



**BROWNFIELD  
SOLUTIONS LTD**

GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

## ALDI STORES LTD

Ruthin Road, Wrexham

Geotechnical Assessment Report

LC/C2917/5894

February 2016



| EXECUTIVE SUMMARY – RUTHIN ROAD, WREXHAM |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Location</b>                          | <p>The site is approximately 1.1 hectares and is located to the north of Ruthin Road, approximately 750m to the south west of Wrexham Town Centre.</p> <p>The site is centred on National Grid Reference 332444, 350126.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Geology</b>                           | <p>Superficial geology comprises Glaciofluvial sands and gravels with clays and silts locally (Secondary A Aquifer) with deposits of glacial till comprising sandy gravelly clay anticipated beneath.</p> <p>Solid geology is the Etruria Formation (Secondary A Aquifer) which forms part of the Pennine Upper Coal Measures and consists of mudstone. No coal seams are shown in the area.</p>                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Ground Conditions</b>                 | <p>Made ground was encountered to a maximum depth of 1.10m during the site investigation. The natural ground encountered was interbedded firm to stiff silty clays and medium dense clayey sands with the strata typical of glaciofluvial sheet deposits.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Foundations and Floor Slabs</b>       | <p>For the proposed development pad foundations founding on firm clays between 900mm and 2000mm below ground levels are considered to be the most suitable option for the site. An allowable bearing pressure of 90kN/m<sup>2</sup> should be assumed for a pad of 1.5m<sup>2</sup>. At this bearing capacity a maximum differential settlement not exceeding 25mm should be achieved.</p> <p>A ground bearing floor can be utilised provided once finished levels are achieved less than 600mm of suitably compacted granular material exists. As the site is located within an area requiring full Radon precautionary measures the floor slab will need to incorporate radon precautions in the form of a membrane and permeable stone and perforated pipes beneath the slab.</p> |
| <b>Highways</b>                          | <p>CBR values of 2% - 5% are likely to be achieved in undisturbed natural soils for pavement design purposes, unless proven otherwise by in-situ testing at sub-base level by a specialist geotechnical engineer.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Further Work</b>                      | <ul style="list-style-type: none"><li>• Environmental Intrusive site investigations</li><li>• Ground gas monitoring programme</li><li>• Further geotechnical site investigation comprising window sampling</li><li>• Foundation design</li><li>• Confirmation of Remedial Strategy Local Authority</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

## PROJECT QUALITY CONTROL DATA SHEET

|                       |                                |  |
|-----------------------|--------------------------------|--|
| <b>Site Name:</b>     | Ruthin Road, Wrexham           |  |
| <b>Report Name:</b>   | Geotechnical Assessment Report |  |
| <b>Report Number:</b> | LC/C2917/5894                  |  |
| <b>Date:</b>          | 23 February 2016               |  |
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| <b>Revision:</b>      |                                |  |
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|                                                                      |                                                                                     |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------|
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#### DRAWINGS

| Drawing Number | Rev | Title                          |
|----------------|-----|--------------------------------|
| C2917/01       | -   | Site Location Plan             |
| C2917/03       | -   | Exploratory Hole Location Plan |
|                |     |                                |

#### APPENDICES

|                   |                                     |
|-------------------|-------------------------------------|
| <b>APPENDIX A</b> | <b>Exploratory Hole Logs</b>        |
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| <b>APPENDIX D</b> | <b>Limitations</b>                  |

**GEOTECHNICAL ASSESSMENT REPORT  
FOR A SITE OFF  
RUTHIN ROAD, WREXHAM**

**1.0 INTRODUCTION**

**1.1 Objectives**

- 1.1.1 This report describes a Geotechnical Assessment carried out by Brownfield Solutions Limited (BSL) for Aldi Stores Ltd on a site off Ruthin Road, Wrexham.
- 1.1.2 The objectives of the assessment were to determine the sites geotechnical setting highlighting potential areas of concern that may affect foundation and highway design at the site.
- 1.1.3 This report should be read in conjunction with the Desk Study Assessment Report (LC/C2917/5320 Rev A) issued on the 6<sup>th</sup> August 2015.

**1.2 Proposed Development**

- 1.2.1 The proposed development is commercial end use comprising a steel framed retail building and associated car park areas.

**1.3 Limitations**

- 1.3.1 This Geotechnical Assessment has been carried out based on information obtained from a number of areas, BSL have assumed that this information is correct.
- 1.3.2 There may be other conditions prevailing on the site which are outside the scope of work and have not been highlighted by this assessment and therefore not been taken into account by this report. Responsibility cannot be accepted for such site conditions not revealed by the assessment.
- 1.3.3 This report has been prepared for the sole use of the client. No other third parties may rely upon or reproduce the contents of this report without the written permission of Brownfield Solutions Ltd (BSL). If any unauthorised third party comes into possession of this report they rely on it at their own risk and BSL do not owe them any Duty of Care.



## **2.0 THE SITE**

### **2.1 Location & Access**

- 2.1.1 The site is approximately 1.1 hectares and is located to the north of Ruthin Road, approximately 750m to the south west of Wrexham Town Centre.
- 2.1.2 The site is centred on National Grid Reference 332444, 350126 as shown on the Site Location Plan C2917/01.
- 2.1.3 Access to the site is gained off Ruthin Road, which bounds the site to the South or via an access road which runs along the eastern site boundary before entering the site in the north.

### **2.2 Surrounding Land Use**

- 2.2.1 The site is bordered by a Morrisons supermarket and petrol station to the east.
- 2.2.2 Wrexham hospital is present to the north of the site at a distance of circa 125m with council offices bordering the site to the west.
- 2.2.3 To the south of the site beyond Ruthin Road the primary land use is residential with a school present to the south west.

### **2.3 Site Description**

- 2.3.1 A walkover survey was carried out on the site on the 5<sup>th</sup> June 2015. The main site features and potential issues identified during this survey are detailed below.
- 2.3.2 The site currently houses an ambulance depot which is located in the south west of the site. The ambulance depot is split into three areas including a maintenance workshop. Several waste oil drums and lubricants were present within the maintenance workshop with a waste oil tank located externally on the north of the building. Some staining was noted on the concrete near to the waste oil tank.
- 2.3.3 A large bunded diesel tank is present on the eastern side of the building. A filling point is present beneath the tank, with evidence of small spills on the concrete. Near to the above ground tank was evidence of a former UST with a fuel pressure gauge, breather pipe and several manholes present.
- 2.3.4 The east of the site is primarily occupied by soft landscaping with a slope present on the eastern boundary sloping downwards approximately 2m to the access road for the site.
- 2.3.5 An unoccupied building and associated hardstanding is present in the north of the site. A small slope is also present along the northern boundary sloping downwards off site to a cycle path.
- 2.3.6 An access road for ambulances is present in the south of the site with this road sloping down to the south. The southern site boundary is marked by a steep slope with Ruthin Road being at a lower elevation than the site.



- 2.3.7 A row of mature deciduous trees is present along the western site boundary.
- 2.3.8 Areas of concern are shown on the Pertinent Site Features and Potential Constraints Plan C2917/03.



### 3.0 DESK STUDY SUMMARY

#### 3.1 Summary

3.1.1 A summary of the relevant points from the desk study is presented in the table below:

- Superficial geology comprises Glaciofluvial sands and gravels with clays and silts locally (Secondary A Aquifer) with deposits of glacial till comprising sandy gravelly clay anticipated beneath.
- Solid geology is the Etruria Formation (Secondary A Aquifer) which forms part of the Pennine Upper Coal Measures and consists of mudstone. No coal seams are shown in the area.
- A fault is shown circa 800m to the east running north west to south east.
- The nearest surface water feature from the site is the River Gwenfro located 55m north west of the site.
- The site is not within a Source Protection Zone (SPZ).
- There are no groundwater abstractions within 500m of the site.
- Full radon protection measures are required.
- The risk from soils on the site is High from radon and Moderate to Low from other sources.
- The risk to groundwater is considered low/high.
- The risk from off-site sources is considered moderate/low.
- The risk from gas is moderate/low.



## 4.0 METHOD OF INVESTIGATION

### 4.1 Objectives

4.1.1 The aim of the fieldwork was to:

- Investigate ground conditions on the site.
- Obtain geotechnical information on the ground conditions at the site for preliminary foundation design and preliminary pavement design purposes.
- Install standpipes to allow future monitoring.
- Give an assessment of the geotechnical risks associated with redevelopment of the site.

### 4.2 Site Works

4.2.1 Three cable percussive boreholes (BH01 to BH03) were drilled to depths of between 6.45m and 15.45m using a Dando 2000 drilling rig on 7<sup>th</sup> December 2015 and 9<sup>th</sup> December 2015.

4.2.2 In addition, two falling head tests to assess the permeability of the strata were undertaken within BH01 and BH02.

4.2.3 The approximate locations of the exploratory holes are indicated on the Exploratory Hole Location Plan Drawing No C2917/02. The exploratory hole logs are presented in Appendix A.

4.2.4 The exploratory holes were positioned to establish general ground conditions across the proposed development. The exploratory holes were logged by an experienced geo-environmental engineer in general accordance with BS 5930 'Code of Practice for Site Investigations' 1999, BS EN 14688-1:2002 'Geotechnical Investigation and Testing – Identification and classification of soil'.

### 4.3 Sampling

4.3.1 During the drilling of the exploratory holes, representative samples were taken at regular intervals to assist in the identification of the soils and to allow subsequent laboratory testing.

4.3.2 A summary of the samples taken is presented in the table below:

| Type      | Number |
|-----------|--------|
| Disturbed | 29     |
| U100      | 6      |

4.3.3 The type of sample is dependent upon the stratum and the purpose of analysis in accordance with current geotechnical guidance.

4.3.5 The distribution of samples taken across the site is recorded on the exploratory logs.



#### 4.4 Laboratory Testing

- 4.4.1 Representative disturbed samples were obtained for all soil types encountered. Selected samples were scheduled for testing at an approved laboratory in accordance with BS 1377 'Method of Test for Soils for Civil Engineering Purposes' 1990. The following tests were scheduled:

| BS Test Number | Description                                                       | No of Samples |
|----------------|-------------------------------------------------------------------|---------------|
| Part 2:        | Natural Moisture Content                                          | 4             |
| Part 2:        | Plasticity Index Analysis                                         | 4             |
| Part 2:        | Particle Size Distribution by Wet Sieve                           | 2             |
| Part 7         | Determination of Undrained Shear Strength in Triaxial Compression | 1             |

- 4.4.2 The Geotechnical Laboratory Testing Results are presented in Appendix B.



## **5.0 GROUND CONDITIONS**

### **5.1 Made Ground**

- 5.1.1 Made Ground was encountered in all of the cable percussive borehole locations to depths of between 0.30m and 1.10m.
- 5.1.2 BH01 was grassed at the surface and was underlain by a slightly sandy slightly gravelly clayey topsoil to 0.30m. This was underlain by a black slightly clayey sandy gravel of mixed lithologies including ash clinker and brick to the base of the made ground at 1.10m. The made ground became less ashy below 0.60m.
- 5.1.3 Within BH03 tarmac surfacing was present to a depth of 0.10m. This was underlain by a sandy limestone hardcore subbase to 0.90m. Within BH02 sandy limestone hardcore gravel was encountered at the surface to the base of the made ground at 0.30m.

### **5.2 Natural Ground**

- 5.2.1 The natural strata underlying the made ground was generally interbedded firm to stiff clays and sands, typical of glaciofluvial sheet deposits.
- 5.2.2 Within BH01 a loose slightly gravelly clayey fine to coarse sand was encountered between 1.10m and 2.00m. This was underlain by a firm to stiff slightly silty sandy clay which was observed as containing bands of clayey silt to a depth of 5.70m.
- 5.2.3 The clay in BH01 was underlain by a dense slightly gravelly fine to coarse sand to 10.20m. Between 10.20m and 15.45m in BH01 the strata was interbedded stiff slightly sandy slightly gravelly clays and medium dense to dense slightly clayey gravelly sand. A band of gravel was encountered between 11.70m and 12.20m.
- 5.2.4 Within BH02 a firm silty sandy clay was encountered directly beneath the made ground to 2.00m, this was underlain by a medium dense slightly silty gravelly sand to 6.70m. The sand was observed as being loose locally at 3.00m.
- 5.2.5 Interbedded stiff to very stiff slightly gravelly slightly sandy silty clays and medium dense slightly clayey silty gravelly sands were observed below 6.70m with clay observed below 11.40m to the base of the hole at 15.45m.
- 5.2.6 Within BH03 a gravelly silty clayey sand was encountered between 0.90m and 1.70m with a clay band present between 0.90m and 1.10m.
- 5.2.7 Between 1.70m and 4.90m a firm slightly sandy slightly gravelly silty clay was encountered which was firm at 2.00m, soft at 3.00m and became very stiff at 4.00m. This clay was underlain by medium dense slightly clayey gravelly sand as previously observed from 4.90m to the base of the borehole at 6.45m.

### **5.3 Bedrock**

- 5.3.1 Bedrock was not encountered in this investigation.



#### **5.4 Groundwater**

- 5.4.1 A groundwater seepage was recorded in BH03 at 1.10m, groundwater seepages were also recorded in BH01 and BH02 at depths of 12.00m and 8.60m.

#### **5.5 Observations**

- 5.5.1 During the works undertaken by BSL observations for both visual and olfactory evidence of contamination were made.
- 5.5.2 With the exception of ash and clinker observed within the made ground in BH01 no visual or olfactory contamination was recorded at the site.



## 6.0 TEST RESULTS

### 6.1 Geotechnical Testing

- 6.1.1 Plasticity index results of 17% were achieved in the samples tested.
- 6.1.2 Based on plasticity index results clays beneath the proposed store of an intermediate volume change potential.
- 6.1.3 Oedometer testing indicates the clays beneath the site to be of have a  $M_v$  of  $0.130\text{MN/m}^2$  under the pressure range for the proposed development indicating the clays to be of medium compressibility.
- 6.1.4 The results of undrained shear strength within BH01 at 3.00m bgl show a  $C_u$  of 197kPa and indicate the clay at this depth to be of very high strength.
- 6.1.5 The results of Particle size distribution can be found across the exploratory hole logs and show gravelly sandy clay with 79% of material passing through the 63 micron sieve.

### 6.2 Falling Head Testing

- 6.2.1 The results of the falling head tests undertaken are summarised in the table below.

| Location | Test | Soil Infiltration Rate (m/sec) |
|----------|------|--------------------------------|
| BH02     | 1    | 7.35E-08                       |
| BH03     | 1    | 4.56E-07                       |

- 6.2.2 The results of the falling head tests indicate poor drainage conditions at the site.
- 6.2.3 The falling head testing results are presented in Appendix C.



## 7.0 GEOTECHNICAL ASSESSMENT

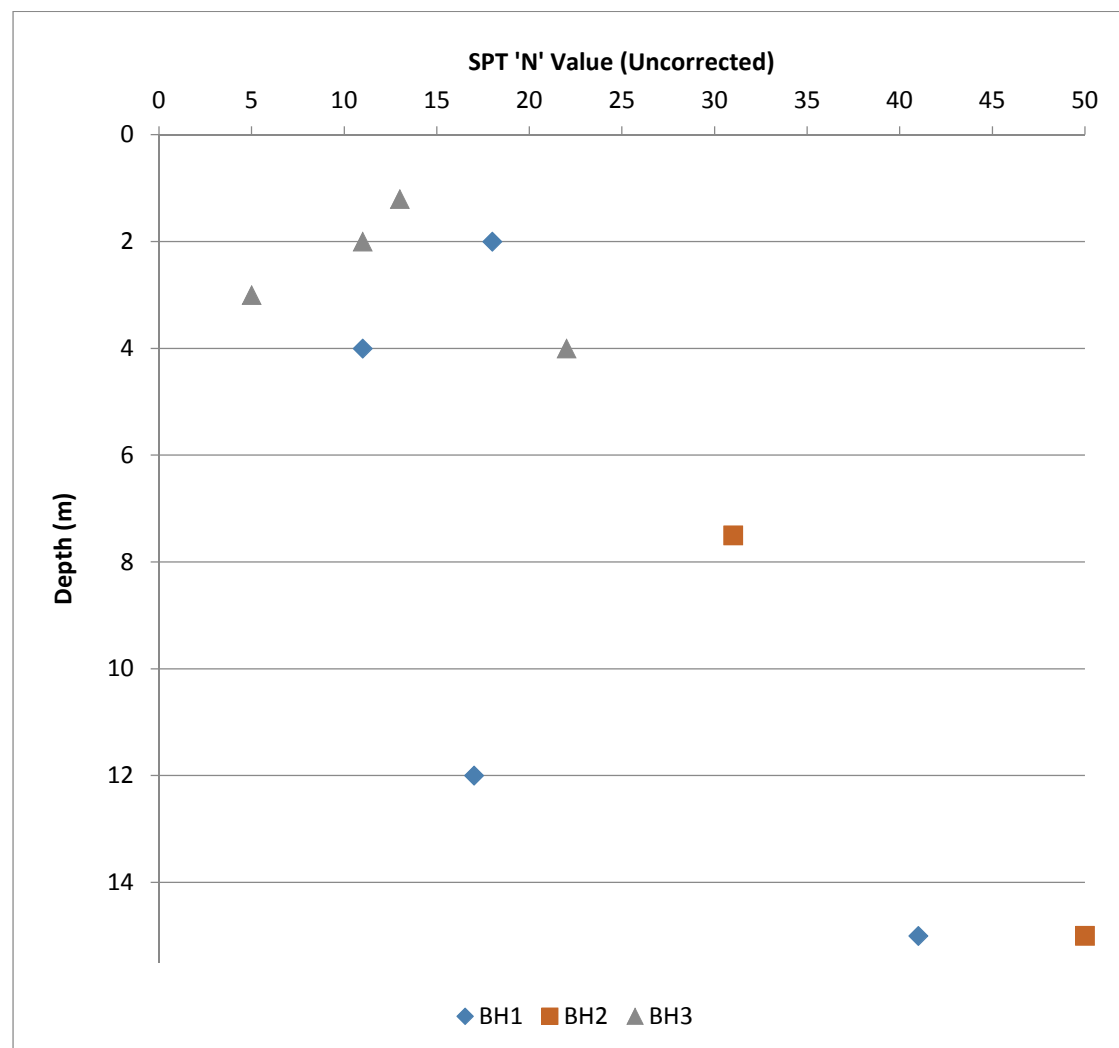
### 7.1 General

7.1.1 The site is currently occupied by an ambulance station and therefore the site investigation was limited by operations at the site. It is therefore recommended that further site investigation comprising window sampling is undertaken to confirm the depth to bearing strata.

7.1.2 Made ground was encountered to a maximum depth of 1.10m during the site investigation. The natural ground encountered was interbedded firm to stiff silty clays and medium dense clayey sands with the strata typical of glaciofluvial sheet deposits.

### 7.2 Soil Parameters

7.2.1 The test results have been evaluated to derive geotechnical soil parameters for the site. A depth to SPT N value graph for clay is provided below to provide a profile of the ground conditions underlying the site.





7.2.2 Characterization of the geotechnical parameters above has been undertaken to obtain a characteristic value, which is a cautious estimate of the value affecting the occurrence of the limit state. There is limited coverage and variable ground conditions at the site.

7.2.3 We have evaluated the data and we have derived a characteristic value shear strength of 50kPa for the upper clay. This value is very conservative and based on limited SPT data and Cu values.

7.2.4 For sand an angle of internal friction of  $30^{\circ}$  has been derived from SPT data.

### **7.3 Foundations**

7.3.1 The most suitable foundations for the proposed commercial development are considered to be pad foundations founding on the firm clays. The depth at which the clays are encountered at the site are variable and therefore foundation depths are likely to range between 0.90m bgl and 2.00m bgl, foundations should be as shallow as possible and founding completely in clay.

7.3.2 Preliminary calculations undertaken using the magnitude of compressibility yield an ultimate bearing capacity of 135kN/m<sup>2</sup> at this design resistance for clay. However at this bearing capacity differential settlement between sands and clays is in excess of the serviceability limit state.

7.3.3 Based on calculations undertaken a pad size of 1.5m<sup>2</sup> would give an allowable bearing capacity of 90kN/m<sup>2</sup>. At this bearing capacity differential settlement of less than 25mm should be achieved.

7.3.4 In order to carry out more robust settlement calculations and to refine the foundation recommendations further works to give a more comprehensive dataset should be undertaken.

7.3.5 It is likely that a change in bearing stratum across the proposed building footprint will occur in this area, therefore it is recommended that further investigation to confirm the depth of clay is undertaken following demolition of existing structures. If any sudden changes from clay to sand or gravel are encountered reference should be made to a suitably qualified engineer, recommendations may include that the foundations should either be deepened to found on the same stratum, or reinforced to reduce the potential for differential settlement.

7.3.6 The bearing stratum should be inspected for 'soft spots' within the natural clay strata, resulting for instance from localised groundwater perched within the overlying fill materials. Any such soft spots should be dealt with in accordance with good site practice.

7.3.7 If the ground conditions encountered during the construction phase differ significantly to the conditions encountered during construction, work should cease and BSL contacted for further advice.

7.3.8 During the construction phase supervision should be on a continuous basis to check the design assumptions are correct and construction conforms to design.

Supervision should include inspections, control ground investigations and monitoring.

#### **7.4 Building Near Trees**

- 7.4.1 If foundation excavations encounter cohesive strata in the vicinity of existing, proposed or recently removed trees, foundations should be adjusted in full accordance with current guidelines. All foundations should be deepened below roots of greater than 5mm diameter during excavations for footings. The clay is of a medium Volume change potential.
- 7.4.2 A survey of all trees and hedges on the site and within influencing distance of the proposed structure should be undertaken to identify tree species and heights. This information will be required in order to assess the effects of trees on the cohesive strata.
- 7.4.3 Where foundation depths due to trees already present or recently removed exceeds 1.50m there is a possibility for heave to occur on removal of the tree. Guidance states that compressible material or void former is required against the inside face of all external wall foundations.

#### **7.5 Floor Slabs**

- 7.5.1 A ground bearing floor can be utilised provided once finished levels are achieved less than 600mm of suitably compacted granular material exists.
- 7.5.2 As the site is located within an area requiring full Radon precautionary measures the floor slab will need to incorporate radon precautions in the form of a membrane and permeable stone and perforated pipes beneath the slab.

#### **7.6 Construction**

- 7.6.1 Instability of excavations through natural soils is not anticipated provided they are not exposed to adverse weather conditions for any substantial period of time. Instability of the Made Ground should be allowed for. All excavations should be carried out in accordance with CIRIA Report 97 'Trenching Practice'.
- 7.6.2 Excavation depths should generally be readily achieved using conventional plant (JCB or similar) although high specification plant (tracked 360° or similar) is recommended to maintain the build programme. Breaking equipment may also be required locally to penetrate old foundations associated with former construction.
- 7.6.3 pH and sulphate testing in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005 should be undertaken. The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.



## **7.7 Highways**

- 7.7.1 CBR values of 2% - 5% are likely to be achieved in undisturbed natural soils for pavement design purposes, unless proven otherwise by in-situ testing at sub-base level by a specialist geotechnical engineer.
- 7.7.2 Some reengineering of the subgrade may be required prior to highway construction to achieve the required design CBR value.
- 7.7.3 The soils are considered to frost susceptible due to the fines content, highway construction should be a minimum thickness of 450mm to mitigate against the risk.

## **7.8 Soakaways**

- 7.8.1 The results of falling head testing at the site indicate poor drainage conditions therefore the use of soakaways within the natural ground at the location and depths tested is unlikely to be feasible.
- 7.8.2 In-situ soakaway testing in accordance with BRE Digest 365 'Soakaway Testing' 2007 should be undertaken to confirm the drainage conditions. If soakaway testing indicates slightly better conditions then soakaways may be feasible may be feasible if an increased capacity in the form of an attenuation tank is installed.
- 7.8.3 If drainage of the highway to soakaways is to be considered it is suggested that this is discussed with the Local Authority at the earliest opportunity, to confirm the adequacy of proposed testing and to allow their inspection of any testing.



## 8.0 CONCLUSIONS

### 8.1 Summary

#### Geotechnical

8.1.1 For the proposed development pad foundations founding on firm clays between 900mm and 2000mm below ground levels are considered to be the most suitable option for the site. An allowable bearing pressure of 90kN/m<sup>2</sup> should be assumed for a pad of 1.5m<sup>2</sup>. At this bearing capacity a maximum differential settlement not exceeding 25mm should be achieved.

8.1.2 Due to the site being located in an area requiring full radon precautionary measures floor slabs will need to be suspended.

8.1.3 The results of falling head testing at the site indicate poor drainage conditions therefore the use of soakaways within the natural ground at the location and depths tested is unlikely to be feasible at present. Further soakaway testing in accordance with BRE Digest 365 'Soakaway Testing' 2007 should be undertaken to confirm the drainage conditions at the site.

### 8.2 Further Work

8.2.1 The following further work is considered necessary to progress the site to construction phase:

- Environmental Intrusive site investigations
- Soakaway testing in accordance with BRE 365
- Ground gas monitoring programme
- Further geotechnical site investigation comprising window sampling
- Foundation design
- Confirmation of Remedial Strategy Local Authority

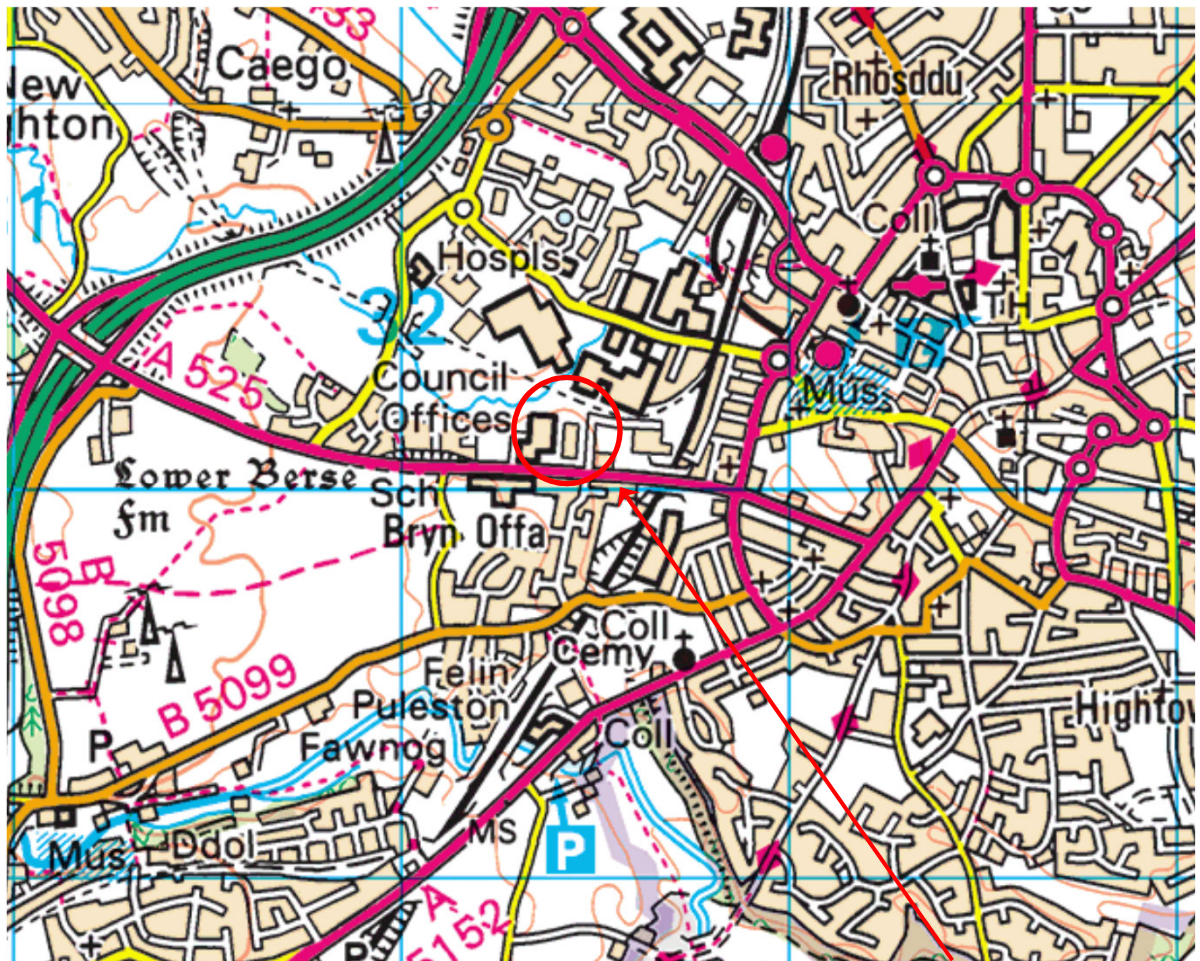


## 9.0 REFERENCES

1. British Standards Institution *“Geotechnical investigation and testing – Identification and classification of soil”* BS EN ISO 14688:2002.
2. BRE Report BR211 *‘Radon – Guidance on protective measures for new buildings’* 2015 Edition.
3. BRE Special Digest 1: *“Concrete in Aggressive Ground”* 3<sup>rd</sup> Ed 2005.
4. NHBC Standards 2006
5. CIRIA *“Asbestos in soil and made ground: a guide to understanding and managing risks”* C733 2014
6. BRE Digest 365 *“Soakaway Design”* 2007.
7. Specification for Highways Works – Series 600 Earthworks November 2006.



## **DRAWINGS**



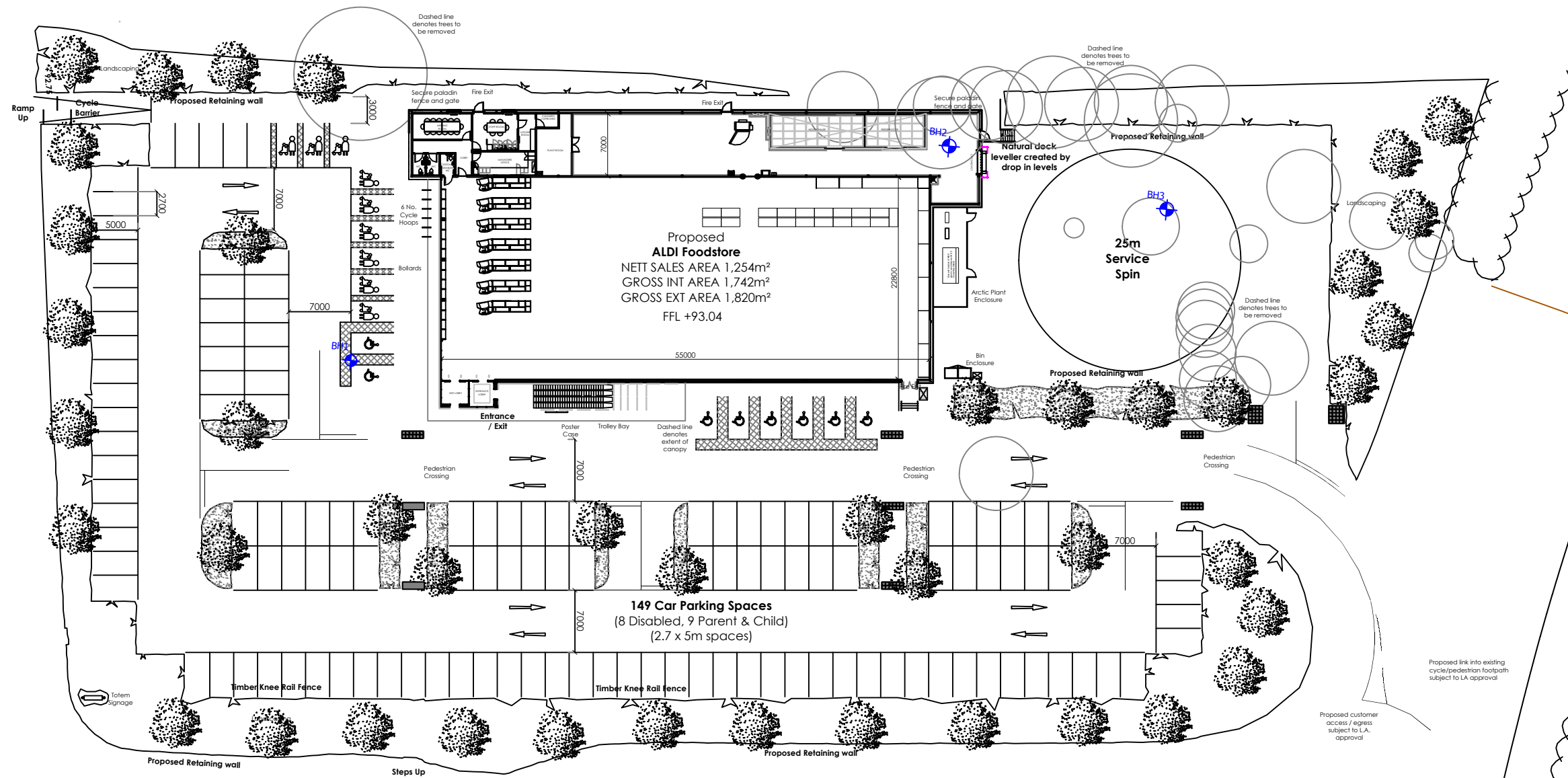
The map shows the Croesnewydd South Junction area. Ruthin Road runs horizontally across the middle. Tenary Road runs vertically, intersecting Ruthin Road. A red circle is drawn on Tenary Road, just north of Ruthin Road. A red arrow points from the right side of the map towards this circle. Other labels include 'Ysgol' to the west, 'Croesnewydd South Junction' to the east, and 'DOLYDD' at the top right. A river is visible in the top left corner.

BSL

Checked By: JD



 Cable Percussive Borehole



| DESCRIPTION                                                                                                                                                       |               | REV                            | DATE          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------------------|---------------|
|  <b>BROWNFIELD SOLUTIONS LTD</b><br>GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE |               |                                |               |
| CLIENT                                                                                                                                                            |               | ALDI STORES LIMITED            |               |
| PROJECT TITLE                                                                                                                                                     |               | RUTHIN ROAD, WREXHAM           |               |
| DRAWING DETAIL                                                                                                                                                    |               | EXPLORATORY HOLE LOCATION PLAN |               |
| DRAWN                                                                                                                                                             | LC            | CHECKED                        | JD            |
| DATE                                                                                                                                                              | February 2016 | SCALE                          | NTS           |
| DRAWING NUMBER                                                                                                                                                    | C2917/03      |                                | REVISION<br>— |



## **APPENDIX A Exploratory Hole Logs**



# Borehole Log

Borehole No.

**BH01**

Sheet 1 of 2

Project Name: RUTHIN ROAD

Project No.  
C2917

Co-ords: -

Hole Type  
CP

Location: WREXHAM

Level:

Scale  
1:50

Client: ALDI STORES LTD

Dates: 07/12/2015 -

Logged By  
SF

| Well | Water Strikes | Samples and In Situ Testing |      |                       | Depth (m) | Level (m) | Legend | Stratum Description                                                                                                                                                                      |    |
|------|---------------|-----------------------------|------|-----------------------|-----------|-----------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|      |               | Depth (m)                   | Type | Results               |           |           |        |                                                                                                                                                                                          |    |
|      |               | 0.30                        |      |                       | 0.30      |           |        | MADE GROUND: Brown slightly sandy slightly gravelly clayey topsoil. Gravel is fine to medium subangular to subrounded of mixed lithology.                                                |    |
|      |               | 0.50                        | D    |                       |           |           |        | MADE GROUND: Black slightly clayey sandy angular to rounded fine to medium gravel of mixed lithology including ash, clinker and brick. <i>Becoming brown and less ashy at 0.60m bgl.</i> | 1  |
|      |               | 1.20<br>1.20 - 1.65         | D    | N=4 (1,1/1,1,1,1)     | 1.10      |           |        | Loose light brown slightly gravelly clayey fine to coarse SAND. Gravel is fine to coarse angular to subrounded of mixed lithologies including sandstone.                                 |    |
|      |               | 2.00<br>2.00 - 2.45         | D    | N=18 (1,2/3,5,5,5)    | 2.00      |           |        | Firm to stiff brown mottled grey slightly silty slightly sandy CLAY with bands of slightly sandy clayey silt.                                                                            | 2  |
|      |               | 3.00 - 3.45                 | U    |                       | 3.00      |           |        | Firm to stiff brown mottled grey slightly silty slightly sandy slightly gravelly CLAY with bands of slightly sandy slightly clayey silt.                                                 | 3  |
|      |               | 3.50                        | D    |                       |           |           |        |                                                                                                                                                                                          |    |
|      |               | 4.00<br>4.00 - 4.45         | D    | N=11 (1,1/2,2,3,4)    |           |           |        |                                                                                                                                                                                          | 4  |
|      |               | 5.00 - 5.45                 | U    |                       |           |           |        |                                                                                                                                                                                          | 5  |
|      |               | 5.50                        | D    |                       | 5.70      |           |        |                                                                                                                                                                                          |    |
|      |               | 6.00<br>6.00 - 6.45         | D    | N=37 (2,4/6,9,10,12)  |           |           |        | Dense light brown slightly gravelly fine to coarse SAND. Gravel is fine to medium angular to subrounded of mixed lithologies including rare coal.                                        | 6  |
|      |               |                             |      |                       |           |           |        | <i>Gravel becomes fine to coarse from 7.00m bgl.</i>                                                                                                                                     | 7  |
|      |               | 7.50<br>7.50 - 7.95         | D    | N=38 (3,5/6,10,10,12) |           |           |        |                                                                                                                                                                                          | 8  |
|      |               | 9.00<br>9.00 - 9.45         | D    | N=33 (5,6/6,10,8,9)   |           |           |        |                                                                                                                                                                                          | 9  |
|      |               |                             |      |                       |           |           |        |                                                                                                                                                                                          | 10 |

Continued on next sheet

## Remarks

1. Hand dug pit to 1.20m bgl
2. Groundwater seepage at 12.00m bgl.
3. Standpipe installed to 12.20m bgl: 11.70m plain pipe, 0.50m slotted pipe.





# Borehole Log

Borehole No.

**BH01**

Sheet 2 of 2

Project Name: RUTHIN ROAD

Project No.  
C2917

Co-ords: -

Hole Type  
CP

Location: WREXHAM

Level:

Scale  
1:50

Client: ALDI STORES LTD

Dates: 07/12/2015 -

Logged By  
SF

| Well | Water Strikes | Samples and In Situ Testing |      |                      | Depth (m) | Level (m) | Legend | Stratum Description                                                                                                                 |    |
|------|---------------|-----------------------------|------|----------------------|-----------|-----------|--------|-------------------------------------------------------------------------------------------------------------------------------------|----|
|      |               | Depth (m)                   | Type | Results              |           |           |        |                                                                                                                                     |    |
|      |               | 10.50 - 10.95               | U    |                      | 10.20     |           |        | Stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to rounded of mixed lithology including coal.   |    |
|      |               | 11.00                       | D    |                      |           |           |        |                                                                                                                                     | 11 |
|      |               | 12.00                       |      |                      | 11.70     |           |        |                                                                                                                                     |    |
|      |               | 12.00 - 12.45               | D    | N=17 (2,3/2,4,5,6)   | 12.20     |           |        | Medium dense brown slightly clayey sandy angular to rounded fine to coarse GRAVEL of mixed lithologies.                             | 12 |
|      |               |                             |      |                      |           |           |        | Stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular to subrounded of mixed lithologies.             | 13 |
|      |               | 13.50                       |      |                      | 13.50     |           |        | Dense brown slightly clayey gravelly fine to coarse SAND. Gravel is fine to medium, angular to subrounded of mixed lithologies.     | 14 |
|      |               | 13.50 - 13.95               | D    | N=33 (8,9/11,8,7,7)  | 14.10     |           |        | Stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium angular to rounded of mixed lithologies including coal. |    |
|      |               | 15.00                       |      |                      |           |           |        |                                                                                                                                     | 15 |
|      |               | 15.00 - 15.45               | D    | N=41 (5,6/6,9,12,14) | 15.45     |           |        | <u>Becoming very stiff at 15.00m bgl.</u><br>End of borehole at 15.45 m                                                             | 16 |
|      |               |                             |      |                      |           |           |        |                                                                                                                                     | 17 |
|      |               |                             |      |                      |           |           |        |                                                                                                                                     | 18 |
|      |               |                             |      |                      |           |           |        |                                                                                                                                     | 19 |
|      |               |                             |      |                      |           |           |        |                                                                                                                                     | 20 |

## Remarks

1. Hand dug pit to 1.20m bgl
2. Groundwater seepage at 12.00m bgl.
3. Standpipe installed to 12.20m bgl: 11.70m plain pipe, 0.50m slotted pipe.





# Borehole Log

Borehole No.

**BH02**

Sheet 1 of 2

Project Name: RUTHIN ROAD

Project No.  
C2917

Co-ords: -

Hole Type  
CP

Location: WREXHAM

Level:

Scale  
1:50

Client: ALDI STORES LTD

Dates: 08/12/2015 -

Logged By  
TH

| Well | Water Strikes | Samples and In Situ Testing |      |                     | Depth (m) | Level (m) | Legend | Stratum Description                                                                                                                                               |    |
|------|---------------|-----------------------------|------|---------------------|-----------|-----------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|      |               | Depth (m)                   | Type | Results             |           |           |        |                                                                                                                                                                   |    |
|      |               |                             |      |                     | 0.30      |           |        | MADE GROUND: Dark grey sandy angular to subangular fine to coarse gravel of limestone hardcore.<br>Firm dark red brown silty sandy CLAY.                          |    |
|      |               | 1.20                        | U    |                     |           |           |        | Occasional fine to medium sand and gravel bands from 1.2m bgl. Gravel is subangular to angular of mixed lithologies.                                              | 1  |
|      |               | 2.00<br>2.00 - 2.45         | D    | N=10 (1,0/2,2,2,4)  | 2.00      |           |        | Medium dense brown slightly silty gravelly fine to coarse SAND. Gravel is fine to medium subangular to subrounded of mixed lithologies including occasional coal. | 2  |
|      |               | 3.00<br>3.00 - 3.45         | D    | N=7 (2,2/2,1,2,2)   |           |           |        | Loose at 3.00m. bgl.                                                                                                                                              | 3  |
|      |               | 4.00<br>4.00 - 4.45         | D    | N=23 (3,5/5,5,6,7)  |           |           |        | Becoming medium dense at 4.00m bgl.                                                                                                                               | 4  |
|      |               | 5.00<br>5.00 - 5.45         | D    | N=19 (2,3/3,3,6,7)  |           |           |        |                                                                                                                                                                   | 5  |
|      |               | 6.00<br>6.00 - 6.45         | D    | N=33 (2,3/6,8,9,10) |           |           |        | Becoming dense at 6.00m bgl.                                                                                                                                      | 6  |
|      |               |                             |      |                     | 6.70      |           |        | Very stiff red brown slightly gravelly slightly sandy silty CLAY. Gravel is fine to medium subangular to subrounded of mixed lithologies.                         | 7  |
|      |               | 7.50<br>7.50 - 7.95         | D    | N=31 (3,4/5,7,10,9) |           |           |        |                                                                                                                                                                   | 8  |
|      |               |                             |      |                     | 8.60      |           |        | Medium dense brown saturated slightly clayey silty gravelly fine to medium SAND. Gravel is fine to medium subangular to angular of mixed lithologies.             | 9  |
|      |               | 9.00<br>9.00 - 9.45         | D    | N=15 (2,4/4,3,4,4)  |           |           |        |                                                                                                                                                                   | 10 |

Continued on next sheet

**Remarks**

1. Hand dug pit to 1.20m bgl
2. Groundwater seepage at 8.60m bgl.
3. Standpipe installed to 9.5m bgl: 8.50m plain pipe, 1.00m slotted pipe.
4. Falling head test at 3.00m bgl for 1 hour.





# Borehole Log

Borehole No.

**BH02**

Sheet 2 of 2

Project Name: RUTHIN ROAD

Project No.  
C2917

Co-ords: -

Hole Type  
CP

Location: WREXHAM

Level:

Scale  
1:50

Client: ALDI STORES LTD

Dates: 08/12/2015 -

Logged By  
TH

| Well | Water Strikes | Samples and In Situ Testing |      |                           | Depth (m) | Level (m) | Legend | Stratum Description                                                                                                                                                             |    |
|------|---------------|-----------------------------|------|---------------------------|-----------|-----------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|      |               | Depth (m)                   | Type | Results                   |           |           |        |                                                                                                                                                                                 |    |
|      |               | 10.50                       |      | N=50<br>(5,8/11,13,12,14) | 11.40     |           |        | Becoming very dense at 10.50m bgl.                                                                                                                                              | 11 |
|      |               | 10.50 - 10.95               | D    |                           |           |           |        |                                                                                                                                                                                 |    |
|      |               | 11.70 - 12.15               | U    |                           |           |           |        | Stiff to very stiff brown slightly sandy slightly gravelly slightly silty CLAY. Gravel is fine to medium with occasional cobbles subangular to subrounded of mixed lithologies. | 12 |
|      |               | 12.20                       | D    |                           |           |           |        |                                                                                                                                                                                 |    |
|      |               | 13.50 - 13.95               | U    |                           |           |           |        |                                                                                                                                                                                 |    |
|      |               | 15.00                       |      | N=50<br>(4,7/9,11,15,15)  | 15.45     |           |        | Becoming very stiff at 15.00m.                                                                                                                                                  | 15 |
|      |               | 15.00 - 15.45               | D    |                           |           |           |        | End of borehole at 15.45 m                                                                                                                                                      | 16 |
|      |               |                             |      |                           |           |           |        |                                                                                                                                                                                 | 17 |
|      |               |                             |      |                           |           |           |        |                                                                                                                                                                                 | 18 |
|      |               |                             |      |                           |           |           |        |                                                                                                                                                                                 | 19 |
|      |               |                             |      |                           |           |           |        |                                                                                                                                                                                 | 20 |

**Remarks**

1. Hand dug pit to 1.20m bgl
2. Groundwater seepage at 8.60m bgl.
3. Standpipe installed to 9.5m bgl: 8.50m plain pipe, 1.00m slotted pipe.
4. Falling head test at 3.00m bgl for 1 hour.





# Borehole Log

Borehole No.

**BH03**

Sheet 1 of 1

Project Name: RUTHIN ROAD

Project No.  
C2917

Co-ords: -

Hole Type  
CP

Location: WREXHAM

Level:

Scale  
1:50

Client: ALDI STORES LTD

Dates: 09/12/2015 -

Logged By  
TH

| Well | Water Strikes | Samples and In Situ Testing |      |                     | Depth (m) | Level (m) | Legend | Stratum Description                                                                                                                                                             |    |
|------|---------------|-----------------------------|------|---------------------|-----------|-----------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|      |               | Depth (m)                   | Type | Results             |           |           |        |                                                                                                                                                                                 |    |
|      |               | 0.10                        |      |                     | 0.10      |           |        | MADE GROUND: Tarmac.                                                                                                                                                            |    |
|      |               | 0.90                        |      |                     | 0.90      |           |        | MADE GROUND: Dark brown grey fine to coarse sand and angular to subangular fine to coarse gravel of limestone hardcore.                                                         |    |
|      |               | 1.20                        |      |                     | 1.20      |           |        | Dark grey gravelly fine to coarse SAND. Gravel is fine to medium subangular to subrounded of mixed lithologies.                                                                 | 1  |
|      |               | 1.20 - 1.65                 | D    | N=13 (1,2/3,3,3,4)  | 1.10      |           |        | Firm grey slightly gravelly sandy CLAY. Gravel is fine to medium medium angular to subangular of mixed lithologies.                                                             |    |
|      |               | 1.70                        |      |                     | 1.70      |           |        | Loose brown slightly silty clayey gravelly fine to coarse SAND with occasional clay bands.                                                                                      | 2  |
|      |               | 2.00                        |      |                     | 2.00      |           |        | Firm dark red brown firm sandy gravelly silty CLAY with occasional saturated sand and gravel bands. Gravel is fine to medium subangular to subrounded of mixed lithologies.     |    |
|      |               | 2.00 - 2.45                 | D    | N=11 (1,2/2,2,3,4)  |           |           |        |                                                                                                                                                                                 |    |
|      |               | 3.00                        |      |                     | 3.00      |           |        | Medium dense brown slightly clayey gravelly fine to medium SAND. Gravel is fine to medium, angular to subrounded of mixed lithologies. Occasional cobbles of mixed lithologies. | 3  |
|      |               | 3.00 - 3.45                 | D    | N=5 (1,1/1,1,1,2)   |           |           |        |                                                                                                                                                                                 |    |
|      |               | 4.00                        |      |                     | 4.00      |           |        |                                                                                                                                                                                 | 4  |
|      |               | 4.00 - 4.45                 | D    | N=22 (3,3/4,5,6,7)  |           |           |        |                                                                                                                                                                                 |    |
|      |               | 5.00                        |      |                     | 4.90      |           |        | Medium dense brown slightly clayey gravelly fine to medium SAND. Gravel is fine to medium, angular to subrounded of mixed lithologies. Occasional cobbles of mixed lithologies. | 5  |
|      |               | 5.00 - 5.45                 | D    | N=29 (3,5/5,5,7,12) |           |           |        |                                                                                                                                                                                 |    |
|      |               | 6.00                        |      |                     | 6.00      |           |        | Becoming dense at 6.00m bgl.                                                                                                                                                    | 6  |
|      |               | 6.00 - 6.45                 | D    | N=34 (4,7/7,7,8,12) | 6.45      |           |        | End of borehole at 6.45 m                                                                                                                                                       | 7  |
|      |               |                             |      |                     |           |           |        |                                                                                                                                                                                 | 8  |
|      |               |                             |      |                     |           |           |        |                                                                                                                                                                                 | 9  |
|      |               |                             |      |                     |           |           |        |                                                                                                                                                                                 | 10 |
|      |               |                             |      |                     |           |           |        |                                                                                                                                                                                 |    |

## Remarks

1. Hand dug pit to 1.20m bgl.
2. Groundwater seepage at 1.10m bgl.
3. Backfilled with arisings.
4. Falling head test at 5.00m bgl. for 1 hour.





**APPENDIX B**  
**Geotechnical Testing Certificates**



# LABORATORY REPORT



4043

**Contract Number: PSL15/6144**

Report Date: 07 January 2016  
Client's Reference: C2917  
Client Name: Brownfield Solutions Limited  
Wychwood House  
1 Queens Street  
Northwich  
Cheshire  
CW9 5JL

**For the attention of: Lucy Crawford**

Contract Title: Ruthin Road, Wrexham

Date Received: 21/12/2015  
Date Commenced: 21/12/2015  
Date Completed: 07/01/2016

**Notes: Opinions and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson  
(Director)

D Lambe  
(Senior Technician)

A Watkins  
(Director)

S Royle  
(Senior Technician)

M Beastall  
(Laboratory Manager)

5 – 7 Hexthorpe Road, Hexthorpe,  
Doncaster DN4 0AR  
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fax: +44 (0)844 815 6642  
e-mail: rgunson@prosoils.co.uk  
awatkins@prosoils.co.uk

Page 1 of

## SUMMARY OF LABORATORY SOIL DESCRIPTIONS

[illegible]

**PSL**  
Professional Soils Laboratory

**Checked / Approved**



Date \_\_\_\_\_

**07/01/16**

**Contract No:**

PSL15/6144

**Client Ref:**

C2917

# RUTHIN ROAD WREXHAM

## SUMMARY OF SOIL CLASSIFICATION TESTS

**(BS1377 : PART 2 : 1990)**

[illegible]

**SYMBOLS :** NP : Non Plastic

**\* : Liquid Limit and Plastic Limit Wet Sieved.**



**PSL**  
Professional Soils Laboratory

**Checked / Approved**



Date \_\_\_\_\_

07/01/16

**Contract No:**

PSL15/6144

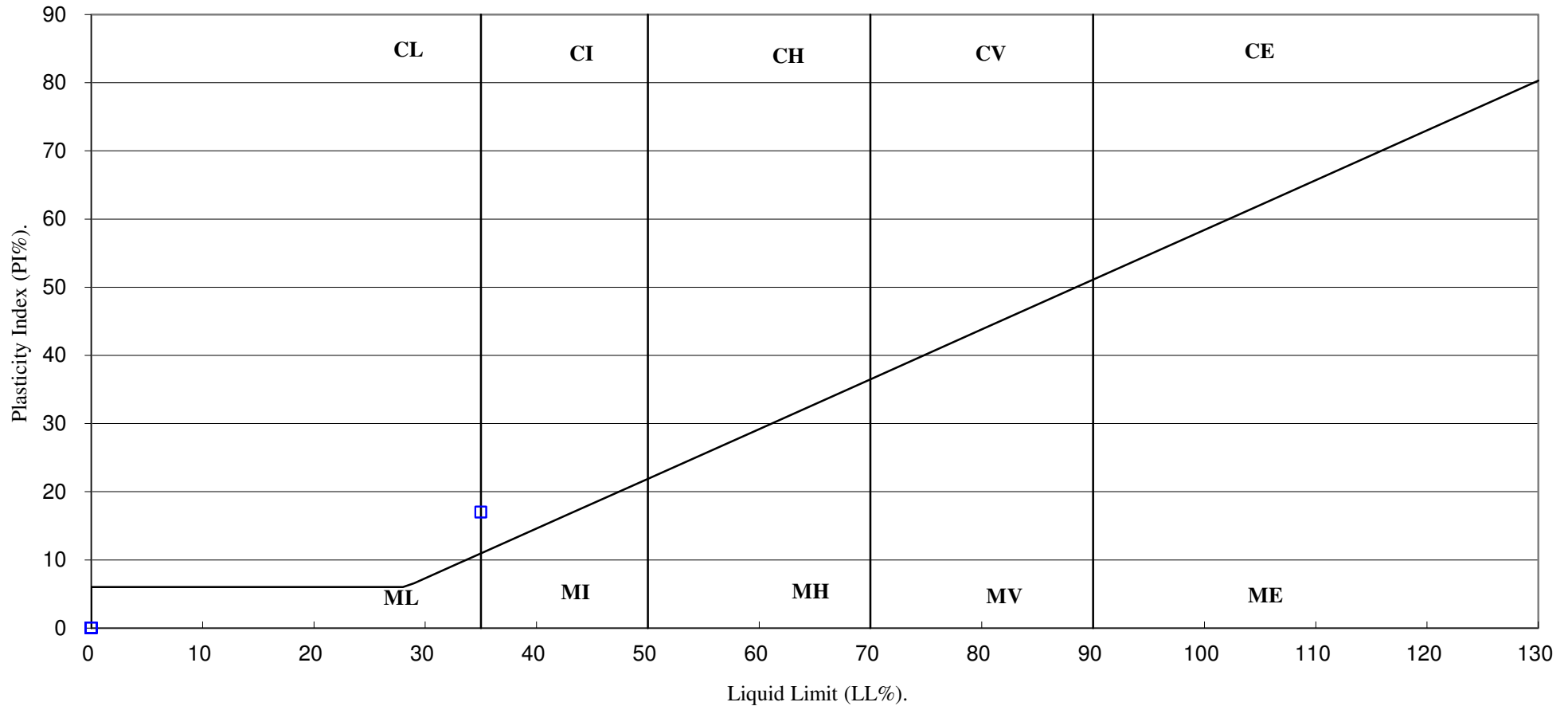
**Client Ref:**

C2917

# RUTHIN ROAD WREXHAM

# PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



**PSL**  
Professional Soils Laboratory

Checked /Approved

*[Signature]*

Date

07/01/16

Contract No:

PSL15/6144

Client Ref:

C2917

RUTHIN ROAD WREXHAM

# PARTICLE SIZE DISTRIBUTION TEST

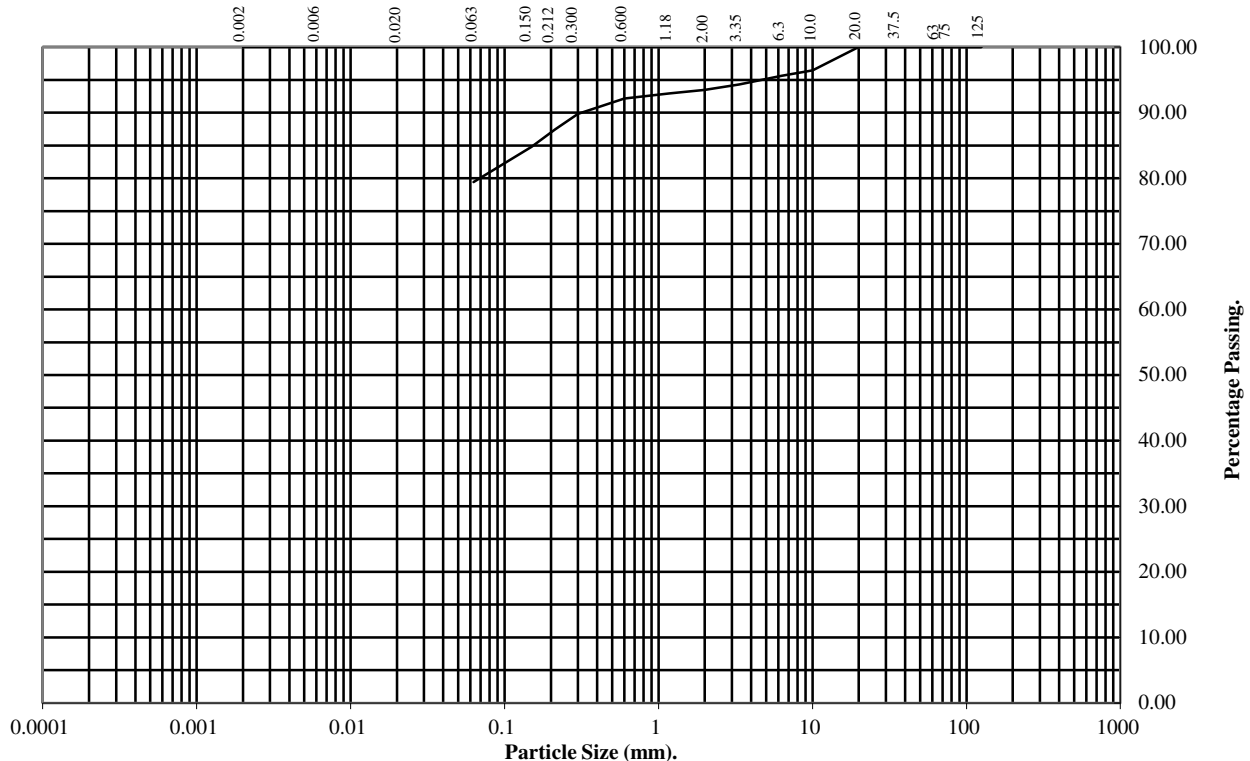
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: BH01 Top Depth (m): 5.00

Sample Number: Base Depth(m): 5.45

Sample Type: U



| BS Test Sieve | Percentage Passing |
|---------------|--------------------|
| 125           | 100                |
| 75            | 100                |
| 63            | 100                |
| 37.5          | 100                |
| 20            | 100                |
| 10            | 96                 |
| 6.3           | 96                 |
| 3.35          | 94                 |
| 2             | 93                 |
| 1.18          | 93                 |
| 0.6           | 92                 |
| 0.3           | 90                 |
| 0.212         | 87                 |
| 0.15          | 85                 |
| 0.063         | 79                 |

| Soil Fraction | Total Percentage |
|---------------|------------------|
| Cobbles       | 0                |
| Gravel        | 7                |
| Sand          | 14               |
| Silt/Clay     | 79               |

## Remarks:

See summary of soil descriptions.



|                     |  |      |          |              |
|---------------------|--|------|----------|--------------|
| Checked / Approved  |  | Date | 07/01/16 | Contract No: |
| RUTHIN ROAD WREXHAM |  |      |          | PSL15/6144   |
|                     |  |      |          | Client Ref:  |
|                     |  |      |          | C2917        |

# ONE DIMENSIONAL CONSOLIDATION TEST

BS 1377: Part 5: 1990: Clause 3

Hole Number: BH01

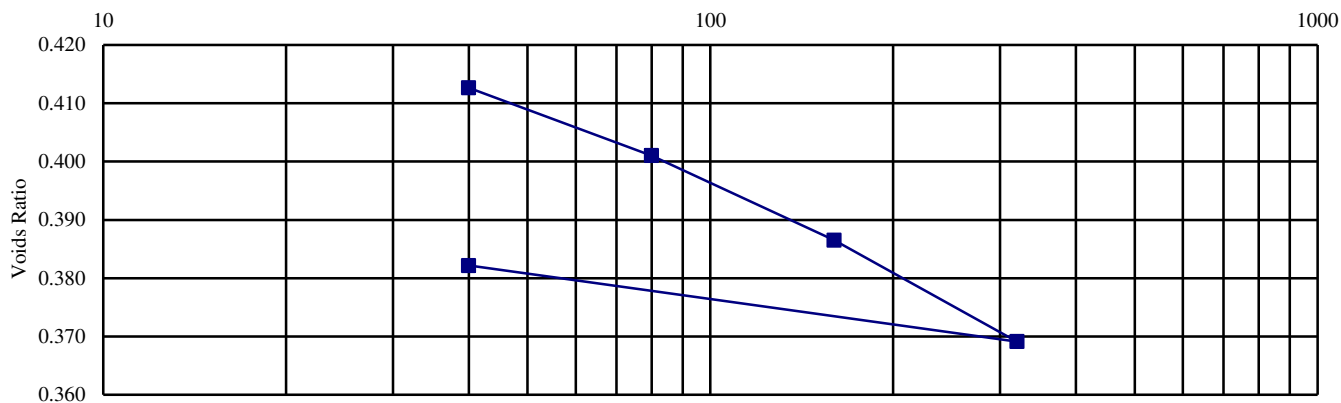
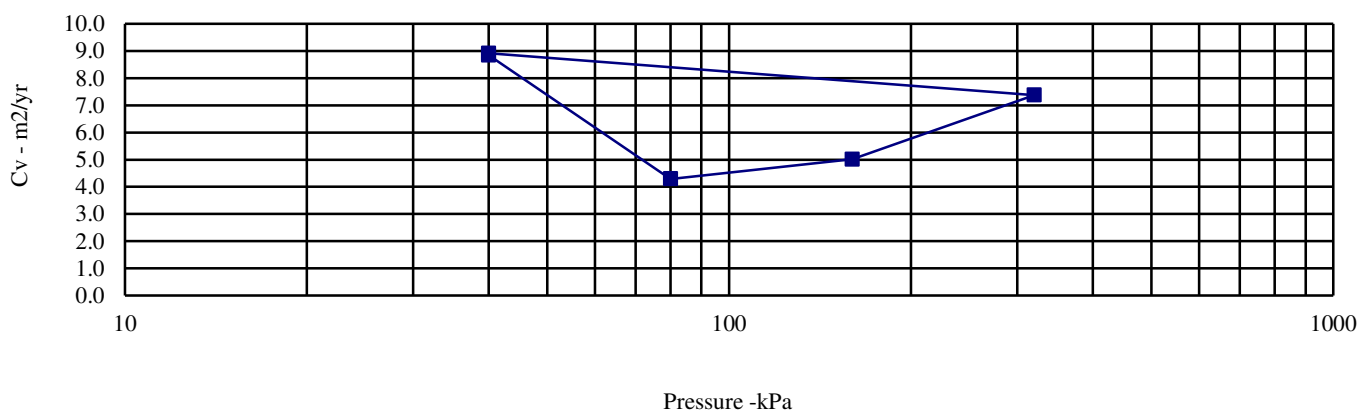
Top Depth (m): 3.00

Sample Number:

Base Depth (m) : 3.45

Sample Type: U

| Initial Conditions        |        | Pressure Range                    |     | Mv    | Cv    | Specimen location   |     |
|---------------------------|--------|-----------------------------------|-----|-------|-------|---------------------|-----|
| Moisture Content (%):     | 16     | kPa                               |     | m2/MN | m2/yr | within tube:        | Top |
| Bulk Density (Mg/m3):     | 2.17   | 0                                 | 40  | 0.198 | 8.849 | Method used to      |     |
| Dry Density (Mg/m3):      | 1.86   | 40                                | 80  | 0.206 | 4.292 | determine CV:       | T90 |
| Voids Ratio:              | 0.424  | 80                                | 160 | 0.130 | 5.018 | Nominal temperature |     |
| Degree of saturation:     | 102.4  | 160                               | 320 | 0.078 | 7.377 | during test 'C':    | 20  |
| Height (mm):              | 20.088 | 320                               | 40  | 0.034 | 8.912 | Remarks:            |     |
| Diameter (mm)             | 75.02  | See summary of soils description. |     |       |       |                     |     |
| Particle Density (Mg/m3): | 2.65   |                                   |     |       |       |                     |     |
| Assumed                   |        |                                   |     |       |       |                     |     |



|  |  |                      |  |      |          |              |
|--|--|----------------------|--|------|----------|--------------|
|  |  | Checked / Approved   |  | Date | 07/01/16 | Contract No: |
|  |  | RUTHIN ROAD, WREXHAM |  |      |          | PSL15/6144   |
|  |  |                      |  |      |          | Client Ref:  |
|  |  |                      |  |      |          | C2917        |

# UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

## WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

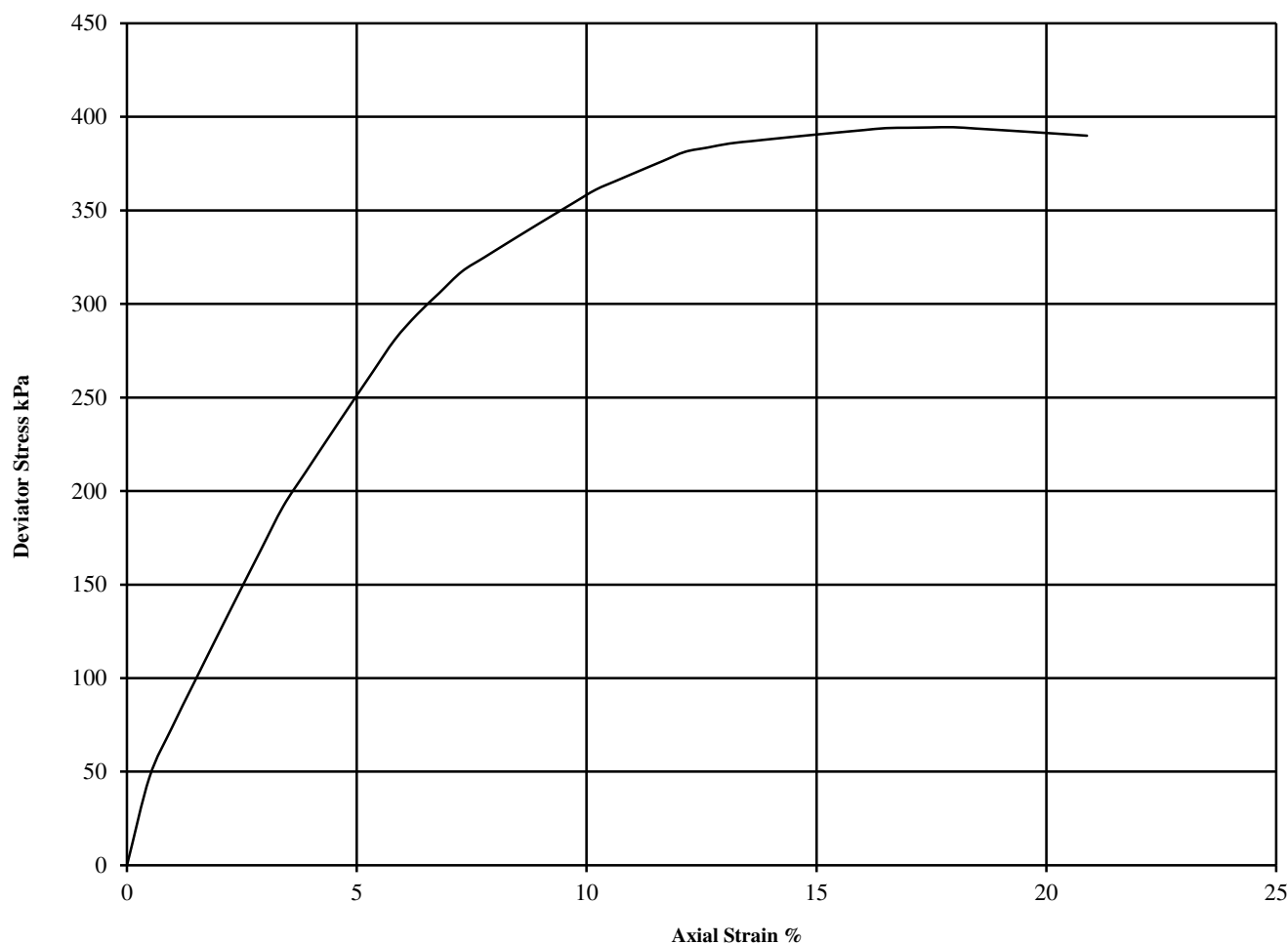
Hole Number: BH01

Top Depth (m): 3.00

Sample Number:

Base Depth (m): 3.45

Sample Type U



| Diameter (mm): |                            | 102.0                      | Height (mm):              |            | 210.0                   | Test:                         | UU Single Stage          |                       | Remarks                           |
|----------------|----------------------------|----------------------------|---------------------------|------------|-------------------------|-------------------------------|--------------------------|-----------------------|-----------------------------------|
| Specimen       | Moisture<br>Content<br>(%) | Bulk<br>Density<br>(Mg/m3) | Dry<br>Density<br>(Mg/m3) | Cell       | Corr. Max.              | Shear                         | Failure<br>Strain<br>(%) | Mode<br>of<br>Failure | Undisturbed Sample                |
|                |                            |                            |                           | Pressure   | Deviator                | Strength                      |                          |                       | Sample taken from top of tube     |
|                |                            |                            |                           | (kPa)      | Stress                  | Cu                            |                          |                       | Rate of strain = 2 %/min          |
|                |                            |                            |                           | (kPa)      | (kPa)                   |                               |                          |                       | Latex Membrane used 0.2 mm thick, |
|                |                            |                            |                           | $\theta_3$ | $(\theta_1-\theta_3)_f$ | $^{1/2}(\theta_1-\theta_3)_f$ |                          |                       | Correction applied           0.34 |
| 1              | 16                         | 2.19                       | 1.89                      | 60         | 394                     | 197                           | 18.0                     | Plastic               | See summary of soil descriptions. |



Checked / Approved

*[Signature]*

Date

07/01/16

Contract No:

PSL15/6144

Client Ref:

C2917

RUTHIN ROAD WREXHAM



## **APPENDIX C**

### **Falling Head Testing Results**

|                                          |     |   |                                   |             |                    |         |
|------------------------------------------|-----|---|-----------------------------------|-------------|--------------------|---------|
| <b>Variable head permeability test</b>   |     |   | Site:                             | Ruthin Road | Location:          | Wrexham |
| Depth below top of casing/standpipe to:  |     |   | Job No:                           | C2917       | Borehole No:       | BH02    |
|                                          |     |   | Date:                             | 08/12/2015  | Sheet:             | 1 of 1  |
| (a) bottom of borehole:                  | 3.5 | m | Ground level<br>(m Aod)           |             | Crew:              | TH      |
| (b) bottom of casing:                    | 3.0 | m |                                   |             |                    |         |
| (c) top of filter material:              |     | m | Weather:                          |             | Rain               |         |
| (d) centre of piezometer tip:            |     | m | Type of Test:                     |             | Falling Head       |         |
| (e) initial groundwater level:           |     | m | Diameter of casing/standpipe (mm) |             |                    | 152.4   |
| Height of casing/standpipe above surface | 0.1 | m | Length of filter (mm)             |             | Dia of filter (mm) |         |
| Elevation of casing/standpipe (Aod)      |     | m |                                   |             |                    |         |

| Test Record:                                                              |                    |                          |      |                    |                          |      |                    |                          |
|---------------------------------------------------------------------------|--------------------|--------------------------|------|--------------------|--------------------------|------|--------------------|--------------------------|
| Time                                                                      | Time elapsed (min) | Depth to water level (m) | Time | Time elapsed (min) | Depth to water level (m) | Time | Time elapsed (min) | Depth to water level (m) |
|                                                                           | 0                  | 0.530                    |      | 25                 | 3.110                    |      |                    |                          |
|                                                                           | 0.5                | 0.850                    |      | 30                 | 3.110                    |      |                    |                          |
|                                                                           | 1                  | 1.040                    |      | 40                 | 3.145                    |      |                    |                          |
|                                                                           | 2                  | 1.390                    |      | 50                 | 3.180                    |      |                    |                          |
|                                                                           | 3                  | 1.670                    |      | 60                 | 3.220                    |      |                    |                          |
|                                                                           | 4                  | 1.870                    |      |                    |                          |      |                    |                          |
|                                                                           | 5                  | 2.050                    |      |                    |                          |      |                    |                          |
|                                                                           | 6                  | 2.200                    |      |                    |                          |      |                    |                          |
|                                                                           | 7                  | 2.320                    |      |                    |                          |      |                    |                          |
|                                                                           | 8                  | 2.430                    |      |                    |                          |      |                    |                          |
|                                                                           | 9                  | 2.500                    |      |                    |                          |      |                    |                          |
|                                                                           | 10                 | 2.580                    |      |                    |                          |      |                    |                          |
|                                                                           | 15                 | 2.850                    |      |                    |                          |      |                    |                          |
|                                                                           | 20                 | 2.990                    |      |                    |                          |      |                    |                          |
| Remarks:                                                                  |                    |                          |      |                    |                          |      |                    |                          |
| Depth to water level measured from top of casing.                         |                    |                          |      |                    |                          |      |                    |                          |
| Note: Depth to water level to be measured from top of casing or standpipe |                    |                          |      |                    |                          |      |                    |                          |

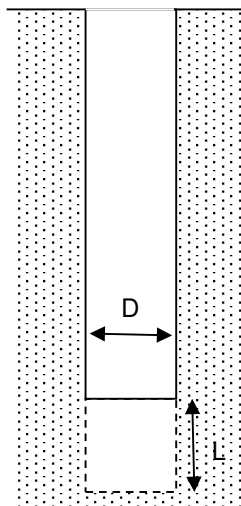
Date:  
08/12/2015

By:  
TH

Checked:  
JD

Falling Head Permeability in accordance with BS 5930

Calculation of Intake Factor (F)



Area of base

$$A = 1.8241 \text{ m}^2$$

Diameter

$$D = 152.4 \text{ mm}$$

$$1.524 \text{ m}$$

Length

$$L = 500 \text{ mm}$$

$$0.5 \text{ m}$$

$$F = \frac{2 \pi L}{\ln \left[ \frac{L}{D} + \sqrt{1 + \left( \frac{L}{D} \right)^2} \right]}$$

$$F = \frac{3.142}{0.322}$$

|                  |
|------------------|
| <b>F = 9.742</b> |
|------------------|

|                                                                                                                                    |                       |  |                  |          |             |
|------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|------------------|----------|-------------|
| Calculation Sheet<br><br>2 of 3                                                                                                    | <b>ALDI STORES UK</b> |  | <b>BSL</b>       |          |             |
|                                                                                                                                    | Ruthin Road, Wrexham  |  |                  |          |             |
|                                                                                                                                    | C2917                 |  |                  |          |             |
| Falling Head Permeability in accordance with BS 5930<br><br>Borehole WS02                                                          |                       |  | Date: 09/12/2015 | By: TH   | Checked: JD |
| At time = 10 mins ( $t_1$ ) Depth to water = 0.75<br><br>Depth to base of borehole = 2.45<br><br>Depth of Water ( $H_1$ ) = 1.7    |                       |  | $t_1$            | 600 sec  |             |
| At time = 60 mins ( $t_2$ ) Depth to water = 0.752<br><br>Depth to base of borehole = 2.45<br><br>Depth of Water ( $H_2$ ) = 1.698 |                       |  | $t_2$            | 3600 sec |             |
| $k = \frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$                                                                                   |                       |  |                  |          |             |
| $k = \frac{1.8241}{29227.17} \ln \frac{1.7}{1.698}$                                                                                |                       |  |                  |          |             |
| <div style="border: 1px solid black; padding: 2px; display: inline-block;"> <b>k = 7.35E-08 m/s</b> </div>                         |                       |  |                  |          |             |

|                                          |     |   |                                   |             |                    |         |
|------------------------------------------|-----|---|-----------------------------------|-------------|--------------------|---------|
| <b>Variable head permeability test</b>   |     |   | Site:                             | Ruthin Road | Location:          | Wrexham |
| Depth below top of casing/standpipe to:  |     |   | Job No:                           | C2917       | Borehole No:       | BH03    |
|                                          |     |   | Date:                             | 08/12/2015  | Sheet:             | 1 of 1  |
| (a) bottom of borehole:                  | 5.5 | m | Ground level<br>(m Aod)           |             | Crew:              | TH      |
| (b) bottom of casing:                    | 5.0 | m |                                   |             |                    |         |
| (c) top of filter material:              |     | m | Weather:                          |             | Rain/Drizzle       |         |
| (d) centre of piezometer tip:            |     | m | Type of Test:                     |             | Falling Head       |         |
| (e) initial groundwater level:           |     | m | Diameter of casing/standpipe (mm) |             |                    | 152.4   |
| Height of casing/standpipe above surface | 0.3 | m | Length of filter (mm)             |             | Dia of filter (mm) |         |
| Elevation of casing/standpipe (Aod)      |     | m |                                   |             |                    |         |

| Test Record:                                                              |                    |                          |      |                    |                          |      |                    |                          |
|---------------------------------------------------------------------------|--------------------|--------------------------|------|--------------------|--------------------------|------|--------------------|--------------------------|
| Time                                                                      | Time elapsed (min) | Depth to water level (m) | Time | Time elapsed (min) | Depth to water level (m) | Time | Time elapsed (min) | Depth to water level (m) |
|                                                                           | 0                  | 1.270                    |      | 25                 | 2.460                    |      |                    |                          |
|                                                                           | 0.5                | 1.350                    |      | 30                 | 2.570                    |      |                    |                          |
|                                                                           | 1                  | 1.430                    |      | 40                 | 2.820                    |      |                    |                          |
|                                                                           | 2                  | 1.490                    |      | 50                 | 3.030                    |      |                    |                          |
|                                                                           | 3                  | 1.570                    |      | 60                 | 3.220                    |      |                    |                          |
|                                                                           | 4                  | 1.640                    |      |                    |                          |      |                    |                          |
|                                                                           | 5                  | 1.680                    |      |                    |                          |      |                    |                          |
|                                                                           | 6                  | 1.730                    |      |                    |                          |      |                    |                          |
|                                                                           | 7                  | 1.790                    |      |                    |                          |      |                    |                          |
|                                                                           | 8                  | 1.830                    |      |                    |                          |      |                    |                          |
|                                                                           | 9                  | 1.870                    |      |                    |                          |      |                    |                          |
|                                                                           | 10                 | 1.920                    |      |                    |                          |      |                    |                          |
|                                                                           | 15                 | 2.110                    |      |                    |                          |      |                    |                          |
|                                                                           | 20                 | 2.280                    |      |                    |                          |      |                    |                          |
| Remarks:                                                                  |                    |                          |      |                    |                          |      |                    |                          |
| Note: Depth to water level to be measured from top of casing or standpipe |                    |                          |      |                    |                          |      |                    |                          |

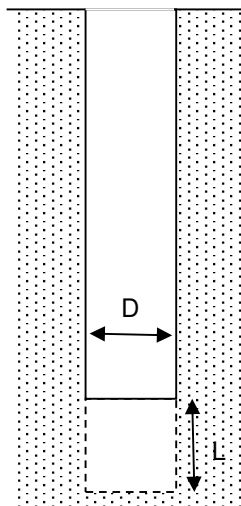
Date:  
09/12/2015

By:  
TH

Checked:  
JD

Falling Head Permeability in accordance with BS 5930

Calculation of Intake Factor (F)



Area of base

$$A = 1.8241 \text{ m}^2$$

Diameter

$$D = 152.4 \text{ mm}$$

$$1.524 \text{ m}$$

Length

$$L = 500 \text{ mm}$$

$$0.5 \text{ m}$$

$$F = \frac{2 \pi L}{\ln \left[ \frac{L}{D} + \sqrt{1 + \left( \frac{L}{D} \right)^2} \right]}$$

$$F = \frac{3.142}{0.322}$$

|                  |
|------------------|
| <b>F = 9.742</b> |
|------------------|

|                                                            |                      |                  |          |             |
|------------------------------------------------------------|----------------------|------------------|----------|-------------|
| Calculation Sheet<br><br>3 of 3                            | ALDI STORES UK       |                  | BSL      |             |
|                                                            | Ruthin Road, Wrexham |                  |          |             |
|                                                            | C2917                |                  |          |             |
|                                                            |                      | Date: 09/12/2015 | By: TH   | Checked: JD |
| Falling Head Permeability in accordance with BS 5930       |                      |                  |          |             |
| Borehole WS07                                              |                      |                  |          |             |
| At time = 10 mins (t <sub>1</sub> ) Depth to water = 0.538 |                      | t <sub>1</sub>   | 600 sec  |             |
| Depth to base of borehole = 1.5                            |                      |                  |          |             |
| Depth of Water (H <sub>1</sub> ) = 0.962                   |                      |                  |          |             |
| At time = 60 mins (t <sub>2</sub> ) Depth to water = 0.545 |                      | t <sub>2</sub>   | 3600 sec |             |
| Depth to base of borehole = 1.5                            |                      |                  |          |             |
| Depth of Water (H <sub>2</sub> ) = 0.955                   |                      |                  |          |             |
| k = $\frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$           |                      |                  |          |             |
| k = $\frac{1.8241}{29227.17} \ln \frac{0.962}{0.955}$      |                      |                  |          |             |
| k = 4.56E-07 m/s                                           |                      |                  |          |             |



## **APPENDIX D Limitations**

## **Standard Limitations**

This ground investigation was conducted and has been prepared for the sole internal use and reliance Aldi Stores Ltd and their appointed consultants SWF Consulting Ltd. This report shall not be relied upon or transferred to any other parties without the express written authorisation of BSL. If an unauthorised third party comes into possession of this report they rely on it at their risk and the authors owe them no duty of care or skill.

The investigation carried out on the site has been conducted to provide the best information and assessment on the ground conditions within site access and budgetary constraints. Exploratory holes only investigate a small area in relation to the overall site area and can therefore only provide a general indication of overall site conditions. Therefore the findings, opinions, geotechnical and environmental recommendations within this report are based on the ground conditions encountered at each location. It should be noted that different ground conditions may exist that have not been identified within this investigation.

The occurrence of and depths to groundwater may vary seasonally due to changes in weather, it should be noted that any observations and recommendations made on groundwater within this report are based on a select number of site visits over a limited period of time and may not be fully representative of groundwater conditions on the site.

Current UK guidance and legislation has been used in the geotechnical and environmental assessment of the site, BSL is not liable for any subsequent changes in the guidance and legislation.

The recommendations within this report are based upon the proposed site end use provided to BSL at the time of the investigation. If the end use or development layout changes from the proposal then the recommendations may change or become invalid.

Although every effort has been made to position exploratory holes in the least sensitive areas of the site, exploratory hole positions were located approximately as part of this investigation and no guarantee can be given as to their accuracy. Consideration should be given to the possibility that exploratory holes excavated as part of this investigation and indeed any previous ground investigation work by others may be encountered beneath or within the influence of individual foundations. BSL cannot be held responsible for structural failures caused by the location of foundations of any form of structure within the influence of exploratory holes.

No existing manhole covers were lifted or drainage runs inspected during the course of this ground investigation. The site plans enclosed in this report should not be scaled off.