ASHBURNHAM HOUSE
1 MAITLAND ROAD
LION BARN ESTATE
NEEDHAM MARKET
SUFFOLK
IP6 8NZ

Telephone (01449) 723 723
Fax (01449) 723 907
www.rsa-geotechnics.co.uk

By Email and Post -
pauljohnson@sisk.co.uk

RSA GEOTECHNICS LTD

Our Ref GM/12886GI2/PJB
Your Ref

30 November 2015

John Sisk & Son Ltd
1 Curo Park
Frogmore
St Albans
Hertfordshire
AL2 2DD

For the attention of Mr Paul Johnson

Dear Paul

SUPPLEMENTARY GEOENVIRONMENTAL INVESTIGATION AND ASSESSMENT: MAIDEN LANE ESTATE, CAMDEN, NW1 9YL

1. Introduction

A scheme is currently underway to redevelop a previous estate of mixed industrial and residential buildings to several blocks of flats between four and eight storeys in height, with one block of nineteen storeys, including area of soft landscaping, public open spaces, communal gardens and some private garden areas. Limited commercial space will be present at ground floor level. The proposed development layout is illustrated on drawing number 12886GI2/1.

The subject site has been subject to a number of previous phases of investigation by RSA Geotechnics Limited, discussing the geotechnical and geoenvironmental aspects of the site. These include:

- Ground Investigation Report, report reference 12886SI, dated October 2011
- Addendum Letter report on Ground Gas Monitoring, report reference PAG/12886SI/LMA, dated 3 November 2011
- Basement Impact Assessment phases 1 to 4 report references 12886CO and 12886CO2, dated January 2013
- Supplementary Interpretative Report, report reference 12886GI, dated August 2013.

It is recommended that this letter report be read in conjunction with the previous reports.

At the time of the initial site investigation (report number 12886SI and PAG/12886SI/LMA), general coverage of the site was limited by the presence of buildings. Further inspection, sampling, testing and associated risk assessment was recommended, following demolition of the existing buildings. Since the initial site investigation, the proposals have also been amended to include the area to the southwest (Block J). The area to the southwest (of Block J) included concrete access/egress ramps, retaining walls and steeply banked landscaping areas for trees and shrubs; there are no areas of public access communal or private gardens.

Previous phases of investigation and assessment had identified locally elevated concentrations of polycyclic aromatic hydrocarbons (PAH) within made ground, based on comparison with human health end user screening values current at the time of the assessment. Clean cover soil systems were recommended for all areas of soft landscaping, with a minimum thickness of 600 mm recommended for private garden areas, and a minimum thickness of 300 mm recommended for areas of communal landscaping. Remediation for end users was not considered necessary beneath the footprints of proposed buildings or areas of hardstanding, as a break in pathway between the source soils and end users would be present in these areas. See subsection 5.5 and 6.0 for further discussion/rationale and closure on this point

Other potential risks identified included a low risk to end users from ground gases, (see subsection 5.4.1.4 following for discussion/rationale and closure on this point), and potential risks to below-ground concrete and potable water infrastructure from determinands within the site soils (further discussed in section 5). It was understood by information provided by John Sisk and Son Ltd, that this hotspot was encountered in the volume of soil being removed to accommodate the basement of Block G. The hotspot was reported to extend to the east and south of Block G. Excavations have subsequently taken place to the east (3.0 m in depth) and to the south (2.0 m in depth). Two trial pits associated with these areas are recorded on attached drawings 12886GI/1 Version A and 12886GI/2 Version A, and discussed in subsection 4.2.

Subsequent testing on behalf of John Sisk & Son Limited, during the removal of shallow site soils to create levels appropriate for construction, identified relatively high concentrations of cyanide to be present locally within the soils. RSA received information

This report details the findings of limited further intrusive investigation and testing to refine the assessment of the site area with respect to geoenvironmental aspects, including the inspection, sampling and testing of soils in the areas of proposed soft landscaping to the west of Block H, to the south of Blocks ABC and around Block J and during the excavation of soils for the retaining wall to the east of Blocks F and G. The report also discusses the measures adopted to mitigate the potential risks to end users from ground gases, and to below-ground concrete from sulphate concentrations within the site soils.

The scope of works was determined through liaison between RSA Geotechnics Limited and John Sisk and Son Limited, based initially on RSA Geotechnics quotations referenced AMP/Quo215, 16 April 2015, and ESG/Quo26A, 26 May 2015, and amended by later correspondence.

Instruction to proceed with the works was provided by an email from John Sisk and Son Limited, dated 1 June 2015.

This report has been prepared for the sole internal use and reliance of John Sisk and Son Ltd. It shall not be relied upon by other parties without the express written authority of RSA Geotechnics Limited. If an unauthorised third party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care and skill.

Advice and recommendations in this report have been based on the results of the soil analyses carried out. It must be appreciated that not finding indicators does not mean that hazardous substances do not exist at the site.

RSA Geotechnics Limited have based this report on the results of the intrusive investigation and testing carried out, as well as the other sources detailed within this report, which are believed to be reliable. However, RSA Geotechnics Limited is not in a position to guarantee the authenticity or reliability of the third party information it has relied upon.

2. Site Location and Description

The Maiden Lane Estate is located within the London Borough of Camden, approximately 2 km north of King's Cross railway station. It can be approximately located to the south west of the junction between York Way (A5200) and Agar Grove and by National Grid Reference TQ 300 842.

The subject site comprised the eastern end of the Maiden Lane Estate that extended over an irregular shaped area measuring up to approximately 200 m from north to south and varying in width from about 20 m to 175 m. The site was bounded to the east by York Way (A5200) and to the south by railway lines that spanned York Way via a bridge adjacent to the south east corner of the site. The western boundary of the southern half of the site coincided with the western side of Broadfield Lane. For the northern part of the site, the western and northern boundaries were marked by terraces of existing flats and maisonettes within the estate.

An updated site visit was undertaken by an engineer from RSA Geotechnics Ltd on 12 May 2015, which reported the site to be in the construction phase. The previously existing buildings had been removed and construction of the new development was in progress.

3. Supplementary Ground Investigation, Sampling and Testing

The recent supplementary fieldwork and laboratory testing that were carried out in June 2015 are described below.

3.1 Fieldwork

RSA Geotechnics Limited attended site on 11 June 2015 to excavate trial pits at selected locations, for the purposes of inspecting and sampling residual soils in areas of the site where elevated determinands had previously been recorded, or where there was previously insufficient sampling coverage. Trial pits TP1 to TP3 were excavated by the contractor on site using a mechanical excavator to target depths of between 0.5 and 1.6 m. Trial pit TP4 and two shallow hand pits (HA1 and HA2) were also excavated by hand, to a depth of 0.6 m.

Representative samples were taken and sealed into appropriate containers to prevent deterioration or moisture content loss. The soils encountered on site were logged by a senior geotechnician.

The locations of the exploratory holes are illustrated on drawing number 12886GI2/2 attached to this report.

The contamination sampling was carried out generally in accordance with BS 10175: 2011 'Investigation of potentially contaminated sites - Code of Practice'.

3.2 Laboratory Testing

The scope for the geoenvironmental laboratory testing was specified to obtain the following data:-

i) Concentrations of water soluble sulphate and determination of pH value
ii) Concentrations of a range of commonly occurring contaminants including heavy metals, cyanide, phenol and speciated polycyclic aromatic hydrocarbons (PAH)
iii) Concentrations of cyanide compounds including complex cyanide, free cyanide and thiocyanate
iv) Screening for the presence of asbestos containing materials.

The chemical contamination analyses were carried out between 15 and 19 June 2015 by QTS Environmental Ltd, which holds MCERTS and UKAS accreditation. A copy of the test results is attached to the back of this letter report, as analytical report number 15-32384.

4. Ground Conditions

4.1 Geology

The 1:50,000 Series British Geological Survey Sheet 256 'North London', and the BGS electronic database, indicated the site to be underlain by London Clay. Worked ground was shown to exist to the east of the site, and was considered to potentially be present in the easternmost part of the site.

The base of the London Clay was indicated to extend to a relative level of about -5 to -10 m AOD. The London Clay was therefore expected to extend to depths of about 35 to 40 m below current ground level.

4.2 Ground Investigation Data

The ground conditions encountered during the ground investigation works comprised made ground over London Clay.

During the course of the groundworks phase, considerable volumes of made ground had already been removed from site to achieve appropriate levels for construction.

Made ground was encountered within all of the exploratory holes and typically ranged in thickness between 0.55 and 1.35 m. A 0.18 m thick layer of crushed brick and concrete, considered to represent remnant piling platform materials, was recorded in TP2, however the made ground was typically described as firm brown or orange brown silty clay with occasional medium to coarse brick, concrete and flint gravel. Fragments of ash and brick were also encountered between 0.1 to 0.6 m depth in HA1. The base of the made ground was not encountered at TP3, which terminated at 1.0 m depth.

The London Clay encountered beneath the made ground in TP1 and TP2 extended beyond the maximum depth of the investigation of 1.5 m and was typically described as firm to stiff orange brown silty clay with occasional grey silt layers and rare fine gypsum.

No groundwater was recorded in any of the window sample holes during the ground investigation works and no visual or olfactory evidence of contamination was recorded within the soils during the collection and logging of samples.

5. Geoenvironmental Considerations

5.1 Introduction

Previous site investigation, testing and associated assessment of the subject site was detailed within the reports referenced within section 1 of this report.

The human health end user risk assessment generally identified a negligible risk for inorganic determinands, based on comparison with screening values current at the time of the assessment. Elevated concentrations of lead were recorded locally, although the upper confidence limit (95th %ile) fell below the adopted screening value.

Elevated concentrations of some polycyclic aromatic hydrocarbon (PAH) compounds were recorded within the shallow made ground, and 'hotspots' of PAH impact were recorded at locations WS8 and WS9, to the west of the proposed Block H.

Due to the identified presence of some elevated concentrations of determinands within shallow site soils, a clean cover soil system comprising suitable imported subsoil/topsoil was recommended to be implemented within all soft landscaping areas. A minimum thickness of 600 mm was recommended for private garden areas, while a minimum thickness of 300 mm was recommended for areas of communal garden or general soft landscaping. RSA Geotechnics Limited previously advised all imported soils once placed should be independently validated with

respect to thickness and the samples should be tested to confirm that they are chemically suitable for the intended end use, as discussed further in subsection 5.5.

A potential risk to end users was determined from ground gas, based on the monitoring of borehole wells, and a CS-2 classification was determined based on reference to CIRIA C665. The works detailed in this report, did not indicate the need to revisit this classification from the previous investigation (report number 12886SI).

A negligible risk was identified to end users from asbestos, based on the fieldwork and testing carried out, however the possible presence of such materials within the made ground and the fabric of the existing buildings pre-demolition could not be discounted. Pre-demolition asbestos surveys of the existing buildings were recommended to identify all asbestos containing materials, which were to be fully removed in accordance with best practice. John Sisk and Son Ltd took vacant possession of the southern half of the site with all the commercial buildings demolished and the piling mat left in place (see subsection 5.4.1.3 following).

Liaison was to be undertaken with the potable water supplier to confirm requirements for pipework and backfill materials.

Buried concrete was to be designed in accordance with BRE Special Digest 1. A Design Sulphate Class of DS-2 was determined for the site. RSA received evidence from John Sisk and Son Ltd to show the concrete specified to achieve this grade.

A discovery strategy was to be maintained throughout the groundworks, to identify any previously undiscovered contamination, which if found was to be reported to the geoenvironmental engineer for appropriate consideration. John Sisk and Son Ltd have pointed out such a discovery strategy remained in place for all excavations and further confirm nothing untoward has been encountered during the recent ground works for block H and I.

Some areas of the site were reduced in level by up to approximately 3 m, to achieve appropriate levels for construction. Testing on behalf of John Sisk and Son Ltd of waste soils generated during groundworks indicated concentrations of determinands to be broadly comparable with those recorded during the previous investigations, however also recorded some high concentrations of cyanide (maximum 494 mg/kg). It is understood that the soils which gave rise to concern were discovered in the upper levels of the basement dig of Block G, possibly to depths in the region of 2.0 m. The soffit of the basement slab in Block G is in excess of 3.0 m below original ground level.

A negligible risk was identified to Controlled Waters, based on the relatively low sensitivity of the site and the presence of the London Clay.

The potential for the area to have been affected by wartime bombing was identified, and further specialist advice was recommended to be sought with respect to unexploded ordnance (UXO).

This section reviews the current status of the works with respect to the geoenvironmental aspects, including the assessment of the recent supplementary investigation and testing, and provides a record of the measures implemented for regulatory review.

Where appropriate, the earlier assessments have been updated in the light of changes to the guidance documents used in the assessment of contaminated land, using a qualitative risk assessment in terms of a source – pathway – receptor analysis.

A conservative 'residential with plant uptake' generic end use has been adopted for the purposes of initial Tier 1 assessment, reflecting the most sensitive end use included within the development, of residential properties with private garden areas.

5.2 Chemical Analyses

From the recent intrusive investigation, four samples of made ground were scheduled for a range of commonly occurring contaminants including heavy metals, phenol, cyanide and speciated polycyclic aromatic hydrocarbons (PAH). The analysis gives the concentrations of the sixteen PAH that are of particular concern.

A Photoionisation Detector (PID) was used to screen for volatile organic compounds (VOC) in all of the samples collected. On a precautionary basis, one sample was scheduled for speciated total petroleum hydrocarbons (TPH) with TPH Criteria Working Group (CWG) banding.

Three further samples of made ground were analysed for total cyanide, complex cyanide, free cyanide and thiocyanate.

Four soil samples were taken and inspected for the presence of asbestos fibres using an optical microscope.

The chemical analyses from the previous phases of investigation by RSA Geotechnics Ltd have also been considered as part of this risk assessment and compared against current guidance.

5.3 Published Guidelines

The results of the chemical analyses have been interpreted by comparing them with the various published guidelines that are currently used for land quality risk assessments. The following guidelines have been used during this assessment:-

i) LQM-CIEH Suitable for Use Levels (S4ULs) for Human Health Risk Assessment, 2015
ii) Category 4 Screening Levels (C4SL) – DEFRA 2014
iii) ATRISK Soil Generic Screening Values, 2009
iv) CL:AIRE – 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', 2008
v) BRE Special Digest 1, 'Concrete in Aggressive Ground', 2005
vi) BS 3882: 2007, 'Specification for topsoil and requirements for use'
vii) CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings', 2007
viii) Environment Agency 'Guidance on the classification & assessment of waste' Technical Guidance WM3.

5.4 Generic Quantitative Risk Assessment by Receptor

The following subsections review the results of the chemical laboratory analyses carried out on samples retrieved from the site.

In order to classify the anticipated risk associated with potential sources of contamination identified on the site the following classification system has been adopted.

Term	Description
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High risk	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 more likely that such harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard but is likely that at worst, this harm if realised would normally be mild.
Negligible risk	The presence of an identified hazard does not give rise to the potential to cause significant harm to a designated receptor.

5.4.1 End Users

The risk to end users of the development has been considered by comparing the results of the chemical analyses from the previous phases of investigation and current investigation with the Tier 1 Human Health Screening Values. The Tier 1 Screening Values have been derived with reference to current guidance, taking into consideration site specific information and are based on the proposed end use comprising the more conservative 'residential with plant uptake' end use. The source of the parameters used in the derivation of the screening values is given in the tables.

Screening values for some organic determinands are sensitive to soil organic matter content. An organic matter content of 1% has been adopted in the assessment, based on measured values.

5.4.1.1 Inorganic Contaminants

Assessment of the inorganic analytical results for the various phases of investigation, including the recent testing, against Tier 1 screening values for a 'residential with plant uptake' end use (Table 5.4.1.1A) is summarised in Table 5.4.1.1B.

Table 5.4.1.1A - Tier 1 Human Health Screening Values for Inorganic Determinands for Residential with Plant Uptake End Use

Determinand	Tier 1 Screening Values (mg/kg)	Source of Data to Derive Tier 1 Screening Values
Arsenic	37	LQM-CIEH S4UL 2015
Boron	290	LQM-CIEH S4UL 2015
Cadmium	11	LQM-CIEH S4UL 2015
Chromium 3	910	LQM-CIEH S4UL 2015
Chromium 6	6	LQM-CIEH S4UL 2015
Copper	2400	LQM-CIEH S4UL 2015
Cyanide	34	ATRISK SOIL
Lead	200	DEFRA C4SL
Mercury	40	LQM-CIEH S4UL 2015
Nickel	130	LQM-CIEH S4UL 2015
Selenium	250	LQM-CIEH S4UL 2015
Zinc	3700	LQM-CIEH S4UL 2015

Table 5.4.1.1B - Inorganic Determinands in Made Ground

Determinand	No. of Tests	Concentration (mg/kg)		Tier 1 Screening Value (Residential With Plant Uptake)	Number of Results Exceeding T1SV	Upper Confidence Limit	Upper Confidence Limit Exceeds T1SV?
		Max	Mean				
Arsenic	35	31.4	10.1	37	0	13.8	No
Boron	35	3.4	0.9	290	0	1.4	No
Cadmium	35	3	0.5	11	0	0.9	No
Chromium III	35	47	27.5	910	0	29.9	No
Chromium VI	35	<2	<2	6	0	<2	No
Copper	35	199	54.1	2400	0	88.4	No
Lead	**35**	**795**	**190.4**	**200**	**13**	**319.4**	Yes
Mercury	35	2.5	0.7	40	0	1.1	No
Nickel	35	42	23.1	130	0	25.3	No
Selenium	35	<1.5	<1.5	250	0	<1.5	No
Zinc	35	525	126.1	3700	0	198.3	No
Total Cyanide	35	2.8	<0.9	34	0	<1.2	No

Elevated concentrations of lead in excess of the current S4UL Tier 1 screening value derived for a 'residential with plant uptake' end use were recorded in thirteen out of the thirty-five samples of made ground.

Statistical analysis indicated that the concentrations of lead were considered statistically significant i.e. the upper confidence limit value (95th%ile) was above the Tier 1 screening value for this determinand. Therefore, lead within made ground was considered to pose a widespread low risk to end users of the development.

Concentrations of all the other analysed inorganic determinands were found to be below their relevant Tier 1 screening values for the proposed end use, and consequently were considered to pose a negligible risk to end users.

The single sample of natural soils tested recorded no elevated concentrations of inorganic determinands to be present.

5.4.1.2 Organic Contaminants

The following screening values for phenol and polycyclic aromatic hydrocarbons (PAH) have been derived for use in the Tier 1 generic risk assessment. A soil organic matter content of 1%, based on measured values, has been used where appropriate in the derivation of the screening values.

The screening values in Table 5.4.1.2A for polycyclic aromatic hydrocarbons (PAH) have been derived for use in the Tier 1 generic risk assessment.

Table 5.4.1.2A - Tier 1 Human Health Screening Values for Speciated PAH for a Residential With Plant Uptake End Use (1% SOM)

Determinand	Tier 1 Screening Values (mg/kg)	Source of Data to Derive Tier 1 Screening Values
Naphthalene	2.3	LQM-CIEH S4UL 2015
Acenaphthylene	170	LQM-CIEH S4UL 2015
Acenaphthene	210	LQM-CIEH S4UL 2015
Fluorene	170	LQM-CIEH S4UL 2015
Phenanthrene	95	LQM-CIEH S4UL 2015
Anthracene	2400	LQM-CIEH S4UL 2015
Fluoranthene	280	LQM-CIEH S4UL 2015
Pyrene	620	LQM-CIEH S4UL 2015
Benz(a)anthracene	7.2	LQM-CIEH S4UL 2015
Chrysene	15	LQM-CIEH S4UL 2015
Benzo(b)fluoranthene	2.6	LQM-CIEH S4UL 2015
Benzo(k)fluoranthene	77	LQM-CIEH S4UL 2015
Benzo(a)pyrene	2.2	LQM-CIEH S4UL 2015
Indeno(123-cd)pyrene	27	LQM-CIEH S4UL 2015
Dibenz(ah)anthracene	0.24	LQM-CIEH S4UL 2015
Benzo(ghi)perylene	320	LQM-CIEH S4UL 2015
Phenol	120	LQM-CIEH S4UL 2015

i) Phenol

The phenol analysis carried out is a general screen that mainly identifies the presence of phenol and to a lesser extent other monohydric phenols such as cresol and chlorinated phenols. Concentrations of phenol were found to be below the derived Tier 1 Human Health Screening Value and therefore the risk to end users was considered to be negligible.

ii) Polycyclic Aromatic Hydrocarbons (PAH)

In previous investigations, elevated concentrations of PAH were recorded locally in made ground within the north western part of the site, and the south-western corner. Statistical analysis at the time of reporting indicated that these areas included 'hotspots' of contamination that could be remediated independently.

Tier 1 screening values have been updated in accordance with current guidance (2015) and have been used to provide an updated assessment of concentrations of PAH recorded within made ground during all phases of the investigation. The results are summarised in Table 5.4.1.2B.

Table 5.4.1.2B - Phenol and PAH Determinands, 1% SOM, Made Ground

Determinand	No. of Tests	Concentration (mg/kg)		Tier 1 Screening Value (Residential with Plant Uptake)	Number of Results Exceeding T1SV	Upper Confidence Limit	Upper Confidence Limit Exceeds T1SV?
		Max	Mean				
Phenol	35	1	1	120	0	1	No
Naphthalene	35	0.6	0.11	2.3	0	0.18	No
Acenaphthylene	35	0.2	0.11	170	0	0.12	No
Acenaphthene	35	1.3	0.16	210	0	0.33	No
Fluorene	35	1.0	0.14	170	0	0.25	No
Phenanthrene	35	7.9	0.70	95	0	1.95	No
Anthracene	35	2	0.22	2400	0	0.52	No
Fluoranthene	35	10.5	1.10	280	0	2.77	No
Pyrene	35	9.5	0.97	620	0	2.41	No
Benz(a)anthracene	35	5.2	0.56	7.2	0	1.38	No
Chrysene	35	6.5	0.65	15	0	1.62	No
Benzo(b)fluoranthene	35	**4.7**	0.58	2.6	**2**	1.28	No
Benzo(k)fluoranthene	35	5.1	0.52	77	0	1.26	No
Benzo(a)pyrene	35	**5.7**	0.54	2.2	**2**	1.35	No
Indeno(123-cd)pyrene	35	3.6	0.36	27	0	0.89	No
Dibenzo(a,h)anthracene	35	**1.0**	0.11	0.24	**1**	**0.25**	Yes
Benzo(ghi)perylene	35	2.8	0.36	320	0	0.80	No

Elevated concentrations of benzo(b)fluoranthene and benzo(a)pyrene were recorded within samples from WS8, 0.5 m depth, and WS9, 1.3 m depth, with the sample from WS8 also recording an elevated value for dibenz(a,h)anthracene.

Statistical analysis indicated that the upper confidence limit values (95%ile) for benzo(b)fluoranthene and benzo(a)pyrene were below the current Tier 1 Screening Values, indicating a negligible risk to end users of the development. The upper confidence limit for dibenz(a,h)anthracene was marginally above the Tier 1 screening value.

It should be noted the elevated concentrations of PAH were recorded during the earliest phase of intrusive investigation in 2011. Any potential risks from elevated concentrations within the made ground would have been partially mitigated by the removal of significant quantities of made ground from across the site, during the groundworks phase of the project.

Given the marginal exceedance of a single PAH compound, and the source reduction from the removal of made ground from the site, a negligible risk was determined from PAH.

iii) Total Petroleum Hydrocarbons (TPH)

Samples recovered as part of the recent investigation were screened for the presence of volatile organic compounds using a photoionisation detector (PID). Concentrations were typically low, ranging between <0.1 and 6.2 parts per million (ppm). A single elevated concentration of 90.6 ppm was recorded at 0.1 m in TP2, which was subsequently scheduled for TPH analysis.

A total of three samples of made ground from all phases of investigation had been scheduled for laboratory analysis to measure the concentrations of TPH carbon bands based on guidance from the TPH Criteria Working Group (CWG), which also splits the hydrocarbons into aliphatic and aromatic species. The results were compared with updated Tier 1 screening values, in accordance with current guidance.

Measurable concentrations were not recorded within two of the samples, with the third recording very low concentrations (total 58.1 mg/kg) and with all concentrations well below the Tier 1 screening values. Therefore, a negligible risk to end users was determined from TPH.

5.4.1.3 Asbestos

From previous ground investigations on site, the potential for asbestos to be present within the made ground could not be discounted, and a potential risk was also determined from the potential presence of asbestos within the existing buildings on the site. It was therefore recommended that pre-demolition surveys for asbestos were undertaken for the existing buildings.

At the time that John Sisk and Son Ltd took over the site, two buildings remained, comprising the two blocks either side of Maiden Lane within the northern area of the site. The industrial warehouse units on the eastern side of Broadfield Lane had

been previously demolished. A survey of these units for asbestos had been undertaken by Eton Environmental Services in November 2011. The report of the survey identified asbestos containing materials (ACM) in floor tiles/bitumen and in sink pads (very low risk), and also in electrical flashguards (low risk).

The identified asbestos containing materials were scheduled to be removed prior to demolition of the units. John Sisk and Son Ltd reported to RSA Geotechnics that it remains their understanding that Camden Council arranged for the demolition of the commercial buildings under a separate contract in accordance with contemporary safety and hazardous waste guidelines to an appropriate landfill site, before they won the site. Therefore, there was no documentation for review. John Sisk and Son Ltd have worked under the presumption that Camden Council ensured the original buildings were demolished, with appropriate controls in place, as further discussed in subsection 5.4.1.5 and section 6.

A further report by Eton Environmental Services dated January 2013 was made available, detailing an asbestos survey of the two blocks either side of Maiden Lane, comprising numbers 1-55 Maiden Lane (western block) and 2-16 Maiden Lane (eastern block). This survey identified no asbestos containing materials to be present.

Four samples of made ground were collected after the demolition of the buildings and screened for the presence of asbestos using optical microscopy, with no asbestos positively identified.

Therefore, a negligible risk has therefore been determined to end users from asbestos based on the fieldwork and testing carried out. However, the possibility that such materials may be encountered locally within remnant made ground cannot be fully discounted. Vigilance will be maintained throughout the groundwork phase to identify any previously undiscovered contamination, including asbestos.

5.4.1.4 Ground Gas

A reassessment of ground gas mitigation was not required by John Sisk and Son Ltd as they noted that as part of the previous assessment of the site, a total of ten return monitoring visits were undertaken between 2011 and 2013. Measureable concentrations of ground gas were recorded and the results were reviewed against the modified Wilson and Card classification 'Situation A – All development types except low rise housing with gardens' as set out in the CIRIA document C665, 2007. The site was classified as characteristic situation 2 (CS-2) for which basic ground gas precautions would be required, in order to protect the end user of the development (see report reference 12886GI, dated August 2013).

Drawings provided by John Sisk and Son are appended (drawing numbers 12886GI2/3, 12886GI2/4 and 12886GI2/5), detailing the specification for membranes (Hydroprufe 6000) and waterproof concrete to mitigate the potential risk from ground gas. A certificate from Prestige Air-Technology for an integrity test on a gas resistant membrane is also appended.

5.4.1.5 Conclusion of End User Risk Assessment

The updated assessment of the site in the light of the recent supplementary investigation and testing, and comparison with contemporary Tier 1 screening values, has indicated that the potential risk from PAH within made ground is lower than the earlier assessments, however as the screening value for lead has reduced, this determinand has been identified as being generally elevated within the made ground, and a low risk has been determined to end users. Consequently, the previous recommendations for clean cover soil systems of minimum thickness 600 mm within domestic gardens, and 300 mm in communal gardens and general soft landscaping, are still considered appropriate for the site.

The further testing of residual soils did not indicate elevated concentrations of cyanide to be present, suggesting that the elevated concentrations recorded during the groundworks phase (from testing of soils generated during excavation to reduce site levels) are no longer present within residual soils.

The design specification for the new construction includes for the provision of anti-ground gas membranes and waterproof concrete, to mitigate the potential risk to end users from ground gases.

Asbestos surveys for the previous buildings on the site have been provided for review – occasional asbestos containing materials (very low to low risk) were identified within the former warehouse units within the southern area of the site; these were reported to have been removed by Downwell Demolition prior to construction. No asbestos containing materials were identified to be present within the residential blocks either side of Maiden Lane, within the northern area of the site. Recent asbestos screening of shallow site soils has not positively identified the presence of asbestos.

RSA Geotechnics were provided with documentation, as per drawing number 12886GI2/6 to indicate that the potable water infrastructure adopted for the site comprises Protectaline MDPE, after recommendations were made by the local authority.

5.4.2 Construction Workers

Construction workers were to be informed of the contamination issues on site and normal site PPE was to be worn including gloves, overalls, site boots, and safety helmet and ready access was to be available to dust masks. Appropriate welfare and hygiene regimes were to be established on site and their usage was to be enforced. Site visitors were to be supervised and protected as necessary.

Construction workers were to be protected from risks associated with the elevated levels of hazardous gases and depleted levels of oxygen in confined spaces, such as excavations.

Evidence of welfare and the enforcement of protective equipment control and safe working procedures was observed during visits to the site.

5.5 Recommendations

The following recommendations are based on a mixed industrial and residential development with blocks of flats between four and eight storeys in height, with one block of nineteen storeys, including areas of soft landscaping, public open spaces, communal gardens and some private garden areas, and limited commercial space at ground floor level. The proposed development plan is illustrated on drawing number 12886GI2/1. Should the proposed development plans alter from the above, a review of the following recommendations may be required.

A review of historic and recent analytical results has identified generally elevated concentrations of lead and marginal concentrations of PAH within shallow made ground, and consequently a suitable thickness of imported clean cover soils (topsoil and subsoil) will be required to be provided within all soft landscaped areas for the protection of end users and human health, to form a break in pathway between existing site soils and end users of the development, and to provide a suitable growing medium for vegetation. A minimum thickness of 600 mm of clean cover is due to be provided in domestic garden areas reducing to a minimum thickness of 300 mm in communal garden and soft landscaped areas. The clean cover soils will also need to meet the horticulturist's specification for the development, taking into account the proposed planting scheme.

As the shallow site soils with inclusions of brick, concrete and glass are unsuitable for use as subsoil or topsoil, its noted that all soils in private gardens and communal areas are to comprise suitable imported soil to minimum depths of 600 mm and 300 mm respectively.

No remediation is required beneath buildings or areas of permanent hardstanding as the pathway between end users of the development and the made ground would be suitably broken.

Any materials imported onto site for use as topsoil or subsoil, or as backfill to excavations, should be accompanied by compliance certification indicating that the materials have originated from 'clean' sources and are chemically potentially suitable for use in a residential development.

Once such materials are on site, John Sisk and Son Ltd intend to re-engage RSA Geotechnics Ltd to complete independent validation and testing of the imported soils, to confirm they are chemically suitable for use on site. The imported materials would be scheduled for a range of commonly occurring contaminants including heavy metals, PAH and TPH, and asbestos screening, as appropriate. The thickness of the clean cover system will be inspected to confirm it meets the minimum requirements.

It is understood that site-won crushed concrete originating from the demolition phase works has been used on site locally beneath areas of hard landscaping, to achieve appropriate construction levels. Assessment of these materials is outside the scope of this report. The crushed material was used as a piling mat and to make up levels. Excess of the materials was removed and certified by the haulage contractor as 6F2 grade material, as detailed in section 6 of the report.

6. Waste Classification

Based on the site investigation test results to date, and reference to the EA document 'Guidance on the classification & assessment of waste' Technical Guidance WM3, the majority of the made ground would be anticipated to be classified as Non-Hazardous for waste disposal purposes, with one sample being classified as Hazardous, and three samples being classified as potentially Hazardous. From the previous investigation (2013), sample D6 from WS9 was classified as Hazardous due to its high pH value. Samples recovered from WS6, WS12 and WS13 were classified as potentially Hazardous due to their elevated concentrations of cyanide, subject to the agreement of the receiving landfill facility.

Waste Acceptance Criteria (WAC) analyses to assess the leachability of any contaminants present was undertaken on four selected samples as part of the previous investigation. Two samples of made ground (from WS11 at 1.8 m and WS2/01 at 1.0 to 2.8) were classified as Non-Hazardous, whilst one sample of made ground (from WS2/03 at 0.25 to 2.8 m) and one sample of shallow natural soil (from WS6 at 0.9 m) was classified as Inert.

It is understood that after taking control of the site, John Sisk and Son identified the need to reduce ground levels within the southern part of the site, which had been capped with recycled aggregate materials resulting from earlier demolition within this area. It is understood from a review of waste transfer documentation that these materials (classified as 6F2) were removed off-site to a licensed waste facility.

A random selection of the overall waste transfer documentation for the site was provided to RSA Geotechnics by John Sisk and Son, for review.

The documents indicate that waste soils and materials were removed from site by licensed waste carriers, and were taken to licensed waste facilities, including RMS Recycled Materials Supplies Silvertown.

Waste carriers for crushed concrete (nominally 6F2), subsoil and non- hazardous building materials included:

- Tophire Ltd, waste carrier licence CB/9N557CN
- GRS Roadstone Ltd, waste carrier licence CB/XM358ON
- RMS Recycled Materials Supplies Silvertown, waste carrier licence CB/VM3786BG

Waste carriers for 'Inert Clay' included:

- Tophire Ltd, waste carrier licence CB/9N557CN
- Lock Bros (Haulage Ltd), waste carrier licence CB/WE5434EX

As discussed in subsection 5.4.1.3, RSA Geotechnics were informed by the client that all the ACM containing materials on site were removed from site in accordance with current safety and hazardous waste guidelines before SISK managed the site, however documentation was not made available for review.

7. Conclusions

A scheme is currently underway to redevelop a previous estate of mixed industrial and residential buildings to several blocks of flats with ground level commercial units, including area of soft landscaping, public open spaces, communal gardens and some private garden areas.

Recent supplementary investigation and assessment including a review of earlier phases of site investigation has indicated that the previous recommendations for clean cover soil systems within all areas of soft landscaping remain appropriate.

In due course, installed clean cover soil systems should be independently inspected and tested to confirm that the appropriate minimum thickness has been achieved, and that the soils meet the chemical requirements for a residential end use. Imported soils should be from a certified source.

Anti-ground gas precautions have been adopted for the development, as detailed within subsection 5.4.1.4 of this report, and on drawing references 12886GI2/3, 12886GI2/4 and 12886GI2/5 appended.

Barrier pipework precautions have been adopted for the site, as detailed within subsection 5.4.1.5 of the report, and the documentation reference 12886GI2/6 has been appended.

It is understood that below-ground concrete has been designed with reference to BRE Special Digest SD1, 'Concrete in Aggressive Ground', adopting a Design Sulphate Class of DS-2.

Vigilance should be maintained throughout the groundworks phase to identify any previously undiscovered contamination, which if found should be brought to the attention of the geoenvironmental engineer for appropriate consideration.

This report should be submitted to the Local Authority, and also to any warrantors for the development, for their review and comment/approval.

This report is based on the results of previous and current phases of fieldwork and laboratory testing carried out and on an examination of the recovered samples from the current ground investigation. The possibility that different conditions may exist other than at the exploratory hole positions, or at greater depth, should not be ruled out. In particular, groundwater and ground gas records apply only to the time and place of the investigation, since wide variations may occur through seasonal, atmospheric or other causes.

We trust the above letter report will fulfil your present requirements but should you need further advice or investigation, please contact us again.

Yours sincerely
RSA Geotechnics Ltd

Gail Mitchell BSc, FGS
Graduate Geoenvironmental Engineer

Adrian Phillips, FGS
Technical Director

Encs Chemical Contamination Analyses Results (QTS 15-32384)
Headspace Monitoring Record Sheet
Waste Transfer Notes for Crushed Concrete
Waste Transfer Notes for 'Inert Clay'
Gas Membrane Inspection Certificate
Proposed Development Layout – Drawing Number 12886GI2/1
Exploratory Hole Location Plan – Drawing Number 12886GI2/2
Anti-Ground Gas Precaution Details – Drawing Number 12886GI2/3
Anti-Ground Gas Precaution Details – Drawing Number 12886GI2/4
Anti-Ground Gas Precaution Details – Drawing Number 12886GI2/5
Drawing Showing Barrier Pipework – Drawing Number 12886GI2/6

RSA GEOTECHNICS LTD