The measured and inferred soil parameters for the weathered London Clay Formation are listed in **Table 7.2** below.

Table 7.2 – Summary of Soil Parameters for Weathered London Clay Formation

Soil Parameters	Range	Results
Liquid Limit (%)	70 - 75	Appendix C
Plastic Limit (%)	29 - 33	Appendix C
Plastic Index (%)	38 - 50	Appendix C
Modified Plasticity Index (%)	38 - 50	
Plasticity Term	Very High	Figure 4
Volume Change Potential (NHBC)	Medium to High	
Moisture Content (%)	25 - 38	Figure 7
SPT 'N' Values	11 - 12	Figure 5
Undrained Shear Strength (kN/m2) measured by Triaxial Testing	72 - 95	Figure 6
Undrained Shear Strength (kN/m2) inferred from SPT 'N' values	47 - 94	Figure 6
Undrained Shear Strength (kN/m2) measured by hand vane	48 - >130	Figure 6
Strength Term	Medium to High	
Consistency Index	0.93 – 1.08	
Consistency Term	Stiff to Very Stiff*	

* Field tests indicate a generally firm to stiff consistency

7.1.5 *London Clay Formation*

Beneath the weathered London Clay, 'fresh' unweathered London Clay was encountered in BH1, BH2 and BH3 at depths of between 5.8m to 6.7m bgl (77.39 - 75.94mAOD), and extending to the base of the boreholes, to a maximum depth of 20m bgl (63.19mAOD). The upper part of the unweathered London Clay comprised stiff fissured dark-brownish grey silty clay, locally slightly sandy (fine sand), with occasional thin laminae of fine glauconitic sand and rare shell fragments. This horizon extended to depths of 13.45m bgl in BH1 and 13.0m bgl in BH2 (i.e. between 69.7 and 70.6mAOD). Below this, the London Clay comprised stiff fissured dark-brownish grey clay, which was only locally silty, with rare pyrite nodules. A band of 'claystone' (carbonate concretion) was encountered at 19.7m bgl in BH1.

The measured and inferred soil parameters for the stratum are listed in **Table 7.3** below.

Table 7.3 – Summary of Soil Parameters for 'fresh' London Clay Formation

Soil Parameters	Range	Results
Liquid Limit (%)	70 - 71	Appendix C
Plastic Limit (%)	23 - 28	Appendix C
Plastic Index (%)	43 - 48	Appendix C
Modified Plasticity Index (%)	43 - 48	
Plasticity Term	Very High	Figure 4
Volume Change Potential (NHBC)	High	

Soil Parameters	Range	Results
Moisture Content (%)	26 - 30	Figure 7
SPT 'N' Values	26 - 38	Figure 5
Undrained Shear Strength (kN/m2) measured by Triaxial Testing	93 – 273 (generally 93 – 142)	Figure 6
Undrained Shear Strength (kN/m2) inferred from SPT 'N' values	110 - 160	Figure 6
Strength Term	High to Very High (generally High)	
Consistency Index	0.94 – 1.02	
Consistency Term	Stiff to Very Stiff	

In general, no material distinction was discernible between the weathered London Clay and underlying 'fresh' London Clay, although the weathered London Clay samples plot slightly lower (i.e. have slightly lower plasticity indices) on a plasticity classification chart (**Figure 4**). Notwithstanding the above, all analyses fall within the very high plasticity clay field. No significant sand or silt dominated beds were encountered, and the principal lithologies encountered were clay dominated (i.e. the primary soil type was a clay). On the basis of this, it is considered that the encountered stratum is compatible with Unit D of the London Clay Formation.

The SPT 'N' Values versus elevation (**Figure 5**) and undrained shear strength versus elevation (**Figure 6)** plots both show consistent increases in values with decreasing elevation (i.e. with increasing depth below ground level), indicating a normal transition from lower strength materials at shallower levels to higher strength materials at depth, with no dramatic change in strength across the boundary of these two units; the undrained shear strength increase with depth is $72 + 4z$ kN/m^2, where z equals depth into the clay.

7.2 Moisture Content and Desiccation Assessment

An assessment of the natural moisture content of the London Clay has been undertaken and indicates that moisture content values in the weathered London Clay are higher (typically 30 – 35%) than those in the underlying 'fresh' London Clay (typically 26 – 30%) (**Figure 7**).

There are a number of mature trees present in the vicinity of the proposed new property. In order to assess whether the London Clay in these areas is currently desiccated, a comparison of the soil moisture profiles and soil index properties have been considered.

The following assessment is based on Driscoll criteria. This criteria indicates that onset of desiccation can be defined if the natural moisture content of the soil is less than 50% of its Liquid Limit and that significant desiccation can be defined if the natural moisture content is less than 40% of its Liquid Limit.

The natural moisture contents of all samples tested were lower than 50% of the Liquid Limit, indicating the potential widespread onset of desiccation. The results of the assessment for samples showing significant desiccation are shown in **Table 7.4** below.

Table 7.4 Desiccation Assessment

BH Depth (m bgl)	Moisture Content (%)	Atterberg Limits			Driscoll Criteria[1]		Desiccation
		LL (%)	PL (%)	PI (%)	0.5 x LL (%)	0.4 x LL (%)	
'Fresh' London Clay							
BH1 (7m)	26	71	23	48	35.5	28.4	Significant
BH2 (8.5m)	27	71	28	43	35.5	28.4	Significant
BH2 (11.5m)	26	71	27	44	35.5	28.4	Significant
Weathered London Clay							
BH3 (5.5m)	26	72*	31*	41*	36	28.8	Significant
WS1 (1.5m)	25						Significant
WS1 (2m)	25						Significant
WS5 (5m)	26						Significant

*Mean values

Although the above assessment and moisture content profiles (**Figure 7**) indicate the onset of desiccation within the upper few metres of the weathered London Clay, only the samples from WS1 (1.5m – 2.0m bgl) show significant desiccation within the vicinity of the proposed development. This borehole is located within the vicinity of mature trees.

The shear strength profile (**Figure 6**) also indicates considerable scatter within hand vane measurements undertaken on soils from the upper 3m of the weathered London Clay, indicating variable undrained shear strengths, which is possibly associated with localised desiccation.

The low moisture contents obtained from samples of 'fresh' London Clay below 7.0m are most likely due to the overconsolidated nature of the soils, and it is considered that desiccation is generally restricted locally to the upper few metres of the London Clay.

7.3 Groundwater

Observations made during the initial site works and subsequent groundwater monitoring suggest that groundwater is present on the site in several distinct settings:

- Perched water is locally present within the Made Ground overlying the weathered London Clay. The occurrence of perched water seepages was variable across the site and was most noticeable where service inspection pits had been dug and left open overnight. In this case, water had time to accumulate within the pit, ponding above the exposed weathered London Clay. Seepages were less commonly encountered where the service pit was dug and the borehole completed immediately afterwards.

  In WS9, in the northwest of the site, a grey plastic pipe in a shingle service corridor was encountered within the Made Ground at 0.25m bgl, and is possibly a land drain.

- Groundwater monitoring installations were installed in WS2 and WS3, within the footprint of the proposed new development and in WS7 in the northwest of the site, with response zones in the weathered London Clay. No apparent seepages were noted within the weathered London Clay during the drilling of the boreholes, but subsequent groundwater monitoring encountered rising water levels within WS2 and WS7. These boreholes were pumped dry and subsequently recharged. It is therefore likely that water seepages are present locally within the weathered London Clay.

- Groundwater was encountered within the Alluvium as a strike at 1.7m bgl in WS10, rising to 1.4m bgl, and as strong seepages at 1.0m in WS11 and WS12 in the northwest of the site, overlying the low permeability weathered London Clay. The surface watercourse to the immediate northwest of the site therefore appears to be underlain by a larger subsurface alluvial tract, which contains water-bearing alluvium.

- Groundwater seepage was encountered within the 'fresh' London Clay Formation at a depth of 13.3m bgl in BH1, within slightly sandy silty clay, directly overlying a more clay-rich horizon. Groundwater seepage was not encountered at the same level in the adjacent BH2, indicating that this seepage may be a fairly localised phenomenon. No other groundwater strikes or seepages were encountered within the London Clay Formation during the site works. However, water levels have subsequently been measured within the piezometers in BH1 and BH3. These holes were pumped dry, with no immediate recharge, but subsequent monitoring has revealed that these boreholes have recharged. Water levels were found to lie at 80.2mAOD and 78.2mAOD for BH1 and BH3, respectively, and are likely to be recording pore water pressures within the London Clay Formation, which may not have reached equilibrium levels.

- Heavy rainfall was noted over the Bank Holiday weekend of 1st to 3rd May 2010. Data logging transducer measurements recorded from BH2, WS3 and to a lesser extent WS7 indicate that water levels recorded in these boreholes at that time have been influence by this period of heavy rain by inundation of the installations with rainwater from the surface, possibly through interflow within the shallow soils, and not through groundwater seepage.

Groundwater level monitoring sheets are presented in **Appendix B**.

A record of the groundwater monitoring programme and observations for each of the exploratory holes is summarised in **Table 7.5**.

Table 7.5 –Groundwater Monitoring Results and Observations

BH	Perched Water	Ground-water Strike	Monitoring installation / piezometer standpipe	Monitoring Results	Interpretation
WS1	✖ (Inspection pit not left open)	✖	✖	Borehole dry on completion (21/4/10)	-
WS2	✓ Seepage at 0.6m, inspection pit left open overnight. Perched water cased out to 2m.	✖	✓ Standpipe installed to 5m	Water at 4.5m on completion (21/4/10) – perched water entered during installation. Slow increase in water level from 4.27m bgl on 23/4/10 to 3.75m bgl on 30/4/10. Borehole pumped dry on 30/04/10 and data logging transducer installed. Slow constant recharge of water from 30/4/10, reaching 0.82m bgl on 18/05/10. Borehole pumped dry on 18/05/10 with slow recharge.	Seepage of water within weathered London Clay?
WS3	✖ (Inspection pit not left open)	✖	✓ Standpipe installed to 5m	Borehole dry on completion (20/4/10) and on 23/4/10. Water level recorded on 30/4/10 at 4.85m bgl. Data logging transducer installed on 30/04/10 Rapid increase in water level on 01 – 02/05/10. Very slow subsequent decay of water level.	Heavy rainfall over bank holiday weekend of 01 – 03/05/10 resulted in installation being inundated with water from ground level (i.e. not groundwater surge). Slow decay of water level indicates low permeability of weathered London Clay within this borehole.
WS4	✖ (inspection pit not left open)	✖	✖	Dipped on completion (20/4/10) – dry Dipped on 23/4/10 – dry Hole backfilled	-

BH	Perched Water	Ground-water Strike	Monitoring installation / piezometer standpipe	Monitoring Results	Interpretation
WS5	✓ Seepage at 0.35m, Inspection pit left open. Perched water cased out to 2m.	✖	✖	Dipped on completion (20/4/10) – dry	-
WS6	✖ (inspection pit not left open)	✖	✖	Dipped on completion (23/4/10) – dry Hole Backfilled	-
WS7	✓ Seepage at 0.6m, inspection pit left open overnight. Perched water cased out to 2m.	✖	✓ Standpipe installed to 5m	Dipped on completion (22/4/10) – dry Dipped 23/4/10 water at 4.39m, water level increasing to 0.75m bgl on 30/04/10. Data logger installed on 30/04/10. Rapid increase in water level on 01 – 03/05/10. Very slow subsequent decay of water level Borehole pumped dry on 18/05/10, recharged over subsequent 48 hours to approximate pre-pumping level of approx. 0.5m bgl.	Probable seepage from made weathered London Clay. Heavy rainfall over bank holiday weekend of 01 – 03/05/10 resulted in installation being inundated with water from ground level (i.e. not groundwater surge).
WS8	✖ (inspection pit left open)	✖	✖	Dipped on completion (21/4/10) – dry Borehole left open Dipped on 23/4/10 – dry Dipped on 30/4/10 – dry Hole backfilled	-
WS9	✖ (inspection pit not left open)	✖	✖	Dipped on completion (21/4/10) – dry Hole backfilled	-

BH	Perched Water	Ground-water Strike	Monitoring installation / piezometer standpipe	Monitoring Results	Interpretation
WS10	✖ (inspection pit left open)	✔ Strike in Alluvium at 1.7m, rising to 1.4m	✔ Standpipe installed to 4m	Water level at 1.4m from 22/4/10 to 30/4/10 Data logging transducer installed on 30/04/10 Slight rise and subsequent decay of groundwater level between 01 – 03/05/10	Groundwater level within alluvium. Recharge with rainwater over wet bank holiday weekend.
WS11	?	✔ Alluvium wet from 1.0m	✔ Standpipe installed to 5m	Dipped on 23/4/10 – water at 1.2m Dipped on 30/4/10 – water at 1.2m Dipped on 18/05/10 – water at 1.05m Dipped on 21/05/10 – water at 1.11m	Groundwater level in alluvium.
WS12	?	✔ Alluvium wet from 1.0m	✔ Standpipe installed to 5m	Dipped on 23/4/10 – water at 0.7m Dipped on 30/4/10 – water at 0.75m Dipped on 18/05/10 – water at 0.47m Dipped on 21/05/10 – water at 0.52m	Groundwater level in alluvium
BH1	✖	✔ Seepage in London Clay at 13.3m	✔ Peizometer response zone 13m to 14m bgl	Groundwater levels increasing between 23/4/10 and 30/4/10 from 7.4m bgl to 5.67m bgl. Piezometer pumped dry on 30/4/10. Piezometer recharged, with water levels rising to 2.97m bgl (80.22mAOD) by 21/05/10.	Slow seepage of water from 'fresh' London Clay, recording pore water pressure. May not have reached equilibrium value.
BH2	✖	✖	✔ Peizometer response zone 4.5m to 5.5m bgl	Borehole left open overnight at 15m. Borehole dry overnight. Data logging transducer installed on 21/04/10. Borehole dry between 21/04/10 and 01/05/10. Very rapid rise in piezometer water level on 02/05/10. Very slow lowering of water level between 02/05/10 and 21/05/10 without fully draining.	Heavy rainfall over bank holiday weekend of 01 – 03/05/10 resulted in installation being inundated with water from ground level (i.e. not groundwater surge). Slow decay of water level indicates low permeability of weathered London Clay within this borehole.

BH	Perched Water	Ground-water Strike	Monitoring installation / piezometer standpipe	Monitoring Results	Interpretation
BH3	✖	✖	✓ Peizometer response zone between 8m and 7m bgl	Water level recorded at approximately 4.7m bgl between 21/4/10 and 30/4/10. Piezometer pumped dry on 30/4/10 and installed with data logging transducer. Slow piezometer recharge recorded between 30/4/10 and 21/05/10, with water levels rising to 4.45m bgl (78.19mAOD) by 21/05/10.	Slow seepage of water from 'fresh' London Clay, recording pore water pressure. May not have reached equilibrium value.

7.4 Foundation Inspection Pits

Five foundation inspection pits were undertaken to determine the existing foundation configurations on the buildings currently on site.

TP1 and TP2 were located adjacent to the party wall with the North London Bowls Club in the northeast of the site. At both locations the party wall was stepped below ground level and was founded on a concrete strip footing 0.2m in thickness. TP1 was founded on the weathered London Clay at a depth of 1.13m bgl, whilst TP2 was founded at a shallower depth of 0.6m bgl, within the Made Ground.

TP3 and TP4 were located on the northwestern and southeastern corners of the current property, respectively. TP3 encountered a mass concrete footing at a depth of 0.46m bgl, founded within the weathered London Clay at 1.31m bgl. TP4 encountered a stepped brick-work profile below ground level, resting on a 0.2m thick concrete strip footing at 0.9m bgl, founded within the weathered London Clay at 1.1m bgl.

TP5 was located adjacent to the southeastern wall of the outbuilding to the east of the main property. TP5 encountered a 0.23m thick concrete strip footing at 0.41m bgl, founded at approximately 0.64m bgl, apparently on a thin layer of Made Ground directly underlain by weathered London Clay. A clay pipe running northeast-southwest was encountered at a depth of 0.3m bgl within this pit.

The foundation pit logs are presented in **Appendix B**.

8. GROUND CONTAMINATION CONDITIONS

8.1 Chemical Analysis of Soil Samples

8.1.1 Introduction

The findings of the investigation have been assessed in relation both to a combination of specific site characteristics, as identified within the Preliminary Conceptual Model, and the future site use proposals.

Chemical analyses have been performed on a total of five representative samples of Made Ground from across the site. In addition to the chemical analyses, the samples of the Made Ground were screened in the laboratory for the presence of asbestos fibres.

All soil samples scheduled for laboratory testing are also inspected visually on receipt at the laboratory for the presence of materials potentially containing asbestos, e.g. fragments of asbestos-cement products.

The full chemical results are presented within **Appendix D**. The results have been assessed with respect to human health, plant phytotoxicity, the performance of construction materials and water resources in the following sections.

8.1.2 Summary of Soil Results with Respect to Human Health

Assessment of risk is considered as a tiered approach. Assessment based on non-intrusive means is considered a Tier 1 assessment, comparison against Generic Assessment Criteria (GACs) is a Tier 2 assessment, and the generation of and comparison with Site Specific Assessment Criteria (SSACs) is a Tier 3 assessment and is conducted when deemed appropriate from the Tier 2 assessment.

The Tier 1 assessment is summarised in the CSM provided in **Chapter 5**. The following represents the Tier 2 assessment and an overview of the methodology applied is provided below. The Tier 2 Human Health Risk Assessment conducted on the results of the laboratory tests on soils sampled from the site were evaluated using Generic Assessment Criteria (GACs) calculated using the final updated CLEA framework, comprising the new CLEA Software (version 1.06), and supporting documents.

It should be noted that the new CLEA Software has not yet incorporated lead and therefore the former CLEA Soil Guideline Value (SGV) for lead, for a residential with plant uptake end use, has been used in this assessment.

It is proposed to redevelop the site with a large detached residential property. Initially the soil chemical results have been compared directly against the residential with plant uptake GACs calculated using the new CLEA software, as these are considered to be the most suitable guidelines to protect the most critical targets from contaminants via all possible exposure routes.

The CLEA software output reports for the site are presented in **Appendix E**.

For non-volatile contaminants the human health risk assessment has been conducted to a depth of 1m. At depths greater than 1m it is considered that no relevant pathway for human exposure to occur will be present. For volatile contaminants, the human health risk assessment may be conducted on samples collected at depths in excess of 1m as it is assumed that an inhalation pathway (i.e. from vapours) could potentially be present regardless of the depth of the contamination.

Non-volatile contaminants are considered to be those that have a Henry's Law Constant of less than 0.001 whilst volatile contaminants are considered to be those that have Henry's Law Constants greater than 0.001.

With regards to metals and petroleum hydrocarbons, no elevated concentrations were recorded in excess of the relevant assessment criteria.

With regards to polycyclic aromatic hydrocarbons (PAHs), only the compounds benzo(a)pyrene and benzo(a)anthracene were locally found to exceed the adopted assessment criteria (assuming 1% soil organic matter), as detailed in **Table 8.1**, below.

Table 8.1 – Data Summary Table

Material	Determinant	Total No of samples tested	Number of Non Detects	Adopted screening value	No of exceed-ances	Maximum concentration (mg/kg)
						Value (Location and Depth in parentheses)
Made Ground	Benzo(a)-pyrene	5	0	0.83	2	1.18 (WS9, 0.5m) 3.56 (WS11, 0.4m)
Made Ground	Benzo(a)-anthracene	5	0	3.1	1	3.56 (WS11, 0.4m)

These exceedances are considered to be associated with the localised presence of small, dispersed fragments of charcoal and coal-type material within the shallow Made Ground at these locations. A PAH double ratio plot (**Appendix D**) confirms this interpretation of the source of PAHs.

Under the proposed development scheme, it is proposed to raise site levels in the vicinity of WS11, which will effectively encapsulate any material within this area, thus breaking any pathways towards human health. With regard to WS9, the marginal exceedance of benzo(a)pyrene occurs in an area of proposed gardens, and as such will required further assessment.

With regards to asbestos, the visual inspection at the laboratory identified no materials suspected of potentially containing asbestos and the scheduled laboratory screening for asbestos found no detectable asbestos fibres within the samples of Made Ground.

In summary, with the exception of localised benzo(a)pyrene in Made Ground within WS9, no other potentially significant risks associated with soil contamination have been identified and it is considered that the majority of the site may be regarded as free from contamination with respect to the end use.

8.1.3 *Summary of Soil Results with Respect to Plant Phytotoxicity Effects*

There are no substances present at concentrations above the relevant assessment values adopted from The Soil Code (1998) with respect to potential phytotoxic effects. There is therefore no risk to any proposed or retained areas of planting.

8.1.4 Summary of Soil Results with Respect to Performance of Building Materials

Table 8.6 – Summary of Soil Results with Respect to Performance of Building Materials

Category of substance	Receptor at risk	Assessment value adopted	Maximum concentration where in excess of assessment value
Sulfates (W Sol SO_4)	Concrete	500mg/l	2880mg/l
TPH*	Fresh concrete	1000mg/kg	NONE
TPH*	Plastics	50mg/kg	NONE

*Note: TPH assessment values are based on the presence of potentially mobile petroleum hydrocarbons

An assessment of the risks to concrete and concrete classification is given in **Section 10.6**.

In addition to the above, the soils testing data has been compared against guideline values in the Water Regulations Advisory Scheme (WRAS) Guidance note No. 9-04-03 (October 2002 - The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land). Local exceedances of these guideline values are outlined below:

- With regards to toxic substances, localised arsenic (18 to 23mg/kg) and mercury (1.13 to 1.52mg/kg) in WS2, WS9 and WS11 (0.4 to 0.5m bgl) exceed the 'threshold' values of 10mg/kg and 1mg/kg, respectively.
- With regards to corrosion, although a single value of 2880mg/kg for sulfate exceeded the 'threshold' level of 2000mg/mg, this value was recorded at a depth of 4.0m bgl and is therefore unlikely to present a risk to buried pipes. However, the pH range of the soils (>8) is above the upper threshold value of 8.

Therefore, consideration will need to be given to the material selection for water supply pipes.

8.1.5 Summary of Soil Results with Respect to Water Resources

With respect to the chemical analyses conducted on soils, only the PAH compounds benzo(a)pyrene and benzo(a)anthracene have been identified at marginally elevated concentrations, associated with the localised presence of small, dispersed fragments of charcoal and coal-type material within the shallow Made Ground. PAHs in general are immobile and almost insoluble in water and as such, it is considered that the encountered materials are likely to be inert and of very low risk to water resources. Notwithstanding the above, the PAHs encountered in WS11 occur within Made Ground overlying water-bearing alluvial-type sediments in the northwest of the site, and it is recommended that water from boreholes in this area is chemically tested to confirm the above qualitative assessment.

8.2 Ground Gas Monitoring

An assessment of ground gas was outside the scope of works for this investigation. However, the encountered ground conditions (Made Ground with very low degradable organic content overlying low permeability London Clay Formation) indicate very low ground gas generation potential and a negligible level of risk for on-site development.

8.3 Waste Classification of Soils

It is understood that the proposed development will include the localised excavation of Made Ground and natural soils to facilitate the formation of basements and foundations.

All excavated material and excess spoil must be classified for waste disposal purposes prior to disposal at landfill. Under the Landfill (England and Wales) Regulations 2002 (as amended) all wastes must be classified as inert, non-hazardous, stable non-reactive hazardous or hazardous wastes prior to disposal. The Environment Agency guidance document WM2 (interpretation of the definition and classification of hazardous waste) outlines the methodology for classifying wastes.

HASWASTE is a waste soils characterisation assessment tool, developed by Envirolab, which follows the guidance within WM2. The analytical results have been run the through this assessment tool for potential off-site disposal of materials. The results are presented in **Appendix F**.

The results indicate that the Made Ground across the site would not be classified as hazardous waste. Waste Acceptance Criteria testing will be required prior to off-site disposal to classify the soils into inert and non-hazardous categories.

It should also be appreciated that the sampling rationale for this investigation has been targeted to characterise the shallow soils by assessing their potential environmental impacts in relation to the proposed redevelopment rather than for waste classification purposes. As such, consideration may need to be given to further sampling in the areas of proposed excavation to determine accurately the likely waste classification of the soils.

It is important to note that the assessment given in this report is for guidance only and it is always necessary to confirm the actual classification with prospective landfill operators prior to disposal.

Further, all hazardous and non-hazardous soils will require pre-treatment prior to disposal at landfill. Pre--treatment is defined as a physical, chemical or biological process that changes the characteristics of the waste in order to reduce its volume / reduce its hazardous nature / facilitate its handling or enhance its recovery. It should also be noted that as an alternative to landfill disposal, inert soils may potentially be suitable for re-use or disposal at an appropriate site, which is exempt from waste management licensing.

8.4 Site Waste Management Plans

It should be noted that the Site Waste Management Plans Regulations 2008 came into force in April 2008. The Regulations require the preparation of a Site Waste Management Plan (SWMP) for all construction projects in England with a value of more than £300,000 and a more detailed plan for projects with a value of more than £500,000. The purpose of the SWMPs is to encourage better resource utilisation and waste management practices in construction, improve environmental performance, minimise the landfilling of wastes, and reduce instances of fly-tipping.

A SWMP will therefore be required for the development and will need to consider all potential construction waste streams, including soils.

Some of the materials tested during this investigation appear to be suitable for re-use on site. In line with the principles of sustainable development and to reduce costs, it is recommended that the remedial strategy for the site should attempt to minimise the volume of contaminated and uncontaminated soils removed off-site for disposal. Prior to commencing any excavation works on site, a Materials Management Plan (MMP) will need to be prepared to establish whether specific materials are classified as waste or not and how excavated materials will be treated and / or re-used, in line with *The Definition of Waste: Development Industry Code of Practice* (CL:AIRE, 2008). The MMP is likely to form part of the Site Waste Management Plan for the site.

9. CONCEPTUAL SITE MODEL AND CONTAMINATION ALLEVIATION MEASURES

9.1 Conceptual Site Model (CSM)

The findings of the investigation have provided some evidence of localised and marginal ground contamination and clarified the geological constraints on contamination migration pathways. The above assessment of potential health and environmental risks from contamination has been used to refine the preliminary CSM of pollutant linkages, which has been amended from that generated following the preliminary investigation.

The conceptual site contamination model of potential risks for the proposed type of development is presented in **Table 9.1**, based on a qualitative risk assessment of the findings of the investigation and with no contamination alleviation measures applied.

Table 9.1 – Conceptual Site Model of Potential Contamination Risks

Substances present at source			Pathways	Receptors
Metals	**Inorganic**	**Organic**		
Arsenic, mercury	Sulfate	PAHs		
✖	✖	✓	Ingestion of contaminated soil, dust, liquid	Human health
✖	✖	✓	Inhalation of contaminated dust and vapours/gases	
✖	✖	✓	Uptake into home grown produce	
✖	✖	✓	Dermal contact with contaminated soil/water/liquid	
✖	✖	✓	Migration of contaminated groundwater/leachate from site to underlying water resources	Groundwater
✖	✖	✓	Migration of contaminated groundwater/leachate from site to surface water	Surface Water
✖	✖	✖	Uptake into vegetation	Flora
✓	✓	✖	Contact with contaminated ground/liquid/vapour	Building materials/ structures

Key:

✖ Based on the findings of the investigation, it is considered that these substances would **not** constitute a significant source of contamination.

✓ Based on the findings of the investigation, it is considered that these substances **may** constitute a source of contamination and a pollutant linkage.

To conclude, the conceptual model for the proposed type of development has identified some evidence of limited and localised potential ground contamination on the site, possible pathways for contamination to migrate and sensitive receptors potentially at risk. Possible pollutant linkages therefore exist that require either further assessment or the implementation of alleviation measures.

9.2 Alleviation Measures in Respect of Ground Contamination

The CSM, as presented in **Table 9.1**, above, indicates that there is no evidence of ground contamination or pollutant linkages across the majority of the site in relation to the proposed development. However, PAHs (associated with dispersed charcoal and coal-type fragments) have locally been encountered (WS9 and WS11) within the Made Ground in the northwest of the site, which could *potentially* present a risk to human health and water resources, although the risk is considered to be low.

Under the proposed development scheme, it is proposed to raise site levels in the vicinity of WS11, which will effectively encapsulate any material within this area, thus breaking any pathways towards human health. With regard to WS9, the marginal exceedance of benzo(a)pyrene occurs in an area of proposed gardens, and as such will required further assessment or remediation. As the exceedance in this area is only marginal, it is possible that with additional sampling and testing, and adoption of a statistical approach to the contamination assessment, the soils may be deemed to be free from contamination with respect to the proposed end use. If contamination is deemed to be present, this may be effectively mitigated either by remove of the source of encapsulation beneath an appropriate clean cover system.

PAHs encountered in WS11 occur within Made Ground overlying water-bearing alluvial-type sediments in the northwest of the site. PAHs in general are immobile and almost insoluble in water and as such, it is considered that the encountered materials are likely to be inert and of very low risk to water resources. In addition, raising site levels in this area will encapsulate this material, further reducing the potential for leaching. Notwithstanding the above, it is recommended that water from boreholes in this area is chemically tested to confirm the above qualitative assessment and to assess whether any alleviation measures are required.

As identified in **Section 8.1.4**, localised concentrations of metals, and the generally high pH (>8) within the Made Ground, will require that consideration is given to appropriate materials selection for water supply pipes. Alternatively, the Made Ground could be excavated in the vicinity of buried services and all service trenches backfilled with certified clean materials.

It is possible that groundworks will encounter different conditions from those revealed by the site investigation. It is therefore recommended that the groundworks be monitored for previously undetected suspect materials and if found appropriate additional testing and advice is sought.