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richard JACKSON plc

GROUND INVESTIGATION REPORT

Old North Road, Sawtry, Cambridgeshire

Davies Street Sawtry Ltd

April 2004

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INVESTOR IN PEOPLE

CONTENTS:-

1. INTRODUCTION

Richard Jackson Plc were instructed to carry out ground investigation works in connection with the development of a parcel of land located off Old North Road, Sawtry, Cambridgeshire. It is understood the site is to be developed with a single large warehouse.

The investigation was instructed in a letter from the client, Jon Bradley Limited, dated 25th March 2004.

The ground investigation comprised the mechanical excavation of nine trial pits, together with associated in situ testing, geotechnical laboratory testing and chemical analysis.

A desk study has been undertaken to document the history and environmental setting of the site using information provided by Landmark Information Group Limited.

This report assesses the findings from the desk study and the intrusive investigation, and makes recommendations for use in the design and construction of the proposed scheme.

2. PURPOSE OF THE INVESTIGATION

The purpose of the investigation was to enable a report to be prepared on the prevailing ground conditions beneath the site and to provide engineering information for use in the assessment and design of the proposed scheme.

A limited course of chemical analysis was undertaken on samples removed from one trial pit to assess the need for any specific remediation.

3. LIMITATIONS

This report is based on the results of the exploratory holes, the laboratory testing carried out on samples recovered from those holes, and on details of the scheme provided by the client.

This report has been prepared for the benefit of Jon Bradley Ltd and its contents should not be relied upon by others without the written authority of Richard Jackson plc. If any unauthorised third party makes use of this report they do so at their own risk and Richard Jackson plc owes them no duty of care or skill.

All information provided by others is taken in good faith as being accurate, but Richard Jackson plc cannot, and does not, accept any liability for the detailed accuracy, errors or omissions in such information.

Subsoils are by their nature hidden from view and no investigation can be exhaustive to the extent that all soil conditions are revealed. Conditions may well be present beneath the site, therefore, which were not revealed by the investigations carried out.

Geological data, with the exception of geological maps held by the Firm, Ordnance Survey maps and aerial photographs have not been inspected, nor has any other data relating to site conditions past or present, other than as indicated in the desk study.

Groundwater levels can be subject to considerable seasonal variations, and the conditions encountered in the exploratory holes may not reflect long-term conditions.

There can be no guarantee that the samples analysed represent the highest concentrations of contamination present beneath the site.

Unless a greater period of retention of samples is agreed, it is our normal practice to discard all samples one month after submission of our final report.

4. SITE LOCATION AND DESCRIPTION

The site is located adjacent to the Old North Road and the A1M Motorway and approximately 350m east of Sawtry, Cambridgeshire. A site location plan is presented as Figure 1 in Appendix A.

The approximate Ordnance Survey grid reference of the site is TL 176 834.

The site comprises a roughly square shaped parcel of land, which is bisected by a road known as Straight Drove, that runs from the south eastern corner of the site to a mid point in the western boundary.

The site can be divided internally into three separate areas, which can be summarised as follows;

1. Black Horse Farm

2. Area to the East of the Farm

3. Area to the South of Straight Drove

Black Horse Farm, to the west on the site, comprises of a farm building, workshed. Old North road, which forms the western site boundary, provides access to the farm. The farm building consists of a two-storey structure constructed from load bearing masonry, which is in a poor condition. The workshed is situated on the north west corner of the site, and is a single storey structure constructed of brickwork and metal cladding. The workshed is currently utilised by the owner for the servicing and repairs to his own vehicles.

The farm estate is surfaced in mixture of gravel and concrete. Semi mature Ash trees of varying height were identified on the western part of the site.

The owner of the property, Mr Robert Smith, reported that a high voltage electricity cable runs from the west to the east across Black Horse Farm.

To the north, the site is bound by a wooden and barbed wire fence, approximately 1.0m in height, with Black Horse Drainage Ditch and agricultural land beyond. A semi-mature Ash tree, approximately 8-10m in height, is located next to the northern boundary.

The eastern area on site consists of an area of undeveloped land, which is surfaced in a mixture of dense shrubs and grass. The area of land exhibits undulating topography, with the far eastern area on site being noticeably raised. The only access is via a gated entrance to the south eastern corner of the site.

Toward the south eastern corner, adjacent to the gated entrance, a small circular area is being used for the burning of waste materials; including vegetation and paper products. A dense area of trees along with a dense hawthorn hedge form the boundary with Straight grove to the south and are between 2-3.5m to 6.0m in height, respectively. It is assumed the trees are not mature as the Hawthorn hedge is twice their height. To the east the site is bound by a barbed wire and wooden posted fence, beyond which lies the Middle Catchwater drainage ditch. The ditch, trending north to south, is approximately 2.0m below the level of Straight Grove, and separates the site from the football ground and areas of agricultural land further to the east

The area to the south of the site consists of an area of overgrown unused land, which is surfaced in a mixture of dense trees, vegetation and grass. Three areas of concrete and a small backfilled pond exist near to Straight Drove, to the south and south west of the site.

Access to the southern area on site is via a single entrance off Straight Drove. The entrance consists of a 4m to 5m gap within the tree-lined boundary, which is infilled with a raised earth bund. The top of the earth bund is approximately 1.5m above the road level of Straight Drove.

Semi-mature and mature Fir, Birch, Poplar and Sycamore trees of various heights exist across the southern site area. One oak tree, approximately 5m to 8m in height was noted to the south west of the site. Dense areas of mature Fir, Sycamore and Poplar trees, ranging in height from 10m to >25m, form the boundary with Straight Drove to the north.

An area of open land extends southwards forms the southern site boundary.

5. PROPOSED DEVELOPMENT

As discussed in Section 1, the site is to be developed with a single, large, presumably steel framed, warehouse unit. The unit will be of approximate maximum dimensions of 190m (north to south) by 90m (east to west). A service yard will be constructed to the east of the unit, with car parking to the west.

The construction of the unit will necessitate the demolition of the existing farm, the removal of Straight Drove and the removal of the majority of the trees on the site.

A limited amount of cut and fill will be required on the site and this is discussed in detail in Section 10.

6. DESK STUDY FINDINGS

The desk study has been largely compiled using information provided by a Landmark Envirocheck report. This comprised of Ordnance Survey maps from 1889 – 1989 at 1:2,500 scale and 1891 – 2000 at 1:10,000 and 1:10,560 scales, together with maps and data sheets detailing the environmental and industrial setting of the site.

6.1 Summary of Site History

The earliest historical map dated 1889 at 1:2,500 scale indicates the site to be developed. Several buildings, which mark the current location of Black Horse Farm, are visible to the west and north west on the site. An enclosure of undeveloped land with occasional trees is visible within the site, to the south of Black Horse Farm. Two ponds are indicated within the site to the north and south of Straight Drove. A drainage ditch is indicated linking

Black Horse Farm with the northern most pond at this time. To the north and east, the site is bound by two drainage ditches, beyond which lies land used for agriculture. These mark the present day Black Horse Drainage and Middle Catchwater Drainage ditches respectively. An unnamed road bisects the site and follows the current line of Straight Drove. A further road, following the line of Old North Road, forms the western site boundary with occasional residential homes and agricultural land beyond. A network of land drains can be seen between 160m and 320m to the south west.

The next three historical maps, dated 1891, 1901 and 1902, at 1:2,500 and 1:10,560 scale, indicate no significant changes of note to the surrounding area. By 1901, part of the Black Horse Drainage Ditch has been reclaimed to form the north western corner of the site. The trees enclosed within the area of undeveloped land to the south of Black Horse Farm have been removed. By 1902, agricultural land to the north east has been named Sawtry Fen and Little Common, while agricultural land beyond the drainage ditch to the east has been called Great Common.

By 1926 (1:2,500) the surrounding land use remains largely unchanged. Residential development has occurred approximately 220m to the west of the site beyond the current Old North Road.

The smaller scale, 1:10,560 historical maps, dated 1927, 1952 and 1958 indicate no significant changes of note to the site or surrounding land.

The next historical map, dated 1976, at 1:2,500 scale indicates that the buildings to the west of the site have been named Black Horse Farm, while to the south a bungalow known as Banners Rest, and Common Barn Farm have been constructed adjacent to Straight Drove. The A1 trunk road has been constructed beyond Old North Road, approximately 160m to the west, with the village of Sawtry beyond.

By 1982 (1:10,000) the site remains largely unchanged. A graveyard is now visible approximately 500m to the north. Development of Sawtry has continued beyond the Great North Road to the west and south west.

The final 1:2,500 scale sheet dated 1989 indicates that the site remains predominantly unchanged. To the north, St. Andrews Nurseries have been established approximately 180m from site. This development includes a pond approximately 170m north of site. To the north west, a bridge across the Great North Road connecting Sawtry Village to Sawtry Fen has been constructed 350m from the site boundary. To the east, the land drain has been named the Middle Level Catchment Drain, and has been extended to the north and south. Development of Sawtry has continued to the west.

The remaining 1:10,000 scale historical maps, dated 1991 and 2000 confirm that the site remained unchanged. During 2000 Great Common, to the east, is now used as a playing field. Sawtry Football Club currently uses the playing field as a pitch. To the south of the site, Banners Rest and Common Barn Farm have been demolished. To the south east, a sewage works is indicated 900m from site.

6.2 Environmental and Industrial Setting

Information from the environmental setting database is included to the rear of Appendix E and comprises a set of data sheets and colour summary maps containing information on the environmental and individual setting of the site and surrounding area.

6.2.1 Geology

The 1:50,000 series British Geological Survey map of the area, Sheet 172, Ramsay, Solid and Drift Edition, 1995, indicates that the site is directly underlain by Oxford Clay Formation of the Jurassic Period. No drift deposits are indicated to overly the Oxford Clay Formation.

6.2.2 Hydrology and Hydrogeology

The 1:100,000 Groundwater Vulnerability map of the area, Sheet 24, North Northamptonshire, indicates that the Oxford Clay as being a Non-Aquifer. An extract of the groundwater vulnerability map, is presented in Appendix E.

The overlying shallow soils are assumed to have a negligible permeability.

The nearest surface water features are the Black Horse Drain and the Middle Catchwater Drain, which from the northern and eastern site boundaries. The nearest river to the site, reported by the Landmark Envirocheck Report, is the Old River Nene 260m to the south, although this is not shown on any of the historical maps

There is one river quality biology sampling point listed within 1km of the site. The sampling point is situated on Monks Lode, 805m to the north east, and has been in use since 1990. Monks Lode has been classified as River Quality B since the year 2000.

There are seventeen discharge consents to controlled waters within 1000m of the site, two of these occur within 500m. The closest of these is listed 260m to the south for the discharge of stormwaters to a tributary of the Old River Nene.

There are three pollution incidents to controlled waters listed between 500m and 1000m of the site. The closest of these refers to a Category 3 – Minor Incident to groundwater, 660m to the south, the cause of which is reported as being leakage from an underground pipe.

There are twenty nine licensed surface water abstractions listed within 2km of the site. Five of these are registered within 250m radius of the site and refer to the abstraction of water for make up and top up purposes and general spray irrigation. The abstractions are licensed to Sawtry Park council and T.E. Darby and Son and refer to catchwater and surface drains to the north east and south east of the site respectively.

There are no records of any licensed groundwater abstractions within a 2km radius of the site.

The site does not lie within a groundwater Source Protection Zone.

A copy of an Environment Agency floodplain map is presented in Appendix E, and shows the majority of the site to lie within an indicative fluvial floodplain. However, the maps produced by the Environment Agency are based largely on ground levels and do not consider existing flood defences. A Flood Risk Assessment should be undertaken prior to any redevelopment.

6.2.3 Radon and Other Geological Hazards

The site lies within an area where less than 1% of homes are above the Radon Action Level, as classified by the National Radiological Protection Board (NRPB). Therefore, no radon protective measures are required.

The site does not lie in an area affected by any past or present coal mining activities, or in an area that has any future mining proposals.

The site is not in area known to be at risk from any shallow mining hazards.

The site is not located in an area that is susceptible to any compressible ground, ground dissolution and/or gulls and cambering subsidence hazards.

The site is located in an area that is classified by the B.G.S as having a low and low to moderate risk of landslip subsidence and swelling clay subsidence hazards due to the presence of Oxford Clay.

6.2.4 Landfill and Waste Sites

There are no registered B.G.S landfill sites or local authority landfill sites listed within a 2km radius of the site.

There are no licensed waste management facilities or waste transfer sites listed within a 2km radius of the site.

6.2.5 Prescribed Processes and radioactive Substances

There are no listed Control of Major Accident Hazards (COMAH), explosive, or Notification of Installations Handling Hazardous Substances (NIHHS) within a 2km radius of the site.

There have been no planning hazardous substance enforcement's issued or approved within a 2km radius of the site.

There are no registered radioactive substance sites within a 2km radius of the site.

6.3 Industrial Setting

The colour summary map and data sheets provide information on land uses in the area.

A total of four contemporary Trade Directory entries exist within 1000m of the site. The closest directory entry is listed on Chapel End, approximately 570m to the north west for an active car repair workshop.

There are two fuel station entries listed between 500m and 1000m of the site. The closest of these refers to K.Cooper Motors petrol filling station, situated approximately 785m to the west.

6.3 Other

A nitrate vulnerable zone encompasses the site.

6.4 Discussion

The desk study has shown that the site has been used for agriculture from prior to 1889 to the present day.

The usage of the site poses no particular significant contamination hazards with respect to the proposed end usage. The maintenance of vehicles within the work shed is a potential source of hydrocarbon contamination, although inspection of the area showed no evidence of contamination.

There are no land uses, past or present, that are likely to have caused contamination of the site.

On the basis of the information viewed, it is considered that there is a low risk of significant contamination affecting the site. The findings from the chemical analysis undertaken as part of the investigation are discussed in Section 11.

The underlying ground conditions are likely to comprise of Oxford Clay Formation of the Jurassic Period. The Oxford Clay Formation is classified as a non-aquifer.

7. FIELDWORK

The fieldwork was undertaken on 15th April 2004 and comprised the excavation of nine trial pits (TP1 to TP9) using a JCB type excavator. A trial pit location plan is presented as Figure 2 in Appendix A.

Where applicable, investigation techniques, sampling and in situ testing complied with the requirements of British Standard BS5930: 1999 "Code of Practice for Site Investigations".

The trial pits were excavated to depths between 2.90m (TP2) and 3.20m (TP1).

Disturbed samples were taken from throughout the trial pits for possible future geotechnical testing and chemical analysis. Samples for chemical analysis were taken in air-tight plastic containers. When organic contamination was suspected, samples were recovered in air-tight glass volatile jars.

Where clay soils were encountered, hand shear vane tests (indicated as HV on the trial pit records) were carried out. Readings of peak undrained shear strength were recorded at 1.0m intervals from each location. The average readings are presented in kN/m² on the trial pit records.

Note was made of any groundwater encountered, and of the stability of the trial pit sides during excavation.

Trial pit records are presented in Appendix B and give both descriptions and depths of the strata encountered, together with details of samples taken, insitu tests and any other relevant details.

8. LABORATORY TESTING

The laboratory testing programme comprised the geotechnical testing and chemical analysis of soil samples.

All laboratory testing was undertaken by UKAS/NAMAS accredited laboratories. Soil Property Testing Limited undertook geotechnical testing and Environmental Analysis Laboratories undertook the chemical analysis. The results are included in Appendices C and D respectively.

8.1 Geotechnical Testing

The programme of geotechnical testing was designed to obtain moisture content and classification data for the Glacial Till and Oxford Clay Formation.

Atterberg limit determinations were carried out on eight samples of clay, to enable the materials to be classified and their engineering behaviour assessed. The natural moisture content was also determined as part of each test. The natural moisture content was also determined for further thirty-one samples.

Laboratory CBR tests were carried out on three samples of clay, re-compacted using the 2.5kg rammer method. CBR measurements were carried out on the top and bottom of each specimen, and the moisture content and dry density of the sample was determined. The CBR samples were tested using a plastic limit of +2%.

All testing was carried out in accordance with BS 1377: 1990 "Methods of Test for Soils for Civil Engineering Purposes".

8.2 Chemical Analysis

8.2.1 Soils

Four samples of soil, which were suspected to be contaminated, were analysed for a broad range of determinants comprising:-

Arsenic	Speciated Polyaromatic Hydrocarbons
Cadmium	Total Petroleum Hydrocarbons
Total Chromium	PH
Copper	Water Soluble Sulphate
Lead	Total Sulphate
Mercury	Sulphide
Nickel	Water Soluble Boron
Selenium	Total Cyanide
Zinc	Total Phenols

The Oxford Clay is a principal sulphate/sulphide bearing strata as classified by the BRE Special Digest 1, "Concrete in Aggressive Ground", 2001. To ascertain if special precautions for the protection of buried concrete, six samples were analysed for the following determinants;

- Water Soluble Sulphate
- Acid Soluble Sulphate
- Total Sulphur
- pH

9. GROUND CONDITIONS

As discussed within Section 6.2, geological records indicate that the site is directly underlain by Oxford Clay Formation of the Jurassic Period.

The investigation did not confirm the above observations, as localised areas of Made Ground were encountered to the east and Glacial Till was recorded overlying the Oxford Clay Formation. The investigation recorded the following sequence of strata from ground level:-

- Topsoil
- Made Ground
- Glacial Till
- Oxford Clay Formation

9.1 Topsoil

A thin layer of Topsoil, proven to a maximum depth of 0.50m below ground level (b.g.l.), was encountered within all of the trial pits, with the exception of TP8.

9.2 Made Ground

Made Ground Deposits were localised and encountered within TP2 and TP8 on northern and eastern parts of the site.

Made Ground material within TP2 generally comprised of a soft to firm, brown and grey, sandy, gravelly clay that was proven to a maximum depth of 1.10m b.g.l.

The Made Ground from TP8 to the northern area of the site generally comprised of a grey, brown and black, gravelly, silty, medium to coarse sand, to a depth of 0.90m, overlying a soft, black, silty, gravelly clay. The Made Ground was proven to a maximum depth of 2.10m.

Frequent hardcore cobbles and whole and half grey and red bricks were encountered within the granular material between ground level and 0.90m.

9.3 Glacial Till

Glacial Till was recorded beneath the Made Ground within trial pits TP2 and TP8 to the east and north of the site, and beneath the topsoil surface in the remaining pits excavated during the investigation. The Glacial Till comprised of a firm, dark to light brown, mottled, silty, sandy clay with occasional roots and frequent coarse gravel sized pockets of orange, gravelly sand.

Hand vane (HV) tests undertaken within cohesive soils gave strength values ranging from 10kN/m^2 - 82kN/m^2.

One very soft horizon of Glacial Till was recorded from TP9 to the north of the site. An undrained shear strength value of 10kN/m^2 was recorded at a depth of 2.0m bgl. The very soft material extending between 1.7m and 2.7m bgl.

Classification tests performed on seven samples of the Glacial Till recovered from trial pits TP1 – TP7 gave liquid limits of 41% and 91% with corresponding plastic limits of 16% and 33%, and plasticity indices of 25% and 58%. This data classifies three samples as CH, an inorganic clay with medium plasticity, three samples as CI, an inorganic clay with high plasticity and one sample as CE, an inorganic clay with an extremely high plasticity. Under guidance given in Chapter 4.2 of the NHBC Standards "Building Near Trees" 2003, a medium to extremely high volume change potential would be assumed.

9.4 Oxford Clay Formation

The Oxford Clay Formation was encountered beneath the Glacial Till in all of the trial pits excavated during the investigation. The Oxford Clay Formation generally comprised of a firm becoming hard, brown and grey, slightly fissured, silty, sandy, gravelly clay, although a softer zone was noted between 1.5m and 2.2m in TP3. Fragmented and whole bi-valve shells were encountered in TP4, TP5, TP6 and TP7 between 2.0 and 3.0m. Toward the base of trial pits TP1, TP4, TP5, TP7 and TP8 the Oxford Clay became thinly laminated between 2.0 and 3.0m.

Hand vane (HV) tests undertaken within the Oxford Clay gave strength values ranging from 32 kN/m^2 to >140 kN/m^2. The lowest value came form the softened horizon in TP3. The highest values of undrained shear strength were obtained from TP4 to TP6 between 2.0m and 3.0m bgl.

Classification tests performed on a sample of Oxford Clay, recovered from trial pit TP6 gave a liquid limit of 63%, with a plastic limit of 25% and a plasticity index of 38%. This data classifies the sample as being of Class CH, an inorganic clay of medium plasticity. In accordance with NHBC guidelines a medium volume change potential may be assumed.

9.5 Groundwater

Seepages of groundwater were observed in TP1 and TP2 at depths of 2.4m and 2.0m respectively.

10. ENGINEERING APPRAISAL

As discussed in Section 5, the site is to be developed with a single large industrial unit with an associated service yard and parking areas.

The proposed floor level is 4.9m OD, which based on current proposals and a construction thickness of 450mm (225mm floor slab, 225mm subbase), will require up to approximately 0.75m of cut to the south of Straight Drove. To the north of Straight Drove an area of localised cut (up to approximately 0.75m) will be required on the western part of the site and adjacent to Black Horse Farm. Ground levels will need to be raised by approximately 0.5m (following a Topsoil strip) on two areas adjacent to the northern and eastern boundaries.

Ground conditions beneath the site have been found to consist of a variable thickness of Glacial Till overlying Oxford Clay Formation. The Glacial Till has been found to comprise materials of variable shear strength.

10.1 Structural Foundations

For a framed structure, such as an industrial unit, structural column loads are generally supported on pad foundations.

Whilst the ground conditions are theoretically suitable for the use of such foundations, the situation is complicated by the variable shear strength of the Glacial Till, softened zones at the top of the Oxford Clay, and the presence of a significant amount of trees on the southern most part of the site.

It is not recommended that foundations bear directly on the Glacial Till, as the layers of soft and very soft soils have the potential to produce unacceptable amounts of differential settlement. To avoid this it is recommended that foundations fully penetrate the Glacial Till and bear on the underlying Oxford Clay. As noted above, softened zones have been recorded at the top of the Oxford Clay and these will also need to be fully penetrated, with foundations bearing a minimum of 150mm into firm Oxford Clay. Prior to the casting of any foundations it is recommend that foundation excavations are carefully inspected by a competent professional to ensure that the Glacial Till and any softened Oxford Clay has been fully penetrated.

Whilst a minimum foundation depth of 1.0m below proposed ground level would be applicable, this is unlikely to be achievable anywhere on the site due to the thickness of Glacial Till, and as discussed further below, the presence of trees.

The Glacial Till and Oxford Clay, being cohesive soils, are susceptible to volume change (shrinkage or heave) due to trees. The proposed development will necessitate the removal of trees from the site, particularly adjacent to, and to the south of Straight Drove. Following the removal of these trees, heave of the ground will occur as moisture contents recover. Such heave may cause damage to structural foundations.

From an examination of the moisture contents obtained, there is evidence of significant desiccation to a depth of between 2.5m and 3m in TP6, located to the south of Straight Drove. Assuming an equilibrium moisture content of 36% for the Oxford Clay, removal of the trees at this location would produce approximately 65mm of heave from the top of the Oxford Clay (1.2m) to a depth of 3m. This figure is given as guidance only and there is obviously the potential for greater degrees of desiccation and hence heave to occur elsewhere on the site.

To avoid damage due to heave, it is common practice when using spread foundations to deepen foundations below the zone of any significant desiccation (moisture deficit).

Although not directly applicable to industrial and commercial buildings, reference is often made to Chapter 4.2 of the NHBC Standards, "Building Near Trees" 2003. This publication gives advice on foundation depths within the influence zone of trees.

The NHBC guidance requires an assessment of soil plasticity and volume change potential, tree height and tree species. The Oxford Clay is a soil of high volume change potential, and whilst the overlying Glacial Till is of variable plasticity, it is recommended that a high volume change potential is also assumed.

Tables 14, 15 and 16 of Chapter 4.2 give foundation depths (up to a maximum of 2.5m) for high, moderate and low water demand tree species, relative to height and distance from a structure. Excluding the hawthorn hedge on the northern boundary of Straight Drove, the trees observed to the north of Straight Drove were ash (moderate water demand) and foundations will fall within the guidance given within Table 15 of Chapter 4.2. However, adjacent to the hawthorn hedge and to the south of Straight Drove, foundations will exceed 2.5m. In such circumstances foundations will need to be engineer designed. This may be achieved by undertaking soil suction profiles within the Oxford Clay, to establish depths of significant desiccation. It should be appreciated that there is obviously a limit to the depth that spread foundations can be economically excavated. If desiccation is encountered beyond the maximum economic depth then the Client must take appropriate precautions to ensure that any movement can be tolerated within the structure. As moisture content deficient profiles generally decrease with depth, it may be the case that removing a proportion of the desiccated soil will reduce any future heave to an acceptable level. It is noted that to the south of Straight Drove, the proposed cut will remove approximately 0.75m of desiccated materials.

If no movement is acceptable then an alternative would be to adopt piled foundations.

For pad foundation design, a nett allowable bearing pressure of 100 kN/m² may be adopted for a 2m square paid foundation, bearing on firm Oxford Clay at a depth of 1.5m.

Total settlements for the above foundation recommendations are likely to be in the region of 25mm, assuming a co-efficient of volume compressibility (m_v) of 0.2m²/MN.

Where foundation depths exceed 1.5m due to the presence of trees, anti-heave precautions will need to be adopted as detailed in Clauses D8 and S4 of Chapter 4.2 of the NHBC Standards.

10.2 Floor Slabs

The proposed floor slab has two potential problems, one due to the presence of softened clays and one due to desiccation.

Preparation of the subgrade should comprise the removal of the Topsoil and all existing construction, including Straight Drove and the concrete slabs noted on the southern part of the site. The Made Ground materials in TP2 and TP8 should also be removed although the former will likely be removed as part of the cut exercise. Following drainage of the pond to the south of Straight Drove, all softened materials should be excavated. Following these works any voids or low areas should be backfilled with well compacted granular fill. It is possible that other infilled ponds may be encountered during the groundworks.

Considering initially the very soft clay, as an initial assessment, under a floor load of 50 kN/m², approximately 50mm of settlement could be anticipated for a 1m thick layer (TP9), assuming a co-efficient of volume compressibility (m_v) of 1 m²/MN. Whilst not accounting for all, a significant percentage of this settlement would likely be differential settlement.

The end solution will depend on the sensitivity of the floor to movement, for example if high bay racking systems are proposed then the floor will be sensitive to movement. If settlements could not be tolerated an option would be to excavate the very soft soils and replace them with well compacted granular fill.

Further investigation will be needed in the vicinity of TP8 and TP9 to fully define the extent of the very soft soils and Made Ground encountered. This may be achieved by a series of shallow window sample boreholes.

If the floor slab will not be sensitive to movement then there would be a case for leaving the very soft soils insitu. If this option were to be adopted then it is recommended that two shallow boreholes are formed to recover undisturbed samples for oedometer testing to determine the compressibility, and confirm the likely anticipated settlements.

With regard to desiccation and heave, the same problems that will affect structural foundations will also affect the floor slab. If the anticipated heave (determined from soil suction profiles) cannot be tolerated (which is likely), then the floor slab construction will need to be engineered to reduce the risk. As with the structural foundations, a proportion of the desiccated materials could be removed and replaced with imported granular fill. Complete removal of all desiccated soils may prove impractical and removal of a proportion of the desiccated materials may keep heave within tolerable levels.

To remove all risks of heave a piled floor slab would need to be adopted, which in terms of cost may be prohibitive.