9.1.4 Compressible Ground

Maximum Compressible Ground* hazard rating identified on the study site — Negligible

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
No indicators for compressible deposits identified. No special actions required to avoid problems due to compressible deposits. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with compressible deposits.

9.1.5 Collapsible Rocks

Maximum Collapsible Rocks* hazard rating identified on the study site — Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Slight possibility for collapsible deposit problems after major changes in loading or groundwater conditions. Normal maintenance to avoid large amounts of water entering the ground through pipe leakage or soak-aways should reduce the likelihood of problems due to collapsible deposits. For new build, assess the possibility of collapsible (loessic) deposits in ground investigation. For existing property, no significant increase in insurance risk from collapsible deposits is likely.

9.1.6 Running Sand

Maximum Running Sand* hazard rating identified on the study site — Very Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Very low potential for running sand problems if water table rises or if sandy strata are exposed to water. No special actions required, to avoid problems due to running sand. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with running sand.

* This indicates an automatically generated 50m buffer and site.

9.2 Radon

9.2.1 Radon Affected Areas

Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level? The site is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

The radon data in this report is supplied by the BGS/Public Health England and is the definitive map of Radon Affected Areas in Great Britain and Northern Ireland. The dataset was created using long-term radon measurements in over 479,000 homes across Great Britain and 23,000 homes across Northern Ireland, combined with geological data. The dataset is considered accurate to 50m to allow for the margin of error in geological lines, and the findings of this report supercede any answer given in the less accurate Indicative Atlas of Radon in Great Britain, which simplifies the data to give the highest risk within any given 1km grid square. As such, the radon atlas is considered indicative, whereas the data given in this report is considered definitive.

9.2.2 Radon Protection

Is the property in an area where Radon Protection are required for new properties or extensions to existing
ones as described in publication BR211 by the Building Research Establishment? No radon protective measures are necessary.

10. Mining

10.1 Coal Mining

Coal mining areas within 75m of the study site — None identified

Database searched and no data found.

10.2 Non-Coal Mining

Non-Coal Mining areas within 50m of the study site boundary — None identified

Database searched and no data found.

10.3 Brine Affected Areas

Brine affected areas within 75m of the study site — None identified
Guidance: No Guidance Required.

Contact Details

Groundsure Helpline
Telephone: 08444 159 000
info@groundsure.com

British Geological Survey Enquiries
Kingsley Dunham Centre
Keyworth, Nottingham NG12 5GG
Tel: 0115 936 3143.
Fax: 0115 936 3276.
Email:
Web:**www.bgs.ac.uk**
BGS Geological Hazards Reports and general geological enquiries:
enquiries@bgs.ac.uk

Environment Agency
National Customer Contact Centre, PO Box 544
Rotherham, S60 1BY
Tel: 03708 506 506
Web: **www.environment-agency.gov.uk**
Email: enquiries@environment-agency.gov.uk

Public Health England
Public information access office
Public Health England, Wellington House
133-155 Waterloo Road, London, SE1 8UG
www.gov.uk/phe
Email:**enquiries@phe.gov.uk**
Main switchboard: **020 7654 8000**

The Coal Authority
200 Lichfield Lane
Mansfield
Notts NG18 4RG
Tel: 0345 7626 848
DX 716176 Mansfield 5
www.coal.gov.uk

Ordnance Survey
Adanac Drive, Southampton
SO16 0AS
Tel: 08456 050505

Local Authority
Authority: London Borough of Camden
Phone: 020 7974 4444
Web: http://www.camden.gov.uk/
Address: Camden Town Hall, Judd Street, London, WC1H 9JE

Gemapping PLC
Virginia Villas, High Street, Hartley Witney,
Hampshire RG27 8NW
Tel: 01252 845444

APPENDIX 3

CHEMICAL TEST RESULTS

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	18-33288-1 18-33288-1
Initial Date of Issue:	02/Nov/2018 02/Nov/2018
Client	Ground Engineering Limited Ground Engineering Limited
Client Address:	Newark Road Peterborough Cambridgeshire PE1 5UA Newark Road Peterborough Cambridgeshire PE1 5UA
Contact(s):	Ashley Murdoch Ashley Murdoch
Project	C14593 C14593 Maria Fidelis Lower School, London, NW1

Quotation No.:		**Date Received:**	29/Oct/2018 2
Order No.:	C14593 C14593	**Date Instructed:**	29/Oct/2018 2
No. of Samples:	9 9		
Turnaround (Wkdays):	5 5	**Results Due:**	02/Nov/2018 0
Date Approved:	02/Nov/2018 02/Nov/2018		

Approved By:

Details: Martin Dyer, Laboratory Manager

Chemtest
The right chemistry to deliver results

Bulk Identification Certificate

Client:	Ground Engineering Limited	**Your Ref.:**	
Site Address:		**Project:**	C14593
Date Sampled:	22-Oct-2018	**Job Number:**	18-33288
Date Received:	29-Oct-2018	**No Samples:**	
		Date Reported:	02-Nov-2018

Sample No.	Sample ID	Sample Ref.	Description	SOP	Accred.	Laboratory	Material	Result
713973	B1		BH1	2185	U	COVENTRY	Cement	Chrysotile

The in-house procedure SOP2185 is in accordance with the requirements of Appendix 2 of the Analyst Guide (HSG 248).

The results relate only to items tested as supplied by the client.

Comments and interpretations are beyond the scope of UKAS accreditation.

Samples associated with asbestos in building surveys are retained for six months (HSG 264 refers)

Chemtest
The right chemistry to deliver results

Results - Soil

Project: C14593 Maria Fidelis Lower School, London, NW1

Client: Ground Engineering Limited		Chemtest Job No.:			18-33288	18-33288	18-33288	18-33288	18-33288	18-33288	18-33288
Quotation No.:		Chemtest Sample ID.:			713954	713956	713957	713958	713959	713960	713961
		Client Sample ID.:			B1	D1	D2	D2	D2	D1	D4
		Sample Location:			BH1	TP4	TP5	TP6	TP3	WS1	WS2
		Sample Type:			SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
		Top Depth (m):			0.10	0.40	0.50	0.65	0.70	0.30	1.10
		Bottom Depth (m):			0.30						
		Date Sampled:			22-Oct-2018	22-Oct-2018	22-Oct-2018	22-Oct-2018	23-Oct-2018	23-Oct-2018	23-Oct-2018
		Asbestos Lab:			COVENTRY						
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	2010		N/A		9.8	8.5	8.0	8.7	10.3	8.6
Moisture	N	2030	%	0.020		8.1	20	16	19	14	17
Stones and Removed Materials	N	2030	%	0.020		< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40		0.47	0.65	2.1	1.0	1.1	0.66
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010		0.22	0.023	0.72	0.30	0.60	0.51
Cyanide (Free)	U	2300	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50		38	4.1	9.9	2.6	5.1	2.4
Arsenic	U	2450	mg/kg	1.0		17	15	28	23	19	25
Cadmium	U	2450	mg/kg	0.10		0.31	0.31	0.19	0.11	< 0.10	0.28
Chromium	U	2450	mg/kg	1.0		20	33	35	28	15	16
Copper	U	2450	mg/kg	0.50		37	36	41	40	58	76
Mercury	U	2450	mg/kg	0.10		1.2	0.20	1.2	0.83	1.1	1.9
Nickel	U	2450	mg/kg	0.50		21	60	48	40	18	23
Lead	U	2450	mg/kg	0.50		310	44	220	280	150	770
Selenium	U	2450	mg/kg	0.20		< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Zinc	U	2450	mg/kg	0.50		80	290	150	59	58	65
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	U	2625	%	0.40		5.7	0.74	2.4	1.6	2.4	2.4
Acenaphthene	U	2700	mg/kg	0.10		2.1	0.36	0.33	< 0.10	6.4	0.21
Acenaphthylene	U	2700	mg/kg	0.10		6.3	0.29	0.25	< 0.10	6.2	0.19
Anthracene	U	2700	mg/kg	0.10		14	1.7	1.1	< 0.10	30	1.1
Benzo[a]anthracene	U	2700	mg/kg	0.10		28	1.6	1.8	< 0.10	38	1.7
Benzo[a]pyrene	U	2700	mg/kg	0.10		25	0.98	1.4	< 0.10	30	1.6
Benzo[b]fluoranthene	U	2700	mg/kg	0.10		30	1.6	2.1	< 0.10	38	2.1
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10		14	0.76	0.58	< 0.10	16	0.86
Benzo[k]fluoranthene	U	2700	mg/kg	0.10		12	1.3	1.1	< 0.10	15	1.2
Chrysene	U	2700	mg/kg	0.10		29	2.4	2.3	< 0.10	40	2.0
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10		5.0	0.32	< 0.10	< 0.10	5.9	1.0
Fluoranthene	U	2700	mg/kg	0.10		63	5.3	4.8	0.64	94	4.0
Fluorene	U	2700	mg/kg	0.10		3.8	0.40	0.41	< 0.10	10	0.24
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10		16	0.47	0.76	< 0.10	20	1.5
Naphthalene	U	2700	mg/kg	0.10		1.5	0.55	< 0.10	< 0.10	2.7	0.35
Phenanthrene	U	2700	mg/kg	0.10		47	5.5	4.1	0.90	92	2.6
Pyrene	U	2700	mg/kg	0.10		57	5.1	4.5	0.69	85	3.8
Total Of 16 PAH's	U	2700	mg/kg	2.0		350	29	26	2.2	530	25
Total Phenols	U	2920	mg/kg	0.30		< 0.30	< 0.30	< 0.30	< 0.30	0.36	< 0.30

Chemtest
The right chemistry to deliver results

Results - Soil

Project: C14593 Maria Fidelis Lower School, London, NW1

Client: Ground Engineering Limited					**Chemtest Job No.:**	18-33288	18-33288	18-33288	18-33288	18-33288	18-33288	18-33288
Quotation No.:					**Chemtest Sample ID.:**	713954	713956	713957	713958	713959	713960	713961
					Client Sample ID.:	B1	D1	D2	D2	D2	D1	D4
					Sample Location:	BH1	TP4	TP5	TP6	TP3	WS1	WS2
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.10	0.40	0.50	0.65	0.70	0.30	1.10
					Bottom Depth (m):	0.30						
					Date Sampled:	22-Oct-2018	22-Oct-2018	22-Oct-2018	22-Oct-2018	23-Oct-2018	23-Oct-2018	23-Oct-2018
					Asbestos Lab:	COVENTRY						
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
ACM Type	U	2192		N/A		Cement						
Asbestos Identification	U	2192	%	0.001		Chrysotile						
Asbestos by Gravimetry	U	2192	%	0.001		0.27						
Total Asbestos	N	2192	%	0.001		0.27						

Chemtest
The right chemistry to deliver results

Results - Single Stage WAC

Project: C14593 Maria Fidelis Lower School, London, NW1

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	18-33288						
Chemtest Sample ID:	713955						
Sample Ref:							
Sample ID:	B2				**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample Location:	BH1						
Top Depth(m):	0.30						
Bottom Depth(m):	0.80						
Sampling Date:	22-Oct-2018						
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	U	%	2.1	3	5	6
Loss On Ignition	2610	U	%	5.7	--	--	10
Total BTEX	2760	U	mg/kg	[C] < 0.010	6	--	--
Total PCBs (7 Congeners)	2815	U	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg	[C] 380	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	150	100	--	--
pH	2010	U		8.2	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.10	--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1450	U	0.0027	< 0.050	0.5	2	25
Barium	1450	U	0.030	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	0.0081	0.081	0.5	10	70
Copper	1450	U	0.0032	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.0035	< 0.050	0.5	10	30
Nickel	1450	U	< 0.0010	< 0.050	0.4	10	40
Lead	1450	U	0.0023	0.023	0.5	10	50
Antimony	1450	U	0.0039	0.039	0.06	0.7	5
Selenium	1450	U	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.013	< 0.50	4	50	200
Chloride	1220	U	1.4	14	800	15000	25000
Fluoride	1220	U	0.21	2.1	10	150	500
Sulphate	1220	U	400	4000	1000	20000	50000
Total Dissolved Solids	1020	N	510	5100	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	6.5	65	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	15

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Chemtest
The right chemistry to deliver results

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63, Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
713955		B2	BH1	22-Oct-2018	C	Plastic Tub 500g

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2185	Asbestos	Asbestos	Polarised light microscopy
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N–dimethyl-p-phenylenediamine.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.

Test Methods

SOP	Title	Parameters included	Method summary
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Chemtest
The right chemistry to deliver results

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX 4

CLASSIFICATION OF AGGRESSIVE CHEMICAL ENVIRONMENT FOR BURIED CONCRETE

TABLE C2 – AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASSIFICATION FOR BROWNFIELD LOCATIONS[a]

Table C2 Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations[a]

Sulfate and magnesium						Groundwater		ACEC
Design Sulfate Class for location	2:1 water/soil extract[b]		Groundwater		Total potential sulfate[c]	Static water	Mobile water	Class for location
1	2 (SO_4 mg/l)	3 (Mg mg/l)	4 (SO_4 mg/l)	5 (Mg mg/l)	6 (SO_4 %)	7 (pH)[d]	8 (pH)[d]	9
DS-1	< 500		< 400		< 0.24	≥ 2.5		AC-1s
							> 6.5[d]	AC-1
							5.5–6.5	AC-2z
							4.5–5.5	AC-3z
							2.5–4.5	AC-4z
DS-2	500–1500		400–1400		0.24–0.6	> 5.5		AC-1s
							> 6.5	AC-2
						2.5–5.5		AC-2s
							5.5–6.5	AC-3z
							4.5–5.5	AC-4z
							2.5–5.5	AC-5z
DS-3	1600–3000		1500–3000		0.7–1.2	> 5.5		AC-2s
							> 6.5	AC-3
						2.5–5.5		AC-3s
							5.5–6.5	AC-4
							2.5–5.5	AC-5
DS-4	3100–6000	≤ 1200	3100–6000	≤ 1000	1.3–2.4	> 5.5		AC-3s
							> 6.5	AC-4
						2.5–5.5		AC-4s
							2.5–6.5	AC-5
DS-4m	3100–6000	> 1200[e]	3100–6000	> 1000[e]	1.3–2.4	> 5.5		AC-3s
							> 6.5	AC-4m
						2.5–5.5		AC-4ms
							2.5–6.5	AC-5m
DS-5	> 6000	≤ 1200	> 6000	≤ 1000	> 2.4	> 5.5		AC-4s
						2.5–5.5	≥ 2.5	AC-5
DS-5m	> 6000	> 1200[e]	> 6000	> 1000[e]	> 2.4	> 5.5		AC-4ms
						2.5–5.5	≥ 2.5	AC-5m

Notes

a Brownfield locations are those sites, or parts of sites, that might contain chemical residues produced by or associated with industrial production (Section C5.1.3).

b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered from previous Digests (Box C7).

c Applies only to locations where concrete will be exposed to sulfate ions (SO_4), which may result from the oxidation of sulfides such as pyrite, following ground disturbance (Appendix A1 and Box C8).

d An additional account is taken of hydrochloric and nitric acids by adjustment to sulfate content (Section C5.1.3).

e The limit on water-soluble magnesium does not apply to brackish groundwater (chloride content between 12 000 mg/l and 17 000 mg/l). This allows 'm' to be omitted from the relevant ACEC classification. Seawater (chloride content about 18 000 mg/l) and stronger brines are not covered by this table.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' have primarily to resist acid conditions and may be made with any of the cements in Table D2 on page 42.
- Suffix 'm' relates to the higher levels of magnesium in Design Sulfate Classes 4 and 5.

Appendix C2: HS2 ground investigation information

1CP01-MDS_ARP-EV-REP-SS08_SL23-990013

1G081-HES-0001
Euston Station - Ground Investigation Factual Report

Document No.: 1G081-WYG-GT-REP-000-000006

Revision	Date	Author	Checked by	Approved by	Revision Details:
P01	20/12/17	F. Baudrain	M. Hawkins	C. Pugh	For Comment
P02	22/01/18	F. Baudrain	N. Paulakis	M. Hawkins	Updated

Co-financed by the European Union
Connecting Europe Facility

1G081-HES-001

Ground Investigation Framework

Euston Station - Ground Investigation Factual Report

WYG Document Reference: 1G081-WYG-GT-REP-000-000006

Status: Final P02

Security Classification: Unclassified

WYG Environment Planning Transport Limited. Registered in England & Wales Number: 03050297
Registered Office: Arndale Court, Otley Road, Headingley, Leeds, LS6 2UJ

Document Control

Document:	**Euston Station - Ground Investigation Factual Report**
Project:	**HS2 Ground Investigation Framework**
Work Package:	**1G081 – HES – 001**
Client:	**High Speed Two Limited**
Job Number:	**A085215-1**
File Origin:	H:\A080000-A089999\A085215\HS2 DELIVERY PHASE\WORK PACKAGE ORDERS\HES-001\Documents\Reports\Factual report\Issue\HES_Final Factual Report.docx

Revision: -	**P01 - Final**	
Date:	**29/09/2017**	
Prepared by:	Checked by:	Approved By:
Franck Baudrain	**Mark Hawkins**	**Chris Pugh**

Revision: -	**P02 - Final**	
Date:	**22/01/2018**	
Prepared by:	Checked by:	Approved By:
Franck Baudrain	**Nick Paulakis**	**Mark Hawkins**

Contents

LIST OF TABLES

Appendices

1 General

1.1 Introduction

WYG Environment Planning Transport Limited (WYG) was commissioned by High Speed Two (HS2) Limited to undertake a ground investigation and produce a factual report for the HS2 Euston Station (HES001) work package. The investigation was specified by HS2 Ltd who also provided assurance on a small sample of site work.

This report has been prepared for High Speed Two (HS2) Limited and other agreed parties in accordance with the terms and conditions of the contract. Attention is drawn to the report conditions, outlined in Appendix A, and the terms and conditions of the engagement.

The Ground Investigation was undertaken in two phases. A first phase comprised a limited deployment for drilling works during Easter term holiday within Maria Fidelis Lower School from the 10th to the 22nd April 2017. The second and main phase of works was undertaken between the 22nd May and the 4th August 2017.

1.2 Objectives of the Investigation

The purpose of the ground investigation is to provide both geotechnical and geo-environmental factual information to enable safe and cost-effective design and construction of the proposed terminus for the proposed HS2 routes to and from the north. To accommodate the proposed new additional high-speed lines the main works will comprise the re-development of the existing Euston station in addition to widening and deepening of the existing Station approach to the north of Euston Station, and extension of Euston Underground Station, linking to Euston Square Underground Station.

2 Site Details

2.1 Site Location

Euston Station is located in central London within the London Borough of Camden.

The 'site' is defined as the required working area within which each of the fieldwork, site compound(s) and access routes are located.

The whole of the site to be investigated is located immediately adjacent to the west side of Euston station and falls within an area of approximately 110,000m2.

The National Grid Reference (NGR) for the centre of the site is approximately E: 529346, N: 182669.

The Site Location Plan (ref: 1G081-HS2-GT-MAP-000-000001) is located in Appendix B.

2.2 Site Description

The site predominantly contains both commercial and residential buildings in addition to public roads. Much of the site, therefore comprises hardstanding ground, with the exception of St James' Gardens and Euston Square Garden. The former is the area of an historical cemetery, which is located towards the centre of the site. Whilst no exploratory holes have been undertaken within St James Gardens, one borehole was drilled within Euston Square Garden.

The site is bordered to the east by the existing Euston Station, the station approach and related rail infrastructure. To the west the site is bordered by Hampstead Road (A400) and to the south by Gower Place. To the north the site is bordered by commercial and residential properties in addition to the existing rail lines servicing Euston Station.

Several existing underground structures have been identified within the site boundary which include but should not be limited to;

LUL tunnels and shafts comprising:

- Northern Line "Bank Branch" – running north-south within west of site area
- Northern Line "Charing Cross Branch" – running east-west within south of site area
- Victoria Line – running east-west within south of site area
- Relief tunnel – running parallel to the Northern Line Charing Cross Branch
- Disused tunnels and shafts
- Cable tunnel (Euston Square Station to Drummond Street)

Obstructions

- Potential bridge abutments
- Possible turn table
- Disused burial ground
- Brick foundations of historic structures/buildings

The site has been classified by the Employer as Yellow in accordance with the Guidance for Safe Intrusive Activities on Contaminated or Potentially Contaminated Land (BDA, 2008). This classification has been based on information presented in the London-West Midlands Environmental Statement.

Potential sources of contamination within the site included the following;

- Former printing works (E:529314, N:182791)
- Garage (centred at E:529445, N:182582)
- Wagon works, garage, hotel (centred at E:529416, N:182642)
- Builders yard (centred at E:529235, N:182860)
- Burial ground/cemetery (centred at E:529331, N:182723)
- Historical warehouses (E:529455, N:182519)
- Historical printing works; municipal building (E:529503, N:182477)
- Railway station and rail land

Further detail is presented in the Geotechnical Desk Study report (reference: C220-ARP-DL-REP-01A-000002) and the Environmental Statement available from HS2 Ltd.

The site is predominantly classed as having a low risk of encountering unexploded ordnance (UXO). An area of medium risk, however, has been identified covering locations ML000-CR001 (formerly CP007), ML000-PC010 & PC011, ML000-CP001, ML000-WS001, 2 and 3.

Further detail and suggested mitigation measures are provided by Zetica in their report titled 'Unexploded Ordnance Desk Study', (HS2 reference: 0615-ZET-GT-REP-000-000001).

2.3 Anticipated Geology

The conjectured geological profile at the site is as follows;

Table 1 – Geological profile

Stratum	Approx. base of strata – depth (mbgl) [elevation mOD]	Approx. Thickness (m)
Made Ground	<3 [+20]	<3
London Clay Formation	19 [+4]	16
Harwich Formation	21 [+2}	<2
Lambeth Group	38 [-15]	19
Thanet Sand Formation	44 [-21]	6
Chalk	-	-

River Terrace Deposits are shown to overly the London Clay to the south of the site and therefore may be encountered during the proposed ground investigation works.

The above geological profile has been inferred from available information, including borehole data from the British Geological Survey (BGS). No assurance is given to its accuracy.

Perched groundwater to be expected in Made Ground and alluvium overlying the London Clay Formation. Small quantities of water to be expected during drilling through sand bands of the London Clay. Standing water has been recorded at approximately 0 – 5mOD within the top of the Lambeth Group, there is expected to be an underdrainage effect of the Lambeth Group and non-hydrostatic pore pressures are expected in the London Clay. Sand channels within the Lambeth Group with potentially high groundwater pressures and running sand should be expected. The Environment Agency (2010) review of groundwater levels shows that the groundwater levels in the chalk beneath the site are between -30m.OD and -40m.OD approximately 60m below ground level.

Further detail is presented in the Geotechnical Desk Study report (ref: C220-ARP-DL-REP-01A-000002).

3 Ground Investigation Works

3.1 Scope of Work

The ground investigation, designed by HS2 Ltd, was undertaken by WYG and their approved subcontractors and was carried out in two distinct mobilisations, although for the purpose of this report the information is reported as one.

The ground investigation was undertaken in stages. In addition to obtaining the latest service diagrams and drawings from the relevant service providers (PASS128 Type D), Stage 1 comprised site reconnaissance (PASS128 Type C) and non-intrusive geophysical mapping surveys (PASS128 Type B) to establish the location and depth of existing utilities. The surveys were carried out at each exploratory hole location prior to breaking ground, in line with PASS128 requirement. Stage 1 works were carried out utilising the following equipment:

- Mala HDR Ground Penetration Radar (GPR).
- RD8000 Tracing Set, transmitter & receiver (Electromagnetic Locator [EML]).

The outputs of the geophysical surveys are enclosed as Appendix C.

Stage 2 comprised the following intrusive investigations and related in-situ testing:

- Excavation of inspection pits (data enclosed as Appendix D.1, D.2, D.3, D.4, D.5 with associated photographs provided as Appendix E.1, E.2, E.3 and E.4) in line with PASS128 Type A verification.
- Rotary Geobore-S boreholes (water flush) through superficial deposits, weathered and solid strata (data enclosed as Appendix D.1 with associated core photographs provided as Appendix E.1). Use of biodegradable polymer (Purebore) was approved for use by HS2 Ltd when drilling through Lambeth Group and Chalk to ease drilling and improve recovery.
- Windowless sampling (exploratory hole logs enclosed as Appendix D.2 with associated photographs provided as Appendix E.2).
- Cable percussive boreholes (exploratory hole logs enclosed as Appendix D.3 with associated photographs for the inspection pits provided as Appendix E.3).
- Cone Penetrometer Test boreholes (exploratory hole logs enclosed as Appendix D.4 with associated photographs provided as Appendix E.4).
- Pavement cores (data enclosed as Appendix D.5 with associated photographs provided as Appendix E.5).
- Recovery of disturbed and undisturbed samples from appropriate intrusive methods.
- Variable head permeability testing in boreholes (results enclosed as Appendix F).

- Down-the-hole geophysical survey to include natural gamma and televiewer (data enclosed as Appendix G).
- Laboratory testing: classification tests; strength tests; compressibility and swelling tests; specialist soil testing; contamination testing; rock testing; and groundwater chemistry (enclosed as Appendix J & K).
- Installation of groundwater monitoring instrumentation and subsequent monitoring, including development and sampling of monitoring wells and ground gas (enclosed as Appendix L).

There were some changes to the scope of work from the original January 2015 specification to the one issued prior to the start of the fieldwork in March 2017. The investigation methods and numbers are given in Table 2 below. Exploratory hole logs are enclosed as Appendix D.

Table 2 – Summary of Investigation Methods

Method	Original Scope (7th January 2015) No. / total meerage	Revised Scope (27th March 2017) No. / total meterage	Completed No. / total meterage
Rotary cored holes	2 / 100m	4 / 200m	5 / 225.8m
Rotary open holes	2 / 100m	2 / 100m	0
Cable percussive holes	7 / 290m	8 / 290m	6 / 218m
Inspection pits	16	18	19
Trial pits	14	0	0
Windowless sampling	5	5	3
Concrete Coring	0	0	2
Pavement Core	2	2	1
CPT	3 / 75m	3 / 75m	3 / 88m
SBPT / Dilatometer	24	14	9
Optical/Acoustic Televiewer	0	0	1 / 23m
Natural Gamma	2 / 100m	5 / 230m	3 / 181m

Some changes were also implemented during the fieldwork phase as follows:

Table 3 – Changes from Final Scope during fieldwork

Location	Reason for change in scope/Comments
ML000-RC007 and ML000-RO001	• Both boreholes are located within the school Maria Fidelis' playground. These formed the Phase 1 of the ground investigation, completed in advance of the main element of work in order that the works could be completed during half term school holiday. • The boreholes were terminated at shallower depths than scheduled (53.75m target of 60m for RC007 and 30m target of 50m for RO001) due to the time restrictions (surrendering the drilling area before start of the term).
ML000-RO001 and ML000-RO002	• Changed due to programming and logistical constraints. • Both boreholes were drilled by rotary coring (Geo-bore S system) in order to provide a better hole quality for the implementation of insitu pressuremeter testing.
ML000-RC012	• The proposed rotary core borehole was located adjacent to the ML000-RO002. • Given ML000-RO002 was cored, ML000-RC012 was deemed obsolete and cancelled.
ML000-CR002 / ML000-CP016	• Location of the two boreholes swapped to mitigate issue of available working areas.
ML000-CR002	• The cable percussive element of the work was cancelled and the borehole drilled solely by rotary coring means (Geo-bore S technique). • The borehole depth was increased from 60 m to 70 m.
ML000-CP003	• The borehole was terminated at shallower depth (29m instead of 40m) due to site constraints and high risk of mud splash to members of the public.
ML000-CR001	• The borehole was terminated at shallower depth (53m instead of 60m) than scheduled due to significant flint obstruction being encountered at 52.65m which

Location	Reason for change in scope/Comments
	could not be penetrated. Numerous attempts and variations of drilling techniques were utilised.
ML000-WS001	• Two inspection pits were excavated for this location, both refused on a concrete obstruction at 0.85-1.2m depth potentially associated with the adjacent former underground station.
ML000-WS005	• The inspection pit was unable to identify safe clearance of existing services to facilitate drilling the borehole safely. • The borehole location was on the pavement and provided limited scope to move its location outside the dense corridor of utility services.
ML000-CP016	• The inspection pit identified type 1 backfill material at 1.2m depth near major utility service. The pit was extended deeper via vacuum extraction system to 2.3m where it refused on an unknown brick structure. Bricks removed from the borehole were shown to a historic brick specialist from EDP Services, who commented that based on colour, composition and size of the bricks removed, the layers of bricks were likely to be late 17th/early 18th century. The bricks contained large air holes and impurities so it is unlikely to have been used for facing and may have formed part of the foundations/basement structures associated with the Georgian properties along Melton Street (formerly Euston Street/Easton Crescent). • The borehole was therefore cancelled.
ML000-CT020	• Given the issue of obstructions identified around ML000-CP016 (see above), the proposed CPT borehole ML000-CT020 was relocated where ML000-RC012 was initially proposed (by the Thistle Hotel).

3.2 Specification and Standards

The investigation was undertaken in accordance with the following specifications:

- UK Specification for Ground Investigation 2nd Edition, Thomas Telford Limited (2012)
- HS2 LTD Ground Investigation Framework Specification for Ground Investigation, Document No. HS2-HS2-GT-SPE-000-000001
- Work Package Specification WPO-HES-001 HS2 Euston Station, Document No. 1G081-HS2-GT-SPE-000-000001

The specifications reference the standards and other documents that have governed the investigation.

3.3 Historical Report

Historical reports were provided to HS2 Ltd by third parties and the factual information requested by HS2 Ltd was digitised and included within the AGS file of the WYG Ground Investigation Works. The two reports are as follows:

- Ian Farmer Associates, Regents Park Estate, London NW1, Report on Ground Investigation, Contract number 52382A, December 2015.
- WSP Limited, 2015 Euston Road, London, Ground investigation Interpretative Report, Ref. 90316L, June 1999

These reports were received by WYG in PDF format and partially in AGS format (for Ian Farmer report only) and are included in Appendix N of this document. Where possible, the factual information was manually converted/digitised by WYG into AGS format as instructed by HS2 Ltd and form part of the AGS file included in Appendix M. The data provided by these two reports should be considered as for information purposes only and WYG cannot take responsibility for their accuracy and or validity. It is understood HS2 Ltd have received approval from all relevant parties to use the information for the reporting requirement.

4 Encountered Ground Conditions

A summary of the ground conditions encountered in the WYG investigation is presented below, with detailed information presented on the exploratory hole logs included in Appendix D.

4.1 Geology

4.1.1 Made Ground/Topsoil

Topsoil was encountered in CP001 located within the Euston Square Gardens. Elsewhere, either asphalt, concrete and/ or cobbles were encountered from ground level.

A variety of potential anthropogenic ground was encountered below all locations within the package beneath the hardstanding cover. The exception to this were ML000-WS002 and ML000-WS003 located within the basement car park of the Ibis Hotel, where the London Clay Formation was encountered directly beneath the concrete.

The inspection pit for borehole CP016 refused at 2.3m below ground level onto some old masonry works. Bricks removed from the pit were shown to an historic brick specialist from EDP Services, who commented that based on colour, composition and size of the bricks removed, the layers of bricks were likely to be late 17th/early 18th century. The brick contained large air holes and impurities so it is unlikely to have been used for facing and may have formed part of the foundations/basement structures associated with the Georgian properties along Melton Street (formerly Euston Street/Easton Crescent).

The inspection pits for ML000-WS001 and WS001A located on each end of the pavement width refused on a concrete slab at 0.85m and 1.2m below ground level. It was considered the slab is likely to be associated with the adjacent building, a disused substation.

4.1.2 Superficial Deposits

Superficial deposits were encountered within the southern end of the site with Made Ground being underlain by orange brown gravelly sand (locally grading to sandy gravel with depth) of the River Terrace Deposits. These were found between 3.7-4.2m bgl in ML000-CP001, 2.7-4.7m in ML000-CP003, 0.8-4.5m in ML000-CP068.

4.1.3 Solid Geology

Anticipated solid geology was encountered in all exploratory borehole locations beneath the Made Ground / Superficial Deposits. The bedrock formations comprised the following in vertical sequence from the shallowest to the deepest:

- London Clay Formation – typically a firm becoming very stiff grey brown clay to 18.0-21.8m bgl weathering grades after Spink and Norbury (1993) have been applied when loggin;
- Lambeth Group (Upper Mottled Clay) – typically multi coloured clay to 22.4-27.35m bgl;
- Lambeth Group (Sand Channel) – typically grey sand to 24.0-25.2m bgl (only encountered in ML000-CP001, CP003 and CP068);
- Lambeth Group (Lower Mottled Clay) – very stiff red blue, greyish brown mottled clay to 28.7-34.77m bgl;
- Lambeth Group (Upnor Formation) – very dense greenish grey gravelly sand to 32.5-36.5m bgl
- Thanet Sand Formation – very dense greenish grey sand to 41.95-43.35m bgl
- Bullhead Beds – dark grey Sand with black flint gravel to 42.22-43.55m bgl (only encountered in ML000-CR001 and RO002);
- Upper Chalk (Seaford Formation) – weak medium density closely to medium spaced fractures chalk with flint bands proven up to 70.0m bgl.

4.2 Groundwater

No obvious groundwater strikes were observed in any of the boreholes; however, the following should be noted:

- Small amounts of water were added to help facilitate drilling within the cable percussive boreholes.
- Due to the water flush technique during the rotary drilling operations, it was not possible to determine any water strikes during drilling operations. However, loss of flush was frequent during drilling within the chalk with some significant water supply requirement to enable drilling process to progress.

Additional information is available within the borehole records included within Appendix D. Water levels have been monitored subsequently to installation of the boreholes with the details included in Appendix L.

4.3 Evidence of land contamination

The presence of Made Ground was generally encountered across the site with frequent presence of extraneous material such as brick, concrete fragments and to lesser extent clinker and ceramic. Otherwise, no obvious visual or olfactory evidence of hydrocarbon/chemical contamination was encountered with the Made Ground.

Levels of potential Volatile Organic Compounds (VOCs) were measured with a handheld PID meter, within the Made Ground of generally less than 10ppm (up to a maximum of 350ppm at ML000-CP066), increasing

to about 100ppm within or immediately beneath asphalt hardstanding (although up to 400ppm at ML000-CP035). Full PID readings are included within the logs in Appendix D long with the calibration certificate.

Some potential hydrocarbon contamination was identified whilst drilling the borehole ML000-CP003, within the River Terrace Deposits between 4.0-4.7 m bgl. Moderate potential hydrocarbon odour and surface oily type sheen was identified on the gravelly sand spoil. Below 4.7m, the River Terrace Deposit was underlain by the London Clay Formation stratum, suggesting the contamination sitting over the less permeable formation. Potential Volatile Organic Compounds of up to 1.6ppm were measured with the handheld PID meter within the potential hydrocarbon contaminated stratum.

The contaminated spoil associated with ML000-CP003 was segregated and appropriately stored before being disposed as non-hazardous waste. Waste characterisation results are included in Appendix K.

Clean drilling technique within ML000-CP003 was employed to prevent cross-contamination of the hydrocarbon onto deeper strata. This included the construction of a 1.5m thick bentonite seal between 4.5m and 6.0m depth and reduced casing from 200mm to 150mm.

5 Laboratory Testing

5.1 Geotechnical Laboratory Testing

Geotechnical tests were scheduled by HS2 Ltd through 4no. specific schedules. The testing was carried out by Professional Soils Laboratories Limited (PSL) at their laboratory in Doncaster, in accordance with their UKAS accreditation. The soil and rock testing is summarised in Table 3 with the results presented as Appendix J and the associated electronic data as Appendix M. Some testing is outstanding and will be submitted as an addendum once completed.

Table 4 – Summary of Geotechnical Testing

Scheduled Tests		Number of Tests scheduled	Number of test completed
Classification Tests	K1.1 Moisture Content	159	159
	K1.2 Atterberg Limits 4 pt	123	123
	K1.4 Shrinkage Linear	18	18
	K1.8 Particle Density by Gas Jar or Pyknometer	25	24
	K1.9 Particle size distribution - Wet Sieving	43	39
	K1.11 Sedimentation - Pipette	38	37
	K2.1 Organic Matter Content	6	6
	K2.2 Mass Loss on Ignition Organic	2	2
Compaction Related Testing	K3.1 Compaction 2.5kg Rammer	4	4
	K3.2 Compaction 4.5kg Rammer	4	4

Scheduled Tests		Number of Tests scheduled	Number of test completed
	K3.5 Dry Density Min Max Granular Soils	2	2
	K3.6 Moisture Condition Value at NMC	3	3
	K3.7 Moisture Condition Value / Moisture Content relationship	2	2
	K3.9 CBR Recompacted Remoulded	6	6
Compressibility, Permeability, Durability Testing	K4.1 One-dimensional Consolidation Properties, Test Period 5 days	9	9
	K4.2 One-dimensional Consolidation Properties, Test Period greater than 5 days	9	8
	K4.3 Measurements of swelling pressure, test period 2 days	15	15
	K4.6.1 Measurement of Swelling Pressure of Stiff Clay, Test Period 7 days	5	5
	K4.6.2 Measurements of expansibility of stiff clay, test period 5 days	5	5
	K5.13 Permeability in a triaxial cell, test period 4 days	2	2
	K5.14 Extra over Item K5.13 for test periods in excess of 4 days	4	4
	K6.4 Shear Strength of a set of three 60 mm x 60 mm square specimens by direct shear, test duration not exceeding 1 day per specimen	10	11

Scheduled Tests		Number of Tests scheduled	Number of test completed
	K6.6 Shear Strength of a set of three 300 mm x 300 mm square specimens by direct shear, test duration exceeding 1 day per specimen	1	0
	K6.16 Undrained shear strength of a single 100 mm diameter specimen in triaxial compression without the measurement of pore pressure	51	51
	K7.2 Consolidated undrained triaxial compression test with measurement of pore pressure (100mm specimens), single stage	4	4
Shear Strength (effective) Testing	K7.11 Isotropically consolidated undrained triaxial compression test on 100mm diameter sample with mid-height porewater pressure measurement	7	8
	K7.13 Anisotropically consolidated undrained triaxial compression test on 100mm diameter sample with small strain and shear wave velocity measurements	5	5
Chalk Testing	K1.7 Density Chalk	28	28
	K8.14 Uniaxial Compressive Strength	8	8
	K8.14.1Uniaxial Compressive Strength with determination of young's modulus and Poisson's ratio	8	4
	K8.21 Measurement of point load strength index of rock specimen (set of ten individual determinations)	9	5

Scheduled Tests		Number of Tests scheduled	Number of test completed
	K8.22 Single measurement of point load strength on irregular rock lump or core sample (either axial or diametral test)	36	40
Ground/Groundwater Aggressivity	K9.4 BRE SD1 D	13	13
Petrographic Analysis	K12.2 X Ray Diffraction	3	3
	K12.3 Optical Microscopy	1	1

Table 5 lists the soil samples scheduled by HS2 that were not tested by the laboratory and any amendments to the testing.

Table 5 – Summary of Amendments to schedule

Schedule number	Sample	Original Scheduled Test affected	Amendments	Communication
2	RC007 – 44.59m	Uniaxial Compressive Strength - K08.14	Sample too short for UCS. Test not undertaken	Email from Franck Baudrain 25/9/2017
2	RC007 – 48.35	Point Load Strength - 3 sets - K08.21.1	Only one determination possible instead of 3 (absence of suitable material for testing)	
3	CR001 – 44.77m	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample not available. Tests not undertaken	
3	CP0068 - 3.5m	Direct Shear Strength 300mm - K06.06	Insufficient sample. Test replaced as small shear box (60mm x 60mm)	Email from Ray Dobiecki 10/10/2017
3	CR001 – 44.77m (C5)	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR K08.14.1	Sample badly fractured. CR001-44.77m split, photographed and chalk density/saturation moisture content and point load test undertaken. Unconfined compressive strength and elastic modulus undertaken on CR001 – 46m (C6)	Email from Ray Dobiecki 16/10/2017

chedule number	Sample	Original Scheduled Test affected	Amendments	Communication
3	RO002 – 48.23m (C47)	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS Original sample replaced by RO002 – 48.98m (C48) for unconfined compressive strength and elastic modulus test	Email from Ray Dobiecki 16/10/2017
3	RO002 – 58.8m (C56)	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS Original sample replaced by RO002 – 57.98m (C55) for unconfined compressive strength and elastic modulus test	Email from Ray Dobiecki 16/10/2017
3	CP001 - 5.2m	Particle size distribution - Wet Sieving - K01.09	Insufficient sample. Test not undertaken	
3	CR001 – 43.45m	Particle size distribution - Wet Sieving - K01.09	Sample is not suitable (rock). Test not undertaken	Email from Ray Dobiecki 14/12/2017
3	CR001 -	Uniaxial Compressive Strength YMPR - K08.14.1	Sample badly fractured. Test not undertaken.	
3	RO002 – 44.43m	Particle size distribution - Wet Sieving - K01.09	Sample is not suitable (rock). Test not undertaken	Email from Ray Dobiecki 14/12/2017
3	RO002 – 48.23m	Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS.	
3	RO002 – 58.80m	Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS.	

Schedule number	Sample	Original Scheduled Test affected	Amendments	Communication
3	CP0035 – 22.5m	Triaxial 100mm Single Stage - K06.16	Sample collapsed upon extrusion due to brittle nature of the material. Original sample replaced by CP0035 – 21-21.45m	Email from Ray Dobiecki 14/12/2017
4	CR002 – 43.05-43.41	Density Chalk - K01.07 Particle size distribution - Wet Sieving - K01.09 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS. PSD not undertaken as sample is not suitable (rock) Original sample proposed to be replaced by CR002 – 45.5-45.8m for unconfined compressive strength and elastic modulus test but normal USC had already been completed on that sample.	Email from Ray Dobiecki 06/11/2017
4	CR002 – 53.4-53.57	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS. Original sample proposed to be replaced by CR002 – 51.57-54.71m for unconfined compressive strength and elastic modulus test but normal USC had already been completed on that sample.	Email from Ray Dobiecki 06/11/2017

Schedule number	Sample	Original Scheduled Test affected	Amendments	Communication
4	CR002 – 59.5-59.87	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS. UCS test cancelled.	Email from Ray Dobiecki 06/11/2017
4	CR002 – 70.09-70.4	Density Chalk - K01.07 Point Load Strength - 3 sets - K08.21.1 Uniaxial Compressive Strength YMPR - K08.14.1	Sample too short for UCS. Original sample proposed to be replaced by CR002 –69.04-69.25m for unconfined compressive strength and elastic modulus test but sample also too short for testing.	Email from Ray Dobiecki 06/11/2017

5.2 Chemical Laboratory Testing

5.2.1 Soil

Chemical testing was scheduled by HS2 Ltd. The testing was carried out by Jones Environmental at their laboratory in Deeside, in accordance with their UKAS / MCERTS accreditations.

The soil testing is summarised in Table 4 below and the results are presented as Appendix K with the electronic data as Appendix M.

Table 6 – Summary of Soil Chemical Testing

Suite	Scheduled Tests	Number of Tests
Suite E	Arsenic, boron, cadmium, chromium (total), copper, lead, mercury, nickel, zinc, pH, water soluble sulphate as SO4, total petroleum hydrocarbons, speciated Poly Aromatic Hydrocarbons (PAHs), phenols, cyanide (total), organic matter (SOM).	24
Suite E1	Dependant option: phenols	2
Suite E4	Dependant option: PAH in macadam	2
Suite E6	Dependant option: hydrocarbons	1
Suite E9	Dependant option: degreasing agents, odorous or high PID values	4
Suite F	Leachates – general	13
Suite G	Leachates – organic	1
Suite H	Asbestos Screen	5
Suite H1	Asbestos Quantification	3

5.2.2 Groundwater

Chemical testing was scheduled by HS2 Ltd. The testing was carried out by Jones Environmental at their laboratory in Deeside, in accordance with their UKAS/ MCERTS accreditations.

The groundwater testing is summarised in Table 5 below and the results are presented as Appendix K with the electronic data as Appendix M.

Table 7 – Summary of Groundwater Chemical Testing

Suite	Scheduled Tests	Number of Tests
Suite I	Arsenic, boron, cadmium, chromium (total), copper, lead, mercury, nickel, zinc, pH, sulphate as SO4, total petroleum hydrocarbons, PAHs, phenol and cyanide (total)	4
Suite I1	Dependant option: Speciated Hydrocarbons	4
Suite I2	VOCs and SVOCs	4
	Total Iron	4
	Total Manganese	4

5.2.3 Surface Water

No chemical testing was required as part of this works package in the absence of surface water within the site.

5.2.4 Land Gas Testing

Land gas testing was not undertaken as part of this work package.

6 Monitoring

Groundwater/ground gas monitoring standpipes were installed in 9 of the 20 exploratory holes, as detailed in Table 9 below. Groundwater levels were monitored during the fieldwork period and are scheduled to be undertaken monthly for twelve months from completion of the fieldworks. Groundwater sampling on selected monitoring standpipes was undertaken on one occasion, generally completed on the first round of monitoring (where access was available). Groundwater sampling was completed following well development and purging (minimum of 3 wells volume) A full set of monitoring records up to the time of writing, are included as Appendix L. Additional monitoring data will be submitted through an addendum report (report number: 1G081-WYG-GT-REP-000-000002).

Table 8– Summary of Installation Response Z

Exploratory Hole	Installation diameter mm/type	Response Zone (Slotted section where applicable) mbgl	Targetted Geological Formation
ML000-CP003	50mm standpipe	2m to 4.5m (2m to 4.5m)	River Terrace Deposits
	35mm piezometer tip	14.5m to 15.5m (14.84m to 14.16m)	London Clay
ML000-CP035	50mm standpipe	34.5m to 37.5m (35m to 37m)	Upnor Formation
	35mm piezometer tip	39m to 40m (39.34m to 39.66m)	Thanet Sand
ML000-CP066	50mm standpipe	2m to 5m (2m to 5m)	Made Ground
	35mm standpipe	35m to 40.5m (35.5m to 40m)	Upnor Formation & Thanet Sand
ML000-CP068	50mm standpipe	1.5m to 4m (2m to 4m)	River Terrace Deposits
	35mm standpipe	22m to 25m (22.5m to 25m)	Lambeth Group – Upper Mottled Beds
ML000-CR001	35mm piezometer tip	14 m to 15m (14.34m to 14.66m)	London Clay
	35mm piezometer tip	29m to 30m (29.34 to 29.66m)	mbeth Group – Lower Mottled Beds
ML000-CR002	50mm standpipe	4m to 70m (44m to 70m)	aford Chalk Formation
	35mm piezometer tip	.5m to 23.5m (22.84m to 23.16m)	mbeth Group – Upper Mottled Beds

Exploratory Hole	Installation diameter mm/type	Response Zone (Slotted section where applicable) mbgl	Targetted Geological Formation
ML000-RC007	50mm standpipe	49.25m to 53.75m (49.25m to 52.25m)	Seaford Chalk Formation
ML000-RO001	Vibrating Wire Piezometer (high entry ceramic tip with a 2.5 litres of water for 3kg of cement and 1 kg of bentonite powder mix)	9m	London Clay
		17m	London Clay
		25m	Lambeth Group – Upper Mottled Beds
ML000-RO002	Vibrating Wire Piezometer (high entry ceramic tip with a 2.5 litres of water for 3kg of cement and 1 kg of bentonite powder mix)	11m	London Clay
		19m	London Clay
		27m	Lambeth Group – Upper Mottled Beds

7 Electronic Data

Electronic data are included as Appendix M as follows:

- AGS 4 data.
- ACAD plans in dwg format.

Notes

1. Standards

All boring operations, sampling of soils, *in situ* testing and geotechnical laboratory testing have been carried out in accordance with the recommendations of the British Standards BS 5930(2015)[1], BS 1377 (1990)[2] and BS10175 (2001)[3].
Soil and rock descriptions follow the recommendations of BS 593. Where descriptions or classifications are based on other documents (e.g. BS 8004 (1986) or CIRIA Project Report 11 (1993)), this is stated in the report text.

2. Site methods

Unless specifically stated otherwise, the following methods are used for exploratory holes.

- Holes described as cable percussive are bored using a light cable percussive rig. Standard penetration tests are carried out where appropriate, as shown in the logs. Disturbed and undisturbed samples are taken from the exploratory holes at the depths on the records.
- Window sampling generally uses the windowless sampling method, using a tracked Geotool.
- Dynamic probes are usually heavy dynamic probes, using the same tracked Geotool used for window sampling.

3. Definitions and abbreviations

The following terms are used in the exploratory hole logs

Samples

U	Undisturbed 102mm dia. sample
TW	Thin Walled undisturbed 102mm dia. sample
B	Bulk sample
D	Small disturbed sample
W	Water sample
CBR	California Bearing Ratio test or CBR value obtained from Mexiprobe test

In situ tests

S	Standard penetration test (SPT)
N	SPT N value (blows/300mm)
HP	Hand penetrometer – shear strength
SV	Hand shear vane – shear strength
VOC	Volatile organic compounds (ppm)
PID	Photo-ionisation detector – used to detect the presence of VOCs.

Core recovery and rock quality

TCR	Total core recovery (%)
SCR	Solid core recovery (%)
RQD	Rock quality designation (%)
FI	Fracture index
NR	No recovery
NI	Not intact

Rotary drilling sizes

	Nominal diameter (mm)	
Index letter	**Borehole**	**Core**
N	75	54
H	99	76
P	120	92
S	146	113

Water strikes

▽	Level of water strike
▼	Water level rose to this level (see Remarks at foot of log for details)

Depth means depth below existing ground level unless otherwise specified. Values specified in soil descriptions given in the exploratory hole logs are depths unless otherwise specified.

Appendices

See separate files.

Appendix D: Risk Assessment Methodology

D1 Background

A generic quantitative assessment of the results of the contemporary phase of ground investigation is provided in the report in accordance with the current UK guidance on the assessment of contaminated land and in particular the Contaminated Land Exposure Assessment (CLEA) framework.

D2 Human health

D2.1 Chemical contamination

D2.1.1 Generic assessment criteria

The UK statutory guidance suggests that generic soil quality guideline values may be used for an initial screening of soil contamination results in relation to human health risk assessment. Generic assessment criteria (GAC) provide an indication of concentrations in soil below which the long-term human health risks for various generic land-use scenarios are considered to be minimal. Concentrations above GAC do not necessarily indicate that significant contamination is present, but rather that further assessment or risk management measures may be warranted.

A generic commercial end use has been considered in the assessment to provide an initial appraisal of the results. The generic commercial end use is based on assessing risks to a female office worker, spending her entire working life (full time) onsite. She frequently uses soft landscaping and is directly exposed to soils being assessed via ingestion, dermal contact, and inhalation of dust and vapour both outside and inside the building. Future users of the Site will not come into direct contact with potential contamination in soils or dust on the Site because the site comprises the footprint of the 1 Triton Square building.

Category 4 Screening Levels (C4SLs), released by Defra for some determinands including lead, have been used in the first instance within this assessment. C4SLs are only available for six contaminants and consequently SDSC has derived GAC using CLEA 1.07 which use C4SL exposure parameters but maintain the traditional minimal risk toxicological benchmarks. Input data for the toxicological effects, physical characteristics and contaminant fate and transport parameters for the determinands have been taken from sources published by the Environment Agency and other industry sources (including LQM/CIEH and the European Food Safety Authority (EFSA). Further details of the derivation of the GACs including changes made to the default user chemical database and exposure assumptions are available on request.

D2.1.2C4SLs

Defra has released a set of Category 4 Screening Levels (C4SLs) which, according to associated guidance may be applicable under the planning regime in some circumstances.

The Contaminated Land Statutory Guidance (2012) defines four 'categories' of land when considering human health and the water environment to assist in determining whether a site might be "Contaminated Land" under Part 2A. Category 1 and 2 would indicate that the site would be determined; whereas in the case of both Category 3 and 4 it would not. Land that has been developed which is assessed to be within category 4 should be acceptable under planning. Defra recently confirmed in writing that C4SL (criteria developed to define the boundary between category 3 and category 4) could be used under the planning regime. It states that C4SL provide a simple test for deciding if land is "suitable for use" and definitely not contaminated. A developer may decide that in the cases where they are providing high quality new development that a higher level of protection may be preferred on a voluntary basis, for instance by using generic assessment criteria based on negligible levels of risk.

The conditions assumed in the C4SL calculations include sandy loam soil and 6% SOM. The detailed description of the Made Ground suggest that the soils could reasonable classified within the sandy loam to sandy clay range; the %SOM is low, typically <1%.

d2.1.3 Asbestos in soil

Work with asbestos in the UK is controlled by the Health and Safety Executive (HSE) and the Control of Asbestos Regulations (CAR) 2012. Certain activities, such as working with asbestos insulation, coatings, and insulting board require licensing and notification to the appropriate authority before work commences. All work with asbestos materials must be initially assessed by a competent person and various requirements arise from that assessment.

The HSE has published a Code of Practice for CAR 2012 which does not include specific guidance regulating asbestos in soils. In March 2014 CIRIA published C733 Asbestos in Soil and Made Ground: A guide to understanding and managing risks.

In order for asbestos found within soil to pose a risk to health, it has to be present in a form that can release fibres to air for inhalation (or may do after it has been disturbed). The potential for fibre release is likely to be relatively lower when asbestos is present in soil in the form of cements or other 'bonded' materials and higher when friable forms or unconsolidated forms such as 'free fibres' are present. However, even cemented and bonded ACM may eventually degrade and release fibres and can be disturbed and broken during construction for instance.

The release of fibres from the soil into the air can occur via wind-blown disturbance or physical disturbance either during site development (e.g. construction, remediation

or earthworks) or during site use after development. The concentration of airborne fibres released is influenced by many factors including asbestos type, ACM type and condition/state, depth, distribution and concentration in soil, soil type, and soil moisture content. There is limited data on the release of airborne fibres from soils in real world environments, but soil moisture content has a particularly significant impact. In laboratory studies, the addition of 5% moisture to a dry soil reduced airborne fibre release by 80-95% and no airborne fibre were detected when the soil moisture content was greater than 15%.

There are currently no generic assessment criteria for asbestos in soils and C733 makes it clear that such criteria are unlikely in the near future due to uncertainties on the mechanisms for fibre release, calculating the likely exposure and the risk of harm at low levels of exposure. Instead the report recommends site specific assessment based on multiple lines of evidence.

In 2016 a guide was published by CL:AIRE referred to as 'Interpretation for managing and working with asbestos in soils CAR-SOILTM', which is currently the most authoritative guide on the topic and should be followed. CAR-SOILTM confirms that all work with asbestos in soil should be carried out under a 'plan of work' and defines the contents of that plan.

Analysis has been performed to the lowest possible accredited detection limit routinely reported by laboratories (0.001%) and a robust strategy to sever plausible pollutant linkages will be adopted in the remediation strategy, to reduce exposure as low as reasonably practicable during development and prevent exposure after development.

D3 Controlled waters

The framework within which the Environment Agency can work with others to manage and protect groundwater is set out within 'Groundwater protection: Principal and practice (GP3), 2013. Groundwater and leachability results have been screened against Water Quality Standards (WQS), initially by comparison with the environmental quality standards (EQS) for inland surface water, or where unavailable freshwater EQS. Where EQS screening criteria are not available, the following guidelines and standards have been referred to in this hierarchy:

- UK Drinking Water Standards (DWS);
- Surface Water Abstraction Directive (SWAD); and
- The World Health Organisation (WHO) Guidelines for Drinking Water.

No criteria are available at all for certain other PAH and for TPH. In the absence of criteria for TPH the withdrawn DWS of 0.01mg/kg has been considered as an initial assessment.

D4 Ground gas

The following published guidance on the assessment of ground gas has been used in the assessment:

- CIRIA 2007 Report C665 Assessing risks posed by hazardous ground gases to buildings;
- BS 8485 (2015) Code of practice for the characterisation and remediation from ground gas in affected developments; and
- Card, Wilson and Haines (2009) Ground gas handbook.

The Ground gas handbook describes a process of deriving gas screening values (GSV) for hazardous ground gases (it summarises the guidance presented in reference 14 and 15 above). The method uses both gas concentrations and borehole flow rates to define a range of characteristic situations (CS1 to CS6) based on limiting borehole gas volume flow for methane and carbon dioxide. The GSV is calculated by multiplying the borehole flow rate (litres per hour) by the gas concentration

D5 Waste assessment methodology

Framework

There are three types of permitted landfill (inert, non-hazardous and hazardous) and four principal types of waste, as outlined below:

- Inert; generally uncontaminated natural soils and certain clean construction materials such as crushed concrete. The material may be disposed of to an inert landfill without testing. If the natural soils are suspected as contaminated then it may be classed as inert if it satisfies the inert waste acceptance criteria (WAC). Made Ground would typically be required to be tested and pass the WAC in order to be classed as inert. Inert materials may also be used as a construction material in other sites given appropriate waste management permitting;
- Hazardous; defined by the analysis of 'total' chemical parameters to assess the hazard properties. The classified waste may only be disposed of to a hazardous landfill (following treatment) if in addition it satisfies the TOC and leachability WAC;
- Stable non-reactive hazardous waste; defined in a similar manner to hazardous waste (i.e. classed as hazardous) but then satisfying a stricter set of WAC. Following treatment, it may be disposed of in specifically designed separate cells in non-hazardous landfills (if the operator has obtained a permit to operate these cells); and
- Non-hazardous waste; if the waste is not classified as inert or hazardous then it is non-hazardous. There is no WAC for non-hazardous waste.

Hazardous waste classification

The following documents were used to carry out the initial waste classification and disposal assessment of Made Ground and natural soil arisings generated by the development:

- Environment Agency (2009), Hazardous Waste – August 2009 Update;
- Environment Agency (2015), Hazardous Waste, Technical guidance WM3;
- The Hazardous Waste (England and Wales) Regulations; and
- Table 3.2 of Annex VI to Regulation (EC) No. 1272/2008.

Metals may be classified as hazardous based on a number of potential hazardous properties including carcinogenic (H7 lowest threshold 1,000mg/kg), ecotoxic (H14 lowest threshold 2,500mg/kg), toxic for reproduction (H10 lowest threshold 5,000mg/kg), harmful (H5 lowest threshold 250,000mg/kg) and toxic (H6 lowest threshold 30,000mg/kg). With the exception of H7, the other classifications are additive i.e. the concentrations are converted to the worst case (for harm) compound and added together before comparison with the thresholds.

Hydrocarbons in contaminated soils are generally categorised against the hazardous properties carcinogenic (H7) and ecotoxic (H14). For H7, waste would be defined as hazardous if category 1 or 2 carcinogenic compounds (e.g. benzene) exceeded 0.1% (1,000mg/kg), or category 3 compounds (e.g. diesel) exceeded 1% (10,000mg/kg). TPH is an aggregate parameter that includes a range of category 1, 2 and 3 compounds, along with other elements not classified as carcinogenic. In most circumstances TPH contaminated soil and stones should be assessed as 'unknown oil' (unless there is a specific documented record or a consistent hydrocarbon profile to indicate diesel or weathered diesel being the contaminating oil) and a worst case should be assumed.

For an unknown oil if the concentration of TPH is ≥ 0.1% the waste will be H7 Carcinogenic and H11 Mutagenic unless the concentration of benzo[a]pyrene is <0.01% of the TPH concentration. Substance specific thresholds have been set for specific PAHs.

The hazardous waste threshold for asbestos is 0.1% w/w. It is noted that the quantification weight percentage of asbestos is difficult to achieve as asbestos can be present in a wide range of forms. While it is likely that ACM, such as cemented asbestos, board or lagging, will exceed such a threshold, the quantity of ACM in a bulk sample will often be below this level. WM3 states that where a waste contains identifiable pieces of ACM (that can be identified as potentially being asbestos by a competent person if examined by the naked eye) then these pieces must be assessed separately. If the ACM cannot be segregated the waste is regarded as hazardous if the concentration of asbestos in the ACM pieces alone is greater than 0.1%.

D6 Risk assessment methodology

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 and NHBC/EA/CIEH risk classification methodology.

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);
- magnitude of the probability (likelihood) of the risk occurring (refer to Table C1-2); and,
- Table C1-3 presents the risk assessment matrix.

Table D1-1 Classification of consequence

Classification	Definition
Severe	Short-term (acute) risk to human health likely to result in 'significant harm' as defined by the Environmental Protection Act 1990, Part IIA. Short-term risk of pollution of a sensitive water resource. Catastrophic damage to buildings or property. A short-term risk to an ecosystem, or organism forming part of such ecosystem.
Medium	Chronic damage to human health. Pollution of a sensitive water resource. A significant change to an ecosystem, or organism forming part of such ecosystem.
Mild	Pollution of a non-sensitive water resource, such as non-classified groundwater. Damage to buildings, structures and services.
Minor	Harm, which may result in a financial loss, or expenditure to resolve. Non-permanent effects to human health, which could easily be prevented by means such as personal protective clothing. Easily repairable effects of damage to buildings, structures and services.

Table D1-2 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 level 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 D1-3 Comparison of consequence against probability

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

Appendix E: Chemical Screening Spreadsheets

1CP01-MDS_ARP-EV-REP-SS08_SL23-990013

Maria Fidelis Human Health Assessment - Soils			Exploratory hole	BH1	TP4	TP5	TP6	TP3
			Sample depth (m)	0.1	0.4	0.5	0.65	0.7
			Date sampled	22/10/2018	22/10/2018	22/10/2018	22/10/2018	23/10/2018
			Strata	MG	MG	MG	MG	MG
			Ground Investigation	GE 2018	GE 2018	GE 2018	GE 2018	GE 2018
			Location	Onsite	Onsite	Onsite	Onsite	Onsite
Determinands	Units	Criterion Com (2.5%)						
Inorganics								
pH	pH	nc			9.8	8.5	8	8.7
Moisture	%	nc			8.1	20	16	19
Sulphate (2:1 Water Soluble) as SO4	g/l	nc			0.22	0.023	0.72	0.3
Sulphide (Easily Liberatable)	mg/kg	nc			38	4.1	9.9	2.6
Cyanide, free	mg/kg	nc			<0.50	<0.50	<0.50	<0.50
Cyanide, Total	mg/kg	nc			<0.50	<0.50	<0.50	<0.50
Soil Organic Matter	%	nc			5.7	0.7	2.4	1.6
Asbestos								
ACM Type	Type	nc		Cement				
Asbestos Identification	%	nc		Chrysotile				
Asbestos by Gravimetry	%	nc		0.3				
Total Asbestos	%	nc		0.3				
Heavy Metals / Metalloids								
Antimony	mg/kg	7350						
Arsenic	mg/kg	635			17	15	28	23
Barium	mg/kg	22100						
Beryllium	mg/kg	11.7						
Boron	mg/kg	236000			0.47	0.65	2.1	1
Cadmium	mg/kg	190			0.3	0.31	0.19	0.11
Chromium	mg/kg	8570			20	33	35	28
Chromium, Hexavalent	mg/kg	32.8			< 0.50	<0.50	<0.50	< 0.50
Copper	mg/kg	68300			37	36	41	40
Lead	mg/kg	2300			310	44	220	280
Mercury	mg/kg	1120			1.2	0.2	1.2	0.83
Nickel	mg/kg	983			21	60	48	40
Selenium	mg/kg	12261			< 0.20	< 0.20	<0.20	<0.20
Vanadium	mg/kg	6360						
Zinc	mg/kg	730000			80	290	150	59
PAHs								
Naphthalene	mg/kg	462 (183)			1.5	0.55	<0.10	< 0.10
Acenaphthylene	mg/kg	96800 (212)			6.3	0.3	0.3	< 0.10
Acenaphthene	mg/kg	97100 (141)			2.1	0.36	0.3	< 0.10
Fluorene	mg/kg	68400.0			3.8	0.4	0.4	< 0.10
Phenanthrene	mg/kg	22300.0			47.0	5.5	4.1	0.9
Anthracene	mg/kg	536000.0			14.0	1.7	1.1	<0.10
Fluoranthene	mg/kg	22700.0			63.0	5.3	4.8	0.6
Pyrene	mg/kg	54400.0			57.0	5.1	4.5	0.7
Benzo(a)anthracene	mg/kg	174.0			28.0	1.6	1.8	< 0.10
Chrysene	mg/kg	352.0			29.0	2.4	2.3	< 0.10
Benzo(b)fluoranthene	mg/kg	44.7			30.0	1.6	2.1	< 0.10
Benzo(k)fluoranthene	mg/kg	1180.0			12.0	1.3	1.1	<0.10
Benzo(a)pyrene	mg/kg	35.5			25.0	0.98	1.4	<0.10
Indeno(1,2,3-c,d)pyrene	mg/kg	506.0			16.0	0.47	0.8	< 0.10
Dibenzo(a,h)anthracene	mg/kg	3.6			5.0	0.3	< 0.10	< 0.10
Benzo(g,h,i)perylene	mg/kg	3950.0			14.0	0.76	0.6	<0.10
PAH - USEPA 16, Total	mg/kg	NC			350.0	29	26.0	2.2
Phenols								
Total Phenols (monohydric)	mg/kg	NC			<0.30	< 0.30	0.3	< 0.30
Monoaromatics & Oxygenates								
Benzene	µg/kg	26.6						
Toluene	µg/kg	56294 (869)						
Ethylbenzene	µg/kg	5706 (518)						
p & m-xylene	µg/kg	NC						
o-xylene	µg/kg	6603 (478)						
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	NC						
Extractable Petroleum Hydrocarbons								
EPH >C8-10	mg/kg	NC						
EPH >C10-12	mg/kg	NC						
EPH >C10-40	mg/kg	NC						
EPH >C12-16	mg/kg	NC						
EPH >C16-21	mg/kg	NC						
EPH >C21-40	mg/kg	NC						
EPH >C8-40	mg/kg	NC						

Maria Fidelis Human Health Assessment - Soils			Exploratory hole	WS1	WS2	ML000-RO001	ML000-RO001
			Sample depth (m)	0.3	1.1	0.15	1
			Date sampled	23/10/2018	23/10/2018	04/11/2017	04/11/2017
			Strata	MG	MG	MG	MG
			Ground Investigation	GE 2018	GE 2018	HES	HES
			Location	Onsite	Onsite	Onsite	Onsite
Determinands	Units	Criterion Com (2.5%)					
Inorganics							
pH	pH	nc		10.3	8.6	8.7	7.86
Moisture	%	nc		14	17		
Sulphate (2:1 Water Soluble) as SO4	g/l	nc		0.6	0.51		
Sulphide (Easily Liberatable)	mg/kg	nc		5.1	2.4		
Cyanide, free	mg/kg	nc		<0.50	<0.50	<0.5	<0.5
Cyanide, Total	mg/kg	nc		<0.50	<0.50	<0.5	<0.5
Soil Organic Matter	%	nc		2.4	2.4	-	15.1
Asbestos							
ACM Type	Type	nc				Fibre Bundles	
Asbestos Identification	%	nc				Chrysotile	
Asbestos by Gravimetry	%	nc				<0.001	
Total Asbestos	%	nc					
Heavy Metals / Metalloids							
Antimony	mg/kg	7350					
Arsenic	mg/kg	635		19	25	16.9	30.1
Barium	mg/kg	22100				454	202
Beryllium	mg/kg	11.7				1.3	1.4
Boron	mg/kg	236000		1.1	0.66	0.2	2.3
Cadmium	mg/kg	190		< 0.10	0.3	0.5	<0.1
Chromium	mg/kg	8570		15	16	21.8	48.5
Chromium, Hexavalent	mg/kg	32.8		< 0.50	<0.50	<0.3	<0.3
Copper	mg/kg	68300		58	76	101	228
Lead	mg/kg	2300		150	770	1700	662
Mercury	mg/kg	1120		1.1	1.9	1.2	5.3
Nickel	mg/kg	983		18	23	19.5	32.6
Selenium	mg/kg	12261		< 0.20	< 0.20	<1	1
Vanadium	mg/kg	6360				42	67
Zinc	mg/kg	730000		58	65	412	137
PAHs							
Naphthalene	mg/kg	462 (183)		2.7	0.4	<0.40	<0.04
Acenaphthylene	mg/kg	96800 (212)		6.2	0.2	1.4	<0.03
Acenaphthene	mg/kg	97100 (141)		6.4	0.2	10.7	<0.04
Fluorene	mg/kg	68400.0		10.0	0.2	2.3	<0.04
Phenanthrene	mg/kg	22300.0		92	2.6	24.1	0.1
Anthracene	mg/kg	536000.0		30.0	1.1	10.7	<0.04
Fluoranthene	mg/kg	22700.0		94	4.0	52.3	0.2
Pyrene	mg/kg	54400.0		85	3.8	40.1	0.2
Benzo(a)anthracene	mg/kg	174.0		38	1.7	22.1	0.1
Chrysene	mg/kg	352.0		40	2.0	19.9	0.1
Benzo(b)fluoranthene	mg/kg	44.7		38	2.1	23.3	0.1
Benzo(k)fluoranthene	mg/kg	1180.0		15.0	1.2	9.1	0.0
Benzo(a)pyrene	mg/kg	35.5		30	1.6	19.9	0.1
Indeno(1,2,3-c,d)pyrene	mg/kg	506.0		20.0	1.5	12.1	0.1
Dibenzo(a,h)anthracene	mg/kg	3.6		5.9	1.0	3.1	<0.04
Benzo(g,h,i)perylene	mg/kg	3950.0		16	0.9	10.7	0.1
PAH - USEPA 16, Total	mg/kg	NC		530	25.0	261.8	1.1
Phenols							
Total Phenols (monohydric)	mg/kg	NC		0.4	<0.30		
Monoaromatics & Oxygenates							
Benzene	µg/kg	26.6				<5	<5
Toluene	µg/kg	56294 (869)				<5	<5
Ethylbenzene	µg/kg	5706 (518)				<5	<5
p & m-xylene	µg/kg	NC				<5	<5
o-xylene	µg/kg	6603 (478)				<5	<5
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	NC				<5	<5
Extractable Petroleum Hydrocarbons							
EPH >C8-10	mg/kg	NC				6	<5
EPH >C10-12	mg/kg	NC				<10	<10
EPH >C10-40	mg/kg	NC					
EPH >C12-16	mg/kg	NC				41	<10
EPH >C16-21	mg/kg	NC				535	<10
EPH >C21-40	mg/kg	NC				2824	<10
EPH >C8-40	mg/kg	NC				3406	<30

Maria Fidelis Controlled Waters Assessment Waste Assessment		Exploratory hole Sample depth (m) Date sampled Strata Ground Investigation Location	BH1 0.3 22/10/2018 GE 2018
Determinants	**Units**	**Inert WAC**	
Arsenic (dissolved)	mg/kg	0.5	< 0.050
Barium (dissolved)	mg/kg	20	< 0.50
Cadmium (dissolved)	mg/kg	0.04	< 0.010
Chromium (dissolved)	mg/kg	1	0.1
Copper (dissolved)	mg/kg	2	< 0.050
Mercury (dissolved)	mg/kg	0.01	0.0
Molybdenum	mg/kg	0.5	0.0
Nickel (dissolved)	mg/kg	0.4	< 0.050
Lead (dissolved)	mg/kg	0.5	0.0
Antimony (dissolved)	mg/kg	0.06	0.0
Selenium (dissolved)	mg/kg	0.1	<0.010
Zinc (dissolved)	mg/kg	4	< 0.50
Chloride (dissolved)	mg/kg	800	14.0
Fluoride (dissolved)	mg/kg	10	2.1
Sulphate as SO4 (dissolved)	mg/kg	1000	4000.0
TDS	mg/kg	4000	5100.0
Phenol Index	mg/kg	1	<0 30
DOC	mg/kg	500	65.0

Maria Fidelis Controlled Waters Assessment Soil Leachate			Exploratory hole	BH1
			Sample depth (m)	0.3
			Date sampled	22/10/2018
			Strata	
			Ground Investigation Location	GE 2018
Determinants	**Units**	**Criterion**	**Source**	
Arsenic	mg/l	0.5	EQS	0.0027
Barium	mg/l	1	EQS	0.03
Cadmium	mg/l	0.05	EQS	< 0.00010
Chromium	mg/l	0.5	EQS	0.0
Copper	mg/l	20	UK DWS 2000	0.0
Mercury	mg/l	0.01	EQS	<0.00050
Molybdenum	mg/l	NC		0.0005
Nickel	mg/l	0.5	UK DWS 1989	< 0.0010
Lead	mg/l	0.5	EQS	0.0023
Antimony	mg/l	0.1	UK DWS 1989	0.0
Selenium	mg/l	0.1	EQS	< 0.00J 0
zinc	mg/l	50	UK DWS 1989	0.0
Chloride	mg/l	NC		1.4
Fluoride	mg/l	15	UK DWS 2000	0.21
Sulphate	mg/l	2500	UK DWS	400
Total Dissolved Solids	mg/l	NC		510.0
Phenol Index	mg/l	5	DWS	< 0.030
Dissolved Organic Carbon	mg/l	NC		6.5

Maria Fidelis
Ground gas monitoring

Monitoring round	BH	Top response zone (m bgl)	Bottom response zone (m bgl)	Date	Atm pressure (mb)	Depth to GW (m)	Flow rate (l/h)	Methane (CH4) (%)	Carbon dioxide (CO2) (%)	Oxygen (O2) (%)	GSV Methane	GSV Carbon dioxide	CS
1	BH1	1	7	01/11/2018	993	Dry	0.1	0.1	1.3	18	0.0001	0.0013	CS1
2	BH1	1	7	14/11/2018	1020	Dry	0.1	0.1	1.3	17.3	0.0001	0.0013	CS1
3	BH1	1	7	21/11/2018	1007	Dry	0.1	0.1	1.4	17.6	0.0001	0.0014	CS1