Hampstead School, London

Remediation Strategy

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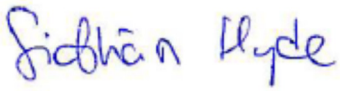
S Hyde BSc (Hons) MSc AIEMA **Project Engineer**		17 July 2015

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For and on behalf of **Curtins**

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1.0 Introduction

In July 2015 Curtins were instructed by Wates Construction to undertake a Remediation Strategy for a site located at Hampstead School, Westbere Road, London. The site is located at National Grid Reference 524398, 185605 within an approximate area of 2.07Ha. A location plan can be found within Appendix A.

It is understood that development proposals for the site comprise the demolition of the existing 1960s school building located to the centre of the site and the construction of a new multi-storey teaching block located in the western part of the site and a sports hall located in the north-eastern corner of the site. A development plan for the school can be found within Appendix A.

As part of the development, the site is to be remediated to a standard that will allow the previously described proposed end-use. The remediation works are to be undertaken as identified within this strategy document.

This Remediation Strategy has been developed with reference to the information provided within HSP Consulting Engineers Ltd's Phase I Preliminary Sources Study and Phase II Geoenvironmental Assessment reports; and Soiltechnics Ltd's Ground Investigation report; the full reference details of which can be found in Appendix B of this strategy.

Additionally, it is envisaged that this document will also satisfy the Local Planning Authority (LPA) conditions with respect to compiling a strategy to identify the parts of the agreed remediation works, which are to be completed by the developer.

Specifically the remediation strategy requires that the developer completes the following works:

- The installation of gas protection measures to CS3 gas regime in order to achieve a protective measure score of 3 for public buildings in accordance with BS8485 2007.
- Installation of barrier pipe (PE/Al/PE) for water supply pipes.
- The installation of a cover system of minimum 300mm of clean and inert capping in areas of new soft landscaping.

The installation of gas protection measures and the clean cover system will need to be independently validated by a suitably qualified and experienced person.

Upon the completion and validation of the above mentioned works, the new development will be suitable for use in line with the National Planning Policy Framework.

This document provides guidance for use by Wates Construction and their sub-contractors for site operations, including completion and validation of the capping layer.

1.1 Particular Requirements of the Remediation Strategy

The document is to account for the following,

- Advice on the remediation measures required with regards the contaminants of concern.
- A description of the materials likely to be encountered by the developer and their sub-contractors.

- Guidance for excavations with respect to the materials likely to be encountered.
- Advice with respect to classification of unsuitable materials for disposal to a suitably licensed facility.
- Advice on action required if unexpected contamination observed.
- Description of required gas protection measures.
- Proposals for the specification of the capping layer to any new soft landscaped areas.
- Proposals for the validation of the capping layer including confirmation of thickness, a regime for sampling and chemical analysis of imported topsoil material.

1.2 Definitions

In this document the following definitions apply,

Site Manager means a representative of Wates Construction or their Principal Contractor for the development who will be resident on site.

Engineer means a suitably qualified representative from Curtins Consulting, who would not normally be resident on site.

New soft landscaping includes areas of the soft landscaping that will be affected by construction activity such those areas where new drainage or service runs will be constructed.

1.3 References

A list of the documentation referred to herein is provided in Appendix B.

2.0 The Site

This section of the report presents a summary of the HSP Consulting Phase I Preliminary Sources Study, report no C1882/LJ/PI Rev B, dated February 2014.

2.1 Current Setting

A site walkover was undertaken on Wednesday 22nd January 2014. The site walkover involved a visual inspection of the site and a brief inspection of the surrounding area.

During the site walkover the following key observations were made:

- The site is roughly rectangular in shape and extends to approximately 2.07ha in area;
- Access to the site is gained via Westbere Road to the west of the site;
- The site currently supports an active secondary school, supporting a number of classroom buildings, hardstanding/playgrounds and a small multi-use games area (MUGA) in the east of the site;
- The main buildings on site comprise three brick built buildings fronting onto Westbere Road, a concrete clad three-storey rectangular building in the centre of the site and a sheet metal clad building in the northwest of the site. A number of ancillary buildings were also observed across the site. It is considered that asbestos containing materials may be present in some structures on the site due to their likely age;
- The site boundaries are defined by residential private rear gardens to the north and south, a playing field to the east and Westbere Road to the west;
- A small number of semi-mature and mature trees were observed across the site and along site boundaries.

Significant topographical gradients were not observed across the site. However, the site was generally observed to fall by approximately 5.0m from east to west.

No signs of flooding were observed at the site or surrounding area.

Notable vegetation was generally recorded to be absent from the site. However, limited grassed areas and a small number of semi-mature and mature trees were recorded across the site and along site boundaries.

Based upon information obtained as part of the walkover no obvious signs of potential significant contamination were observed.

A plan showing the layout of the existing school can be referred to in Appendix A.

2.2 Site History

Initial mapping from 1866-1873 shows the site is part of a large open field. No significant changes are observed until 1915-1920 when a school has been constructed on the western section of the site, later named as Haberdasher's Aske's School for Boys.

By 1948-1953, mapping shows that additional buildings have been added to the school. The eastern section is now marked as a playing field with a tennis court in the north eastern corner.

Mapping from the 1970s shows a large rectangular building has been constructed on the former playing fields on the eastern section of the site. The school is mapped as Hampstead School by 1991.

There are no further significant changes.

No historical fuel tanks have been identified on the site on the historical mapping and within the EnviroInsight Report.

2.3 Surrounding Land Use

The earliest map detailing the land around the site shows a railway line located 120m west of the site running in a northwest to southeast direction, with Childshill Station located 480m to the northwest. Cowhouse Farm is located 240m to the northeast of the site. A potential pond feature is located 300m to the south of the site. The remaining land is mapped as open fields.

By the 1890s, the railway is mapped as the Midland Railway and Cowhouse Farm is renamed as Avenue Farm. Hampstead Cemetery is located 180m to the southeast of the site. The London General Omnibus Company's depot is located 255m northwest of the site. Several large units have been constructed to the northwest of the site; a covered reservoir is located 490m to the south. Residential development has occurred 480m north and south of the site.

Mapping dated 1915-1920 shows Westbere Road adjacent to the sites western boundary. Allotment gardens are mapped immediately south and southwest of the site. Several roads and houses have been constructed to the west of the railway line and 100m to the south of the site. An athletic ground and pavilion are mapped 200m north of the site. By this time, significant residential development has occurred in the surrounding area.

By the 1930s, several roads and houses have been constructed immediately north and south of the site. Parts of the athletic ground are now mapped as a cricket ground. Residential development continues throughout the 1940s-1950s as housing is established west of Westbere Road adjacent to the railway line.

There are four records of potentially contaminative industrial sites located within 250m of the site, it should be noted that three of the records are for the same location. The closest entry relates to a publishing company recorded 65m southeast of the site.

There are no records of petrol or fuel sites within 250m of the site. The closest petrol or fuel site is located 310m southwest of the site and is recorded as open.

There are no records of high pressure underground pipelines (oil and gas) within 250m of the site.

Four electricity substations have been identified within a 250m radius of the site. The closest is recorded on site.

2.4 Geology

A study of the GeoInsight records and British Geological Survey (BGS) 1:50,000 mapping records (Bedrock and Superficial Editions) for North London (Sheet 256) indicates the following geological succession underlying the site.

Rock Name	Rock Type	Geological Age
No superficial deposits		
London Clay Formation	Clay, Silt and Sand	Palaeogene

No superficial deposits are expected to be encountered upon the site. Some made ground should be anticipated associated with the development of the original school and playing fields.

The Envirocheck Report confirms that there is a very low risk to no hazard from the following ground stability hazards on and around the site; collapsible, ground dissolution, landslide, running sand and compressible ground. However, shrinking or swelling clays have been assigned a moderate risk rating on site.

The property is not recorded to be within a Radon Affected Area.

2.4.1 Mining

No BGS Mineral Sites have been identified within 500m of the site boundary.

Eleven Historic Ground Workings has been identified within 500m of the site boundary. Ten of these relate to a cemetery which is located 114m to the east of the site. The remaining entry is for a cutting 174m south of the site.

No Historic Underground Workings have been identified within 500m of the site boundary

The site is in an area believed to not be affected by underground or open cast coal mining, consequently a Coal Authority report for the site has not been obtained.

2.5 Hydrogeology and Hydrology

The bedrock deposits at the site are designated as Unproductive strata, described as ‘rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

The site is not within an Environment Agency indicative floodplain. The site does not lie within an area benefitting from flood defences or within an area used for flood storage.

No surface water features have been identified within 250m of the site boundary according to the EnviroInsight Report.

No Environment Agency River Quality Records have been identified within 1km of the site.

The site not located within a Source Protection Zone.

No licensed surface or groundwater abstractions points have been identified within 1000m of the site boundary.

There are no licensed potable groundwater abstractions located within 1000m of the site.

2.6 Landfill

No Environment Agency or Historic landfill sites have been identified within a 500m radius of the site.

Several areas of potentially infilled land are identifiable within 500m of the site boundary on the historical mapping or within the EnviroInsight Report. The closest areas relate to a railway line that is located 120m to the west of the site and Hampstead Cemetery which is located 180m to the southeast of the site.

Several pond features have been identified upon historical mapping within 500m of the site boundary, the closest are approximately 200m to the south and 200m north east of the site. As the land around the site has been developed the ponds have been infilled within unknown materials.

3.0 Site Investigation

This section of the report presents a summary of the HSP Consulting 2014 and Soiltechnics 2015 site investigation reports, as referenced in Appendix B.

3.1 General

The HSP site investigation fieldworks were undertaken in January 2014 under the supervision of a suitably qualified engineer and comprised the advancement of two cable percussive boreholes, BH01 and BH01a; and six window sample boreholes, WS1 to WS6.

Appropriate chemical and geotechnical testing was undertaken on soils representative of the ground conditions revealed.

Gas and groundwater monitoring standpipes were installed within three of the window sample boreholes (WS1, WS3 and WS5) to allow short term monitoring of the ground gas regime.

The Soiltechnics site investigation fieldworks were carried out in April 2015 under the supervision of a suitably qualified engineer and comprised the advancement of twenty one boreholes formed using driven tube sampling equipment, designated DTS101 to DTS121. All soils exposed in excavations were described in accordance with BS EN ISO 14688 'Identification and Classification of Soil'.

Appropriate chemical and geotechnical testing was undertaken on soils representative of the ground conditions revealed. Combined gas and groundwater monitoring standpipes were installed in boreholes DTS101, DTS104, DTS105, DTS107, DTS110 and DTS112.

Drawing No. 02 records the locations of the exploratory holes from the 2014 and 2015 site investigations; a copy of which is contained within Appendix A.

No groundwater inflows were observed in any of the exploratory excavations with the exception of borehole DTS107, where perched groundwater was encountered between 0.7-0.8m bgl.

3.2 Land Condition

The sequence of strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map. The sequence may be generally summarised as made ground with topsoil locally, overlying the London Clay Formation.

3.2.1 Topsoil & Made Ground

Made ground was encountered to between depths of 0.3m and 1.0m across the site and generally comprised grey/brown gravelly, silty, sandy clay and grey/brown, clayey, sandy gravel. Gravels comprised brick, flint, quartzite, ash, coal, bituminous bound material, clinker, metal, concrete, slate, glass, mudstone, sandstone, limestone and chalk.

Topsoil was encountered at surface in seven locations (boreholes WS1 to WS4, WS6, DTS115 and DTS116), which comprised grey brown clay with occasional ash and brick fragments.

3.2.2 London Clay

London Clay generally comprised medium and high strength brown and grey silty clay with occasional orange mottling. Occasional sand and gravel sized gypsum crystals were encountered throughout. A siltstone boulder in a blue grey clay matrix was recorded in BH01 at a depth of 8.00m causing the borehole to be terminated at this depth and relocated.

The full extent of the London Clay formation was not proven in any location.

3.2.3 Site Soils

As discussed previously, a total of twenty nine exploratory boreholes were advanced across the development site during the 2014 and 2015 site investigations.

Representative samples of the shallow soils encountered were taken from the exploratory hole locations. The Phase II Ground Investigation reports compared the chemistry analysis results against a '*Residential without the Consumption of Produce'* end use as a conservative assessment, with exposure times refined to reflect the average school year.

Accordingly, HSP Consulting derived site specific assessment criteria (SSAC) for a number of contaminants including PAHs and Arsenic. Soiltechnics subsequently adopted these SSAC values for the supplementary 2015 site investigation.

With respect to the proposed end use of the site, the Tier 1 thresholds have been exceeded within the made ground site soils in a number of locations across the site with respect to arsenic, copper, lead, zinc, PAHs and TPHs.

Total PAH concentrations of greater than 100mg/kg were recorded in the made ground samples of WS5, WS6, DTS104, DTS110, DTS111 and DTS113, at concentrations of between 210mg/kg and 680mg/kg.

With reference to the UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' document reference 10/WM/03/21 advice is given on the appropriate materials for these ground conditions.

It is considered that specialist materials may be required for water supply pipes at the site where they are taken through made ground. If laid within natural clay deposits normal pipe materials should be sufficient. However confirmation of supply pipes should be sought from Thames Water.

3.2.5 Waste Classification

Soiltechnics scheduled the testing of one composite made ground samples to measure the parameters listed in Table 5.1 'landfill waste acceptance criteria' within the publication '*Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures'* produced by the Environment Agency (Version 1, April 2005).

Comparison of test data with landfill waste acceptance criteria indicates that made ground soils are suitable for disposal as stable non-reactive hazardous waste in non-hazardous landfill.

However it should be noted that this information is for guidance only and material identified for disposal will have to be confirmed in accordance with WM3 to enable classification during the works.

Once classification is determined, Hazardous Waste Acceptance Criteria testing will be required to allow appropriate disposal facilities to be identified.

3.3 Groundwater / Surface Water

The site lies in an area designated as Unproductive strata, with no active abstraction points within 1km of the site. The site is not located within a source protection zone and there are no surface water features within 250m of the site.

As such, it is considered that there are no viable surface or ground water receptors worthy of further consideration.

3.4 Soil Gases

Gas monitoring pipe work was installed in boreholes WS1, WS3 and WS5 following the HSP site investigation and boreholes DTS101, DTS104, DTS105, DTS107, DTS110 and DTS112 following the Soiltechnics site investigation. A total of nine monitoring visits have been undertaken with the monitoring now complete.

Barometric pressure has been recorded at the site from 991mb to 1021mb during the nine visits. A maximum positive flow of 14.4l/hr has been recorded in DTS107 during the fifth monitoring visit. A maximum concentration of 6.2% $^{v}/_{v}$ Carbon Dioxide (CO_2) was recorded in WS1 on the fourth monitoring visit. This maximum level of CO_2 results in a calculated Gas Screening Value (GSV) of 0.8928 as maximum flow is taken as 14.4 /hr.

Maximum concentrations of Hydrogen Sulphide (H_2S) and Carbon Monoxide (CO) of 2ppm and 11ppm have been recorded. A concentration of 0.1% $^{v}/_{v}$ of Methane (CH_4) has been recorded. This low concentration of CH_4 results in a calculated Gas Screening Value (GSV) of 0.0144.

With reference to Situation A non-traditional construction as defined by the NHBC and the modified Wilson & Card classification as contained within CIRIA C665, the maximum carbon dioxide concentration and gas screening value indicate Characteristic Situation 3 (CS3) gas regime requiring gas protection measures for the proposed new school development.

No radon protective measures are necessary in the construction of new dwellings or extensions.

4.0 Risk Assessment

4.1 General

When assessing the potential effects of land contamination it is necessary to determine whether a viable source-pathway-receptor linkage exists before the significance of any potentially contaminating material can be established.

4.2 Sources

Given that the proposed end use is a school the assessment of the environmental chemistry results for soil samples considered Tier 1 thresholds for '*Residential without the Consumption of Produce*' end use as a conservative assessment.

This assessment determined that the thresholds have been exceeded in the site shallow soils in a number of locations across the site with respect to arsenic, copper, lead, zinc, PAHS and TPHs.

Ground gas monitoring of the site following the HSP 2014 and Soiltechnics 2015 site investigations has recorded elevated levels of carbon dioxide within the site soils.

4.3 Pathways

The main potential pathways for contaminants on this site are through direct or indirect ingestion, via dermal contact, by inhalation, or by vertical or lateral percolation. The main groups affected by these pathways would be end users of the site, ground workers during construction and water supply pipes.

End users are particularly at risk of coming into contact with the potential contaminants in areas of soft landscaping by direct or indirect ingestion, dermal contact or inhalation of toxic gases. Buildings and areas of hardstanding provide a barrier between the source and the end user of the site and therefore the risk is much lower in these areas.

Water supply pipes and building materials may be affected by the contamination observed in site soils.

The potential contaminants recorded may also be taken up by plants. This can present a problem to the vegetation if the contaminants are phytotoxic.

The three main factors influencing gas to migrate are pressure differential, diffusion along concentration gradients and flow, in dissolved form, within liquids.

Soil gases can enter buildings via several routs such as; cracks or gaps in both solid and suspended floors, joints formed during the construction process, fractures in sub surface walls, around service pipes and ducts and within wall cavities.

4.4 Receptors

Potential receptors that could be impacted by contamination include:-

- End users of the development

- Construction workers, particular ground workers
- Building materials
- Vegetation

Foundation, building services and drainage excavations will penetrate into this material, the designers and or suppliers and or installers and / or construction contractors and sub-contractors should refer to Table 4.4 below and account for the potentially contaminative material accordingly.

If a more detailed assessment is required then the excavations can be sub-divided into smaller areas/runs and the relevant chemistry analysis results for that location can be referred to. A complete record of the strata revealed, and soil chemistry analysis results can be referred to in the previously mentioned site investigation reports as referenced in Appendix B.

Table 4.4 *Maximum concentration of contaminants recorded on site.*

Potential Contaminant	Concentration (mg/kg)	Potential Contaminant	Concentration (mg/kg)
Arsenic	55	Benzo(a)pyrene	72
Mercury	1.2	Benzo(b)fluoranthene	80
Lead	1000	Benzo(k)fluoranthene	33
Copper	2100	Dibenzo(a,h)anthracene	12
Benzo(a)anthracene	55	Indeno(1,2,3-cd)pyrene	58
Chrysene	51	TPH Aromatic C21-C35	590

It is considered unlikely that any excavations on the site will reveal material that differs in nature from that observed in the exploratory holes undertaken previously. In the event that this does occur reference should be made to the advice given in Section 6.0 of this document.

4.5 Conclusions

The risk posed to site end users from made ground soils on site is considered to be **Moderate** due to the recorded occurrences of arsenic, copper, lead, zinc, PAHs and TPHs above Tier 1 residential threshold levels for a conservative assessment.

Construction workers are to be provided with appropriate PPE and sanitary facilities with reference to the contaminants of concern observed in the site soils.

Elevated concentrations of PAHs and TPHs were determined within the made ground across the site. Consequently, the risk posed to water supply pipes laid in this material is considered to be **Moderate**.

The risk posed to site end users from soil gases on site is considered to be **High** due to the recorded elevated concentrations of carbon dioxide, resulting in the site being classed as a CS3 gas regime.

5.0 Remediation

5.1 General

In this document the term 'remediation' is used to define specific works required to address potential problems arising from land contamination with due account taken of the known history of the site and the proposed end user.

'Reclamation' is defined as the total works required in order to bring the site up to a standard whereby the proposed re-development is not unduly affected by abnormal construction works resulting from the past use of the site. Reclamation works may include soil remediation, demolition, removal of asbestos from buildings and site re-profiling for example.

There are two items of concern which will be addressed as part of the site reclamation, remediation and development phase, this is:

- Recorded concentrations of arsenic, copper, lead, zinc, PAHS and TPHs above Tier 1 Thresholds for an assessment against '*Residential with the Consumption of Produce'* end use in a number of exploratory hole locations across the site.
- Elevated concentrations of carbon dioxide have been recorded, requiring gas protection measures to CS3.

5.2 Remediation Objective

The overall aim of the remediation is to provide a situation upon which the proposed construction can be safely developed and furthermore ensure that the site will not have a detrimental effect on the future site occupiers and or other receptors identified by previous assessments.

After review of the data obtained in the site investigation report, measures have been identified and when implemented as part of the reclamation works will enable the site to be re-developed for the intended end-use.

The proposed development comprises the construction of a new school teaching block and sports hall with associated areas of hard standing for car parking and soft landscaping.

5.2.1 Soil Contamination

It is recommended that the development levels of the site are designed to allow minimal off-site disposal of site material so as not to incur a significant expense in disposal costs.

The risk posed to site end users from made ground soils on site is considered to be **Moderate** due to the recorded occurrences of arsenic, copper, lead, zinc, PAHS and TPHs above Tier 1 residential threshold levels.

It is considered that the provision of a capping layer applied to areas of new soft landscaping will mitigate any risk presented to site end users by non-volatile contamination present within the soil.

Capping material emplaced to new areas of landscaping should meet the specification provided in Section 8.0 of this report. This material and emplacement should be independently tested and validated.

If cut and fill operations of site won materials are required on site they must be undertaken in compliance with the CL:AIRE publication The Definition of Waste: Development Industry Code of Practice which requires the compilation of a Materials Management Plan with declaration to the Environment Agency by a 'Qualified Person'.

Construction workers are to be provided with appropriate PPE and sanitary facilities with reference to the contaminants of concern observed in the site soils.

With reference to the UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' document reference 10/WM/03/21 advice is given on the appropriate materials for these ground conditions.

It is considered that specialist materials may be required for water supply pipes at the site where they are taken through Made Ground. If laid within natural Clay deposits normal pipe materials should be sufficient. However confirmation of supply pipes should be sought from Thames Water.

5.2.2 Soil Gases

With reference to Situation A non-traditional construction as defined by the NHBC and the modified Wilson & Card classification as contained within CIRIA C665, the maximum carbon dioxide concentration and gas screening value indicates Characteristic Situation 3 (CS3) gas regime requiring gas protection measures for the proposed new school development.

No radon protection measures are necessary in the construction of new dwellings.

6.0 Remediation Strategy

6.1 General

Reclamation of the site will be undertaken in several stages of which the remediation is a critical part. The various key stages are outlined below:

- Disconnection/diversion of live services on the site.
- Site clearance of existing vegetation, topsoil, shrubs, trees and hard standing.
- Earthworks.
- Remedial works.
    - Soft Landscaping.
    - Gas Protection Measures.
    - Water Supply Pipes.
- Supervision.

6.2 Definitions

For the purposes of the Remediation Strategy outlined in this document the 'Environmental Consultant' or 'Engineer' shall be Curtins Consulting.

The 'Client' and 'Principal Contractor' is Wates Construction.

6.3 Disconnection of Live Services and Demolition

Live services are to be either disconnected or diverted on site as required by the development proposals.

These works do not form part of this Remediation Strategy.

6.4 Site Clearance and Excavations

All surface vegetation, including grasses, shrubs and non-TPO trees in the area of the development are to be removed and disposed off-site at a suitable disposal facility. Any fly-tipped material is also to be removed to a suitably licensed disposal facility.

If during site clearance works and/or other excavations unusual visual and or olfactory evidence of previously unrecorded contamination is observed, the Principal Contractor shall inform the Environmental Consultant immediately.

Following discussions with the Environmental Consultant, these soils shall then be sampled (numbers to be confirmed with the Environmental Consultant) and chemical contamination testing carried out. The Environmental Consultant shall decide upon the chemical-testing suite at the time of sampling having reviewed the materials in question. If it is considered by the Environmental Consultant that the concentrations are likely to present a risk to receptors the soils affected will be removed or remediated until the contaminants are proved to no longer present a risk to future site users or other receptors.

If such visual and or olfactory evidence of contamination is encountered, excavation at the location shall cease until the results of the analytical testing have been received.

Only in exceptional circumstances, if it is unavoidable that excavation continues, the removed soils shall be placed separately from other materials on an impermeable membrane that is securely covered at the end of each working day to prevent rain entering the soils and leachate migrating from the material.

In the event that unexpected below ground structures (in addition to those identified to date), which may contain potentially contaminating materials such as tanks and back-filled pits, are encountered, the contractor will inform the Environmental Consultant and work at that location will cease until the structure has been fully inspected. The Principal Contractor shall provide a Method Statement for the removal of the structure, which shall be agreed by the Environmental Consultant prior to its removal. Soil sampling and water sampling (if present) shall be undertaken under/around the structure/tank to the satisfaction of the Environmental Consultant following removal.

Site operatives should keep physical contact with the made-ground soils and perched waters to a minimum and appropriated PPE is to be used e.g. gloves and overalls where contact is unavoidable. Specific details of procedures to be applied will be provided by the Principal Contractor in the Health and Safety Plan for the works.

Copies of Consignment Notices for hazardous waste (special waste) and Waste Transfer Notes for non-hazardous waste shall be kept on site for review by Curtins Consulting.

After site clearance of surface debris and vegetation it is proposed that a visual and olfactory inspection be carried out to confirm the site ground conditions; i.e. to ensure that there is no unexpected contamination.

6.5 Earthworks

6.5.1 General

Excavation of site soils will be required to facilitate the construction of foundations and service trenches.

These arising could be re-used as a general fill if geo-technically suitable, all in accordance with the parameters for re-use described in Section 5.

6.5.2 Off Site Disposal

Guidance on the disposal of contaminated soils has previously been provided by the Environment Agency in their publication, ‘Guidance on the Disposal of “Contaminated Soils”, Version 3 dated April 2001.

In July 2004 revised guidance was published by the Environment Agency,

a) Framework for the Classification of Contaminated Soils as Hazardous Waste, Version 1, July 2004.
b) Hazardous Waste and Contaminated Soil, July 2004.

The guidance was amended to incorporate the requirement of the Landfill Directive whereby from the 16th July 2004 co-disposal of non-hazardous wastes and hazardous wastes cease. Hazardous waste will only be accepted at landfill sites whose operators have appropriate permits. Furthermore, since 16th July 2004, there has been a legal requirement to treat all hazardous waste prior to its disposal to landfill.

Further position statements have since been published by the Environment Agency with regard to the classification of contaminated soils.

On the 1st of June 2015, revised guidance on the assessment and classification of hazardous waste in England, Wales and Northern Ireland, or special waste as it is known in Scotland, was published. The document, known generally as WM3, replaces the previous guidance WM2.

As previously, the assessment and classification depends on the type of code(s) identified and codes are now divided into four types of entry:

- wastes that may be hazardous or non-hazardous, known as 'mirror hazardous' and 'mirror non-hazardous' entries;
- wastes that are always hazardous, known as 'absolute hazardous' entries; and
- wastes that are always non-hazardous, known as 'absolute non-hazardous' entries.

Construction soil waste is a mirror entry i.e. it is not defined as an absolute hazardous or absolute non-hazardous entry and thus needs to be assessed. As a mirror entry the classification is defined by a specific hazardous substance or a specific hazardous property

For construction soils the waste codes will be one of those shown below:

Waste Type	Waste Status	Waste Code
Soil and stones containing dangerous substances	Hazardous	17-05-03*
Other soil and stones	Non-hazardous	17-05-04

The six-digit codes in the List of Waste (LoW) that are hazardous wastes have an asterisk (*) next to them

WM3 provides detailed advice with regard to the method of classification. It is understood that the Environment Agency are still advising that the environmental chemistry analysis results, undertaken for the intrusive investigation of the site and based on risk assessment of likely presence of contaminants, can still be used for classification of waste but an absolute requirement in the classification process is the need to also assess for Persistent Organic Pollutants (POPs).
Excluding visible free product and or 'pure' chemicals (indicated by colour and nature) revealed within the site soils, the classification for hazardous and non-hazardous materials is to be based on mirror entries, i.e. 'soils containing dangerous substances'.

An assessment of the composition of the soil should be undertaken to determine the concentrations of dangerous substances and POPs, and hence whether it should be classified as hazardous waste.

The principal contractor (or any other sub-contractor undertaking excavations) should, in conjunction with the proposed disposal facility, use where possible the relevant environmental chemistry analyses results to classify any surplus material identified for off-site disposal.

However it should be noted that this information is for guidance only and material identified for disposal will have to be tested and assessed in accordance with WM3 to enable classification during the works.

Once classification is determined, Hazardous Waste Acceptance Criteria testing will be required to allow appropriate disposal facilities to be identified.

6.5.3 Arising of Natural Strata

Underlying shallow deposits of natural materials comprise clay. It is considered that this material will be suitable for re-use as general fill if geo-technically suitable, all in accordance with the parameters for re-use described in Section 5.

6.6 Remedial Works

6.6.1 Soft Landscaping

It is recommended that the development levels of the site are designed to allow minimal off-site disposal of site material.

Due to the recorded presence of a number of contaminants within the made ground soils across the site, it is recommended that subject to Local Authority approval a cover system of minimum 300mm of clean and inert capping is installed in areas of new soft landscaping in order to break the source-pathway-receptor linkage to site end users.

For deeper rooted planting isolated rooting pits will be required.

As the new soft landscaping works does not include areas of productive garden or areas likely to be accessible to young children (considered the critical human receptor) on a regular (daily) basis a 300mm capping layer is considered adequate.

Construction workers are to be provided with appropriate PPE and sanitary facilities with reference to the contaminants of concern observed in the site soils.

The Environmental Consultant will validate the depth of the capping layer in areas of soft landscaping. Capping material emplaced on site should meet the specification provided in Section 8.0 of this report.

6.6.2 Gas Protection Measures

Following the 2014 HSP and 2015 Soiltechnics site investigations a total of nine gas monitoring visits have been undertaken. A maximum concentration of Carbon Dioxide (CO_2) of 6.2% $^{v}/_{v}$ has been recorded in WS1. A maximum positive flow of 14.4l/hr has been recorded in DTS107.
With reference to Situation A non-traditional construction as defined by the NHBC and the modified Wilson & Card classification as contained within CIRIA C665, the maximum carbon dioxide concentration and gas screening value indicate Characteristic Situation 3 (CS3) gas regime requiring gas protection measures for the proposed new school development.

In accordance with BS8485 2007 'Code of practice for the characterisation and remediation from ground gas in affected development' the building designer can consider appropriate protective measures in order to achieve a protective measure score of 3 for public buildings.

The Environmental Consultant will validate the installation of these protection measures.

6.6.3 Water Supply Pipes

With reference to the UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' document reference 10/WM/03/21 advice is given on the appropriate materials for these ground conditions.

Elevated concentrations of PAHs and TPHs were determined within the made ground across the site. Therefore, as a precautionary measure it is recommended that appropriate materials for water supply pipes would comprise a 'barrier' (PE/AL/PE) pipe. The exact requirements are to be confirmed with the relevant utility supplier.

The Environmental Consultant will validate the installation of these protection measures.

7.0 Strategy for Handing Contaminated or Potentially Contaminated Soils on Site

7.1 General

Surplus soils to be removed from site which have been identified as contaminated should be loaded onto a lorry and transported to the landfill facility immediately. Where stockpiling is unavoidable the stockpile should be located on an impermeable membrane and be covered also with a low permeability membrane at the end of each working day. Where soils are wet when excavated, measures should be taken to ensure there is no runoff from the soils onto the surrounding soils.

Under his duty of care, the Principal Contractor shall ensure the proper and safe disposal of waste from the site after it has been passed on to another party. In this respect details of the landfill facility to be used and the company disposing of the waste with regard to hazardous (special) and non-hazardous waste shall be provided to the Site Manager. Copies of Consignment Notices for special waste and Waste Transfer Notes for hazardous and non-hazardous waste shall be kept on site for review by Curtins Consulting.

In the event that material is revealed on site of a nature that does not accord with the previously observed and recorded descriptions, the following procedure is to be complied with.

a) Cease and make safe all excavations in this location and report observations to the Site Manager.
b) The Site Manager is to notify the Engineer.
c) Under guidance of the Engineer take representative samples of the suspect materials and forward to a suitably accredited testing house for analysis.
d) Await Engineers instructions with respect to re-commencement of the works and or removal from site of suspect material to a suitably licensed disposal facility.
e) Local Authority EHO and if relevant the Environment Agency are to be kept fully informed of any such occurrences.

8.0 Imported Soils

8.1 General

Soils may need to be imported if the site levels are to be raised or as a 'clean and inert' capping layer in areas of soft landscaping and areas of hard standing across the development site.

Prior to placement on site the Environmental Consultant shall be informed of the source of **ALL** imported materials and where considered necessary details of the site in terms of past history in order that the Environmental Consultant can assess the potential contaminants in the materials to be imported.

8.2 Imported Fill Material

Subject to acceptable verification sample results all excavations should be backfilled with clean and inert granular material; Specification for Highways Works grade 6F5 imported recycled material. For recycled material, undertake compliance testing for potential contamination at a frequency of 1 test per 175m^3 used; in addition imported 6F5 must be supplied under a WRAP protocol to establish it as a non-waste material.

Where ALL concentrations are less than those values given in Tables 8.3.1a to 8.3.1c, the fill shall be considered suitable for use

8.3 Topsoil and Subsoil to Landscaped Areas

The thickness' of clean and inert cover for non-productive gardens and managed soft landscaped areas is;

- 300mm of clean and inert capping, subject to Local Authority approval, comprising minimum 150mm topsoil over subsoil or alternatively the capping can comprise topsoil only.

For deeper rooted planting isolated rooting pits will be required.

Capping materials shall be from a source where at least 3 No. representative soil samples have been taken, subject to a minimum rate of at least 1 sample per 250m^3.

8.3.1 Topsoil

All topsoil will be reused existing or imported and will be a minimum of 150mm thick in soft landscaped areas. The topsoil will be supplied and placed in accordance with the Architects' specification.

The imported topsoil is to be 'Multipurpose' in accordance with BS 3882:2007 'Specification for Topsoil and Requirements for Use'. One sample for every 250m^3 imported is to be tested by the supplier in accordance with Clause 5 of BS 3882:2007. Chemical analysis of the topsoil is to be undertaken at a frequency of one sample every 250m^3 used. The environmental chemistry analysis suite is shown in Table 8.3.1a on the following page.

Concentrations of the above determinands shall not exceed CLEA soil guideline values where available for Residential end use. Where not available the concentrations shall not exceed the values shown in Table 8.3.1b and 8.3.1c.

Where ALL concentrations are less than these values the soils shall be defined as 'clean and inert'.

If the topsoil is not naturally sourced, for example if it is a recycled soil, further chemical determinands may be added to the chemical analysis suite at the discretion of the engineer.

Review of the thresholds in Tables 8.3.1b and 8.3.1c may be made for specific soil sources whereby the Soil Organic Matter is proving to be routinely above 6%.

Table 8.3.1a Environmental chemistry analysis suite for imported soils.

Suite Reference	Environmental Chemistry Analysis
Imported Soil	Total metals : Arsenic, cadmium, chromium, chromium VI, lead, mercury, selenium, copper, nickel, zinc, water soluble boron; Total cyanide Total sulphate Elemental sulphur Sulphide Total monohydric phenols pH Soil Organic Matter Asbestos Screening Total Petrol Hydrocarbons (Full TPHCWG analysis – aromatic/aliphatic split, Detection Limit 0.01mg/kg for each banding C5 to C10 and 1mg/kg for bandings above C10) Polyaromatic Hydrocarbons by GC-MS (Detection Limit 0.1mg/kg for each compound)

Table 8.3.1b Inorganics, PAH's and Phenol

Determinands	Threshold Trigger Concentration For Planned End Use	
	Source	Value (mg/kg)
Arsenic	CLEA SGV for residential end use published May 09	32
Boron	Recognised threshold to prevent phytotoxic affects	3
Cadmium	CLEA SGV for residential end use published July 09	10
Chromium (VI)	In-house assessment by CLEA v1.04	14.4
Copper	Recognised threshold to prevent phytotoxic affects	250
Cyanide (Free)	In-house assessment by CLEA v1.04	34
Lead	CLEA SGV for Residential without Plant Uptake end use	450
Mercury	CLEA SGV for residential end use published March 09	1
Nickel	CLEA SGV for residential end use published May 09	130

Determinands	Threshold Trigger Concentration For Planned End Use	
	Source	Value (mg/kg)
Selenium	CLEA SGV for residential end use published March 09	350
Sulphate	Recognised threshold for protection of sub-surface concrete	2400
Sulphur (Free)	Recognised threshold for all end uses	5000
Sulphide	Recognised threshold for all end uses	250
Zinc	Recognised threshold to prevent phytotoxic affects	1000
pH	Typical value in uncontaminated soils	6-8
Phenol	Recognised threshold for protection of services	5
Acenaphthene	In-house assessment by CLEA v1.04	588
Anthracene	In-house assessment by CLEA v1.04	8270
Benz(a)anthracene	In-house assessment by CLEA v1.04	4.52
Benzo(a)pyrene	In-house assessment by CLEA v1.04	0.82
Benzo(b)fluoranthene	In-house assessment by CLEA v1.04	7.72
Benzo(ghi)perylene	In-house assessment by CLEA v1.04	96.2
Benzo(k)fluoranthene	In-house assessment by CLEA v1.04	84.4
Chrysene	In-house assessment by CLEA v1.04	585
Dibenz(ah)anthracene	In-house assessment by CLEA v1.04	0.84
Fluoranthene	In-house assessment by CLEA v1.04	822
Fluorene	In-house assessment by CLEA v1.04	615
Indeno(123cd)pyrene	In-house assessment by CLEA v1.04	7.31
Naphthalene	In-house assessment by CLEA v1.04	0.59
Pyrene	In-house assessment by CLEA v1.04	563

Table 8.3.1c TPH's

Carbon Range	Threshold Trigger Concentration For Planned End Use		
	Source	Aromatic	Aliphatic
C5 – C6	In-house assessment by CLEA v1.04	0.0493 (C5-C7)	3.01
C6 – C8	In-house assessment by CLEA v1.04	86.9 (C7-C8)	7
C8 – C10	In-house assessment by CLEA v1.04	1.59	0.977
C10 – C12	In-house assessment by CLEA v1.04	9.58	5.74
C12 – C16	In-house assessment by CLEA v1.04	47.7	2400
C16 – C21	In-house assessment by CLEA v1.04	272	88200
C21 – C35	In-house assessment by CLEA v1.04	888	

8.3.2 Subsoil

Sub-soil will be supplied and placed in accordance with the Architects specification and will typically be of a fine granular cohesive matrix that will allow free-drainage and root stability. Imported subsoil is to be sampled and analysed for solid concentrations of critical chemical determinands at a frequency of 1 sample per every 250m^3 imported as Section 8.3.1 above.

Additions to the suite and frequency of sampling may be required based on the source of the imported materials.

Concentrations of the above determinands shall not exceed CLEA soil guideline values where available for Residential end use. Where not available the concentrations shall not exceed the values shown in Table 8.3.1b and 8.3.1c.

Where ALL concentrations are less than these values the soils shall be defined as 'clean and inert'.

8.3.3 Validation of 'Clean and Inert' Capping

If as a part of the development, areas likely to be accessible to young children are established, upon completion of the 300mm thick capping a programme of hand dug exploratory holes with photographic record will be undertaken by Curtins Consulting to identify the thickness of the topsoil and subsoil capping layer provided.

9.0 Contamination: Soils Testing

9.1 General

Where required by the nature of the remediation works the results of any soils analyses will be required by the Environmental Consultant within three to four days of sample receipt at the laboratory.

Where required, a UKAS and where appropriate a MCERTS accredited laboratory will undertake laboratory testing of the existing made-ground soils, site won material and imported material.

All soil samples shall be correctly sampled in containers appropriate for the contaminant to be tested for and stored under appropriate conditions until analysis at the laboratory. In this respect, should it not be possible to transport samples to the laboratory the same day, provision may be made on site for a fridge to store certain soil samples.

10.0 Reporting

10.1 General

Curtins Consulting will issue a Verification Report on completion of the remediation. The Verification Report will incorporate the following information:

a) A description of the works undertaken;
b) All certificates and environmental testing results for any material removed from site to a suitable licensed disposal facility
c) Photographic record and verification certificates of the gas protection measures;
d) All imported soil certification and environmental testing results as required by this Remediation Strategy;
e) Photographic record of the clean and inert capping layer to the soft landscaped areas;
f) Photographic record of installed water supply pipes; and
g) Areas of contamination still existing on site.

The completed Verification Report shall be included within the site Health and Safety Plan to inform future site workers / contractors of areas of potential contamination still present on site.

Appendix A – Drawings

A1 Soiltechnics Ltd, Site Location Plan, drawing no. 01, dated May 2015.

A2 Soiltechnics Ltd, Plan Showing Existing Features and Location of Exploratory Points, drawing no. 02, dated May 2015.

A3 Soiltechnics Ltd, Plan Showing Existing and Site Features, Footprint of Proposed Development and Location of Exploratory Points, drawing no. 03, dated May 2015.

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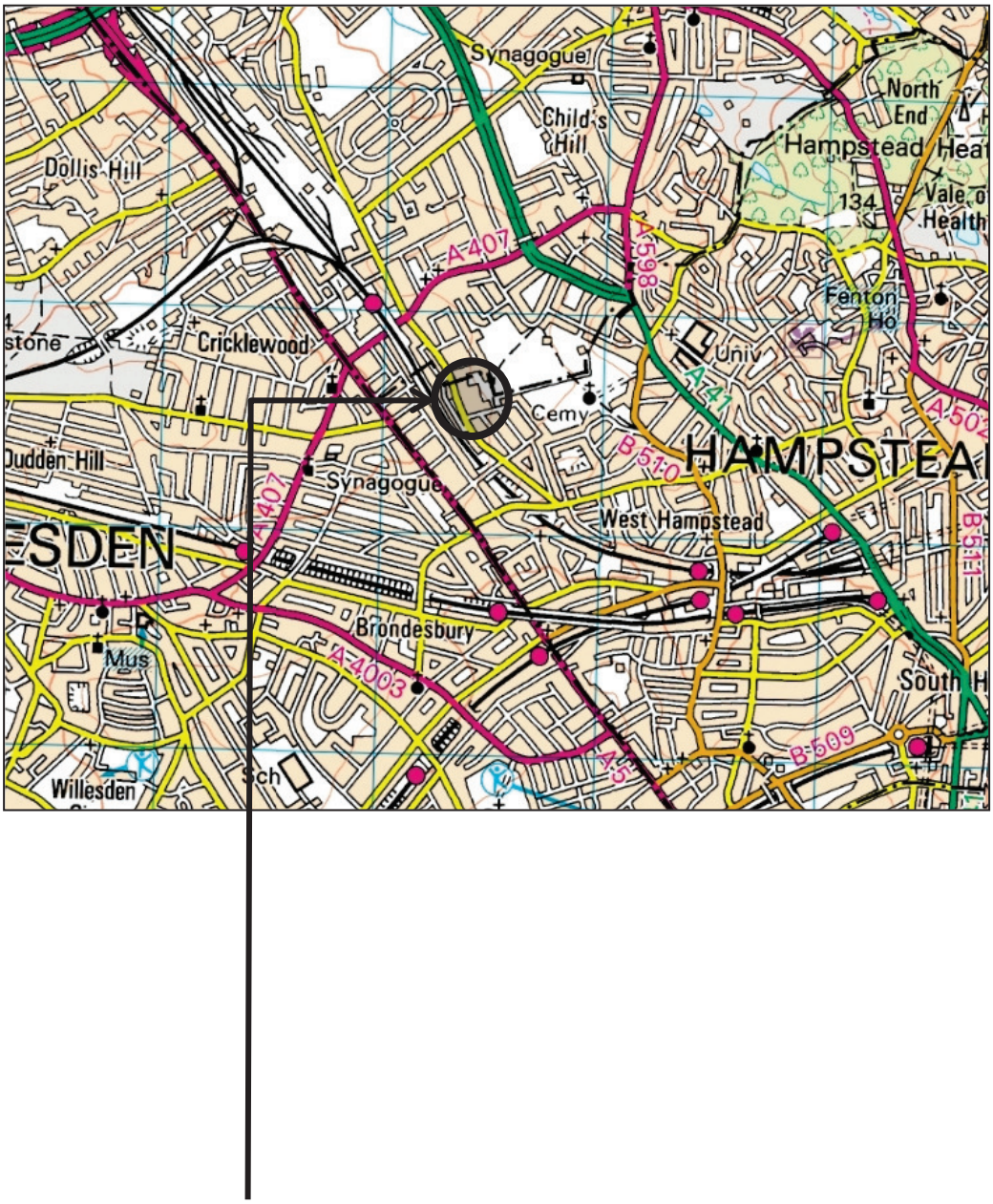

Approximate area of investigation

Title	Scale	Drawing number
Site location plan	Not to scale	01

Proposed redevelopment,
Hampstead School, London

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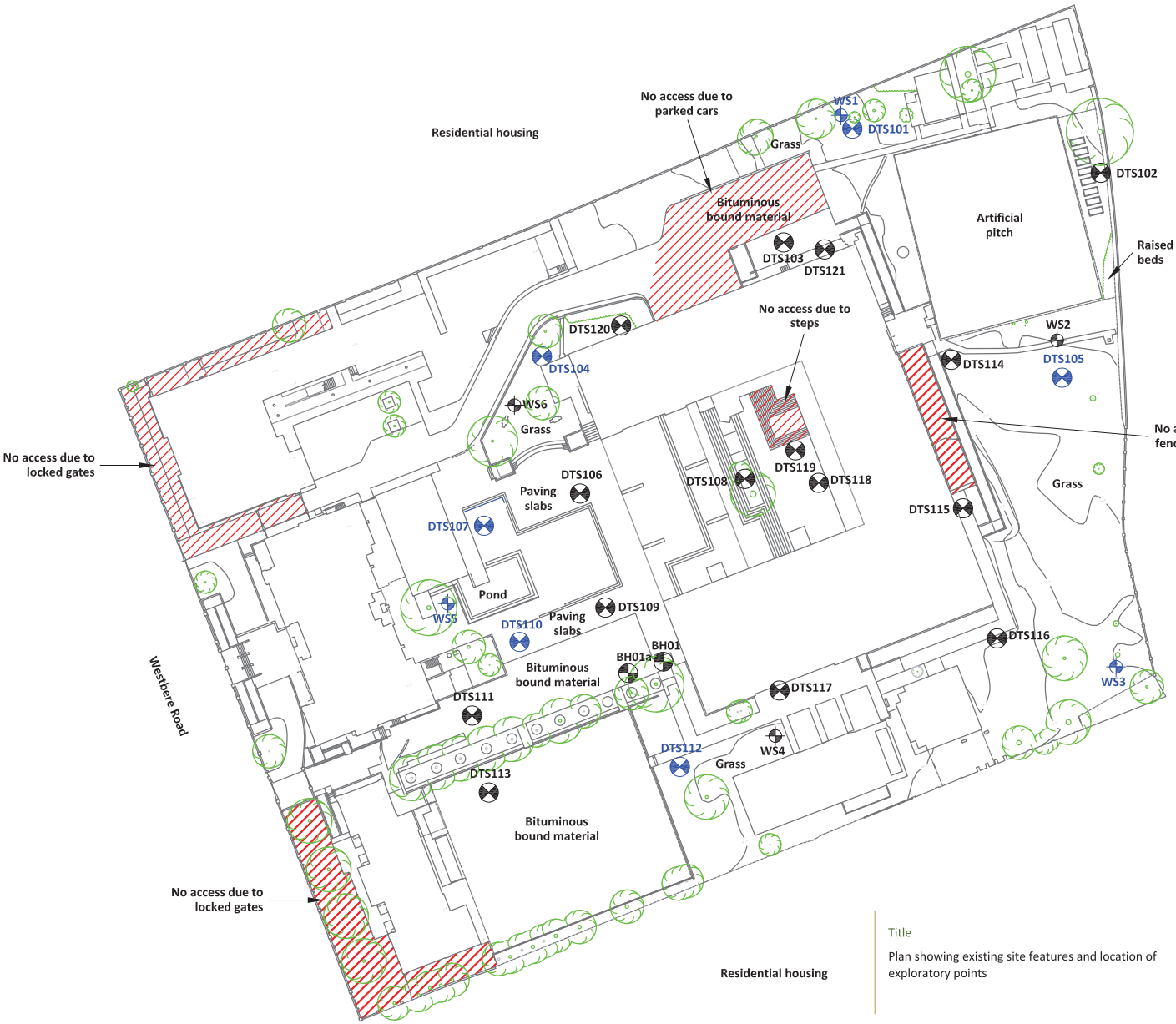


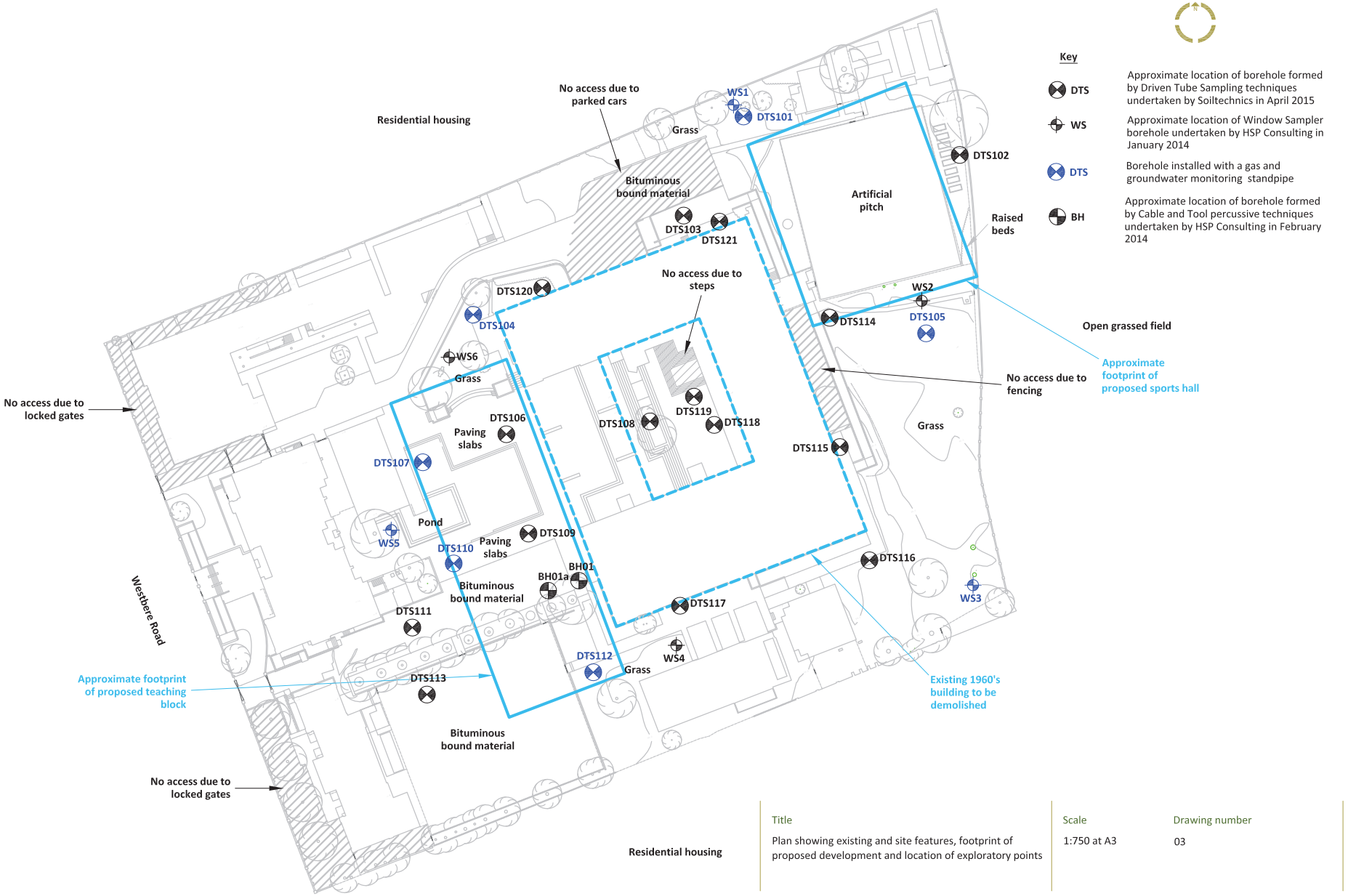
Key

DTS	Approximate location of borehole formed by Driven Tube Sampling techniques undertaken by Soiltechnics in April 2015
WS	Approximate location of Window Sampler borehole undertaken by HSP Consulting in January 2014
DTS	Borehole installed with a gas and groundwater monitoring standpipe
BH	Approximate location of borehole formed by Cable and Tool percussive techniques undertaken by HSP Consulting in February 2014

Title	Scale	Drawing number
Plan showing existing site features and location of exploratory points	1:750 at A3	02

Proposed redevelopment,
Hampstead School, London

soiltechnics
environmental and geotechnical consultants



Title	Scale	Drawing number
Plan showing existing and site features, footprint of proposed development and location of exploratory points	1:750 at A3	03

Report Ref: STM3101N-G01
Revision: 0

May 2015

Appendix B – References

B1 HSP Consulting Engineers Ltd – Phase I Preliminary Sources Study report (ref: C1882/LJ/PI Rev B) dated February 2014.

B2 HSP Consulting Engineers Ltd – Phase II Geo-Environmental Assessment report (ref: C1882/LEJ/PII Rev B) dated April 2014.

B3 Soiltechnics Ltd – Ground Investigation report (ref: STM3101N-G01) dated May 2015.

It is envisaged that the recipients of the Remediation Strategy report will have been issued with these documents separately and therefore further copies are not incorporated herein.

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