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For the attention of Ms Rachel Betts

Geotechnical Department

Our ref: 351221/RP

3 March 2017

Dear Rachel,

RE: MAITLAND PARK – REMEDIATION PLAN

CET Infrastructure (CET) was instructed by Price and Myers LLP (P&M) to prepare Remediation Plan for the Maitland Park study site located at Maitland Villas, Camden, London NW3 2HG.

The site currently comprises residential apartments, a gym building, garages, car parking, access and communal soft landscaped areas. It is further understood that the site is to be redeveloped into three multi storey residential apartment blocks with associated access, private rear gardens and communal landscaped areas.

Summary of Review of Existing Reports & II Contaminated Land Assessments

CET carried out a review of the existing reports by Ramboll (Geotechnical and Environmental Desk Study January 2013 and Contaminated Land letter report May 2014) in January 2017.

The Ramboll contaminated land letter report concluded that potential sources of ground contamination identified at the site included vanadium, heavy metals and PAHs and concentrations of TPH that could have the potential to impact buried water supply pipes. The concentrations of the determinands in the groundwater samples recovered for testing were low and were not considered to pose a significant risk to controlled waters. With regards to ground gas a Characteristic Situation of CS1 was calculated from the gas data and as a result no specific ground gas protection measures were recommended by Ramboll.

CET's review of the reports indicated that the results were analysed against the soil guideline values (SGVs), and as these have now been superseded the results of the chemical analysis were compared against available Suitable 4 Use Levels (S4ULs) and Category 4 Screening Levels (C4SLs). Concentrations of lead and PAHs in Made Ground were found to exceed the respective screening criteria.

CET concurred with Ramboll that based upon the findings of the supplied reports further sampling at the study site was required to increase the dataset and gain a better understanding of the spatial extent of the identified contamination with respect to human health. In the absence of any sensitive water receptors within the vicinity of the site and that no significant concentrations of determinands were recorded in the groundwater samples tested the risks to controlled waters are considered to be negligible.

The CET site investigation commenced on the 23 January 2017 with the formation five window sample boreholes and eight hand dug trial pits, some extended by hand auger. The concentrations of the majority of determinands tested were less than the respective S4ULs that considered a residential end use without home grown produce and are therefore not considered to have the potential to pose a significant risk to human receptors. However, elevated concentrations of PAHs and lead were identified in the Made Ground and as such contaminants are judged to have the potential to pose a risk to future site occupants from the direct contact, ingestion and dust inhalation exposure pathways. The findings of the initial phase of assessment were presented in an interpretative report dated February 2017 (ref: 351221).

Since the report was completed plans have been supplied to CET that indicate some of the properties will have private rear gardens. As a result the end use criteria is be 'residential with home grown produce', which is considered to be the most sensitive end use for human health. When comparing the data to the appropriate S4ULs/C4SLs it is noted that six of the concentrations (including one from the Ramboll investigation) exceed the lead C4SL, four samples (including two from the Ramboll investigation) exceed the S4ULs for various PAHs and one sample from the Ramboll investigation exceeds the S4UL for aromatic TPH C16-C21. This Remediation Plan will be therefore be based on the most sensitive end use of residential with home grown produce.

Remediation Plan

In order for a risk to be posed to a sensitive receptor a pollutant linkage, comprising a source, pathway and receptor of ground contamination, must be established. In this instance the identified source of contamination is the Made Ground underlying the site that was found to contain elevated concentrations of lead and PAHs. Future site users, construction workers and occupants of neighbouring properties were identified as potentially sensitive human receptors.

Pre development, there is a risk that construction workers could be exposed to contaminated soils. However, it is considered that the risks could be effectively ameliorated by the use of appropriate personal protective equipment (PPE) and health and

hygiene practices. During the construction process off site human receptors could be exposed to on site contaminated soils via dust inhalation. However, this specific pathway would be severed by the use of appropriate dust suppression measures that, as good practice, should be implemented at construction sites regardless of the presence of contamination.

Post development, buildings and permanent hardcover represent a physical barrier that would effectively sever the dust inhalation, ingestion and direct contact pathways and as such soils beneath these portions of the site are not considered to have the potential to pose a significant risk to site occupants. The gas monitoring undertaken by Ramboll resulted in a classification of Characteristic Situation 1, for which no specific ground gas protection measures are considered necessary. Furthermore, as the initial phases of investigation and assessment failed to identify a potential source of ground gases it is considered there is a negligible risk of potentially hazardous gases permeating cracks or joints in hardstanding and posing a risk to human receptors.

Although exceedances of TPH were identified in one sample of shallow Made Ground from the Ramboll investigation, they exclusively comprised heavier C16 to C35 carbon ranges. The 'LQM/CIEH S4ULs for Human Health Risk Assessment' document indicates the contribution of total exposure from the inhalation of indoor or outdoor vapour of these specific determinands to be 0%. It is therefore judged that the volatilisation exposure pathways are not significant and as such soils surfaced by buildings or permanent hardstanding will not require remediation.

With regards to controlled waters, based on the low sensitivity of the study site, and the absence of potentially sensitive receptors, this assessment failed to identify a complete pollutant linkage requiring remediation.

There does however remain a risk that future occupants of the residential development could be exposed to contaminated Made Ground soils via the direct contact, ingestion and dust inhalation exposure pathways in any garden and soft landscaped areas. In order to ameliorate these risks we suggest establishing a cover system of appropriate thickness to sever the identified exposure pathways and pollutant linkages between human receptors and the identified contamination. The required thickness of cover soils has been devised with reference to the BRE guidance entitled "Cover Systems for Land Regeneration". This document uses the following equation which considers both the measured and permissible concentrations of contaminants in soils:

$$X = M(C_g - 1)/(C_g - C_c)$$

Where:

X = Cover Thickness

M = Mixed Zone (assumed to be 600mm i.e. two spade depths)

C_g = Contaminant concentration of existing ground (expressed as a multiple of the GAC)

C_c = Contaminant concentration of cover as a proportion of the GAC (assumed to be half of the GAC)

The following calculations have been carried out with reference to the contaminants recorded in excess of the respective guideline values as part of the ground investigation. Benzo(a)pyrene and dibenzo(ah)anthracene have been used to represent the identified PAH contamination.

Determinand	True Mean Site Conc. (US95)	S4UL	Cg	$M(C_g - 1)/(C_g - C_c)$	Cover Thickness (mm)
Lead	3112	200	$3112/200 = 15.6$	$600(15.6 - 1)/(15.6 - 0.5)$	580
Benzo(a)pyrene	25.1	2.2	$2.7/2.2 = 11.4$	$600(11.4 - 1)/(11.4 - 0.5)$	573
Dibenzo(ah)anthracene	4.0	0.28	$0.66/0.24 = 14.3$	$600(14.3 - 1)/(14.3 - 0.5)$	578

The true mean site concentration includes outliers as the data does not have a normal distribution. The above calculations indicate that the cover thickness is 580mm. However, it should be noted that sporadic hotspots of PAH, TPH and lead contamination exist and therefore it is considered most practical and prudent to install a cover layer of the full 600mm thickness. At the base of the cover system a 'capillary break' comprising a geotextile membrane and/or layer of 'clean' crushed concrete will be required to reduce the potential of mixing of clean and contaminated soils. Where trees are to be retained it will be necessary to grade the cover system up to the tree trunks so as not to disturb the existing root systems.

Notwithstanding the above, concentrations of TPH may make the Made Ground unsuitable for the installation of HDPE water supply pipes. The UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (ref: 10/WM/03/21 Jan 2011) includes a threshold value of 500mg/kg for TPH (C16-C40 aliphatic and aromatic). The sample tested by Ramboll from BH3 at 0.5m bgl recorded a concentration of 2142mg/kg of TPH (C16-C35) and is therefore considered to have to potential to adversely impact plastic water supply pipes. Based on the results to date the worst case scenario would be to use appropriate barrier water supply pipes or to lay HDPE pipes in suitable 'clean' imported fill with a geotextile membrane to break the direct contact pathway with the Made Ground. It would be prudent to discuss the type of water supply pipe required with the service provider prior to installation. Alternatively further targeted investigation should be undertaken along the route of the proposed water pipes at the invert depth so that a more detailed risk assessment can be prepared.

Methods of Verification

In order to demonstrate to the Local Authority Contaminated Land Officer that the remediation works specified in this correspondence has been successfully completed it will be necessary to prepare a closure (validation) report. The following section discusses the information and documentation required to satisfy the requirements of regulators and therefore work towards the discharge of all outstanding planning conditions regarding contaminated land.

In the first instance it will be necessary to ensure that the Made Ground soils have been removed to a sufficient depth from all garden and soft landscaped areas of the development to enable the placement of the 600mm of cover soils and capillary break layer. It should be noted that where relatively shallow deposits of Made Ground are present it may be prudent to excavate them entirely as by removing the source of contamination there would be no requirement for a specific depth of cover soils to disrupt the pollutant linkage. However, for amenity purposes, a depth of topsoil no less than 300mm is likely to be appropriate.

Furthermore, the following should also be taken into consideration when preparing the site:

- Any building material and general construction waste present within the proposed soft landscaped areas of the development would need to be thoroughly cleared prior to cover soil placement;
- The ground should be compacted prior to placement of the cover system, however prepared locations should not be allowed to induce water logging; and
- If plants are to be grown within the cover system imported media then it should incorporate a topsoil layer, ideally at least 300mm thick.

It will be necessary for a CET Environmental Scientist to attend site to inspect the stripped formations, including water service trenches if necessary, and take photographs for inclusion in the final closure report. It should be noted that if the exposed soils exhibit visual and/or olfactory evidence of contamination over and above that already encountered at the site by CET then it may be necessary to recover additional samples for chemical testing and risk assessment purposes to ensure compliance with this remediation specification.

All soil material imported to the site should be sourced from a reputable supplier and accompanied by appropriate certificates of analysis, which can be included in the final closure report. It would be prudent for CET to carry out a review of available chemical information prior to purchase and importation of any soil material.

It will also be necessary to recover samples of the imported material, both topsoil and subsoil, for chemical testing to ensure that the material is suitable for its proposed end use. A testing frequency of one sample per 500m³ or 1 test per two plots in areas of private gardens of imported material, with a minimum of five samples, is proposed. Additional samples would be required if the topsoil and subsoil was purchased from more than one source or is noted to differ significantly across the site.

Any spoil (waste soil) removed from site will have to be disposed of at an appropriately licensed disposal site in accordance with current best practice. All waste transfer notes, disposal tickets and duty of care paperwork should be completed and kept by the client in line with current waste management regulations. Copies of this paperwork should be supplied to CET for inclusion in the closure report.

Summary

In order to satisfy the requirements of the Local Authority it will be necessary to provide a closure report which will detail the successful completion of the aforementioned remediation works. This report will need to include the following:

- Photographic evidence that the soils present within all gardens and soft landscaped areas of the site have been either removed entirely or excavated to a depth to enable the incorporation of the 600mm cover system including break layer;
- Photographic evidence and appropriate testing will also be required if the water supply trenches are to be lined with clean imported fill;
- Copies of all Duty of Care information demonstrating that any soils removed from site as waste have been appropriately handled and disposed of;
- A review of chemical data accompanying the soil material imported to site to form the cover system to ensure it has been appropriately sourced;
- Validation of the completed cover system by a CET Environmental Scientist. The site visit would comprise an inspection of all remediated areas to enable the recovery of soil samples for confirmatory testing; and
- Provision of a generic human health risk assessment which will demonstrate that the cover soils are chemically suitable for use at the site.

It is important to note that without all of the information listed above CET will not be able to issue a final closure report that satisfies the requirements of the Local Authority and ensure discharge of relevant planning conditions.

We trust our remediation proposals accurately meet your requirements. Prior to the start of any remediation works on site it would be necessary to issue a copy of this Remediation Plan to the Local Authority Contaminated Land Officer for comment. Please note that the scope of works detailed herein is subject to approval by Local Authority and there is a risk that the outstanding planning conditions relating to contaminated land will not be discharged if they are not in full agreement with our recommended approach.

Kind regards,



Catherine Tame BSc MSc MEnvSc
Senior Environmental Scientist

For and on behalf of CET Infrastructure