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REPORT ON A GROUND INVESTIGATION

Prepared for

Engineers Haskins Robinson Waters

Acting on behalf of

Mr Adam Kaye

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1.0 INTRODUCTION

1.1 Outline and Limitations of Report

At the request of Engineers Haskins Robinson Waters, acting on behalf of Mr Adam Kaye, a ground investigation was carried out in connection with a proposed residential development at the above site. A Phase 1 Preliminary Risk Assessment (Desk Study) is presented under separate cover in Site Analytical Services Limited Report Reference 14/22714-1.

The information was required for the design and construction of foundations and infrastructure for the proposed development which includes the demolition of the existing building and construction of a new three storey residential property with a basement. Information was also required to assess whether any remediation was required for the protection of the end-user from the presence of potential contamination within the soils encountered.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

1.2 Remit and Approach

Environmental assessors use a source-pathway-receptor conceptual site model when determining the risk posed by potentially contaminated sites. For potential risk to arise each stage of the SPR linkage must be present, plausible and significant.

2.0 SITE DETAILS

(National Grid Reference: TQ 260 862)

2.1 Site Location

The site is located to the west of Branch Hill in the London borough of Camden at approximate postcode NW3 7NA. The site comprises of a detached modern house with a driveway at the front and a rear garden area.

The surrounding land use is primarily residential and recreational. There is a large forested area to the north and open space to the east. The surrounding area has a suburban street pattern.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by the Bagshot Formation resting on the Claygate Member with the London Clay Formation at depth.

2.3 Previous Investigations

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 14/22714-1 dated November 2014) was undertaken across the site by Site Analytical Services Limited. The Phase 1 PRA should be read in full in conjunction with this Phase 2 report.

In order to make an assessment of potentially unacceptable risks relating to sensitive receptors on and off-site, a Phase 2 site investigation was recommended.

2.4 Proposed development

It is proposed to demolish the existing building on-site and construct a new three storey residential property with a lower ground floor level.

Proposed plans of the development are included in Appendix D to this report.

3.0 SCOPE OF WORK

3.1 Site Works

The exploratory investigation included for an inspection of the site and near surface soils in order to:-

- Determine the presence, extent and significance of potential contaminants in the sub-surface strata associated with current and former activities at the site and surrounds identified during the Phase 1 PRA.
- Assess the significance of potential impacts on sensitive receptors at or adjacent to the site.
- Assess the potential environmental liabilities and consequences associated with the site.
- Identify requirements for further works, including the design of any additional investigative/monitoring works and remedial measures if deemed necessary.

The proposed scope of works was agreed by the client prior to the commencement of the investigations. To achieve this, the following works were undertaken:-

- The drilling of one rotary percussive borehole to a depth of 15.0m below ground level (104.90mOD) (Borehole 1) and one continuous flight auger borehole to a depth of 6.00m below ground level (111.30mOD)(Borehole 2).
- The installation of a groundwater monitoring standpipe to a depth of 10m below ground level (109.00mOD) in Borehole 1.
- The excavation by hand of one trial pit to expose existing foundations of the retaining wall at the site (Trial Pit 1). In the event the trial pit was terminated at 0.12m below ground level (117.28mOD) due to the presence of a concrete obstruction.
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes and trial pit.
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory holes.
- Interpretative reporting on foundation options for the proposed building and infrastructure.
- A study into the possibility of the presence of toxic substances in the soil, together with limited comment on any remediation required.

3.2 Ground Conditions

The locations of the exploratory holes are shown on the site sketch plan, Figure 1.

The site is set on two levels, with the ground floor set lower than the site entrance and driveway. The drop in elevation from east to west across the site is approximately 2m. The ground level for Borehole 1 was approximately 2m higher than Borehole 2.

The boreholes and trial pit revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised Made Ground up to 0.80m in thickness with the Bagshot Formation at depth.

For detailed information on the ground conditions encountered in the boreholes and trial pit, reference should be made to the exploratory hole records presented in Appendix A.

The Made Ground extended to a depth of 0.80m below ground level (119.10mOD) in Borehole 1 and 0.75m below ground level (116.55mOD) in Borehole 2 and to the full depth of investigation of 0.12m below ground level (117.28mOD) in Trial Pit 1. The material generally comprised of a soft brown silty sand with brick and concrete fragments and rubble.

The Bagshot beds were encountered beneath the Made Ground in both boreholes and generally comprised of loose becoming medium dense clayey silty fine sand locally becoming stiff silty sandy clay. These soils extended down to the full depths of investigation of 15.00m below ground level (104.90mOD) in Borehole 1 and 6.00m below ground level (111.30mOD) in Borehole 2.

3.3 Groundwater

Groundwater was not encountered during the excavation of the trial pit and the soils remained essentially dry throughout. Groundwater was encountered in both boreholes during boring, at 7.20m below ground level (112.70mOD) in Borehole 1 and 5.00m below ground level (112.30mOD) in Borehole 2.

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and trial pit and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

Groundwater was subsequently found to have stabilised at a depth of 7.11m below ground level (112.79mOD) in the monitoring standpipe placed in Borehole 1 after a period of approximately two weeks.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (October 2014) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU AND LABORATORY TESTS

4.1 Standard Penetration Tests

The results of the Standard Penetration Tests carried out in the natural soils are shown on the exploratory hole records in Appendix A. SPT 'N' values range between 9 and 34.

The results of the tests are shown on the appropriate borehole records and summary sheets presented in Appendix A.

4.2 Undrained Triaxial Compression Test Results

A single Quick Undrained Triaxial Compression test was carried out on an undisturbed 100mm diameter sample taken from Borehole 1. The results show the sample to be of a stiff consistency.

The results of the test is presented on Table 1, contained in Appendix B.

4.3 Classification Tests

Atterberg Limit tests were conducted on three selected samples taken from the cohesive sections of the natural soils in Boreholes 1 and 2 and showed the samples tested to fall into Class CI, according to the British Soil Classification System.

These are fine grained silty clay soils of intermediate plasticity and as such generally have a low permeability and a medium susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values between 23% and 28%, with all of the samples being below the 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

The test results are given in Table 2, contained in Appendix B.

Particle size distribution tests were also carried out on six selected samples of essentially granular natural soil using wet sieving methods and the results are presented in both tabular and graphical format, contained in Appendix B.

4.4 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on three soil samples selected to be close to anticipated foundation level are presented on Table 3, whilst further analyses on soil samples are given within the contamination test results, both contained in Appendix B. The results presented on Table 3 show the soil samples tested to have water soluble sulphate contents of up to 0.07g/litre associated with slightly acidic pH values. The samples of Made Ground tested indicated water soluble sulphate contents of up to 0.11g/litre associated with slightly alkaline pH values.

5.0 CONTAMINATION TESTING

5.1 Exploratory Hole Locations

The sampling strategy employed during the Phase 2 site investigation was designed to provide adequate coverage across the site. A selection of samples submitted for a broad screen of total potential contaminants.

A total of two exploratory holes were excavated across the site providing a density equivalent to a circa 25m grid. The holes were sited in order to provide site wide coverage, whilst also targeting potential sources of contamination, as detailed in Table A.

Table A : Summary of Borehole Sites

Site Area/Activity	Exploratory Hole Location(s)	Surface
General site coverage where made ground of unknown origin.	BH1, BH2	Hardstanding

Samples were obtained from 0.25m and 0.50m in BH1 and from 0.50m and 0.75m in BH2 made at the locations indicated on the site sketch plan (Figure 1). Samples were analysed from this depth range below ground level as it is felt that these soils will be representative of those of highest end-user exposure through the dermal contact, dust inhalation, soil ingestion and vegetable consumption pathways.

5.2 Interpretation of Findings

The hazard caused by the presence of a substance or element is not absolute but depends on the proposed end use of the site.

It is understood that the site is to be developed for residential purposes with areas of private gardens. As such the Soil Guideline Values for residential use and Category 4 screening levels for residential use with home-grown produce have been used in the following soil assessment.

Site data has been assessed against current generic assessment criteria (GAC) / guideline values in accordance with current industry practice and statutory guidance; chemical toxicology (TOX), Soil Guideline Value (SGV) reports developed using the new Contaminated Land Exposure Assessment (CLEAv1.06) framework, CLR 11 (Environment Agency, 2009) and SP1010: Development of Category 4 screening levels for assessment of land affected by contamination (DEFRA, 2014).

However, it must be remembered that GAC are not binding standards but can be useful in forming judgements regarding the level of risk i.e. unacceptable or acceptable. Exceedance of GAC does not automatically result in the requirement for remedial / risk management work but would warrant further assessment.

5.3 Category 4 Screening Levels, Soil Guideline Values, CLR Documents & Chartered Institute of Environmental Health Values

Under Part 2A of the Environmental Protection Act 1990, land is determined as contaminated if it is deemed to be causing significant harm, or where there is a Significant Possibility of Significant Harm to human health.

From January 2009 revised Soil Guidance Values for certain contaminants were issued in the Contaminated Land Reports (CLR) by the Environment Agency in conjunction with Department of the Environment, Food, Agriculture and Rural Affairs. These values and the CLEA methodology used to derive them have superseded CLEA and TOX reports for soil contaminants.

The CLR Documents are a series of contaminated land guidance documents developed by various past and present government agencies involved with protection of the environment.

These documents aim to provide a set of generic Soil Guideline Values and a site specific modelling programme based upon tolerable predicted uptakes from experimental data for a variety of common industrial toxic contaminants. In instances of carcinogenic and mutanagenic substances the guideline values are set on the basis of "As Low As Reasonably Practicable" (ALARP), as theoretically mutation can occur on exposure to a single particle of the contaminant.

Revised Statutory Guidance to support Part 2A of the Environmental Protection Act 1990 was published in April 2012, which introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health, where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low.

'Category 4 Screening Levels' (C4SLs) have been introduced in March 2014 to provide a simple test for deciding when land is suitable for use and definitely not contaminated land. The Category 4 Screening Levels consist of estimates of contaminant concentrations in soils that are considered to present an 'acceptable' level of risk, within the context of Part 2A.

The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology.

At the time of writing this report Category 4 Screening Levels are only in place for Arsenic (37mg/kg), Benzene (0.87mg/kg), Benzo(a)pyrene (5mg/kg), Cadmium (26mg/kg), Chromium VI (21mg/kg and Lead (200mg/kg) - for a residential scenario with home-grown produce.

At the time of writing this report Soil Guideline Values are only in place for Selenium (350mg/kg), Nickel (130mg/kg), Mercury (1-170mg/kg), Ethylbenzene (350mg/kg), Xylenes (230-250mg/kg), Toluene (610mg/kg) and Phenols (420mg/kg) - for a residential scenario.

The Environment Agency has also released a new version of the CLEA software and its handbook to help assessors estimate risks. The Chartered Institute of Environmental Health Generic Assessment Criteria for Human Health Risk Assessment adopt the Environment Agency's CLEA UK (Beta) Model and as such have derived guideline values that are compatible with current English legislation, policy and technical guidance.

Generic Assessment Criteria for Human Health Risk Assessment for Trivalent Chromium (Chromium III) has been produced by Chartered Institute of Environmental Health at 627mg/kg for a residential scenario.

Assessment criteria for selected individual Polycyclic Aromatic Hydrocarbons have been produced by Chartered Institute of Environmental Health; however no values have been attached to Total Polycyclic Aromatic Hydrocarbons. Sixteen individual Polycyclic Aromatic Hydrocarbons with attached screening values include Dibenzo(a,h)anthracene (0.76-0.90mg/kg), Fluorene (160-780mg/kg) and Naphthalene (1.5-8.7mg/kg) for a residential scenario.

The concentrations of the phytotoxic substances Total Copper, Total Zinc and Boron have been assessed against the Chartered Institute of Environmental Health Generic Assessment Criteria for Human Health Risk Assessment of 2330mg/kg, 3750mg/kg and 291mg/kg respectively which assumes a residential scenario.

The concentrations of Total Petroleum Hydrocarbons have been assessed against assessment criteria for individual Aromatic and Aliphatic carbon band ranges produced by Chartered Institute of Environmental Health for a residential scenario.

As no generic UK derived guidance is currently available for acceptable concentrations of Total Cyanide a screening value of 20mg/kg (Thiocyanate) has been used as a preliminary screening tool to identify where potential risks may exist.

As described in Using Soil Guideline Values – Environment Agency 2009, chemical data from the analysis of samples generated during the intrusive investigation have been used to create a data set for the site. The entire data set, as opposed to individual results has been analysed on the assumption that the samples from the site investigation are to some degree representative of the contaminant concentration throughout the area or volume of soil investigated. The most appropriate method for assessing a given dataset is dependent upon a range of specific factors together with the quantity and quality of the data generated.

In accordance with the recommendations provided within Guidance on comparing soil contamination data with a critical concentration – CIEH/CL:AIRE, 2008, we have selected the one sample t-test at a 95% confidence level as the most appropriate statistical tool for generating site representative soil concentration values and have assumed that the data is normally distributed. We have assumed that this statistical test is required to draw conclusions about the condition of the land under scrutiny as part of a planning scenario as opposed to the Part 2A scenario. Under a planning scenario, comparison is made between a value larger than the sample mean, in this case the Upper Confidence Limit and the critical concentration.

In instances where the Upper Confidence Limit exceeded the given critical value, then the Grubbs Test has been used to identify upper outliers to assess whether the highest value belongs to the general population of the dataset or is representative of an outlier.

5.4 Assessment of Soil Analyses

It is understood that the site is to be developed for residential properties with private gardens. As such the Soil Guideline Values for residential use and Category 4 screening levels for residential use with home-grown produce have been used in the following soil assessment. The samples selected for contamination assessment were sub-contracted to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) and their report is contained in Appendix B.

5.5 Discussion

5.5.1 Human health risk assessment (on site residents and neighbouring residents)

Concentrations of the zootoxic heavy metals Total Arsenic, Total Cadmium and Hexavalent Chromium in the samples analysed did not exceed the Category 4 Screening Levels for a residential scenario with home-grown produce. As such there is not considered to be any potentially significant level of end-user risk associated with the concentrations of these contaminants encountered.

The concentrations of Total Lead encountered in the samples from 0.25m depth in BH1 at 220mg/kg and 0.50m in BH2 at 410mg/kg were in excess of the Category 4 Screening Levels of 200mg/kg for a residential scenario with home-grown produce. It was therefore decided to undertake statistical analysis of the data set, using the arithmetic mean and standard deviation for Lead. Following a test scenario from a planning perspective, it was concluded that the true mean of the sample population was in excess of the Category 4 Screening value of 200mg/kg, and as such the potential risks to end-users of the site cannot be discounted at this stage.

The concentrations of Total Selenium, Total Mercury and Total Nickel encountered did not exceed the Soil Guideline Values for residential use in the samples analysed. As such there is not considered to be any potentially significant level of end-user risk associated with the concentrations of these contaminants encountered.

The concentrations of Trivalent Chromium encountered did not exceed CIEH Generic screening value for residential use.

The concentrations of Total Cyanide were below the screening value of 20mg/kg and the concentrations of Total Phenol were below the Soil Guideline Value for residential use and as such there are not considered to be any significant risks to end-users of the site from these contaminants.

The concentrations of Benzo(a)pyrene encountered in the samples from site did not exceed the Category 4 Screening Levels for a residential scenario with home-grown produce. As such there is not considered to be any potentially significant level of end-user risk associated with the concentrations of these contaminants encountered.

The concentrations of individual Polycyclic Aromatic Hydrocarbons encountered did not exceed CIEH Generic screening values for residential use.

The concentrations of Petroleum Hydrocarbons encountered within individual Aromatic and Aliphatic carbon band ranges in the samples analysed did not exceed the generic screening values produced by Chartered Institute of Environmental Health for a residential scenario.

The concentrations of Benzene encountered did not exceed the Category 4 Screening Levels for a residential scenario with home-grown produce. Concentrations of the other BTEX substances (Toluene, Ethylbenzene and Xylenes) encountered did not exceed the Soil Guideline Values for residential use in the samples analysed. As such there is not considered to be any potentially significant level of end-user risk associated with the concentrations of these contaminants encountered.

There was no MTBE detected within the samples analysed.

5.5.2 Asbestos Containing Materials

The Made Ground at each exploratory location was screened for the presence of asbestos containing material. Loose Chrysotile fibres were encountered in the Made Ground in BH1 at 0.25m and Chrysotile insulation lagging in the sample from 0.50m depth in BH2.

In both cases, risks associated with the asbestos containing material would be deemed high should they remain in-situ. Any activities that would result in the asbestos containing material being disturbed would be considered as a potential risk and should be taken into consideration should any future development be proposed for the site.

5.5.3 Landscape Planting

The concentrations of the phytotoxic substances Total Copper, Total Zinc and Boron encountered in the samples obtained were below the CIEH Generic screening values for residential use and are not considered to be a significant risk to human health on-site.

The concentrations of the phytotoxic substances Total Nickel, Total Copper and Total Zinc did not exceed the landscape planting generic assessment levels and therefore are not expected to affect sensitive plant species on-site.

5.5.4 Buildings and Construction Materials

Concrete Cast In-Situ

The range of concentrations of water soluble sulphate within the Made Ground at the site were within BRE (2005) Design Class DS-1 for concrete cast in-situ. This should be taken into account should any concrete structures be installed within the soils represented by these samples.

Potable Water Supply Pipes

If at any point in the future it be intended to install new water supply pipes within the Made Ground then consideration to the pipe materials used and/or the trench construction in accordance with UKWIR (2010). Based upon the analysis undertaken, the concentrations of TPH returned by several of the samples of Made Ground may preclude the use of standard PE pipe materials at the site.

5.5.5 Controlled water (Unproductive aquifer)

Controlled waters have been identified as a potential receptor at the site due to the designation of the underlying Bagshot Formation as Secondary A Aquifer. We have assumed that any leachate generated from the Made Ground at the site would be high risk due to a groundwater source protection zone on site as the receptor. We have based our assessment on the following:-

- The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by the Bagshot Formation resting on the Claygate Member with the London Clay Formation at depth.
- The bedrock geology underlying the site is classified as Secondary Aquifer A class; materials with permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.
- The underlying chalk (principal aquifer) is afforded protection from any potential mobile contamination from the superficial strata at the site by the presence of a layer of impermeable London Clay.
- The site is not located within a source protection zone.
- There are no groundwater abstraction licences listed within one kilometre of the site.
- The nearest surface water is 299m north of the site. Due to the distance from the site the potential for contamination from the site is seen as low risk.
- There are no fluvial or tidal floodplains located within one kilometre of the site.
- There are no sensitive land uses within one kilometre of the site.

A large portion of the existing and the proposed site is under permanent hardstanding that would reduce to a minimum any surface water infiltration into the underlying soil and therefore any potential leachate from contamination within Made Ground on-site. It is considered that there remains a low risk for the slight contamination encountered to enter the underlying Secondary A Aquifer under site.

5.6 Conclusions

The findings of the Phase 2 site investigation have demonstrated that in the context of a residential use of the site with private gardens, the contaminants of concern with respect to end-user protection were elevated concentrations of Lead encountered in both boreholes on site and asbestos containing materials encountered, with the critical receptors being the end-users / residents (0-6 year old child) of the site and site construction workers. It is considered that the concentrations of all other determinants analysed for were not present in sufficient quantities to pose any significant risks to end-users.

Additional potential receptors include adjacent residents, site construction workers and potable water supply pipes.

Risks to other identified receptors (i.e. landscape planting, controlled water and buildings and construction materials) are not considered to represent a significant risk at the concentrations encountered.

It may be possible that the extent of remediation required on the site could be minimised if further investigation of the site was undertaken. Thereby the extent of contamination could be more accurately identified and removed, treated or encapsulated to avoid potential risks to end-users of the site.

There remains the potential for some level of end-user risk posed by the concentrations of contaminants encountered. It is anticipated that the protection of the end-user may be achieved by the following:

Areas of proposed hardstanding (e.g. building footprint, roadways etc.)

In areas of permanent hardstanding such as the building footprint and roadways etc., the development itself would adequately break exposure pathways to human health and therefore further remedial measures may not be required in these areas.

Sensitive end use areas (soft-landscaping etc.)

In areas of sensitive end use such as soft-landscaping etc. soils should be removed from the site to mitigate the risks to end-users and break exposure pathways. It would be recommended that the soils be excavated down to at least 600mm and replaced with a clean cohesive fill material of at least 600mm.

Any materials brought onto the site (soils and / or clay) should be validated either at source or once laid at site. Given the nature of the ground conditions, appropriate health and safety practices should be adhered to in order to protect site workers. Any waste material leaving site for off-site disposal (soil and / or water) should be handled in accordance with the current Waste Management and Duty of Care Regulations.

The above conclusions have been drawn on the results of the tests carried out on the soil samples analysed and address remediation issues for the protection of the end-user only. It is recommended that any remedial measures suggested in this report should be subject to formal approval by local Environmental Health and/or Planning Departments and approval should be obtained prior to any works being undertaken. The comments made in this report do not address any third party liability.

6.0 FOUNDATION DESIGN

6.1 General

It is proposed to demolish the existing building on the site and construct a new three storey residential property with a lower ground floor level, swimming pool and parking areas. The maximum depth of the proposed lower ground floor level is approximately 1.44m below existing lower ground floor level (116.56mOD is the existing level, 115.12mOD is the proposed). Exact details of the structures, layouts and loadings were not available at the time of preparation of this report, although anticipated foundation loads for the proposed new buildings are expected to be in the order of 100-150kN/m^2 and ground slab loadings are expected to be of the order of 10-15kN/m^2.

6.2 Site Preparation Works

The CDM Co-ordinator should be informed of the site conditions and risk assessment undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions. It is recommended that extensive searches of existing man made services are undertaken over the site prior to final design works.

6.3 Conventional Spread Foundations

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural strata of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in Borehole 2 drilled at lower ground floor level, it should be possible to support the proposed new development on conventional strip or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural firm and stiff silty sandy clay deposits which were encountered at levels of about 116.3mOD to 118.0mOD across the site.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 150kN/m^2 at 1.00m depth (116.3mOD) increasing to 250kN/m^2 at 2.50m depth (114.8mOD) in order to allow for a factor of safety of 2.5 against general shear failure. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from "Foundation Design and Construction", Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

In addition, foundations may need to be taken deeper should they be within the zones of influence of both existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is