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24th January 2008
JCB/16316

**PRELIMINARY
GROUND INVESTIGATION AND TEST REPORT
AT
DORSET HOUSE
BRISTOL**



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APPENDIX

SECTION

- A Borehole Logs
- B Geotechnical Laboratory Test Results
- C Contamination Test Results
- D CLEA Assessment
- E Landfill Gas Results
- F Envriochek Report (CD ROM)
- G Drawing
- H Notes on Site Investigation Reports



1 Introduction

- 1.1 It is proposed to sell a site on Dorset Road in Kingswood, Bristol. An intended residential redevelopment is proposed and provisionally will consist of 7 houses and 6 flats with some associated car parking and gardens.
- 1.2 Upon the instruction of John Flowith & Partners, consultant to the client, S J Curtis Esq., a preliminary ground investigation has been carried out comprising seven window sample boreholes. Where applicable, the fieldwork was undertaken in accordance with BS 5930 ^(Ref. 1). The scope of works was devised by Ground Investigation and Piling Limited (GIP) but was limited by onsite access, as the workshop/garage areas were partially inaccessible and much of the site was covered in scrap vehicles. A desk study is included, consisting of a review of in-house geological maps and a review of the appended Envirocheck report (CD ROM).
- 1.3 The purpose of this preliminary investigation was to assess the prevailing physical and chemical ground conditions with regards to foundation design and a Contaminated Land Exposure Assessment (CLEA) for the proposed development and to identify development constraints for potential developers.
- 1.4 This report contains a factual record of the fieldwork, strata encountered, chemical contamination analysis and laboratory testing, details of which are appended. Comments and recommendations are also provided upon the foundation engineering geology and aspects of contamination with regard to CLEA for the proposed development.
- 1.5 The geotechnical laboratory tests were undertaken by G.I.P. Ltd and are accredited by the United Kingdom Accreditation Services (UKAS). However, it should be appreciated that opinions and interpretations expressed in this report are outside the scope of UKAS accreditation. The testing was carried out in accordance with BS 1377 ^(Ref. 2) and comprised :-

Test Description	Part	Method	UKAS Accredited Test	Number of Tests
Moisture Content	2	3	✓	7
Liquid Limit	2	4	✓	7
Plastic Limit	2	5	✓	7



Additional testing for a range of chemical contaminants and concrete classification tests were carried out by ALcontrol Geochem. The results of all the above tests are in appendix B and C.

- 1.6 We are confident that the conclusions drawn from the findings of this preliminary investigation and desk study are appropriate for the proposed development. However, we cannot guarantee that they would be accepted by regulatory authorities without question. It is recommended that the reports are submitted and approval gained from such bodies, prior to the undertaking of detailed design, construction work or other irreversible processes.

2 The Site

- 2.1 The site is 'L' shaped and covers approximately 0.22 Ha in area. The site is at the junction of Dorset Road and Downend Road in Kingswood, Bristol with residential properties directly to the south and east, Gilbert Road to the north, and industrial/commercial properties to the west.
- 2.2 At the time of this investigation the site was occupied by a large building used as a vehicle repair centre and car park, much of the site was inaccessible due to the storage of cars associated with the vehicle repair centre. Residential properties and gardens bordered the site to the south and east, with Gilbert Road bordering the site to the north, and industrial/commercial properties to the west of the site. The entrance of the site sloped down onto the site, with levels varying by approximately a metre.
- 2.3 The approximate centre of the site is denoted by National Grid Reference 364680, 174170.



3 Site History

- 3.1 Records of old Ordnance Survey coverage for the site area as contained within the enclosed Envirocheck report (on CD-ROM appendix E) have been reviewed. These indicate:-
- 3.2 **1882:** The site occupies a field located just east of Wall's Lane. To the north of the site and west of the site are a number of small roads with some orchard noted. Approximately 200m to the south of the site are a number of residential properties running along an unknown road. Approximately 180m to the south-west of the site is a Clay Pit and Brick Works.
- 3.3 **1903:** The western end of the site is occupied by a Boot and Shoe Factory which located off Downend Road. The remainder of the site is un-occupied. To the south of the site, the surrounding area has undergone large residential development. To the east of the site runs an un-named road and unoccupied fields. The Clay Pit and Brick Works to the south-west are now disused.
- 3.4 **1916:** The site remains unchanged. A number of residential properties lie to the southern border of the site.
- 3.5 **1949-50 and 1951:** The Boot and Shoe Factory has undergone some expansion, now occupying the western part of the site and is identified as a Boot Studs Factory. Directly north-west of the site is an electrical sub-station. Running along the southern boundary of the site is Dorset Road. To the east of the site, on the opposite side of Gilbert Road, are a row of residential properties and gardens and allotments. Approximately 140m to the east of the site is a Refuse Heap.
- 3.6 **1953-68 and 1966-74:** By 1953 the Boot and Shoe Factory that previously occupied the site is now a Metal Heel Factory. The Refuse Heap to the east of the site is no longer shown and has been replaced by residential properties and allotments.
- 3.7 **1975-82:** The site remains unchanged. Approximately 35m to the north-west of the site is a Printing Works.
- 3.8 **1992 to 2007:** The site and immediate surroundings remain unchanged.



- 3.9 Following a recent site walkover it would appear that a good working practice was in place at the garage. There was no apparent evidence of oil spillages or storage drums across the site. However large parts of the site were being used for scrap vehicle storage.



4 Envirocheck Report

4.1 The appended Envirocheck report provides environmental information regarding the site and immediate area. The key points of note are as follows;

- The nearest discharge consent license is approximately 60m north-west of the site.
- There are no water abstraction licences within 250m of the site.
- The strata beneath the area of the proposed development is designated a 'Minor Aquifer'.
- The nearest surface water feature is approximately 510m to the north.
- The site is not located upon a fluvial indicative flood plain.
- The site is not located within 250m of a recorded landfill site; the nearest site is approximately 830m to the north-west of the site.
- The nearest pollution incident to controlled waters occurred approximately 651m south-west of the site and was designated a 'Category 3 – Minor Incident'.
- The site is not within a Source Protection Zone.
- The site is within an area of mining instability.
- The site is within an area, which may be affected by coal mining.
- The site is within an area with potential for landslide ground stability issues.
- The site is within an area potentially affected by shallow mining hazards.



4.2 Coal Authority Report

A Coal Authority report has been obtained for the site and a copy is included within the appendix. It notes that the property is within the likely zone of influence on the surface from workings in 4 seams of coal at depths of between 80m and 260m, the last date of working being 1900. Ground movement from these past workings should by now have ceased. The Authority has no knowledge of any mine entries (shafts) upon the site or within 20m of the boundary of the property.

5 Ground Conditions

5.1 Recorded Ground Conditions

5.1.1 The available published geological information ^(Ref.3) indicates the site to be underlain by the Middle to Lower Coal Measures of the Carboniferous. No superficial deposits are shown over lying the solid geology.

5.2 Encountered Ground Conditions

5.2.1 For full details of the strata encountered reference should be made to the appended engineer verified logs (appendix A), however, the salient features of the engineering geology can be summarised as follows :-

5.2.2 **Made Ground** –was recorded in all positions to depths of between 1.00m and 2.30m as variably cohesive and granular soils containing quartz, brick, hardcore, mudstone and ash.

5.2.3 **Coal Measures Strata** – encountered beneath the made ground as typically firm to very stiff clay which was occasionally softened near surface. Very weak rocklike ground was encountered at 3.00m in BH1.

5.2.5 **Groundwater** – was not encountered in any of the exploratory holes for the brief period of time that they remain open. It is cautioned that the window sampling rig drills rapidly. It is possible that groundwater entries were sealed off before they were able to be noted.



6 Comments and Recommendations: Geotechnical

6.1 General Comments

6.1.1 It is proposed to sell a site on Dorset Road in Kingswood, Bristol. An intended residential redevelopment is proposed and provisionally will consist of 7 houses and 6 flats with some associated car parking and gardens.

6.1.2 It is to be noted that the whole of the site was not accessible at the time of this investigation, most notably the areas around the workshop/garage, due to this being an operational concern.

6.2 Past Coal Workings

6.2.1 From the available published geological information it has shown that the solid geology beneath the site comprises of the upper horizons of the Lower Coal Series between New Smith Doxall and Hanham Red Ash coal seams. As a result there are upto six possible coal seams present beneath the site between Homes Rock coal and Little Fiery coal. A number of shafts are present in the general locality.

6.2.2 Due to the possibility of worked coal seams occurring beneath the site, it is recommended that a rotary hole is sunk to a provisional depth of 40m, this depth is dependent on the findings. Subject to these finding it may be necessary to carry out proof drilling across the site.



6.3 Foundation Design

- 6.3.1 The following foundation design recommendations assume that a stable rock head is present beneath the site with regard to past mining.
- 6.3.2 The made ground is not considered a suitable founding material for any form of foundation. Any foundations will need to be deepened on to the naturally derived clay that was encountered at between 1.00m and 2.30m beneath existing ground level. These clays are predominantly firm that become stiff and very stiff with depth. Providing soils of at firm consistency (C_u of 55kPa or more) are exposed at formation level (minimum depth of 0.75m in view of the intermediate volumetric change potential of the soils), these strata should be capable of supporting a nett design bearing pressure of 100kN/m² for 1.00m wide strip foundations with long term settlements less than 25mm. By over excavating to expose a stiff formation (depths of in the order of 2.00m) an increased nett design bearing pressure of 165kN/m² would be available for settlements of up to 15mm.
- 6.3.3 Due to the limited nature of this preliminary site investigation, it is possible that deeper areas of made ground may be present across the site, together with old, buried foundations of former buildings. It may be necessary to use mass concrete trench fill foundations and remove obstructions.
- 6.3.3 The soils at formation should be carefully inspected by a suitably experienced person and not left to groundworks contractor. In addition, any soft pockets encountered at formation should be over excavated and replaced with well compacted granular material or the foundations deepened in these areas using mass concrete.
- 6.3.4 In view of the predominantly cohesive nature of the bearing stratum, the exposed soils should be quickly blinded with concrete in order to prevent softening due to frost or rain. Where this is unavoidable, any softened layer should be removed prior to building.



6.4 Ground Floor Slab

- 6.4.1 Due to the varying nature of the made ground and intermediate plasticity of the natural ground fully suspended floor slabs are recommended.

6.5 Concrete Classification

- 6.5.1 A range of tests have been carried out by Alcontrol Ltd upon selected soil samples in accordance with those listed in BRE Special Digest 1 ^(Ref. 4) and the results are included within appendix B, listed together with the contamination analyses. These tests determine the Class of concrete for the proposed redevelopment. It is recommended that the ACEC class of AC-1s is adopted for the design of buried concrete for the proposed development.

6.6 Index Property Tests

- 6.6.1 Atterberg limit analyses of seven natural superficial clay samples have produced results within the intermediate plasticity and low volumetric change potential ranges. Because of the likelihood of exposing a cohesive formation stratum beneath the proposed development, where trees are not within influencing distance, a minimum foundation depth of 0.75m below existing ground level, or if levels are to be reduced, 0.75m below proposed ground level is recommended, i.e. below the zone of potential seasonal moisture content variations. Where trees are within influencing distance, dependant upon their size and species, greater foundation depths of up to 2.00m would be required. Reference should be made to the NHBC publication 'Building Near Trees', Chapters 4.2 and BRE Digest 240, September 1993, for guidance with regard to depth and construction of foundations in relation to the influence of trees.

6.7 Further works

- 6.7.1 It is recommended that supplementary trial pits are carried out across the site upon demolition to better understand the ground conditions, in light of the use of traditional, potentially deepened foundations, this should also incorporate additional contamination testing (see section 7.7).



7 Comments and Recommendations: Contamination

7.1 Initial Conceptual Site Model

7.1.1 In accordance with Environment Agency (EA) document CLR11 'Model Procedures for the Management of Contaminated Land' the information from the desk study and site investigation have been used to generate a risk assessment. The purpose of this is to confirm and modify the initial conceptual site model to establish whether there are any potentially unacceptable risks present and determine the action required to provide any further information to refine the model.

- Made Ground was recorded in all positions to depths of between 1.00m and 2.30m as variably cohesive and granular soils containing quartz, brick, hardcore, mudstone and ash.
- Coal Measures Strata – encountered beneath the made ground typically firm to very stiff clay, which was occasionally soft near surface. Very weak rocklike ground was encountered at 3.00m in BH1.
- The strata beneath the area of the proposed development is designated a 'Minor Aquifer'.
- No groundwater was encountered during this investigation.
- The end use of the site is to be houses and apartments with parking and some gardens.
- Currently the site is occupied by a vehicle repair workshop, prior to which the buildings were used for the manufacture of metal heels, boot studs, boots and shoes.



7.2 Potential Sources of Contamination

7.2.1 From the desk study and site walk over, potential sources of contamination associated with the site and adjacent plots are identified as:-

- Made ground
- Vehicle repair workshop
- Light engineering and shoe manufacture.

7.3 Potential Contaminants of Concern

7.3.1 EA Document CLR 8 'Potential Contaminants for the Assessment of Land', does not specifically identify potential contaminants associated with the identified land usages and hence a general suite of common contaminants has been identified which includes:-

- Organics: poly-aromatic hydrocarbons (PAH) and phenols. A general total petroleum hydrocarbons (TPH) screen has been carried out on a number of samples.
- Metals: cadmium, chromium, copper, lead, mercury, nickel, vanadium and zinc.
- Non metals: arsenic, sulphur and cyanide.

7.4 Potential Receptors

- 7.4.1
- Humans including construction works and future occupiers of the proposed development.
 - Groundwater (an assessment of contamination on groundwater has not been undertaken).
 - The building substructure.



7.5 Potential Pathways

- 7.5.1
- Skin / eye contact, ingestion and inhalation during site development and by contact / inhalation from future occupiers / visitors.
 - Percolating water may act to mobilise contaminants and transport them downwards under gravity towards the water table.
 - Migration of contaminants in groundwater under the local hydraulic gradient.

7.6 Contamination Analyses

7.6.1 In order to assess the potential for contamination soils samples were forwarded to ALcontrol Geochem Laboratories Ltd for analysis of a range of contaminants in accordance with the Conceptual Site Model. The samples tested appeared to be representative of the soils present upon the northern plot of the site. It should be appreciated that there remains the potential for unidentified areas of contamination. Suspect areas as may be identified in the future would have to be further investigated/assessed. Risk assessment work has its limitations and uncertainties ranging from those introduced by the type and quality of the data, analytical methods though to the choice of the model adopted.

7.7 Assessment of Risk to Human Health

7.7.1 Research undertaken by the Department for the Environment, Food and Rural Affairs and the Environment Agency (DEFRA/EA) has produced 'Soil Guideline Values' (SGVs), the primary purpose of which is as 'intervention values' in the regulatory framework for assessment of human health risk in relation to land use ^(Ref. 5). The SGVs apply to the assessment of direct human exposure to soil contamination and do not consider other potential receptors, such as ground and surface water, buildings or ecosystems. Initially generic values are used as a screening process.



7.7.2 The CLEA (Contaminated Land Exposure Assessment) model combines information on the toxicity of soil contaminants with estimates of potential exposure by adults and children living, working and/or playing on land affected by contamination over long periods of time. It predicts the amount of contaminant to which they might be exposed based on a given soil contaminant concentration. By comparing predicted exposure with health criteria values on tolerable or acceptable contaminant intakes the model can be used to modify generic SGV's that establishes a contaminant concentration in soil that is protective of Human Health. Where SGV's are not available, soil Screening Values (SSV's) recently produced by Atkins Consultants, available from the ATRISK_{SOIL} ^(Ref.6) web site, have been adopted. Unmodified SGV's have been used in this instance. The site has been assessed using residential with plant uptake as it most closely represents the end usage.

Metal, Non Metal and Phenol Contamination

7.7.3 The results of the analyses are included within appendix C together with the statistical assessment. In the Mean Value Test SGVs / SSVs for arsenic, lead and zinc were exceeded by the Upper 95th percentile. In terms of the Maximum Value Test one outlier was recorded for Mercury.

Polyaromatic Hydrocarbons (PAH)

7.7.4 Polyaromatic Hydrocarbons (PAH) SSVs have been derived for 14 out of the 16 US EPA list of priority contaminants. The test results have been assessed statistically and the calculation sheet is included within the appendix. In the Mean Value Test benzo(a)pyrene exceeded the SSV thresholds by the Upper 95th percentile. In terms of the Maximum Value Test no outliers were recorded.

Total Petroleum Hydrocarbons (TPH)

7.7.5 A maximum result of 500mg/kg for C₂₀-C₄₀ was detected in BH6 from the TPH testing. It is possible that certain individual SGV's would be exceeded. It is recommended that aromatic/aliphatic split testing is carried out across the site. This could be carried out at the same time as the supplementary site investigation (see section 6.7.1) and would serve to better identify the distribution of contaminants and if necessary amend the proposed remediation given below.



7.8 Risk to Controlled Waters

7.8.1 Groundwater was not encountered during this investigation hence an assessment of contamination in groundwater is not included.

7.9 Recommendations for Remediation (subject to supplementary investigations)

7.9.1 **Impact on Human Health** – At the levels of contamination revealed by the testing undertaken to date, the risk posed to future occupiers of the proposed commercial development is considered to be moderate and remediation is considered necessary. The source-pathway-receptor linkage could be broken by the use of the application of clean imported topsoil/subsoil over all garden areas. Using BRE soil mixing spreadsheets a cover of 600mm has been calculated as being required. Construction workers should adopt basic Personnel Protective Equipment (PPE) which should include gloves, boots and overalls and washing facilities should be provided.

7.9.2 **Impact on Controlled Waters** - It is the remit of the Environment Agency to protect 'Controlled Waters', which includes groundwater and surface waters. The Agency is also a statutory consultee in the planning process. The site is on a minor aquifer, which is overlain by natural superficial clays and no groundwater was encountered during this investigation. It is therefore concluded that the risk that the site poses to 'Controlled Waters' can be deemed to be 'low', however it should be noted that an assessment of contamination in groundwater has not been undertaken.



8.0 Disposal of Excavated Materials

- 8.1 If excavated materials are to be removed for disposal off site, in accordance with the recently introduced EU Landfill Directive (England and Wales) Regulations 2002 there are three main categories; Inert, Non Hazardous and Hazardous Waste. Each category is defined by individual parameters which govern the types of waste accepted for classification. However it should be noted that individual landfill sites will have the final decision regarding the acceptance of the waste for disposal. The first stage is the Hazardous Waste Risk Assessment which determines whether the waste is Hazardous or not. This process involves comparing total concentrations of contaminants of concern against a predetermined list of hazards. If the identified hazards for the contaminants fall below the established parameters, then the waste can be classified as Non Hazardous Waste
- 8.2 Once it has been confirmed that the made ground is Non Hazardous Waste, further assessment can take place to determine whether the waste is inert.
- 8.3 From the testing undertaken the majority of the made ground is Non Hazardous waste but supplementary testing would be necessary to confirm whether or not it is inert. If required, analysis could be done on samples from this investigation which will be retained for four weeks following the date of this report. However, considering the made ground present upon the site it is unlikely that the materials would be classified as inert. Reference can be made back to this office if required, but in order to avoid the costly screening of all site material, specific materials should be identified.



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References

- 1 British Standards Institution 5930 (1999) Code of Practice for Site Investigation.
- 2 British Standards Institution BS1377 (1990) Methods of tests for soils for civil engineering purposes.
- 3 British Geological Survey Sheet 251 'Bristol' British Geological Survey 1:50,000 Series, Solid and Drift Editions.
- 4 Building Research Establishment, Special Digest 1 (2005). Assessing the Aggressive Chemical Environment.
- 5 Department for the Environment, Food & Rural Affairs & The Environment Agency (2002). Soil Guideline Values for Contamination. R & D Publication SGV 1-9.
- 6 www.atrisksoil.co.uk Atkins Consultants have developed Soil Screening Values (SSVs) applicable to the UK for common contaminants not currently covered by SGVs issued by DEFRA and the Environment Agency.