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Report on a Ground Investigation

At

1 Regents Park Terrace, London, NW1 7EE

For

Richard Mitzman Architects

1.0 INTRODUCTION

At the request of Richard Mitzman Architects, a ground investigation was carried out in connection with a proposed residential basement development at the above site.

The information was required for the design and construction of foundations and infrastructure for the proposed development which includes the construction of a basement below the existing garage at the site in connection with the conversion of the outbuilding to ancillary to the main building accommodation. The maximum depth of basement is expected to be approximately 1.40m below existing ground level.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory hole 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 location 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.

2.0 SITE DETAILS

(National Grid Reference: TQ 286 837)

2.1 Site Location

The site is situated at the south end of Regent's Park Terrace, at the junction with Gloucester Crescent in the Camden Town area of London, at approximate postcode NW1 7EE. The site is currently occupied by a four storey end terrace property and associated garage and driveway. The site covers an area of approximately 0.04 Hectares and the general area is under the authority of the London Borough of Camden.

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 London Clay Formation.

3.0 SCOPE OF WORK

3.1 General

The scope of the investigation was specified by the Consulting Engineers and comprised:

- The drilling of one continuous flight auger borehole to a depth of 8m below ground level (Borehole 1).
- The placement of a gas and groundwater monitoring standpipe to a depth of 5m below ground level in Borehole 1.
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the borehole.
- Interpretative reporting on foundation options for the proposed building works and infrastructure.
- A study into the possibility of the presence of toxic substances in the soil, together with any remediation required was outside the scope of the present investigation.

3.2 Ground Conditions

The location of the borehole is shown on the site sketch plan (Figure 1).

The exploratory hole revealed ground conditions that were slightly inconsistent with the geological records and known history of the area and comprised 3.40m thickness of Made Ground resting on deposits typical of Superficial Head with the London Clay Formation at depth.

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

The Made Ground extended down to a depth of 3.40m below ground level in the borehole and comprised a surface cover of concrete overlying a combination of clayey silty sand and sandy silty clay with fine to medium gravel, ashes, brick and concrete fragments.

The underlying natural materials comprised of stiff sandy silty gravelly clay which extended down to a depth of 5.30m below ground level in Borehole 1. These soils are typical of Superficial Head deposits.

The underlying material comprised of stiff becoming very stiff fissured silty clay with occasional partings of silty fine sand and scattered small gypsum crystals. These materials are typical of the London Clay Formation and extended down to the full depth of investigation of 8.00m below ground level in Borehole 1.

3.3 Groundwater

Groundwater was not encountered during the drilling of Borehole 1 and the material remained essentially dry throughout.

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

Isolated pockets of groundwater may 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 4.02m below existing ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately four weeks.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (October and November 2013) 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 In-Situ Tests

In essentially granular soils and cohesive soils with a granular content, Mackintosh Probe tests were made in order to assess the relative density or undrained shear strength of the materials. The results indicate that the cohesive soils within the Made Ground are of a stiff becoming firm consistency, all results being based on the generally accepted correlation as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

In the essentially cohesive natural soils encountered at the site, in-situ shear vane tests were made at regular depth increments in order to assess the undrained shear strength of the materials. The results indicate that the natural soils are of a generally stiff becoming very stiff consistency with increasing depth below ground level.

The results of the in-situ tests are shown on the appropriate exploratory hole records contained in Appendix A.

4.2 Classification Tests

4.2.1 Atterberg Limit Tests

Atterberg Limit tests were conducted on two selected samples taken from the upper cohesive portion of the natural soils in Borehole 1 and showed the samples tested to fall into Classes CH and CV according to the British Soil Classification System.

These are fine grained silty clay soils of high and very high plasticity and as such generally have a low permeability and a high 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 43% and 45%, with both samples being above 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 1, contained in Appendix B.

4.3 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on three natural soil samples selected to be close to anticipated foundation level and to give a range of depth are presented on Table

2, contained in Appendix B. The results show the natural soil samples to have water soluble sulphate contents of up to 2.60g/litre associated with near neutral pH values.

5.0 GROUNDWATER MONITORING

5.1 Groundwater Monitoring Results

The standpipe installed in Borehole 1 was monitored for groundwater levels on 5th November and 20th November 2013 the results are presented on Tables 3 and 3a, contained in Appendix B.

The groundwater level measurements indicate that the groundwater level has stabilised after a period of about four weeks at a depth of 4.02m below ground level in the monitoring standpipe installed in Borehole 1.

6.0 FOUNDATION DESIGN

6.1 General

It is proposed to construct a basement below the existing garage at the site in connection with the conversion of the outbuilding to ancillary to the main building accommodation. The maximum depth of basement is expected to be approximately 1.40m below existing ground level.

6.2 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 the borehole, it should be possible to support the proposed new development on conventional spread or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural stiff sandy gravelly silty clay deposits which occur at a depth of approximately 3.50m below ground level.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 250kN/m^2 at 3.50m depth 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.

Foundations may need to be taken deeper should they be within the zones of influence of either 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 shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, “Building near Trees" and it is considered that this document is relevant in this situation.

6.3 Retaining Walls

It is understood that there are proposals to excavate a new subterranean basement at the site. Exact details of the structure, layout and loadings were not available at the time of preparation of this report.

Retaining walls should generally be designed as self-supporting cantilevered retaining walls. The excavations for a basement must not affect the integrity of adjacent structures and therefore will need to be supported. Two forms of support could be considered, these being temporary works i.e. sheet piling which could be removed after the earth retaining walls have been constructed or as permanent works incorporated into the final design.

Generally, cantilevered piled walls have an open face to embedded ratio of about one to two, i.e. a supported face three metres in height would require a penetration into the ground of about six metres below the base of the excavation. Should the piled retaining wall be purely an unsupported cantilever, then it is likely that quite deep section sheet piles or large diameter bored piles would be required.

The section of the sheet or the diameter of the piles could be reduced by installing a braced waling to the wall. Piles placed as part of the permanent works would be propped by the roof to the basement and would not be acting purely as a cantilevered support in the long term.

To reduce the likelihood of loss of ground if a sheet piled wall was adopted when removing the sheets, it is considered that the sheet piles should be incorporated into the final wall design. Assuming that the earth retaining wall will be propped, i.e. have its base slab and first floor slab cast in place soon after excavation, it is unlikely that full if any earth pressures will act on the wall while it is not propped. The greatest force acting on the wall, in the short term, is likely to be from the hydrostatic head should water percolate and be retained to the rear of the earth retaining structure.

The design parameters for each element of soil recorded in the relevant exploratory hole are provided in Table A below.

Founding Material	Depth to top (m)	Description	Critical Angle of Shearing Resistance (°) (Φ'_{crit})[1]	Coefficient active pressure (Ka)	Coefficient passive resistance (Kp)
Superficial Head	3.40	Stiff very sandy silty gravelly CLAY	21	0.47	2.12
London Clay	5.30	Stiff becoming very stiff silty CLAY	21	0.47	2.12

Table A. Summary of design parameters for proposed basement foundation

<u>Notes:</u>

1. Calculated using guidance from BS8002 (1994)

2. These values should be used as guidance only and should be seen as 'very cautious values' using guidance from Eurocode 7.

The site lies above the London Clay Formation known to have a high and very high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2 (2010).

The amount of movement will depend upon a number of factors including the construction timetable, ultimate loads and critically, the depth of the final excavation. Consideration should therefore be given to providing heave protection measures to the floor slab and foundations to mitigate this.

The main phase of uplift or heave will come immediately following the excavation of the basement when the greatest elastic rebound of the soil (caused by the loss of the overburden pressure) will occur. Heave can be reduced by proceeding with the excavation in stages and observing and recording any movement that occurs over a set period of time using strain gauges or similar following the guidance from Boscardin and Cording (1989).

It may be advantageous to delay the construction until an adequate proportion of the uplift has occurred. Once this monitoring period has elapsed and a suitably qualified engineer is confident that the majority of uplift has occurred, basement construction can commence.

These processes and other ways of dealing with ground movements are described at length in BS8004 (British Standard Code of Practice for Foundations).

6.4 Piled Foundations

In the likely event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation would be needed. In these ground conditions, it is considered that some form of auger bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site, should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

6.5 Excavations

Shallow excavations for the basements and services are likely to require nominal side support in the short term and groundwater is unlikely to be encountered in significant quantities once any accumulated surface water within the Made Ground has been removed. Deeper and longer excavations below existing ground or basement level will require close side support and some light seepages of groundwater may well be encountered towards the base of the Made Ground.

No particular difficulties are envisaged in removing such water by conventional internal pumping methods from open sumps.

Normal safety precautions should be taken if excavations are to be entered.

6.6 Chemical Attack on Buried Concrete

The results of the chemical analyses show the natural soil samples to have water soluble sulphate contents of up to 2.60g/litre associated with near neutral pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

Segregations of gypsum were noted within the London Clay and scattered small gypsum crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-3 conditions.

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