0.0	N/A	N/A	N/A	N/A	N/A	
BH103	13/09/2018 1400	1018	18	Peak: Steady:	Peak: 0 Steady: 0	Initial										59.23	N/A	N/A	N/A	Unable to be recorded due to patient's car being parked over installation cover
						30														
						60														
						90														
						120														
						150														
						180														
BH105 (S)	13/9/18 1410	1018	18	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						57.07	3.39	3.66	53.68	
						30	0		0.1	19.1										
						60	0		0.1	19.1										
						90	0.1		0.2	19.1										
						120	0.1		0.2	19.1										
						150	0.1		0.2	19.1										
						180	0.1		0.2	19.1										
BH105 (D)	13/9/18 1420	1018	18	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						57.07	3.4	9.98	53.67	
						30	0		0.1	19.1										
						60	0		0.1	19.1										
						90	0.1		0.2	19.1										
						120	0.1		0.2	19.1										
						150	0.1		0.1	19.1										
						180	0.1		0.2	19.1										
BH106	13/9/18 1430	1018	18	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.1						59.24	Dry	14.97	N/A	
						30	0		0.1	19.3										
						60	0.1		0.1	19.3										
						90	0.1		0.2	19.3										
						120	0.1		0.1	19.3										
						150	0.1		0.2	19.3										
						180	0.1		0.2	19.3										
BH107	13/9/18 1440	1018	18	Peak: Steady:	Peak: 0 Steady: 0	Initial	0		0.1	20.4						59.24	2.23	5.95	57.01	
						30	0.1		0.4	19.4										
						60	0.1		0.6	19.5										
						90	0.1		0.6	19.6										
						120	0.1		0.7	19.6										
						150	0.1		0.7	19.6										
						180	0.1		0.7	19.6										

ARCADIS

Project:	Epsom Hospital - Main Hospital Site		
Job Number:	10020221	Date:	13/09/2018

Weather:		Overcast with bright spells
Engineer:		SC

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Temp. (°C)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Surface Elevation (m AOD)	Depth to water (m)	Depth to base (m)	Groundwater Elevation	Comments (all readings from GL, note datum height if different)
WS106	13/9/18 1350	1018	18	Peak:	Peak: 0	Initial	0		0.9	16.5						61.10	1.12	4.92	59.98	
						30	0		2.5	16.4										
						60	0.1		2.8	16.2										
						90	0.1		3	16										
				Steady:	Steady: 0	120	0.1		3.1	15.9										
						150	0.2		3.2	15.9										
						180	0.2		3.1	15.9										
WS107	13/9/18 1100	1018	18	Peak:	Peak: 0	Initial	0		0.8	20.1						60.04	2.54	3.92	57.5	
						30	0		1.2	19.9										
						60	0.1		1.9	19.3										
						90	0.1		2.1	19.3										
				Steady:	Steady: 0	120	0.1		2.3	19.3										
						150	0.2		2.4	19.3										
						180	0.2		2.4	19.3										
WS108	13/9/18 1110	1018	18	Peak:	Peak: 0	Initial	0		2.1	20.1						57.74	Dry	1.05	N/A	
						30	0		2.5	18.6										
						60	0.1		2.5	17.9										
						90	0.1		2.5	17.9										
				Steady:	Steady: 0	120	0.1		2.5	17.9										
						150	0.2		2.5	17.9										
						180	0.2		2.5	17.9										
WS110	13/9/18 1120	1018	18	Peak:	Peak: 0	Initial	0		0.1	20.1						56.46	Dry	1.12	N/A	
						30	0		0.1	19.1										
						60	0		0.1	19.1										
						90	0.1		0.2	19.1										
				Steady:	Steady: 0	120	0.1		0.2	19.1										
						150	0.1		0.2	19.1										
						180	0.1		0.2	19.1										
WS111	13/9/18 1130	1018	18	Peak:	Peak: 0	Initial	0		0.1	20.4						59.46	Dry	1.45	N/A	
						30	0.1		0.5	18.8										
						60	0.1		1.9	18.4										
						90	0.1		0.4	19.4										
				Steady:	Steady: 0	120	0.1		0.6	19.5										
						150	0.1		0.6	18.8										
						180	0.1		1.4	18.4										
WS112	13/9/18 1140	1018	18	Peak:	Peak: 0	Initial	0		0.1	20.4						59.06	Dry	2.05	N/A	
						30	0		0.2	20.3										
						60	0.1		0.2	20.1										
						90	0.1		0.2	20.1										
				Steady:	Steady: 0	120	0.1		0.2	20.1										
						150	0.1		0.2	20.1										
						180	0.1		0.2	20.1										

ARCADIS

Project:	Epsom Hospital - Main Hospital Site		
Job Number:	10020221	Date:	28/09/2018

Weather:	Overcast
Engineer:	M.T.

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Temp. (°C)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Depth to Water (m)	Depth to base (m)	Comments (all readings from GL, note datum height if different)
BH103	28/09/2018 08:20	1022	10	Peak: 0	Peak: 13	30	0.1	1.0	2.6	19.5	0	10	-	-	0	0.43	10.67	
						60	0.1	1.0	2.7	19.4	0	10	-	-				
						90	0.1	1.0	2.7	19.4	0	10	-	-				
						120	0.1	1.0	2.7	19.4	0	10	-	-				
				Steady: 0	Steady: 3	150	0.1	1.0	2.7	19.4	0	10	-	-				
						180	0.1	1.0	2.7	19.4	0	10	-	-				
BH105 (Shallow)	28/09/2018 07:15	1022	8	Peak: 0.1	Peak: 0.2	30	0.1	2.0	0.4	3.2	0	23	-	-	0	1.28	2.99	
						60	0.1	2.0	0.4	2.5	0	21	-	-				
						90	0.1	2.0	0.4	2.3	0	20	-	-				
						120	0.1	2.0	0.4	2.2	0	18	-	-				
				Steady: 0	Steady: 0	150	0.1	2.0	0.4	2.1	0	17	-	-				
						180	0.1	2.0	0.4	2.0	0	16	-	-				
BH105 (Deep)	28/09/2018 07:20	1022	8	Peak: 0	Peak: -12.5	30	0.1	1.0	0.4	18.0	0	5	-	-	0	2.33	10.01	
						60	0.1	1.0	0.4	18.3	0	5	-	-				
						90	0.1	1.0	0.4	18.4	0	5	-	-				
						120	0.1	1.0	0.4	18.5	0	6	-	-				
				Steady: 0	Steady: -1.2	150	0.1	1.0	0.4	18.5	0	6	-	-				
						180	0.1	1.0	0.4	18.5	0	6	-	-				
BH106	28/09/2018 10:25	1024	10	Peak: 0	Peak: 0	30	0.1	1.0	1.2	14.9	0	6	-	-	0	11.15	14.82	
						60	0.1	1.0	1.2	14.9	0	6	-	-				
						90	0.1	1.0	1.2	15.0	0	6	-	-				
						120	0.1	1.0	1.1	15.1	0	6	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	1.1	15.2	0	6	-	-				
						180	0.1	1.0	1.1	15.6	0	6	-	-				
						210	0.1	1.0	1.0	15.9	0	0	-	-				
						240	0.1	1.0	0.9	16.2	0	5	-	-				
BH107	28/09/2018 10:15	1024	10	Peak: 0	Peak: 0	30	0.1	1.0	0.6	20.7	0	4	-	-	0	2.21	5.94	
						60	0.1	1.0	0.6	20.7	0	4	-	-				
						90	0.1	1.0	0.6	20.7	0	4	-	-				
						120	0.1	1.0	0.6	20.7	0	4	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	0.6	20.7	0	4	-	-				
						180	0.1	1.0	0.6	20.7	0	4	-	-				

ARCADIS

Project:	Epsom Hospital - Main Hospital Site		
Job Number:	10020221	Date:	28/09/2018

Weather:	Overcast
Engineer:	M.T.

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Temp. (°C)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Depth to Water (m)	Depth to base (m)	Comments (all readings from GL, note datum height if different)
WS 106	28/09/2018 09:30	1024	10	Peak: 0	Peak: 0	30	0.0	0.0	0.4	20.9	0	5	-	-	0	1.14	4.92	
						60	0.1	1.0	0.4	20.9	0	5	-	-				
						90	0.1	1.0	0.4	20.9	0	5	-	-				
						120	0.1	1.0	0.4	20.9	0	5	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	0.4	20.9	0	4	-	-				
						180	0.1	1.0	0.4	20.9	0	4	-	-				
WS 107	28/09/2018 09:45	1024	10	Peak: 0	Peak: 0	30	0.1	1.0	0.2	20.9	0	4	-	-	0	2.07	3.90	
						60	0.1	1.0	0.2	20.9	0	4	-	-				
						90	0.1	1.0	0.2	20.9	0	4	-	-				
						120	0.1	1.0	0.2	20.8	0	4	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	0.2	20.7	0	4	-	-				
						180	0.1	1.0	0.3	20.7	0	4	-	-				
WS 108	28/09/2018 08:40	1022	10	Peak: 0	Peak: 0	30	0.1	1.0	0.6	21.0	0	8	-	-	0	Dry	1.04	
						60	0.1	1.0	0.6	21.0	0	7	-	-				
						90	0.1	1.0	0.6	21.0	0	7	-	-				
						120	0.1	1.0	0.6	21.0	0	7	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	0.7	21.0	0	7	-	-				
						180	0.1	1.0	0.7	21.0	0	7	-	-				
WS 111	28/09/2018 10:45	1024	12	Peak: 0	Peak: 0	30	0.1	1.0	1.5	19.8	0	4	-	-	0	1.36	1.39	
						60	0.1	1.0	1.5	19.8	0	4	-	-				
						90	0.1	1.0	1.5	19.8	0	4	-	-				
						120	0.1	1.0	1.5	19.7	0	4	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	1.5	19.7	0	4	-	-				
						180	0.1	1.0	1.5	19.7	0	4	-	-				
						210	0.1	1.0	1.5	19.6	0	4	-	-				
WS 112	28/09/2018 10:35	1024	11	Peak: 0	Peak: 0	30	0.1	1.0	0.1	21.2	0	3	-	-	0	Dry	2.04	
						60	0.1	1.0	0.1	21.2	0	3	-	-				
						90	0.1	1.0	0.1	21.2	0	3	-	-				
						120	0.1	1.0	0.1	21.2	0	3	-	-				
				Steady: 0	Steady: 0	150	0.1	1.0	0.1	21.2	0	3	-	-				
						180	0.1	1.0	0.1	21.2	0	3	-	-				

APPENDIX F - Geotechnical Laboratory Testing Data

Laboratory Report

GEO Site & Testing Services Ltd

Contract Number: 40564

Client Ref: **10020221**
Client PO:

Report Date: **17-09-2018**

Client **Arcadis**
Fortran Rd
St Mellons
Cardiff
CF3 0EY

Contract Title: **Epsom Hospital- Main Hospital site**
For the attention of: **Mark Wilson**

Date Received: **03-09-2018**
Date Commenced: **03-09-2018**
Date Completed: **17-09-2018**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	29
4 Point Liquid & Plastic Limit (LL/PL) BS 1377:1990 - Part 2 : 4.3 & 5.3 - * UKAS	18
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	2
PSD: Sedimentation by pipette carried out with Wet Sieve (Wet Sieve must also be selected) BS 1377:1990 - Part 2 : 9.4 - * UKAS	1
One-dimensional Consolidation 75mm or 50mm diameter specimens (5 days) BS 1377:1990 - Part 5 : 3 - * UKAS	1
Quick Undrained Triaxial Compression Test - Multi-stage Loading of a single specimen (100mm diameter) BS1377 : 1990 Part 7 : 9 - * UKAS	6

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

Approved Signatories:
Alex Wynn (Associate Director) - Ben Sharp (Contracts Manager) - Emma Sharp (Office Manager)
Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager) - Sean Penn (Administrative/Accounts Assistant)
Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

Laboratory Report

GEO Site & Testing Services Ltd

Contract Number: 40564

Test Description	Qty
(GI) BRE SD1 Reduced Suite pH, Acid Soluble Sulphate, Water Soluble Sulphate and Total Sulphur BS 1377:1990 - Part 3 & BRE CP2/79 - @ Non Accredited Test	5
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

Approved Signatories:
Alex Wynn (Associate Director) - Ben Sharp (Contracts Manager) - Emma Sharp (Office Manager)
Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager) - Sean Penn (Administrative/Accounts Assistant)
Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL	LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5) DESCRIPTIONS	
Contract Number	**40565**	
Site Name	**Epsom Hospital- Main Hospital site**	

Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
BH103	7	D	3.00	-	3.10	Grey silty CLAY.
BH103	8	U	4.00	-	4.45	Grey silty CLAY.
BH103	13	D	6.00	-	6.10	Brown silty CLAY.
BH103	14	U	6.50	-	6.95	Grey silty CLAY.
				-		
				-		

Operators	Checked	25/09/2018	Emma Sharp	
RO/MH	Approved	26/09/2018	Paul Evans	

UKAS

GSTL	LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5) DESCRIPTIONS	
Contract Number	**40564**	
Site Name	**Epsom Hospital- Main Hospital site**	

Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
BH105	14	D	2.00	-	2.45	Brown fine to coarse sandy silty CLAY.
BH105	20	D	4.00	-	4.45	Grey sandy silty CLAY.
BH106	5	B	0.50	-	0.70	Brown fine to coarse sandy silty CLAY.
BH106	14	B	3.00	-	3.45	Brown fine to coarse sandy silty CLAY.
BH106	16	D	4.00	-	4.45	Brown fine to coarse sandy silty CLAY.
BH106	19	D	5.50	-	5.60	Grey sandy silty CLAY.
BH106	20	D	6.50	-	6.60	Black silty CLAY.
BH107	1	B	0.50	-	1.00	Brown silty clayey fine to coarse gravelly SAND.
BH107	13	D	4.50	-	4.60	Brown silty CLAY.
BH107	14	D	5.00	-	5.10	Grey silty CLAY.
BH107	15	D	6.00	-	6.10	Grey silty CLAY.
BH107	22	D	11.00	-	11.10	Grey silty CLAY.
				-		
				-		
				-		
				-		

Operators	Checked	16/09/2018	Emma Sharp	
RO/MH	Approved	17/09/2018	Paul Evans	

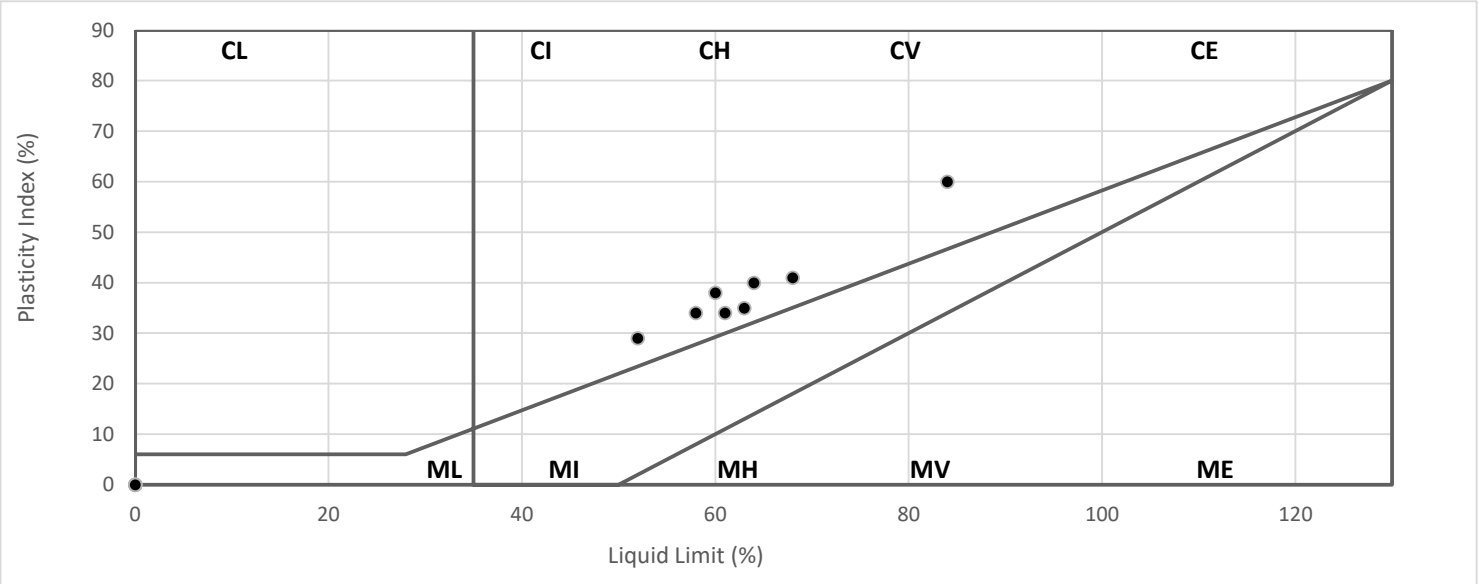
UKAS

GSTL	LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	**40565**	
Site Name	**Epsom Hospital- Main Hospital site**	

Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing .425mm %	Remarks
BH103	7	D	3.00	-	3.10	36	62	26	36	100	CH High Plasticity
BH103	8	U	4.00	-	4.45	33					
BH103	13	D	6.00	-	6.10	31	69	24	45	100	CH High Plasticity
BH103	14	U	6.50	-	6.95	29					
				-							
				-							

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

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



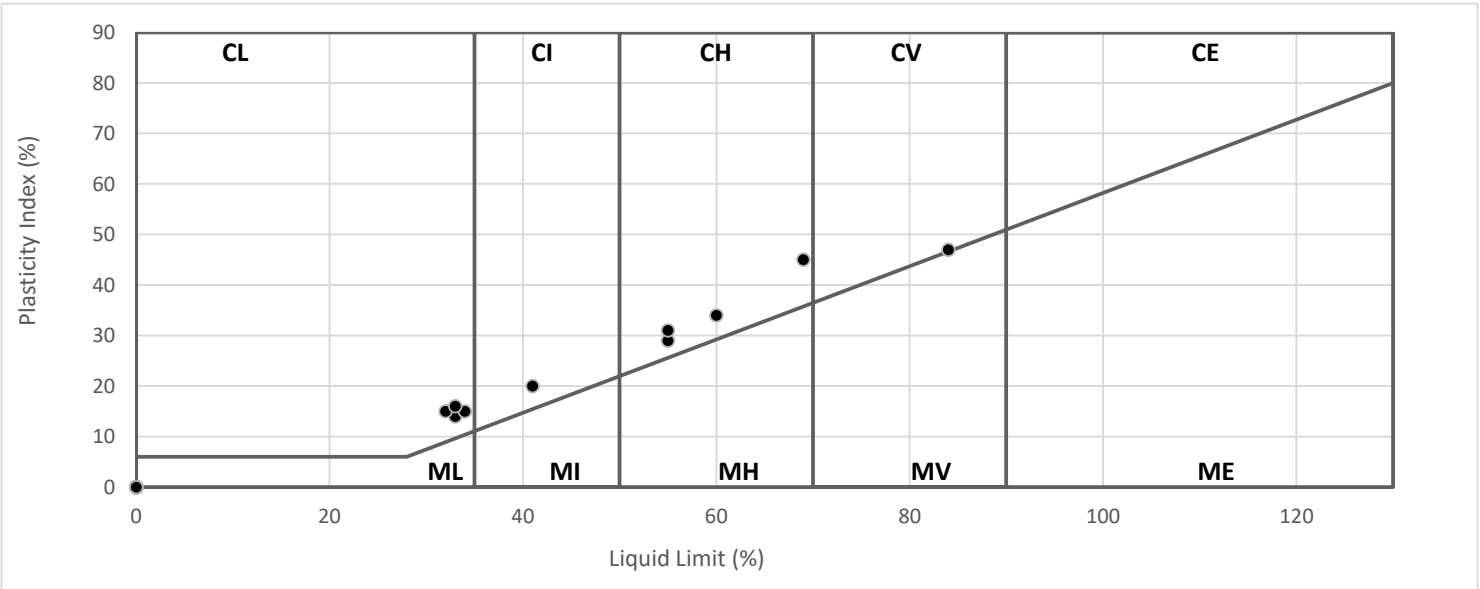
Operators	Checked	25/09/2018	Emma Sharp	
DB	Approved	26/09/2018	Paul Evans	

GSTL	LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	**40564**	
Site Name	**Epsom Hospital- Main Hospital site**	

Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing .425mm %	Remarks
BH105	14	D	2.00	-	2.45	17	33	19	14	50	CL Low Plasticity
BH105	19	D	3.80	-	3.90	28					
BH105	20	D	4.00	-	4.45	25	41	21	20	100	CI Intermediate Plasticity
BH105	2	U	5.00	-	5.45	27					
BH106	5	B	0.50	-	0.70	19	32	17	15	61	CL Low Plasticity
BH106	14	B	3.00	-	3.45	14	34	19	15	56	CL Low Plasticity
BH106	16	D	4.00	-	4.45	12	33	17	16	60	CL Low Plasticity
BH106	18	U	5.00	-	5.45	31					
BH106	19	D	5.50	-	5.60	32	60	26	34	100	CH High Plasticity
BH106	20	D	6.50	-	6.60	34	55	26	29	100	CH High Plasticity
BH107	1	B	0.50	-	1.00	21		NP		24	#VALUE!
BH107	7	B	2.00	-	2.50	9.4					
BH107	12	U	4.00	-	4.45	28					
BH107	13	D	4.50	-	4.60	27	69	24	45	100	CH High Plasticity
BH107	14	D	5.00	-	5.10	32					
BH107	15	D	6.00	-	6.10	44	84	37	47	100	CV Very High Plasticity
BH107	16	U	6.50	-	6.95	26					
BH107	20	U	9.50	-	9.95	31					
BH107	22	D	11.00	-	11.10	25	55	24	31	100	CH High Plasticity
BH107	24	U	12.50	-	12.95	14					
				-							
				-							
				-							
				-							

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

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	16/09/2018	Emma Sharp	
DB	Approved	17/09/2018	Paul Evans	

GSTL

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
(BS 1377 : Part 2 : 1990 Method 5)
DESCRIPTIONS

Contract Number	**40564**
Site Name	**Epsom Hospital- Main Hospital site**

Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
WS106	10	D	1.20	-	1.65	Brown fine to medium gravelly sandy silty CLAY.
WS106	11	D	2.00	-	2.45	Brown fine to medium gravelly sandy silty CLAY.
WS106	13	D	4.00	-	4.45	Brown fine to medium gravelly sandy silty CLAY.
WS107	9	D	1.20	-	1.65	Brown fine to medium gravelly sandy silty CLAY.
WS107	11	D	3.00	-	3.45	Brown fine to medium gravelly sandy silty CLAY.
WS109	4	B	0.70	-	0.90	Brown fine to medium gravelly sandy silty CLAY.
WS110	2	B	0.30	-	0.50	Brown fine to medium gravelly sandy silty CLAY.
WS111	5	I	1.20	-	2.00	Brown fine to medium gravelly sandy silty CLAY.
WS111	6	I	2.00	-	3.00	Brown silty CLAY.
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		

Operators	Checked	16/09/2018	Emma Sharp	
RO/MH	Approved	17/09/2018	Paul Evans	

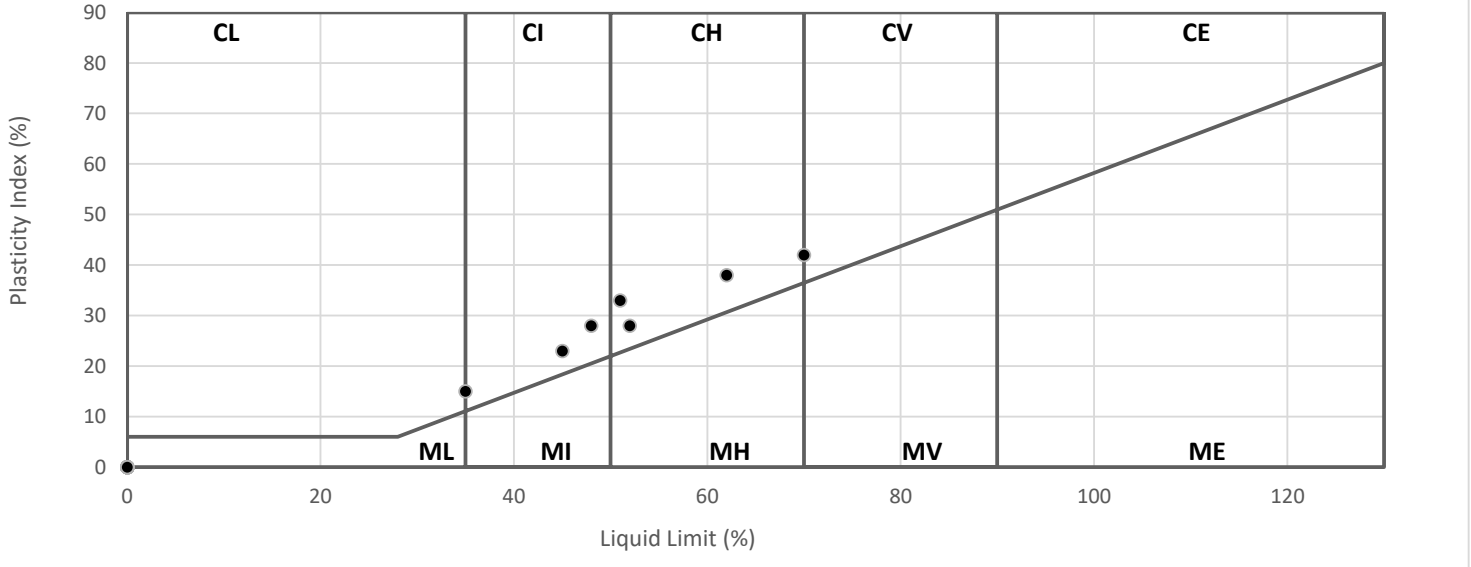
UKAS

GSTL	LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	**40564**	
Site Name	**Epsom Hospital- Main Hospital site**	

Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing .425mm %	Remarks
WS106	10	D	1.20	-	1.65	21	51	18	33	83	CH High Plasticity
WS106	11	D	2.00	-	2.45	31	70	28	42	84	CH/V High/HighPlasticity
WS106	13	D	4.00	-	4.45	23	52	24	28	100	CH High Plasticity
WS107	9	D	1.20	-	1.65	29	45	22	23	87	CI Intermediate Plasticity
WS107	11	D	3.00	-	3.45	25	48	20	28	100	CI Intermediate Plasticity
WS109	4	B	0.70	-	0.90	20					
WS110	2	B	0.30	-	0.50	14	35	20	15	59	CL/I Low/Inter. Plasticity
WS111	5	I	1.20	-	2.00	14					
WS111	6	I	2.00	-	3.00	32	62	24	38	100	CH High Plasticity
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							

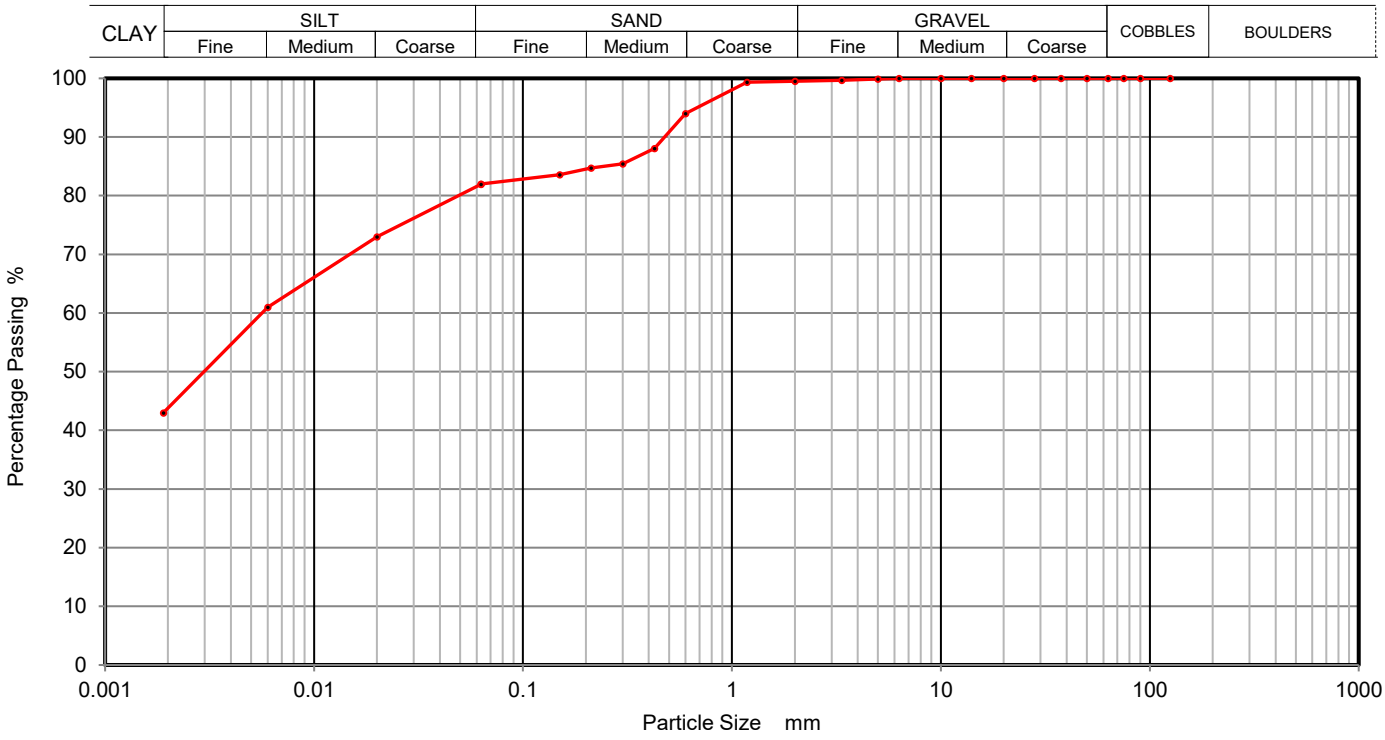
Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	16/09/2018	Emma Sharp	
DB	Approved	17/09/2018	Paul Evans	

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4	Contract Number	40564
		Borehole/Pit No.	BH105
Site Name	Epsom Hospital- Main Hospital site	Sample No.	19
Soil Description	Grey fine to coarse sandy silty CLAY	Depth Top	3.80
		Depth Base	3.90
		Sample Type	D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	73
90	100	0.0060	61
75	100	0.0019	43
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	94		
0.425	88		
0.3	85		
0.212	85		
0.15	84		
0.063	82		

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	18
Silt	39
Clay	43

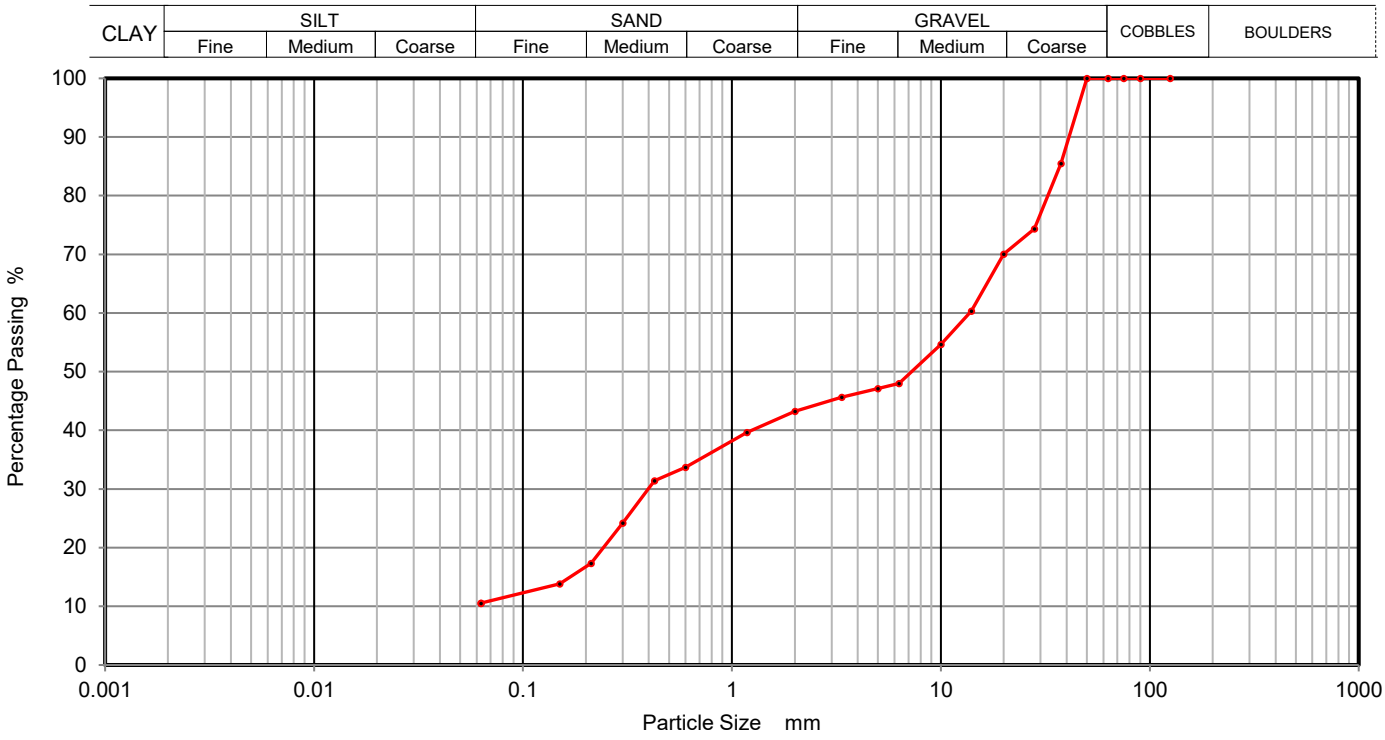
Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	16/09/2018	Emma Sharp	
RO/MH	Approved	17/09/2018	Paul Evans	

GSTL	**PARTICLE SIZE DISTRIBUTION** **BS 1377 Part 2:1990** **Wet Sieve, Clause 9.2**	Contract Number	**40564**
		Borehole/Pit No.	**BH107**
Site Name	**Epsom Hospital- Main Hospital site**	Sample No.	**7**
Soil Description	Brown silty fine to coarse sandy fine to coarse GRAVEL.	Depth Top	**2.00**
		Depth Base	**2.50**
		Sample Type	**B**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	
90	100	0.0060	
75	100	0.0019	
63	100		
50	100		
37.5	85		
28	74		
20	70		
14	60		
10	55		
6.3	48		
5	47		
3.35	46		
2	43		
1.18	40		
0.6	34		
0.425	31		
0.3	24		
0.212	17		
0.15	14		
0.063	11		

Sample Proportions	% dry mass
Cobbles	0
Gravel	57
Sand	32
Silt and Clay	11

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	16/09/2018	Emma Sharp	
RO/MH	Approved	17/09/2018	Paul Evans	

UKAS TESTING

GSTL	**Certificate of Chemical Analysis** **(BRE BR 279)**	**Contract Number**	40565
		Client Reference	10020221
Client	Arcadis	**Date Received**	
Site Name	Epsom Hospital- Main Hospital site	**Date Started**	06/09/2018
		Date Completed	26/09/2018
		No. of Samples	7

Hole Number	Sample Number	Sample Type	Depth (m)			Acid Soluble Sulphate	Aqueous Extract Sulphate	Chloride Content	Ph Value	Total Sulphur	Magnesium	Nitrate
BH103	8	U	4.00	-	4.45	0.49	0.11		6.97	0.19		
				-								
				-								
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Key	**Reported As**
Acid Soluble Sulphate	% SO_4
Aqueous Extract Sulphate	g/l SO_4
Chloride Content (Semi)	mg Cl/l
PH Value	@ 25°
Total Sulphur	% S
Magnesium	g/l SO_4
Nitrate	NO_3 mg/l

Remarks

NCP = No Chloride Present

Test Operator	Checked and Authorised by		Ben Sharp
Darren Bourne	Date	26/09/2018	

GSTL	**Certificate of Chemical Analysis (BRE BR 279)**	**Contract Number**	40564
		Client Reference	10020221
Client	Arcadis	**Date Received**	
Site Name	Epsom Hospital - Main Hospital Site	**Date Started**	06/09/2018
		Date Completed	17/09/2018
		No. of Samples	5

Hole Number	Sample Number	Sample Type	Depth (m)			Acid Soluble Sulphate	Aqueous Extract Sulphate	Chloride Content	Ph Value	Total Sulphur	Magnesium	Nitrate
BH105	18	B	3.00	-	3.50	0.27	0.06		7.51	0.11		
BH106	16	D	4.00	-	4.45	0.31	0.06		7.82	0.14		
BH107	12	U	4.00	-	4.45	0.31	0.05		7.47	0.14		
WS109	4	B	0.70	-	0.90	0.08	0.08		7.30	0.05		
WS111	5	L	1.20	-	2.00	0.27	0.05		7.28	0.12		
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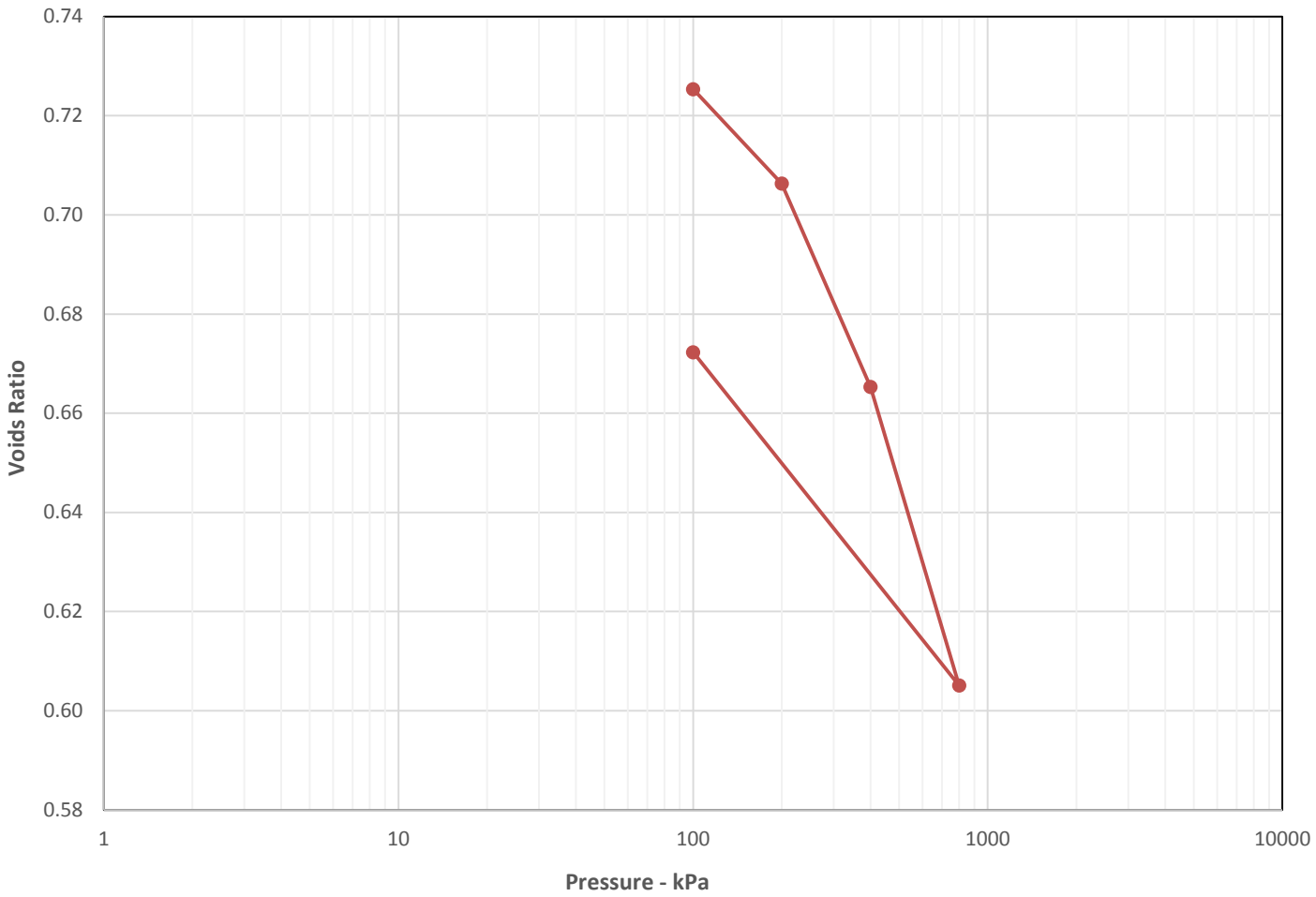
<u>Key</u>	<u>Reported As</u>
Acid Soluble Sulphate	% SO_4
Aqueous Extract Sulphate	g/l SO_4
Chloride Content (Semi)	mg Cl/l
PH Value	@ 25°
Total Sulphur	% S
Magnesium	g/l SO_4
Nitrate	NO_3 mg/l

Remarks

NCP = No Chloride Present

Test Operator	Checked and Authorised by		Ben Sharp	
Darren Bourne	Date	17/09/2018		

GSTL	ONE DIMENSIONAL CONSOLIDATION TEST BS1377:Part 5:1990, clause 3	Contract Number	40565
		Borehole/Trialpit No.	Bh103
Site Name	Epsom Hospital- Main Hospital site	Sample No.	8
Soil Description	Dark grey silty stiff CLAY	Depth Top (m)	4.00
		Depth Base (m)	4.45
Lab Temperature	20°c	Sample Location	Top
Remarks	Cv Calculated Using T90	Sample Type	U

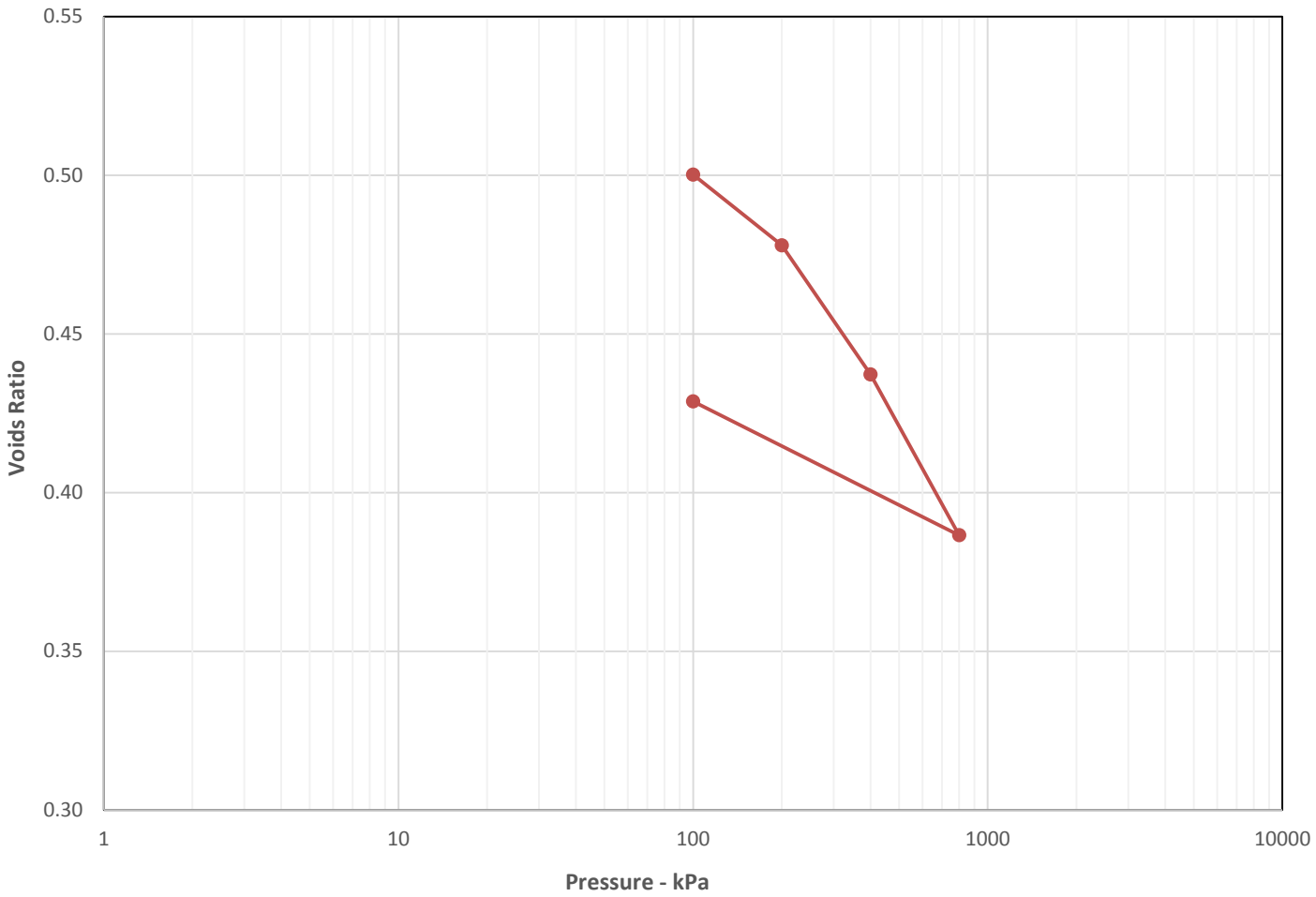


Initial Sample Conditions		Pressure Range			Mv m2/MN	Cv m2/yr	Pressure Range			Mv m2/MN	Cv m2/yr
Moisture Content (%)	25	0	-	100	0.024	31		-			
Bulk Density (Mg/m3)	1.92	100	-	200	0.11	8.9		-			
Dry Density (Mg/m3)	1.53	200	-	400	0.12	12		-			
Voids Ratio	0.7295	400	-	800	0.090	6.9		-			
Degree of saturation	90.9	800	-	100	0.06	4.3		-			
Height (mm)	19.82		-					-			
Diameter (mm)	75.01		-					-			
Particle Density (Mg/m3)	2.65		-					-			

Operators	Checked	13/09/2018	Richard John	
LG	Approved	14/09/2018	Ben Sharp	

UKAS TESTING
2788

GSTL	ONE DIMENSIONAL CONSOLIDATION TEST BS1377:Part 5:1990, clause 3	Contract Number	40564
		Borehole/Trialpit No.	Bh107
Site Name	Epsom Hospital- Main Hospital site	Sample No.	12
Soil Description	Greyish brown silty stiff CLAY	Depth Top (m)	4.00
		Depth Base (m)	4.45
Lab Temperature	20°c	Sample Location	Top
Remarks	Cv Calculated Using T90	Sample Type	U

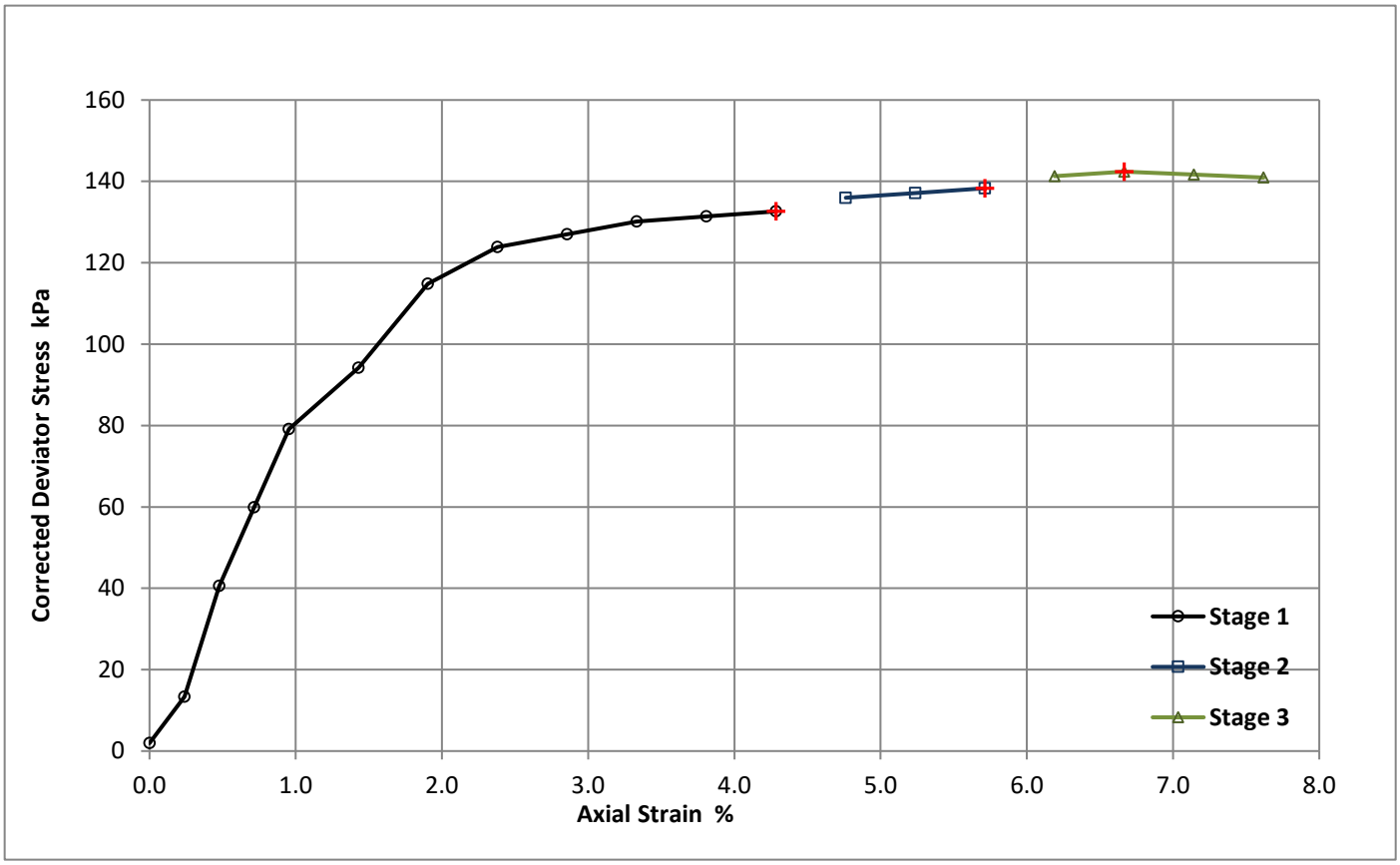


Initial Sample Conditions		Pressure Range			Mv m2/MN	Cv m2/yr	Pressure Range			Mv m2/MN	Cv m2/yr
Moisture Content (%)	19	0	-	100	0.2	18		-			
Bulk Density (Mg/m3)	2.06	100	-	200	0.15	4.6		-			
Dry Density (Mg/m3)	1.73	200	-	400	0.14	4.1		-			
Voids Ratio	0.5312	400	-	800	0.088	3.1		-			
Degree of saturation	94.3	800	-	100	0.043	2.1		-			
Height (mm)	19.65		-					-			
Diameter (mm)	74.99		-					-			
Particle Density (Mg/m3)	2.65		-					-			

Operators	Checked	13/09/2018	Richard John	
LG	Approved	14/09/2018	Ben Sharp	

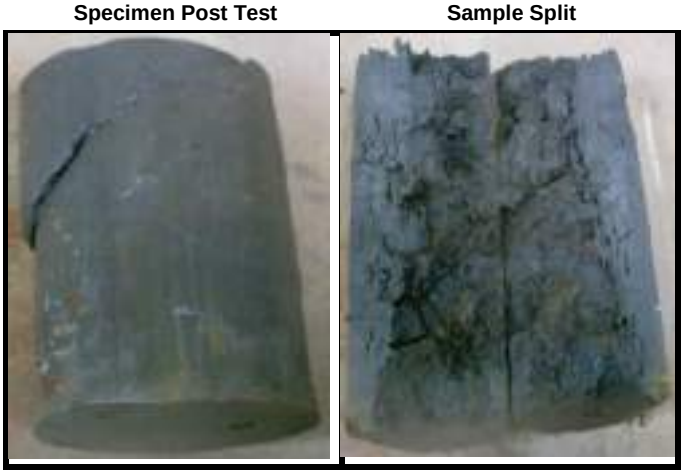
UKAS TESTING
2788

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40565
		Borehole/Pit No.	BH103
Site Name	Epsom Hospital- Main Hospital site	Sample No.	14
Soil Description	Brown silty CLAY	Depth Top	6.50
		Depth Base	6.95
		Sample Type	U



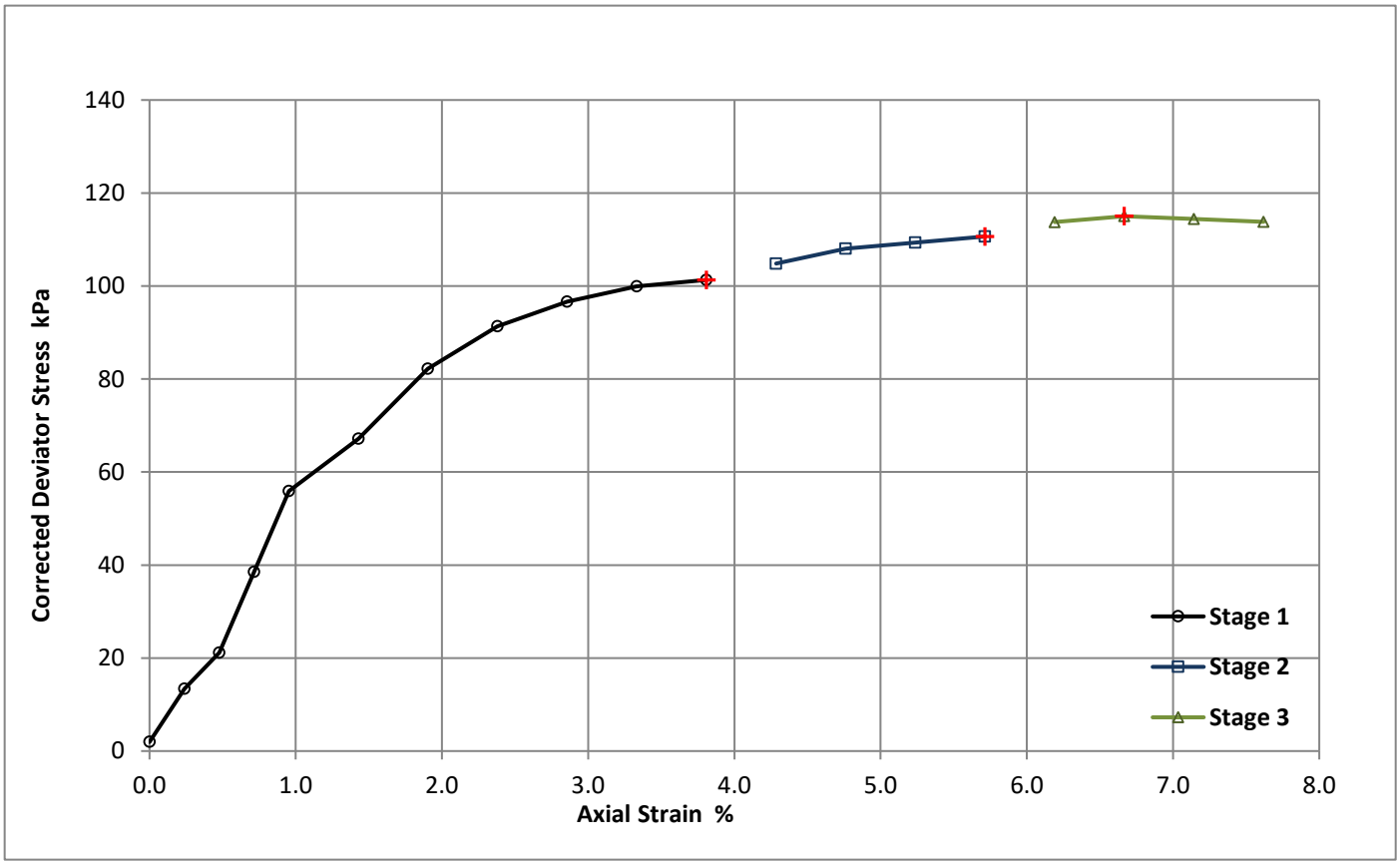
Moisture Content (%)	29		
Bulk Density (Mg/m^3)	1.87		
Dry Density (Mg/m^3)	1.45		
Specimen Length (mm)	210		
Specimen Diamteter (mm)	104		
Cell Pressures (kPa)	100	125	150
Deviator Stress (kPa)	133	138	142
Undrained Shear Strength (kPa)	66	69	71
Failure Strain (%)	4.3	5.7	6.7
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

Specimen Post Test **Sample Split**



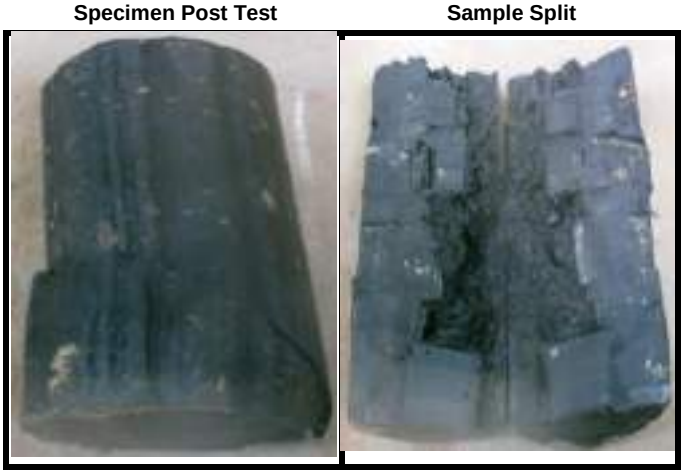
Checked	13/09/2018	Ben Sharp	
Approved	14/09/2018	Paul Evans	

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40565
		Borehole/Pit No.	BH103
Site Name	Epsom Hospital- Main Hospital site	Sample No.	8
Soil Description	Grey silty CLAY	Depth Top	4.00
		Depth Base	4.45
		Sample Type	U



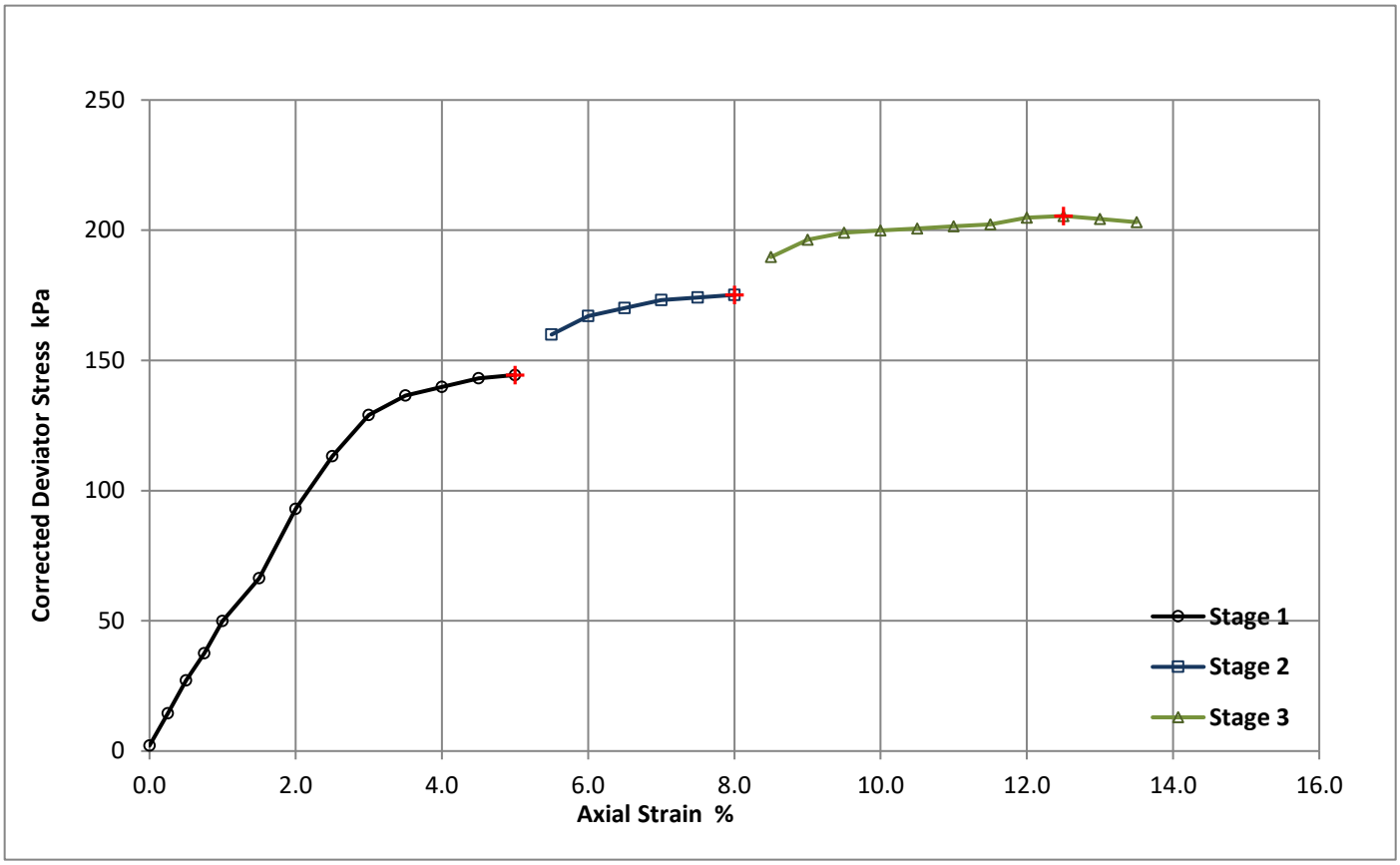
Moisture Content (%)	33		
Bulk Density (Mg/m^3)	1.84		
Dry Density (Mg/m^3)	1.39		
Specimen Length (mm)	210		
Specimen Diamteter (mm)	104		
Cell Pressures (kPa)	100	125	150
Deviator Stress (kPa)	101	111	115
Undrained Shear Strength (kPa)	51	55	58
Failure Strain (%)	3.8	5.7	6.7
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

Specimen Post Test **Sample Split**



Checked	13/09/2018	Ben Sharp	
Approved	14/09/2018	Paul Evans	

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40564
		Borehole/Pit No.	BH105
Site Name	Epsom Hospital- Main Hospital site	Sample No.	
Soil Description	Brown/grey sandy silty CLAY.	Depth Top	5.00
		Depth Base	5.45
		Sample Type	U



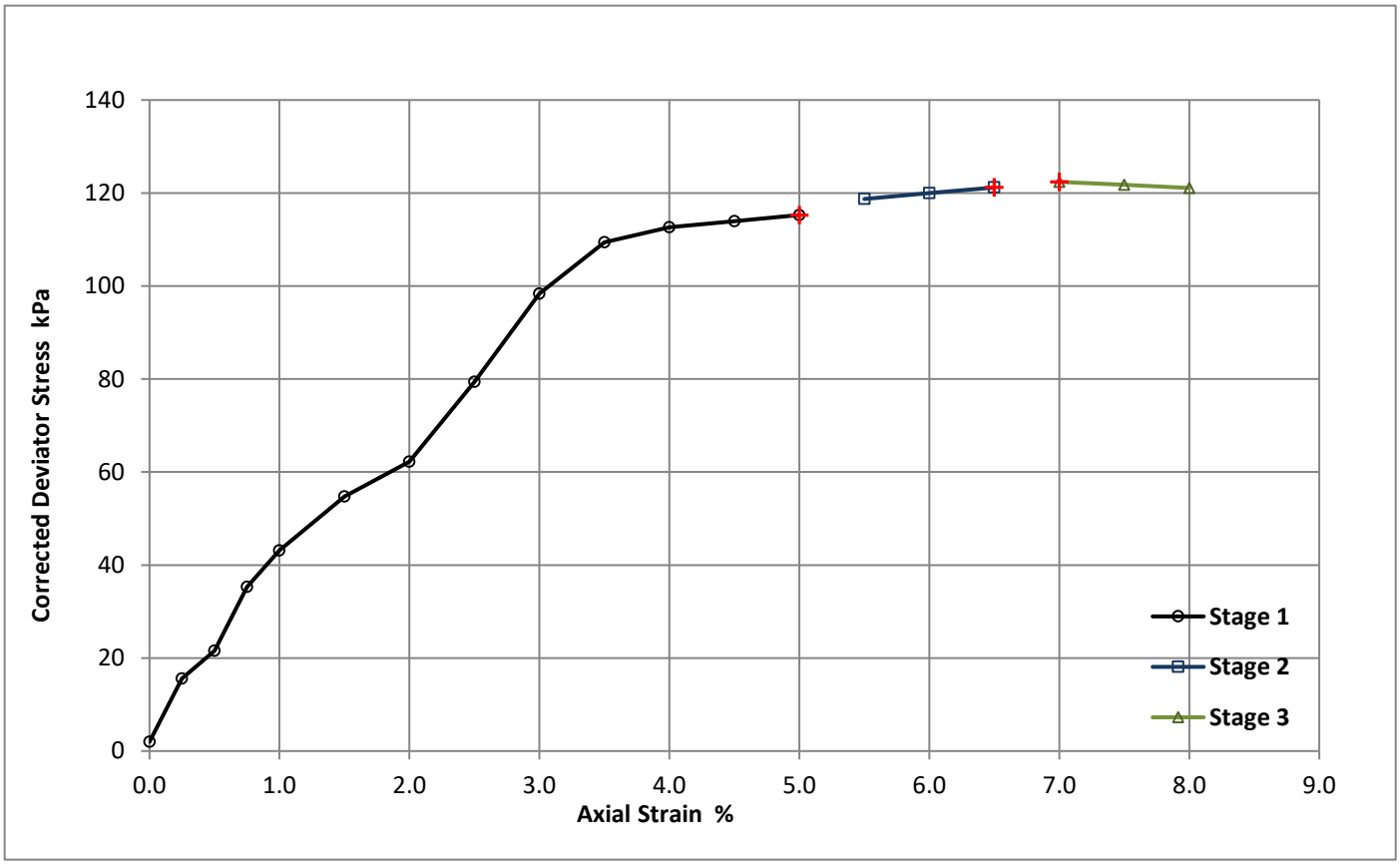
Moisture Content (%)	27		
Bulk Density (Mg/m^3)	2.02		
Dry Density (Mg/m^3)	1.59		
Specimen Length (mm)	200		
Specimen Diamteter (mm)	100		
Cell Pressures (kPa)	100	150	200
Deviator Stress (kPa)	144	175	205
Undrained Shear Strength (kPa)	72	88	103
Failure Strain (%)	5.0	8.0	13
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

Specimen Post Test **Sample Split**

Checked	16/09/2018	Ben Sharp	
Approved	17/09/2018	Paul Evans	

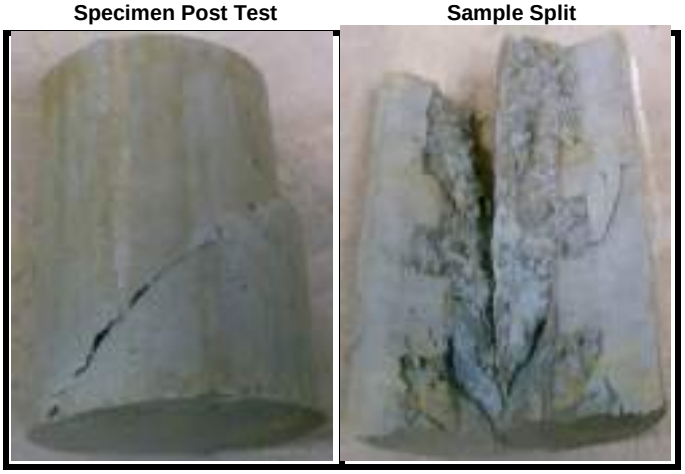
UKAS

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40564
		Borehole/Pit No.	BH106
Site Name	Epsom Hospital- Main Hospital site	Sample No.	
Soil Description	Brown/grey silty CLAY.	Depth Top	5.00
		Depth Base	5.45
		Sample Type	U



Moisture Content (%)	31		
Bulk Density (Mg/m^3)	1.90		
Dry Density (Mg/m^3)	1.45		
Specimen Length (mm)	200		
Specimen Diamteter (mm)	103		
Cell Pressures (kPa)	100	150	200
Deviator Stress (kPa)	115	121	122
Undrained Shear Strength (kPa)	58	61	61
Failure Strain (%)	5.0	6.5	7.0
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

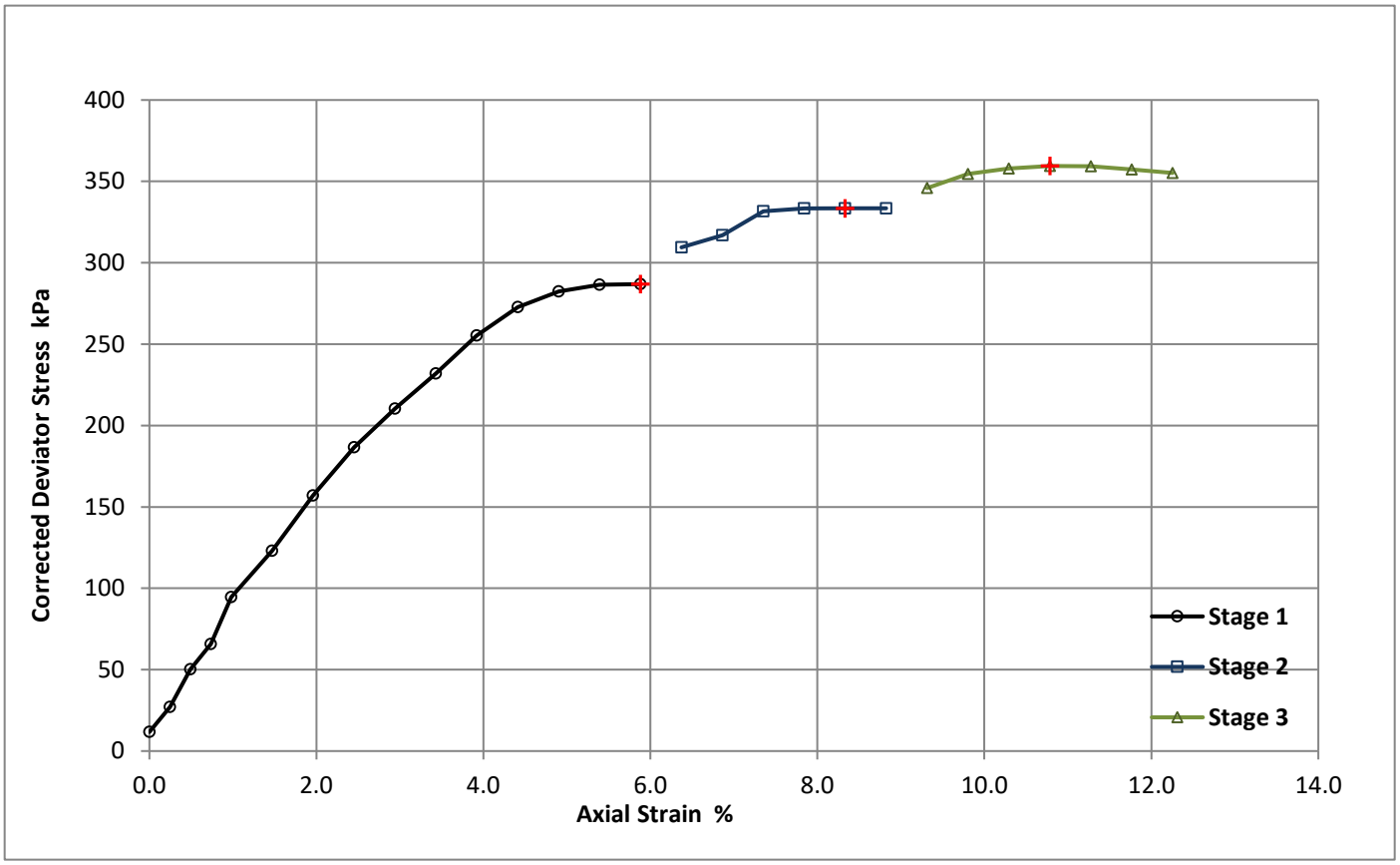
Specimen Post Test **Sample Split**



Checked	16/09/2018	Ben Sharp	
Approved	17/09/2018	Paul Evans	

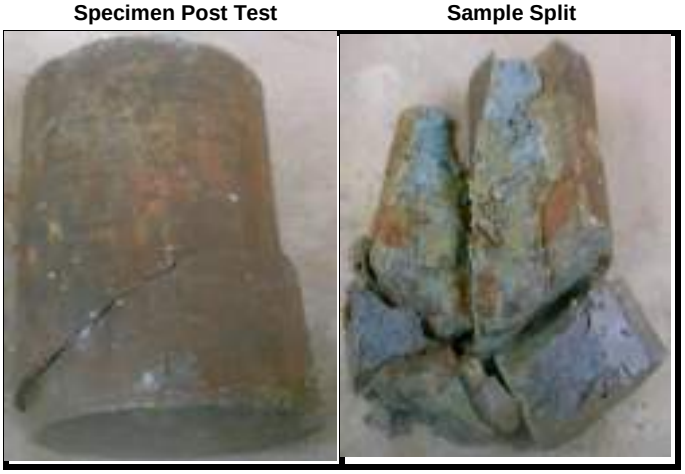
UKAS TESTING 2956

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40564
		Borehole/Pit No.	BH107
Site Name	Epsom Hospital- Main Hospital site	Sample No.	
Soil Description	Brown/grey sandy silty CLAY.	Depth Top	12.50
		Depth Base	12.95
		Sample Type	U



Moisture Content (%)	14		
Bulk Density (Mg/m^3)	2.11		
Dry Density (Mg/m^3)	1.85		
Specimen Length (mm)	204		
Specimen Diamteter (mm)	104		
Cell Pressures (kPa)	250	300	350
Deviator Stress (kPa)	287	333	359
Undrained Shear Strength (kPa)	143	167	180
Failure Strain (%)	5.9	8.3	10.78
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

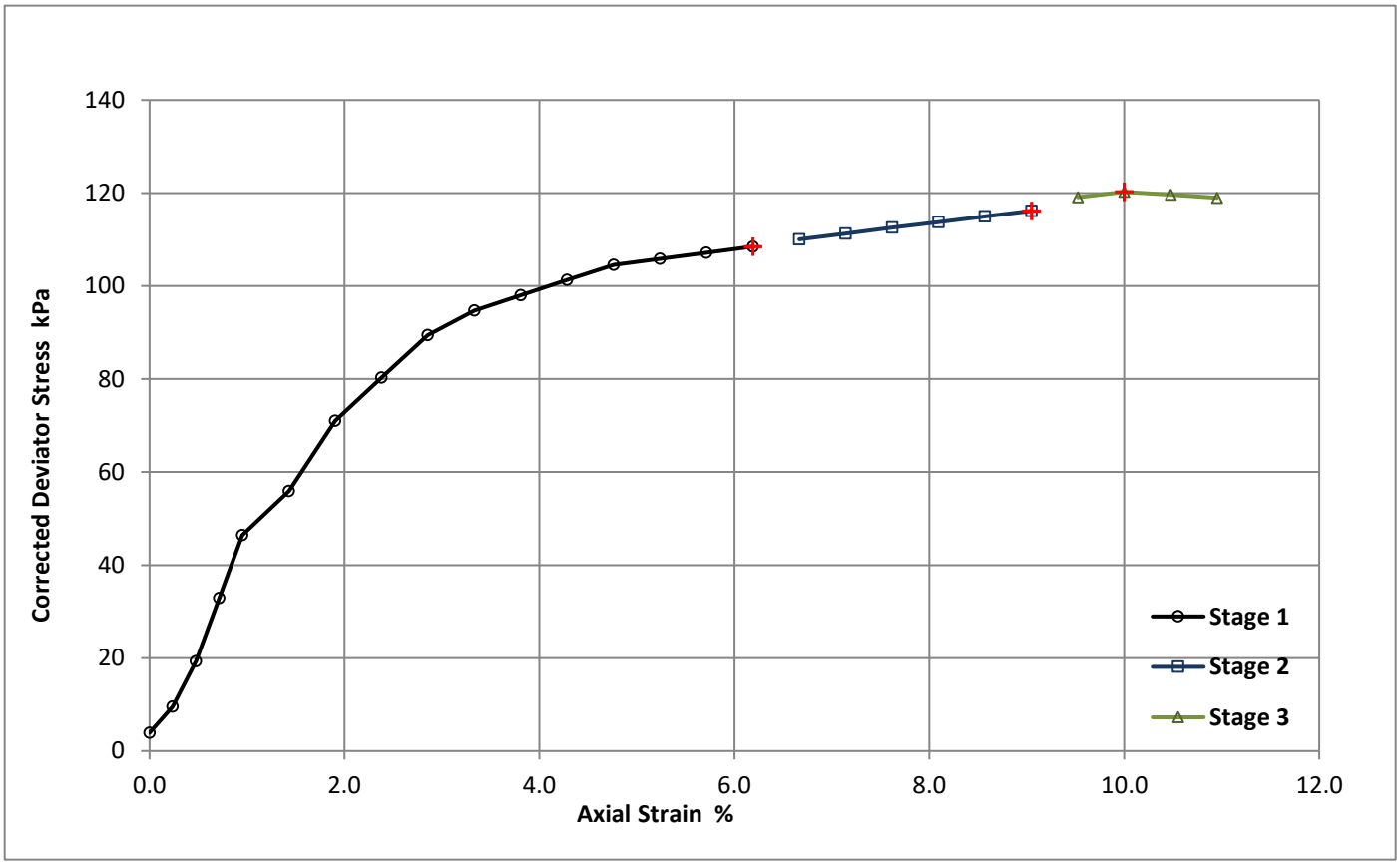
Specimen Post Test **Sample Split**



Checked	16/09/2018	Ben Sharp	
Approved	17/09/2018	Paul Evans	

UKAS

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40564
		Borehole/Pit No.	BH107
Site Name	Epsom Hospital- Main Hospital site	Sample No.	
Soil Description	Brown/grey silty CLAY.	Depth Top	4.00
		Depth Base	4.45
		Sample Type	U



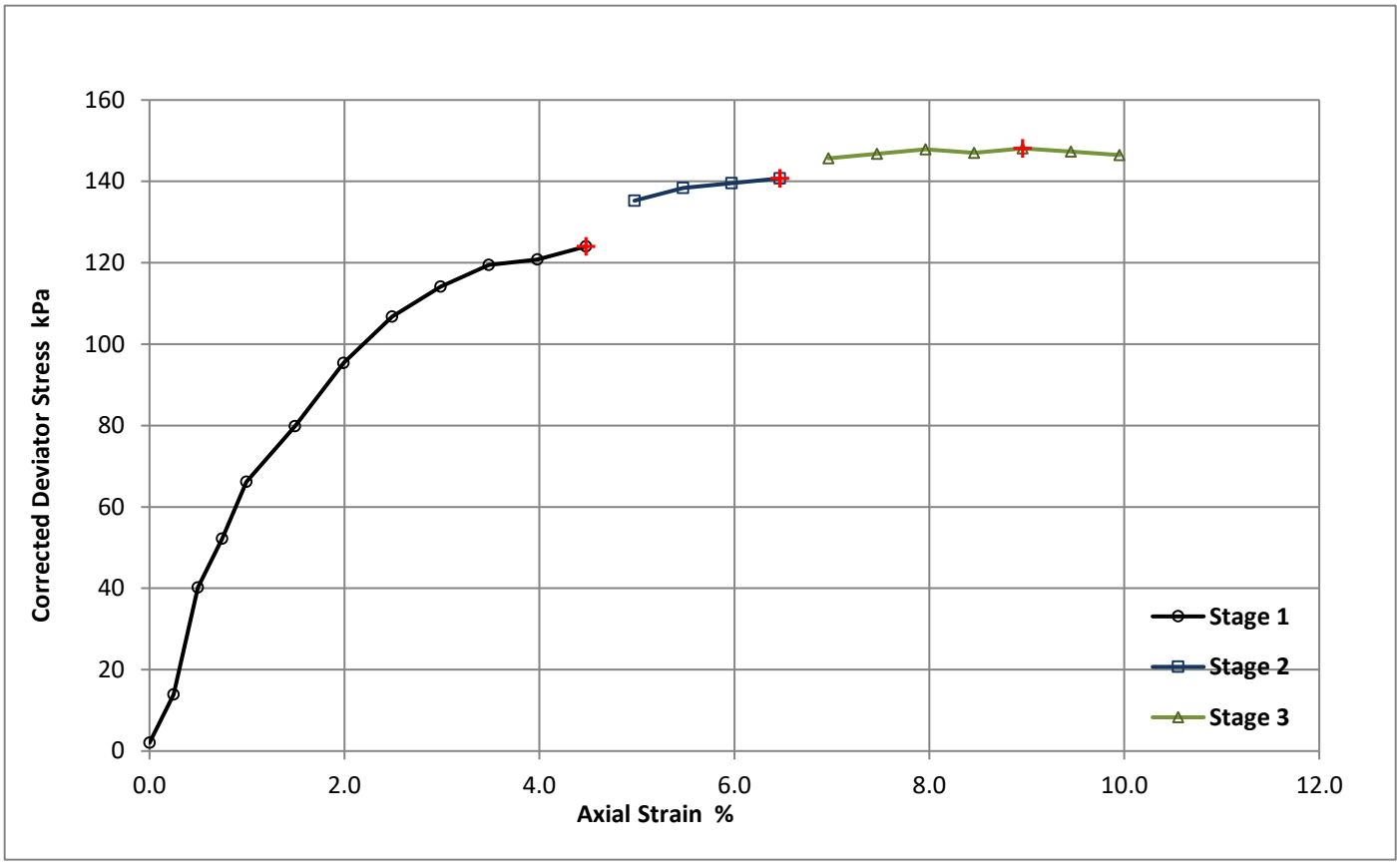
Moisture Content (%)	28		
Bulk Density (Mg/m^3)	2.01		
Dry Density (Mg/m^3)	1.58		
Specimen Length (mm)	210		
Specimen Diamteter (mm)	104		
Cell Pressures (kPa)	100	125	150
Deviator Stress (kPa)	108	116	120
Undrained Shear Strength (kPa)	54	58	60
Failure Strain (%)	6.2	9.0	10
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

Specimen Post Test **Sample Split**

Checked	16/09/2018	Ben Sharp	
Approved	17/09/2018	Paul Evans	

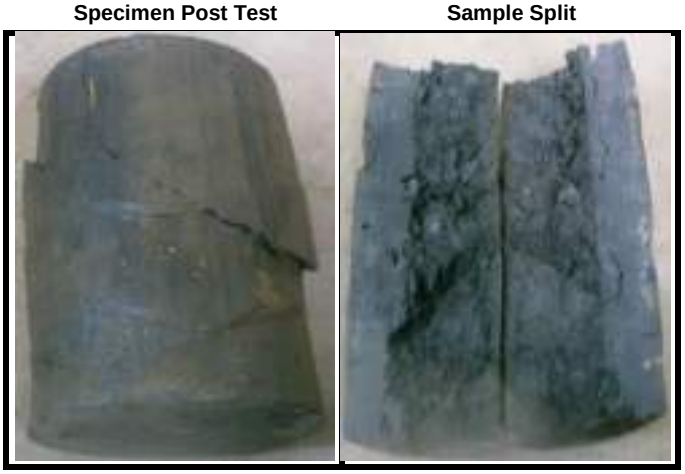
UKAS

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40564
		Borehole/Pit No.	BH107
Site Name	Epsom Hospital- Main Hospital site	Sample No.	
Soil Description	Brown/grey silty CLAY.	Depth Top	6.50
		Depth Base	6.95
		Sample Type	U



Moisture Content (%)	26		
Bulk Density (Mg/m^3)	1.99		
Dry Density (Mg/m^3)	1.58		
Specimen Length (mm)	201		
Specimen Diamteter (mm)	102		
Cell Pressures (kPa)	100	150	200
Deviator Stress (kPa)	124	141	148
Undrained Shear Strength (kPa)	62	70	74
Failure Strain (%)	4.5	6.5	8.96
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

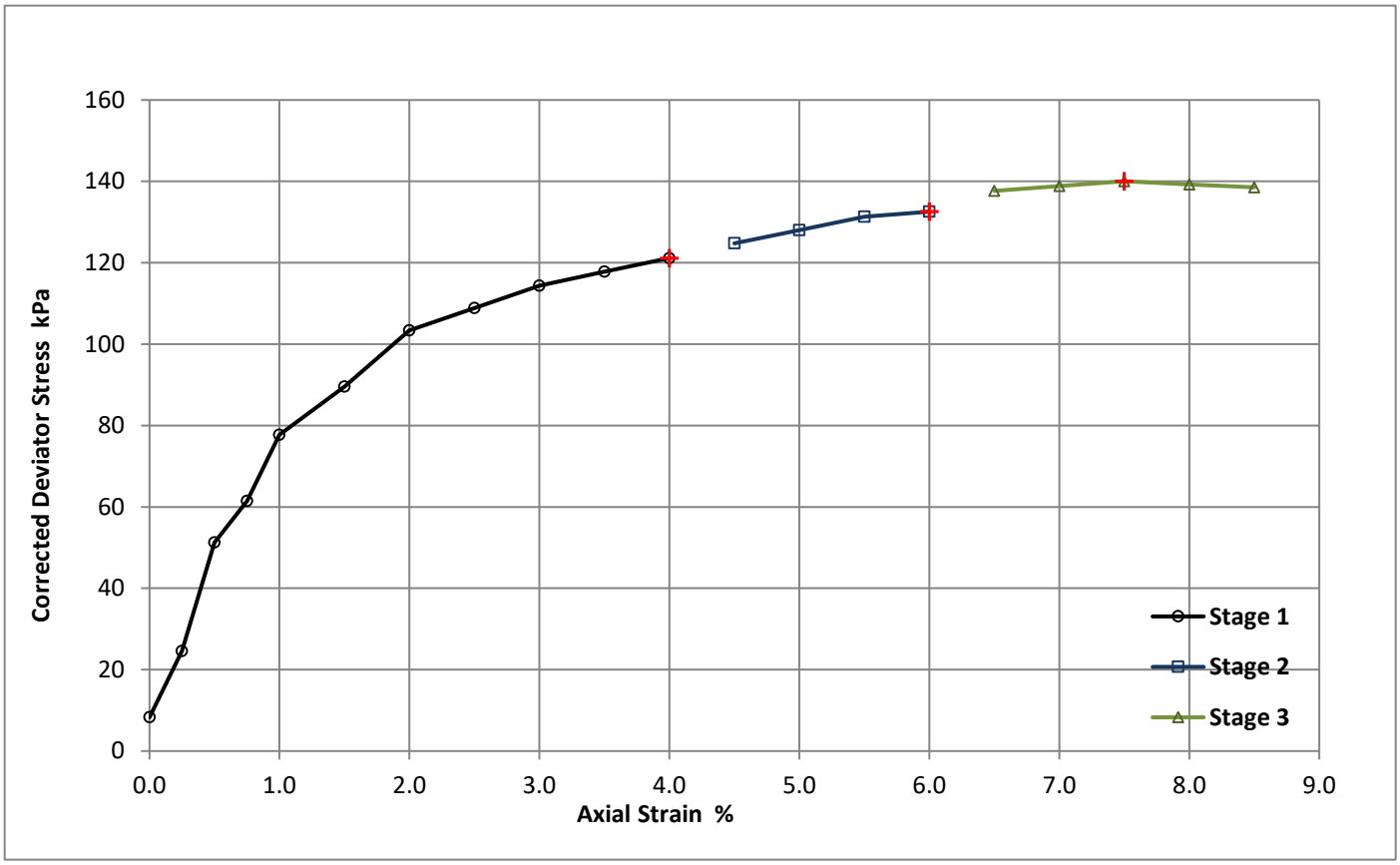
Specimen Post Test **Sample Split**



Checked	16/09/2018	Ben Sharp	
Approved	17/09/2018	Paul Evans	

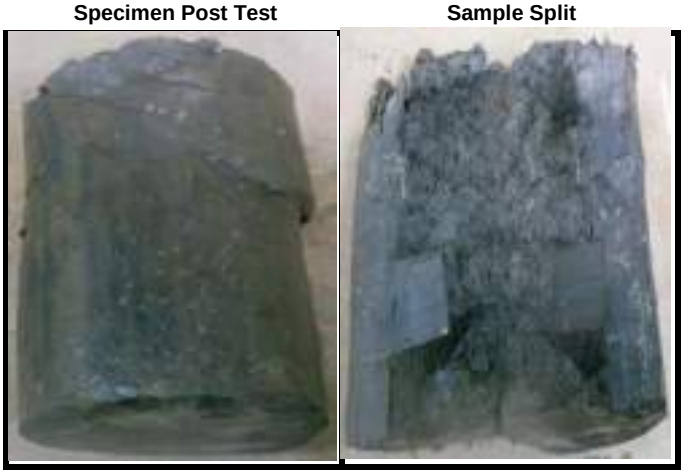
UKAS TESTING 2956

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	40564
		Borehole/Pit No.	BH107
Site Name	Epsom Hospital- Main Hospital site	Sample No.	
Soil Description	Brown/grey silty CLAY.	Depth Top	9.50
		Depth Base	9.95
		Sample Type	U



Moisture Content (%)	31		
Bulk Density (Mg/m^3)	1.99		
Dry Density (Mg/m^3)	1.53		
Specimen Length (mm)	200		
Specimen Diamteter (mm)	101		
Cell Pressures (kPa)	175	225	275
Deviator Stress (kPa)	121	133	140
Undrained Shear Strength (kPa)	61	66	70
Failure Strain (%)	4.0	6.0	7.50
Mode Of Failure	Compound		
Mrmbrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

Specimen Post Test **Sample Split**



Checked	16/09/2018	Ben Sharp	
Approved	17/09/2018	Paul Evans	

UKAS

APPENDIX G - Geo-Environmental Laboratory Data

Ian Parsons
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Analytical Report Number : 18-97270-B

Replaces Analytical Report Number : 18-97270, issue no. 2

Project / Site name:	Epsom Hospital Main Hospital Site	**Samples received on:**	21/08/2018
Your job number:	10020221	**Samples instructed on:**	21/08/2018
Your order number:		**Analysis completed by:**	10/09/2018
Report Issue Number:	3	**Report issued on:**	13/09/2018
Samples Analysed:	4 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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Analytical Report Number: 18-97270-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1028128	1028129	1028130	1028131	
Sample Reference				WS106	WS106	WS107	WS107	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.30	0.70	0.30	1.20	
Date Sampled				15/08/2018	15/08/2018	15/08/2018	15/08/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	8.6	3.8	7.4	20	
Total mass of sample received	kg	0.001	NONE	0.38	0.42	0.39	0.39	
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	Chrysotile	-	-	-	
Asbestos in Soil	Type	N/A	ISO 17025	Detected	Not-detected	Not-detected	Not-detected	
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	< 0.001	-	-	-	
Asbestos Quantification Total	%	0.001	ISO 17025	< 0.001	-	-	-	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.5	7.9	7.5	7.6	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.024	0.012	0.032	0.20	
Fraction Organic Carbon (FOC)	N/A	0.001	NONE	-	-	-	0.0031	
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	
Phenanthrene	mg/kg	0.05	MCERTS	0.34	< 0.05	< 0.05	< 0.05	
Anthracene	mg/kg	0.05	MCERTS	0.12	< 0.05	< 0.05	< 0.05	
Fluoranthene	mg/kg	0.05	MCERTS	1.0	< 0.05	< 0.05	< 0.05	
Pyrene	mg/kg	0.05	MCERTS	0.90	< 0.05	< 0.05	< 0.05	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.53	< 0.05	< 0.05	< 0.05	
Chrysene	mg/kg	0.05	MCERTS	0.59	< 0.05	< 0.05	< 0.05	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.91	< 0.05	< 0.05	< 0.05	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.35	< 0.05	< 0.05	< 0.05	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.68	< 0.05	< 0.05	< 0.05	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.40	< 0.05	< 0.05	< 0.05	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.45	< 0.05	< 0.05	< 0.05	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	6.29	< 0.80	< 0.80	< 0.80	
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	12	11	11	9.0	
Boron (water soluble)	mg/kg	0.2	MCERTS	0.9	0.5	1.0	1.0	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	27	26	23	44	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	30	12	24	42	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	120	30	44	23	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	19	17	15	27	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	110	39	63	64	

Analytical Report Number: 18-97270-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1028128	1028129	1028130	1028131	
Sample Reference				WS106	WS106	WS107	WS107	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.30	0.70	0.30	1.20	
Date Sampled				15/08/2018	15/08/2018	15/08/2018	15/08/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPH6 - Aliphatic (C6 - C8)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aliphatic (C8 - C10)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aliphatic (C10 - C12)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
TPH6 - Aliphatic (C12 - C16)	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	
TPH6 - Aliphatic (C16 - C21)	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	
TPH6 - Aliphatic (C21 - C35)	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	
TPH6 - Aliphatic (C6 - C35)	mg/kg	10	NONE	< 10	< 10	< 10	< 10	
TPH6 - Aromatic (C6 - C8)	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aromatic (C8 - C10)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aromatic (C10 - C12)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
TPH6 - Aromatic (C12 - C16)	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	
TPH6 - Aromatic (C16 - C21)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	
TPH6 - Aromatic (C21 - C35)	mg/kg	10	MCERTS	21	< 10	< 10	< 10	
TPH6 - Aromatic (C6 - C35)	mg/kg	10	NONE	21	< 10	< 10	< 10	

Analytical Report Number: **18-97270** B
Project / Site name: **Epsom Hospital Main Hospital Site**
Your Order No:

Certificate of Analysis - Asbestos Quantification

Methods:

Qualitative Analysis

The samples were analysed qualitatively for asbestos by polarising light and dispersion staining as described by the Health and Safety Executive in HSG 248.

Quantitative Analysis

The analysis was carried out using our documented in-house method A006 based on HSE Contract Research Report No: 83/1996: Development and Validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (Davies et al, 1996) and HSG 248. Our method includes initial examination of the entire representative sample, then fractionation and detailed analysis of each fraction, with quantification by hand picking and weighing.

The limit of detection (reporting limit) of this method is 0.001 %.

The method has been validated using samples of at least 100 g, results for samples smaller than this should be interpreted with caution.

Both Qualitative and Quantitative Analyses are UKAS accredited.

Sample Number	Sample ID	Sample Depth (m)	Sample Weight (g)	Asbestos Containing Material Types Detected (ACM)	PLM Results	Asbestos by hand picking/weighing (%)	Total % Asbestos in Sample
1028128	WS106	0.30	110	Loose Fibres	**Chrysotile**	< 0.001	**< 0.001**

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Analytical Report Number : 18-97270-B

Project / Site name: Epsom Hospital Main Hospital Site

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1028128	WS106	None Supplied	0.30	Brown loam and sand with gravel.
1028129	WS106	None Supplied	0.70	Brown sand with gravel.
1028130	WS107	None Supplied	0.30	Brown loam and sand.
1028131	WS107	None Supplied	1.20	Grey clay with vegetation.

Analytical Report Number : 18-97270-B

Project / Site name: Epsom Hospital Main Hospital Site

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Asbestos Quantification - Gravimetric	Asbestos quantification by gravimetric method - in house method based on references.	HSE Report No: 83/1996, HSG 248, HSG 264 & SCA Blue Book (draft).	A006-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Fraction of Organic Carbon in soil	Determination of fraction of organic carbon in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L009-PL	D	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH6 (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method	L076-PL	D	MCERTS

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

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Analytical Report Number : 18-97314-B

Replaces Analytical Report Number : 18-97314, issue no. 3

Project / Site name:	Epsom Hospital Main Hospital Site	**Samples received on:**	21/08/2018
Your job number:	10020221	**Samples instructed on:**	22/08/2018
Your order number:		**Analysis completed by:**	10/09/2018
Report Issue Number:	4	**Report issued on:**	13/09/2018
Samples Analysed:	9 soil samples		

Signed: 

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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Analytical Report Number: 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1028359	1028365	1028366	1028367	1028368
Sample Reference				BH103	WS108	WS109	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.20	0.30	0.70	0.70
Date Sampled				20/08/2018	16/08/2018	17/08/2018	17/08/2018	17/08/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	37	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	13	6.4	11	12	13
Total mass of sample received	kg	0.001	NONE	1.1	0.40	0.45	0.37	0.48
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	Amosite	-	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Detected	Not-detected	Not-detected	Not-detected	Not-detected
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	< 0.001	-	-	-	-
Asbestos Quantification Total	%	0.001	ISO 17025	< 0.001	-	-	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.8	7.7	8.5	8.0	8.1
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	6	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.050	0.022	0.13	0.059	0.082
Fraction Organic Carbon (FOC)	N/A	0.001	NONE	-	-	-	-	0.014
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.50	< 0.05	1.6	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	0.33	< 0.05	9.1	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	10	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	18	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	2.6	0.32	130	0.68	0.63
Anthracene	mg/kg	0.05	MCERTS	0.63	< 0.05	37	0.38	0.21
Fluoranthene	mg/kg	0.05	MCERTS	7.4	0.72	190	2.3	2.0
Pyrene	mg/kg	0.05	MCERTS	6.2	0.58	160	1.7	1.8
Benzo(a)anthracene	mg/kg	0.05	MCERTS	4.2	0.27	110	1.5	1.4
Chrysene	mg/kg	0.05	MCERTS	4.0	0.39	69	1.1	1.1
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	6.4	0.50	160	1.6	1.8
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	1.5	0.28	36	0.62	0.64
Benzo(a)pyrene	mg/kg	0.05	MCERTS	4.3	0.47	130	1.2	1.4
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	2.4	0.23	59	0.57	0.70
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.78	< 0.05	19	0.25	0.23
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	2.7	0.26	70	0.66	0.81
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	43.9	4.02	1200	12.6	12.7
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	19	10	13	9.1	13
Boron (water soluble)	mg/kg	0.2	MCERTS	0.4	0.6	0.5	1.9	2.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	0.6	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	23	27	16	28	28
Copper (aqua regia extractable)	mg/kg	1	MCERTS	76	34	35	26	38
Lead (aqua regia extractable)	mg/kg	1	MCERTS	320	160	280	100	330
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	1.0	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	30	15	13	18	18
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	140	63	130	51	130

Analytical Report Number: 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1028359	1028365	1028366	1028367	1028368
Sample Reference				BH103	WS108	WS109	WS109	WS110
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.20	0.30	0.70	0.70
Date Sampled				20/08/2018	16/08/2018	17/08/2018	17/08/2018	17/08/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Petroleum Hydrocarbons								
TPH6 - Aliphatic (C6 - C8)	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH6 - Aliphatic (C8 - C10)	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH6 - Aliphatic (C10 - C12)	mg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
TPH6 - Aliphatic (C12 - C16)	mg/kg	2	MCERTS	-	< 2.0	-	< 2.0	-
TPH6 - Aliphatic (C16 - C21)	mg/kg	8	MCERTS	-	< 8.0	-	< 8.0	-
TPH6 - Aliphatic (C21 - C35)	mg/kg	8	MCERTS	-	< 8.0	-	< 8.0	-
TPH6 - Aliphatic (C6 - C35)	mg/kg	10	NONE	-	< 10	-	< 10	-
TPH6 - Aromatic (C6 - C8)	mg/kg	0.001	NONE	-	< 0.001	-	< 0.001	-
TPH6 - Aromatic (C8 - C10)	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH6 - Aromatic (C10 - C12)	mg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
TPH6 - Aromatic (C12 - C16)	mg/kg	2	MCERTS	-	< 2.0	-	< 2.0	-
TPH6 - Aromatic (C16 - C21)	mg/kg	10	MCERTS	-	< 10	-	< 10	-
TPH6 - Aromatic (C21 - C35)	mg/kg	10	MCERTS	-	21	-	21	-
TPH6 - Aromatic (C6 - C35)	mg/kg	10	NONE	-	21	-	21	-
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	-	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	-	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	-	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-	48	-	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	-	140	-	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	-	420	-	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	-	610	-	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	-	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	-	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	-	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	26	-	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-	210	-	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	19	-	1900	-	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	44	-	5300	-	17
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	64	-	7500	-	24

Analytical Report Number: 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1028369	1028370	1028371	1028372	
Sample Reference				WS111	WS111	WS112	WS112	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.20	0.70	0.40	1.20	
Date Sampled				17/08/2018	17/08/2018	17/08/2018	17/08/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	13	11	6.5	11	
Total mass of sample received	kg	0.001	NONE	0.36	0.42	0.40	0.47	
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	-	-	-	-	
Asbestos Quantification Total	%	0.001	ISO 17025	-	-	-	-	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.0	8.1	8.5	7.4	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.022	0.013	0.056	0.038	
Fraction Organic Carbon (FOC)	N/A	0.001	NONE	-	-	-	-	
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.5	< 0.05	
Acenaphthylene	mg/kg	0.05	MCERTS	0.23	< 0.05	2.5	< 0.05	
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.32	< 0.05	
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.1	< 0.05	
Phenanthrene	mg/kg	0.05	MCERTS	0.67	0.46	12	< 0.05	
Anthracene	mg/kg	0.05	MCERTS	0.24	< 0.05	4.7	< 0.05	
Fluoranthene	mg/kg	0.05	MCERTS	2.6	0.61	30	< 0.05	
Pyrene	mg/kg	0.05	MCERTS	2.5	0.54	24	< 0.05	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.7	0.35	23	< 0.05	
Chrysene	mg/kg	0.05	MCERTS	1.7	0.27	14	< 0.05	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	2.9	0.40	27	< 0.05	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.86	0.12	6.7	< 0.05	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	2.2	0.30	20	< 0.05	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.2	< 0.05	8.8	< 0.05	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.35	< 0.05	3.5	< 0.05	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.3	< 0.05	9.6	< 0.05	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	18.4	3.05	189	< 0.80	
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	16	13	14	9.7	
Boron (water soluble)	mg/kg	0.2	MCERTS	1.3	0.8	0.9	0.8	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	0.6	< 0.2	
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	23	24	22	30	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	42	41	27	9.2	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	300	170	190	30	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	0.8	< 0.3	< 0.3	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	16	16	15	17	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	170	59	110	49	

Analytical Report Number: 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1028369	1028370	1028371	1028372	
Sample Reference				WS111	WS111	WS112	WS112	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.20	0.70	0.40	1.20	
Date Sampled				17/08/2018	17/08/2018	17/08/2018	17/08/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	-	-	-	
Toluene	µg/kg	1	MCERTS	< 1.0	-	-	-	
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	-	-	-	
p & m-xylene	µg/kg	1	MCERTS	< 1.0	-	-	-	
o-xylene	µg/kg	1	MCERTS	< 1.0	-	-	-	
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	-	-	-	
Petroleum Hydrocarbons								
TPH6 - Aliphatic (C6 - C8)	mg/kg	0.001	MCERTS	-	-	< 0.001	-	
TPH6 - Aliphatic (C8 - C10)	mg/kg	0.001	MCERTS	-	-	< 0.001	-	
TPH6 - Aliphatic (C10 - C12)	mg/kg	1	MCERTS	-	-	< 1.0	-	
TPH6 - Aliphatic (C12 - C16)	mg/kg	2	MCERTS	-	-	3.1	-	
TPH6 - Aliphatic (C16 - C21)	mg/kg	8	MCERTS	-	-	8.3	-	
TPH6 - Aliphatic (C21 - C35)	mg/kg	8	MCERTS	-	-	59	-	
TPH6 - Aliphatic (C6 - C35)	mg/kg	10	NONE	-	-	70	-	
TPH6 - Aromatic (C6 - C8)	mg/kg	0.001	NONE	-	-	< 0.001	-	
TPH6 - Aromatic (C8 - C10)	mg/kg	0.001	MCERTS	-	-	< 0.001	-	
TPH6 - Aromatic (C10 - C12)	mg/kg	1	MCERTS	-	-	1.4	-	
TPH6 - Aromatic (C12 - C16)	mg/kg	2	MCERTS	-	-	16	-	
TPH6 - Aromatic (C16 - C21)	mg/kg	10	MCERTS	-	-	160	-	
TPH6 - Aromatic (C21 - C35)	mg/kg	10	MCERTS	-	-	640	-	
TPH6 - Aromatic (C6 - C35)	mg/kg	10	NONE	-	-	820	-	
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	-	-	-	
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	-	
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	-	
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	-	-	
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-	-	-	
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	-	-	-	
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	-	-	-	
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	-	-	-	
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	-	-	-	
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	-	-	-	
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	-	-	-	
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	-	-	-	
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	-	-	-	
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	-	-	-	
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	34	-	-	-	
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	43	-	-	-	

Analytical Report Number: **18-97314** B
Project / Site name: **Epsom Hospital Main Hospital Site**
Your Order No:

Certificate of Analysis - Asbestos Quantification

Methods:

Qualitative Analysis

The samples were analysed qualitatively for asbestos by polarising light and dispersion staining as described by the Health and Safety Executive in HSG 248.

Quantitative Analysis

The analysis was carried out using our documented in-house method A006 based on HSE Contract Research Report No: 83/1996: Development and Validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (Davies et al, 1996) and HSG 248. Our method includes initial examination of the entire representative sample, then fractionation and detailed analysis of each fraction, with quantification by hand picking and weighing.

The limit of detection (reporting limit) of this method is 0.001 %.

The method has been validated using samples of at least 100 g, results for samples smaller than this should be interpreted with caution.

Both Qualitative and Quantitative Analyses are UKAS accredited.

Sample Number	Sample ID	Sample Depth (m)	Sample Weight (g)	Asbestos Containing Material Types Detected (ACM)	PLM Results	Asbestos by hand picking/weighing (%)	Total % Asbestos in Sample
1028359	BH103	0.50	108	Loose Fibres	**Amosite**	< 0.001	**< 0.001**

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Analytical Report Number : 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1028359	BH103	None Supplied	0.50	Black loam and sand with rubble and coal.
1028365	WS108	None Supplied	0.20	Brown loam and sand with stones and vegetation.
1028366	WS109	None Supplied	0.30	Black gravely sand with brick and clinker
1028367	WS109	None Supplied	0.70	Brown clay and loam with gravel.
1028368	WS110	None Supplied	0.70	Brown clay and sand with gravel and vegetation.
1028369	WS111	None Supplied	0.20	Brown loam and sand with vegetation and gravel.
1028370	WS111	None Supplied	0.70	Brown clay and sand with gravel.
1028371	WS112	None Supplied	0.40	Brown clay and sand with rubble and brick.
1028372	WS112	None Supplied	1.20	Brown clay and sand with brick.

Analytical Report Number : 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Asbestos Quantification - Gravimetric	Asbestos quantification by gravimetric method - in house method based on references.	HSE Report No: 83/1996, HSG 248, HSG 264 & SCA Blue Book (draft).	A006-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Fraction of Organic Carbon in soil	Determination of fraction of organic carbon in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L009-PL	D	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS

Analytical Report Number : 18-97314-B

Project / Site name: Epsom Hospital Main Hospital Site

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH6 (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method	L076-PL	D	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS

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

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Analytical Report Number : 18-97517

Replaces Analytical Report Number : 18-97517, issue no. 1

Project / Site name:	Epsom Hospital	**Samples received on:**	21/08/2018
Your job number:	10020221	**Samples instructed on:**	23/08/2018
Your order number:		**Analysis completed by:**	05/09/2018
Report Issue Number:	2	**Report issued on:**	05/09/2018
Samples Analysed:	4 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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Analytical Report Number: 18-97517

Project / Site name: Epsom Hospital

Lab Sample Number				1029458	1029459	1029460	1029461	
Sample Reference				BH106	BH106	BH106	BH107	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.25	0.60	1.10	0.50	
Date Sampled				21/08/2018	21/08/2018	21/08/2018	20/08/2018	
Time Taken				1200	1200	1200	1600	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	2.3	8.5	7.7	16	
Total mass of sample received	kg	0.001	NONE	1.3	1.1	1.3	0.93	
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9.6	11.7	8.1	8.5	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.060	0.033	0.036	0.32	
Fraction Organic Carbon (FOC)	N/A	0.001	NONE	-	0.015	-	-	
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	5.1	< 0.05	< 0.05	
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	14	< 0.05	< 0.05	
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	2.5	< 0.05	0.56	
Fluorene	mg/kg	0.05	MCERTS	0.23	12	0.23	0.55	
Phenanthrene	mg/kg	0.05	MCERTS	1.4	110	1.5	7.0	
Anthracene	mg/kg	0.05	MCERTS	0.28	30	0.68	2.2	
Fluoranthene	mg/kg	0.05	MCERTS	1.5	150	2.3	13	
Pyrene	mg/kg	0.05	MCERTS	1.3	120	1.8	11	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.84	71	1.3	6.1	
Chrysene	mg/kg	0.05	MCERTS	0.90	60	1.0	5.9	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.0	74	1.2	8.4	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.44	32	0.82	2.8	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.76	65	1.0	6.5	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	28	0.44	2.7	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	7.7	< 0.05	0.65	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	31	0.48	3.2	
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	8.70	808	12.8	70.6	

Analytical Report Number: 18-97517

Project / Site name: Epsom Hospital

Lab Sample Number				1029458	1029459	1029460	1029461	
Sample Reference				BH106	BH106	BH106	BH107	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				0.25	0.60	1.10	0.50	
Date Sampled				21/08/2018	21/08/2018	21/08/2018	20/08/2018	
Time Taken				1200	1200	1200	1600	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	4.9	12	7.0	14	
Boron (water soluble)	mg/kg	0.2	MCERTS	0.5	1.6	0.7	0.7	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	31	23	21	32	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	25	22	15	42	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	52	140	25	190	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	12	17	16	23	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	42	110	35	74	
Petroleum Hydrocarbons								
TPH6 - Aliphatic (C6 - C8)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aliphatic (C8 - C10)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aliphatic (C10 - C12)	mg/kg	1	MCERTS	2.4	< 1.0	< 1.0	1.8	
TPH6 - Aliphatic (C12 - C16)	mg/kg	2	MCERTS	9.3	< 2.0	< 2.0	2.3	
TPH6 - Aliphatic (C16 - C21)	mg/kg	8	MCERTS	55	< 8.0	< 8.0	11	
TPH6 - Aliphatic (C21 - C35)	mg/kg	8	MCERTS	560	< 8.0	< 8.0	8.7	
TPH6 - Aliphatic (C6 - C35)	mg/kg	10	NONE	630	< 10	< 10	23	
TPH6 - Aromatic (C6 - C8)	mg/kg	0.001	NONE	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aromatic (C8 - C10)	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH6 - Aromatic (C10 - C12)	mg/kg	1	MCERTS	< 1.0	7.4	< 1.0	< 1.0	
TPH6 - Aromatic (C12 - C16)	mg/kg	2	MCERTS	14	120	6.7	3.7	
TPH6 - Aromatic (C16 - C21)	mg/kg	10	MCERTS	93	1300	25	74	
TPH6 - Aromatic (C21 - C35)	mg/kg	10	MCERTS	1300	2300	25	110	
TPH6 - Aromatic (C6 - C35)	mg/kg	10	NONE	1400	3800	57	190	

Analytical Report Number : 18-97517

Project / Site name: Epsom Hospital

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1029458	BH106	None Supplied	0.25	Grey loam and sand with rubble.
1029459	BH106	None Supplied	0.60	Brown clay and sand with rubble.
1029460	BH106	None Supplied	1.10	Brown clay and sand with gravel.
1029461	BH107	None Supplied	0.50	Brown gravelly loam.

Analytical Report Number : 18-97517

Project / Site name: Epsom Hospital

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Fraction of Organic Carbon in soil	Determination of fraction of organic carbon in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L009-PL	D	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH6 (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method	L076-PL	D	MCERTS

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

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Analytical Report Number : 18-97669-B

Replaces Analytical Report Number : 18-97669, issue no. 3

Project / Site name:	Epsom Hospital Main Hospital Site	**Samples received on:**	23/08/2018
Your job number:	10020221	**Samples instructed on:**	23/08/2018
Your order number:		**Analysis completed by:**	10/09/2018
Report Issue Number:	4	**Report issued on:**	13/09/2018
Samples Analysed:	3 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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Analytical Report Number: 18-97669-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1030521	1030522	1030523		
Sample Reference				BH105	BH105	BH105		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.00-0.10	0.30-0.50	0.50-0.70		
Date Sampled				23/08/2018	23/08/2018	23/08/2018		
Time Taken				1500	1500	1500		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1		
Moisture Content	%	N/A	NONE	0.43	16	16		
Total mass of sample received	kg	0.001	NONE	1.1	1.0	0.80		
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	Chrysotile	-		
Asbestos in Soil	Type	N/A	ISO 17025	-	Detected	Not-detected		
Asbestos Quantification (Stage 2)	%	0.001	ISO 17025	-	< 0.001	-		
Asbestos Quantification Total	%	0.001	ISO 17025	-	< 0.001	-		
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	7.8	7.9		
Total Cyanide	mg/kg	1	MCERTS	-	< 1	< 1		
Free Cyanide	mg/kg	1	MCERTS	-	< 1	< 1		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.48	0.15		
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	-	< 1.0	< 1.0		
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05		
Acenaphthylene	mg/kg	0.05	MCERTS	-	0.26	< 0.05		
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05		
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05		
Phenanthrene	mg/kg	0.05	MCERTS	-	1.3	0.65		
Anthracene	mg/kg	0.05	MCERTS	-	0.41	0.18		
Fluoranthene	mg/kg	0.05	MCERTS	-	4.1	2.2		
Pyrene	mg/kg	0.05	MCERTS	-	3.3	1.8		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	2.3	1.1		
Chrysene	mg/kg	0.05	MCERTS	-	2.2	1.1		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	3.7	1.6		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	1.2	0.55		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	2.9	1.2		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	1.5	0.73		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	0.49	< 0.05		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	1.7	0.85		
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	25.3	11.9		
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	21	11		
Boron (water soluble)	mg/kg	0.2	MCERTS	-	9.3	5.9		
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	0.6	< 0.2		
Chromium (hexavalent)	mg/kg	4	MCERTS	-	< 4.0	< 4.0		
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	29	30		
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	68	36		
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	450	170		
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	0.7	0.5		
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	24	20		
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0	< 1.0		
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	380	130		

Analytical Report Number: 18-97669-B

Project / Site name: Epsom Hospital Main Hospital Site

Lab Sample Number				1030521	1030522	1030523		
Sample Reference				BH105	BH105	BH105		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.00-0.10	0.30-0.50	0.50-0.70		
Date Sampled				23/08/2018	23/08/2018	23/08/2018		
Time Taken				1500	1500	1500		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-	< 1.0	-		
Toluene	µg/kg	1	MCERTS	-	< 1.0	-		
Ethylbenzene	µg/kg	1	MCERTS	-	< 1.0	-		
p & m-xylene	µg/kg	1	MCERTS	-	< 1.0	-		
o-xylene	µg/kg	1	MCERTS	-	< 1.0	-		
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	< 1.0	-		
Petroleum Hydrocarbons								
TPH6 - Aliphatic (C6 - C8)	mg/kg	0.001	MCERTS	-	-	< 0.001		
TPH6 - Aliphatic (C8 - C10)	mg/kg	0.001	MCERTS	-	-	< 0.001		
TPH6 - Aliphatic (C10 - C12)	mg/kg	1	MCERTS	-	-	< 1.0		
TPH6 - Aliphatic (C12 - C16)	mg/kg	2	MCERTS	-	-	< 2.0		
TPH6 - Aliphatic (C16 - C21)	mg/kg	8	MCERTS	-	-	< 8.0		
TPH6 - Aliphatic (C21 - C35)	mg/kg	8	MCERTS	-	-	< 8.0		
TPH6 - Aliphatic (C6 - C35)	mg/kg	10	NONE	-	-	< 10		
TPH6 - Aromatic (C6 - C8)	mg/kg	0.001	NONE	-	-	< 0.001		
TPH6 - Aromatic (C8 - C10)	mg/kg	0.001	MCERTS	-	-	< 0.001		
TPH6 - Aromatic (C10 - C12)	mg/kg	1	MCERTS	-	-	< 1.0		
TPH6 - Aromatic (C12 - C16)	mg/kg	2	MCERTS	-	-	< 2.0		
TPH6 - Aromatic (C16 - C21)	mg/kg	10	MCERTS	-	-	< 10		
TPH6 - Aromatic (C21 - C35)	mg/kg	10	MCERTS	-	-	24		
TPH6 - Aromatic (C6 - C35)	mg/kg	10	NONE	-	-	24		
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	< 0.001	-		
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	< 0.001	-		
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	< 0.001	-		
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	< 1.0	-		
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	< 2.0	-		
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	< 8.0	-		
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	< 8.0	-		
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	< 10	-		
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	< 0.001	-		
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	< 0.001	-		
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	< 0.001	-		
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	< 1.0	-		
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	< 2.0	-		
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	18	-		
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	71	-		
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	89	-		
Miscellaneous Organics								
Coal Tar	mg/kg	10	NONE	< 10.0	-	-		

Analytical Report Number: **18-97669** B
Project / Site name: **Epsom Hospital Main Hospital Site**
Your Order No:

Certificate of Analysis - Asbestos Quantification

Methods:

Qualitative Analysis

The samples were analysed qualitatively for asbestos by polarising light and dispersion staining as described by the Health and Safety Executive in HSG 248.

Quantitative Analysis

The analysis was carried out using our documented in-house method A006 based on HSE Contract Research Report No: 83/1996: Development and Validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (Davies et al, 1996) and HSG 248. Our method includes initial examination of the entire representative sample, then fractionation and detailed analysis of each fraction, with quantification by hand picking and weighing.

The limit of detection (reporting limit) of this method is 0.001 %.

The method has been validated using samples of at least 100 g, results for samples smaller than this should be interpreted with caution.

Both Qualitative and Quantitative Analyses are UKAS accredited.

Sample Number	Sample ID	Sample Depth (m)	Sample Weight (g)	Asbestos Containing Material Types Detected (ACM)	PLM Results	Asbestos by hand picking/weighing (%)	Total % Asbestos in Sample
1030522	BH105	0.30-0.50	136	Loose Fibres	**Chrysotile**	< 0.001	**< 0.001**

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Analytical Report Number : 18-97669-B

Project / Site name: Epsom Hospital Main Hospital Site

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1030521	BH105	None Supplied	0.00-0.10	Black tar with gravel. **
1030522	BH105	None Supplied	0.30-0.50	Brown clay and sand with gravel.
1030523	BH105	None Supplied	0.50-0.70	Brown loam and clay with gravel.

** Non MCERTS matrix.

The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 18-97669-B

Project / Site name: Epsom Hospital Main Hospital Site

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Asbestos Quantification - Gravimetric	Asbestos quantification by gravimetric method - in house method based on references.	HSE Report No: 83/1996, HSG 248, HSG 264 & SCA Blue Book (draft).	A006-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Coal Tar in Soil	In-house method by GC-MS, by calculation of discrete polyaromatic content.	In-house method by calculation	L064-UK	D	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE

Analytical Report Number : 18-97669-B

Project / Site name: Epsom Hospital Main Hospital Site

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPH6 (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method	L076-PL	D	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS

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

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Analytical Report Number : 18-97864-B

Project / Site name:	Epsom Hospital - Main Hospital Site	**Samples received on:**	24/08/2018
Your job number:	10020221	**Samples instructed on:**	24/08/2018
Your order number:		**Analysis completed by:**	04/09/2018
Report Issue Number:	1	**Report issued on:**	05/09/2018
Samples Analysed:	6 water samples		

Signed: 

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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Analytical Report Number: 18-97864-B

Project / Site name: Epsom Hospital - Main Hospital Site

Lab Sample Number				1031735	1031740	1031741	1031742	1031743
Sample Reference				BH103	WS106	WS107	BH107	BH105 (s)
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Date Sampled				23/08/2018	23/08/2018	23/08/2018	23/08/2018	23/08/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.5	7.2	7.1	7.3	7.8
Total Cyanide	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	< 10
Free Cyanide	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	< 10
Sulphate as SO_4	µg/l	45	ISO 17025	133000	1290000	1990000	70800	130000
Sulphate as SO_4	mg/l	0.045	ISO 17025	133	1290	1990	70.8	130
Alkalinity	mgCaCO3/l	3	ISO 17025	650	560	490	700	550
Dissolved Oxygen	mg/l	1	NONE	-	-	-	-	< 1.0
Phenols by HPLC								
Catechol	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Resorcinol	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Ethylphenol & Dimethylphenol	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cresols	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Naphthols	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Isopropylphenol	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Phenol	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Trimethylphenol	µg/l	0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Total Phenols								
Total Phenols (HPLC)	µg/l	3.5	NONE	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	0.88	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	0.84	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	0.69	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total PAH								
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	< 0.16	< 0.16	2.41	< 0.16
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	0.15	ISO 17025	3.74	0.43	0.69	0.68	0.49
Boron (dissolved)	µg/l	10	ISO 17025	55	260	260	68	95
Cadmium (dissolved)	µg/l	0.02	ISO 17025	0.06	0.07	0.16	0.44	< 0.02
Calcium (dissolved)	mg/l	0.012	ISO 17025	-	-	-	-	99
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chromium (dissolved)	µg/l	0.2	ISO 17025	0.6	< 0.2	0.4	0.4	< 0.2
Copper (dissolved)	µg/l	0.5	ISO 17025	7.1	3.5	3.8	7.0	2.5
Lead (dissolved)	µg/l	0.2	ISO 17025	0.4	< 0.2	0.7	0.2	< 0.2
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (dissolved)	µg/l	0.5	ISO 17025	9.1	6.7	13	4.6	1.4
Selenium (dissolved)	µg/l	0.6	ISO 17025	55	2.8	3.0	2.5	24
Zinc (dissolved)	µg/l	0.5	ISO 17025	16	13	15	9.8	2.6

Analytical Report Number: 18-97864-B

Project / Site name: Epsom Hospital - Main Hospital Site

Lab Sample Number				1031735	1031740	1031741	1031742	1031743
Sample Reference				BH103	WS106	WS107	BH107	BH105 (s)
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Date Sampled				23/08/2018	23/08/2018	23/08/2018	23/08/2018	23/08/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10	< 10	< 10

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 18-97864-B

Project / Site name: Epsom Hospital - Main Hospital Site

Lab Sample Number				1031744				
Sample Reference				BH105 (d)				
Sample Number				None Supplied				
Depth (m)				None Supplied				
Date Sampled				23/08/2018				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.6				
Total Cyanide	µg/l	10	ISO 17025	< 10				
Free Cyanide	µg/l	10	ISO 17025	< 10				
Sulphate as SO_4	µg/l	45	ISO 17025	98400				
Sulphate as SO_4	mg/l	0.045	ISO 17025	98.4				
Alkalinity	mgCaCO3/l	3	ISO 17025	620				
Dissolved Oxygen	mg/l	1	NONE	6.0				
Phenols by HPLC								
Catechol	µg/l	0.5	NONE	< 0.5				
Resorcinol	µg/l	0.5	NONE	< 0.5				
Ethylphenol & Dimethylphenol	µg/l	0.5	NONE	< 0.5				
Cresols	µg/l	0.5	NONE	< 0.5				
Naphthols	µg/l	0.5	NONE	< 0.5				
Isopropylphenol	µg/l	0.5	NONE	< 0.5				
Phenol	µg/l	0.5	NONE	< 0.5				
Trimethylphenol	µg/l	0.5	NONE	< 0.5				
Total Phenols								
Total Phenols (HPLC)	µg/l	3.5	NONE	< 3.5				
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01				
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01				
Fluorene	µg/l	0.01	ISO 17025	< 0.01				
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01				
Anthracene	µg/l	0.01	ISO 17025	< 0.01				
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Pyrene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Chrysene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01				
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01				
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01				
Total PAH								
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16				
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	0.15	ISO 17025	0.87				
Boron (dissolved)	µg/l	10	ISO 17025	44				
Cadmium (dissolved)	µg/l	0.02	ISO 17025	< 0.02				
Calcium (dissolved)	mg/l	0.012	ISO 17025	110				
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0				
Chromium (dissolved)	µg/l	0.2	ISO 17025	< 0.2				
Copper (dissolved)	µg/l	0.5	ISO 17025	< 0.5				
Lead (dissolved)	µg/l	0.2	ISO 17025	< 0.2				
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05				
Nickel (dissolved)	µg/l	0.5	ISO 17025	1.5				
Selenium (dissolved)	µg/l	0.6	ISO 17025	23				
Zinc (dissolved)	µg/l	0.5	ISO 17025	0.6				

Analytical Report Number: 18-97864-B

Project / Site name: Epsom Hospital - Main Hospital Site

Lab Sample Number				1031744				
Sample Reference				BH105 (d)				
Sample Number				None Supplied				
Depth (m)				None Supplied				
Date Sampled				23/08/2018				
Time Taken				None Supplied				
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	µg/l	1	ISO 17025	< 1.0				
Toluene	µg/l	1	ISO 17025	< 1.0				
Ethylbenzene	µg/l	1	ISO 17025	< 1.0				
p & m-xylene	µg/l	1	ISO 17025	< 1.0				
o-xylene	µg/l	1	ISO 17025	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0				
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10				
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10				

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 18-97864-B

Project / Site name: Epsom Hospital - Main Hospital Site

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Alkalinity in Water	Determination of Alkalinity by discreet analyser (colorimetry). Accredited matrices: SW, PW, GW.	In house method based on MEWAM & USEPA Method 310.2.	L082-PL	W	ISO 17025
Boron in water	Determination of boron in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW	In-house method based on MEWAM	L039-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Dissolved Oxygen in water	Determination of dissolved oxygen.	In-house method	L086-PL	W	NONE
Free cyanide in water	Determination of free cyanide by distillation followed by colorimetry.Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW.	L080-PL	W	ISO 17025
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	W	ISO 17025
Phenols, speciated, in water, by HPLC	Determination of speciated phenols by HPLC.	In house method based on Blue Book Method.	L030-PL	W	NONE
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
Sulphate in water	Determination of sulphate in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW, PrW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Total cyanide in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	NONE

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

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH103		W	18-97864	1031735	c	pH at 20oC in water (automated)	L099-PL	c
BH105 (d)		W	18-97864	1031744	c	Dissolved Oxygen in water	L086-PL	c
BH105 (d)		W	18-97864	1031744	c	pH at 20oC in water (automated)	L099-PL	c
BH105 (s)		W	18-97864	1031743	c	Dissolved Oxygen in water	L086-PL	c
BH105 (s)		W	18-97864	1031743	c	pH at 20oC in water (automated)	L099-PL	c
BH107		W	18-97864	1031742	cd	BTEX and MTBE in water (Monoaromatics)	L073B-PL	d
BH107		W	18-97864	1031742	cd	TPHCWG (Waters)	L070-PL	d
BH107		W	18-97864	1031742	cd	pH at 20oC in water (automated)	L099-PL	c
WS106		W	18-97864	1031740	cd	BTEX and MTBE in water (Monoaromatics)	L073B-PL	d
WS106		W	18-97864	1031740	cd	TPHCWG (Waters)	L070-PL	d
WS106		W	18-97864	1031740	cd	pH at 20oC in water (automated)	L099-PL	c
WS107		W	18-97864	1031741	cd	BTEX and MTBE in water (Monoaromatics)	L073B-PL	d
WS107		W	18-97864	1031741	cd	TPHCWG (Waters)	L070-PL	d
WS107		W	18-97864	1031741	cd	pH at 20oC in water (automated)	L099-PL	c

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

APPENDIX H - Geo-Environmental Risk Assessment Information

CONCEPTUAL SITE MODEL

General

The aim of the initial conceptual model and risk assessment is to provide a preliminary identification of the risks to controlled waters, proposed future site users and the surrounding area posed by any contamination present on site. The assessment is based on identification of 'contaminant linkages', i.e. contaminant-pathway-receptor relationships. This approach accords with the guidance that accompanies Part 2A of the Environmental Protection Act of 1990 where land is considered to be contaminated when 'significant harm' is occurring, or where there is the 'significant possibility of significant harm' or where significant pollution of controlled waters is being, or is likely to be caused. In such cases the contaminant linkage itself is defined as being 'significant'.

A source of contamination and a pathway to receptors must be present for there to be a risk. The preliminary risk assessment assesses the strength of the link between the source, the pathway and the receptor.

Source - Contaminant that has potential to cause harm to environmental receptors. In a wider sense, sources can include particular ground conditions, for example the existence of redundant footings, which have the potential to impact on development proposals.

Pathway - The route by which the source is brought into contact with the receptor. This can include the transport of contamination via groundwater, wind-blown dust, vapours, excavation and deposition etc.

Receptor - Human beings, other living organisms, physical systems and built structures that could be affected by the source. A receptor will only be affected if a pathway from the source to the receptor is present. Groundwater and surface water systems can be considered as receptors in their own right as their quality is regulated by the statutory bodies, as well as being pathways for contaminant migration to other receptors.

ENVIRONMENTAL RISK ASSESSMENT

Qualitative Methodology

The risk assessment considers the potential sources, receptors and pathways identified in the Conceptual Site Model.

The environmental assessment has been undertaken with due regard to Contaminated Land Guidance Documents issued by the Department of the Environment Food and Rural Affairs (DEFRA). The Guidance requires a risk-based approach; with the potential environmental risk assessed qualitatively using the 'source-pathway-target' contaminant linkage concept contained in Part 2A of the Environment Protection Act. Unless specifically stated as relating to 'Contaminated Land' as defined in the Environmental Protection Act 1990 (as amended), references to 'contamination' and 'contaminants' relate in general terms to the presence of potentially hazardous substances, in, on or under the subject site.

Based on information presented in

- CIRIA C552 (2001) Contaminated Land Risk Assessment: A guide to good practice; and
- NHBC / EA/ CIEH (2008) R&D Publication 66: (Volume 1) Guidance for the Safe Development of Housing on Land Affected by Contamination
- DEFRA (2012) Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance

Risk assessment considers the identified sources, the potential receptors and the pathways linking them together.

The designation of risk is based upon the consideration of both:

a. **the severity of the potential consequence -** this takes into account both the potential severity of the hazard and the sensitivity of the receptor
b. **the magnitude of probability** (i.e. likelihood) - this takes into account both the presence of the hazard and receptor and the integrity of the pathway

Severity (consequence) can be defined as the adverse effects (or harm) arising from a defined hazard, which impairs the quality of human health or the environment in the short or longer term. Definitions of different categories of severity are detailed in Table 1 below.

Probability can be defined as the chance of a particular event occurring in a given period of time. Definitions of different categories of probability are detailed in Table 2 below.

A contaminant linkage must first be established before tests for probability and consequence are applied. If there is no contaminant linkage then there is no potential risk.

Table 1 - Classification of Potential Consequence (Severity)

	Human Health	Controlled Water	Built Environment[1]	Ecosystems[2]
Severe	Short term (acute) risk to human health. Concentrations present likely to result in "significant harm" as defined by Part 2A.	Substantial pollution of sensitive water resources.	Catastrophic damage to buildings, structures or the environment, including building collapse.	Major damage to aquatic or other ecosystem, which is likely to result in a substantial adverse change or irreversible change in its functioning or harm to a species of special interest.
Medium	Chronic damage to human health. Concentrations present that could result in significant harm.	Pollution of sensitive water resources or small scale pollution of sensitive water resources	Significant damage to buildings, structures or the environment making it unsafe to occupy, or damage that may impair a scheduled ancient monument.	Significant damage to aquatic or other ecosystems or organism forming part of an ecosystem that could endanger the long term maintenance of a population at that location.
Mild	Slight short term health effects to humans. Exposure to human health unlikely to lead to significant harm.	Pollution to non-sensitive water resources	Minor damage to sensitive buildings, structures, services or the environment.	Minor or short lived damage to aquatic or other ecosystems.
Minor	Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.)	Insubstantial pollution to non-sensitive water resources	Easily repairable effects of damage to buildings or structures	Harm (although not necessarily significant harm which may result in financial loss or expenditure to resolve e.g. loss of plants in a landscape scheme).

1. Property includes crops including timber, produce grown domestically (gardens or allotments for consumption), livestock, other owned or domesticated animals or wild animals which are subject to shooting or fishing rights. It also includes buildings, meaning any structure or erection, but does not include plant or machinery within a building or buried services.
2. Where ecological system effects relate to a Site of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Marine Nature Reserve (MNR), and areas of Special Protection for Birds, a "European site", or any habitat or site afforded protection under the Wildlife & Countryside Act 1981 and The Conservation of Habitats and Species Regulations 2010, i.e. candidate Special Areas of Conservation, potential Special Protection Areas and listed Ramsar sites.

Table 2 Classification of Probability

(Only applies if there is a possibility of a contaminant linkage being present)

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

Table 3 Classification of Risk

Once the severity and probability have been classified for a contaminant linkage they can be compared to produce a risk category from very high risk to very low risk as shown in the matrix below.

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

Table 4 Risk Classification Descriptions

Table 4 below describes the risk classifications.

Risk Term	Description
Very High Risk	There is a high probability that significant harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action or there is evidence that significant harm to a designated receptor is already occurring.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remedial action. Remediation works may be necessary in the short-term and are likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However it is either relatively unlikely that any such harm would be severe or if any harm were to occur it is more likely that such harm would be relatively mild. Some remediation work may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely, at worst, that this harm if realised would normally be mild. Any subsequent remediation works are likely to be relatively limited.
Very Low Risk	It is a low possibility that harm could arise to a receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

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