

LAND AT WARREN HALL, BROUGHTON,  
FLINTSHIRE

Agricultural Land Classification

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## LAND AT WARREN HALL, BROUGHTON: Agricultural Land Classification and Soil Resource Survey

### 1. INTRODUCTION

This report provides detailed information on the agricultural land quality within land to the south west of the village of Broughton, Flintshire. The survey area is approximately 80 ha in extent and is centred on OS Grid Reference SJ 324 625.

### 2. SITE DESCRIPTION

#### 2.1 Altitude & Relief

The survey area is generally gently undulating with a general slope from west to east at an altitude of approximately 80 mAOD falling to 40 mAOD. However, a number of valley features are present with gradients being the largest in the centre and east of the survey area. Gradients within some of these areas are in excess of 7° and hence constitute a limitation to the agricultural usage of the site.

#### 2.2 Climate

Climate affects the grading of land through the assessment of an overall climatic limitation and also through interactions with soil characteristics. The key climatic variables used for grading this site are given in Table 1 and were obtained from the published 5 km grid dataset using the standard interpolation procedures (Meteorological Office, 1989).

**Table 1 Climatic & Altitude Data**

Grid reference	SJ 324 625
Altitude (mAOD)	60
Accumulated temperature (day °C Jan - June)	1404
Average annual rainfall (mm)	769
Field capacity days (days)	174
Moisture deficit, wheat (mm)	95
Moisture deficit, potatoes (mm)	83
Overall climatic grade	1

The climatic criteria are considered first when classifying land as climate can be overriding irrespective of favourable site or soil conditions. The main parameters used in the assessment of an overall climatic limitation are average annual rainfall and accumulated temperature. The combination of rainfall and temperature at the two survey areas result in no limitation to the agricultural quality of the land.

### **2.3 Published Soils Information**

The 1:250 000 scale reconnaissance soil map of the area (Soil Survey, 1983) shows the majority of the survey area to be mapped as soils of the Brickfield Association with a very small area of Salop Association soils in the north east corner. Brickfield Association soils are briefly described by the Soil Survey (1983) as 'Slowly permeable seasonally waterlogged fine loamy, fine loamy over clayey and clayey soils'. Salop Association soils are described as 'Slowly permeable seasonally waterlogged reddish fine loamy over clayey, fine loamy and clayey soils associated with fine loamy over clayey soils with slowly permeable subsoils and slight seasonal waterlogging' (Soil Survey, 1983).

The survey area has been previously surveyed by the ADAS (Statutory) Resource Planning Team in 1992 following a previous survey in 1988. The 1988 survey was prior to the introduction of the revised guidelines and criteria for grading the quality of agricultural land issued by the Ministry of Agriculture, Fisheries and Food in October 1988. The re-survey in 1992 was carried out in accordance to the revised guidelines. This survey found the area to be a mix of Subgrade 3a, 3b and Grade 4 quality land but the boundaries in some areas were not able to be definitively defined due to time constraints.

### **2.4 Land Use**

At the time of the survey the agricultural land comprised grassland being grazed by sheep. Land within the north eastern field had been disturbed during the works for the construction of a roundabout.

### 3. SURVEY METHODS

The survey was undertaken on 19th to 21st March 2019. Soil profiles were examined using a hand auger and/or spade to a depth of 120 cm where possible. The fieldwork was conducted at a detailed density of at least one auger boring per hectare on a 100 m grid based on the Ordnance Survey intersections and were located using a hand held GPS device (Figure 1 and Appendix I). Soil pits were dug in representative soil types (Appendix II) to assess subsoil structure and allow the preparation of a statement of soil physical characteristics (Appendix III).

### 4. SOIL PHYSICAL CHARACTERISTICS

This survey showed the site to contain very variable soils all of which showed evidence of gleying and mottling usually within all the soil horizons, including the topsoil. The texture of the topsoil across the survey area was also very variable with many of the textures being very close to borderlines between adjacent textures within the textural triangle (sand, silt and clay fractions), as was found from laboratory analysis on samples from the 1992 ADAS survey. Hence definitive topsoil textures are sometimes not given where it was difficult to accurately assign a single texture to a sample. However, the survey area has been assessed to comprise four main soil types but within these main soil types transitional soils having the characteristics of more than one soil type were found. The statement of soil physical characteristics of the main soil types is given at Appendix III.

#### 4.1 *Soil Type 1*

*Soil Type 1* is the most widespread soil type across the survey area and comprised a non-calcareous, very slightly stony, topsoil with various textures but predominantly medium clay loam or sandy clay loam. The stones are of mixed lithology but mostly comprise quartzite and sandstone fragments which vary in size from small to medium sized but are occasionally large. The topsoil is usually mottled or has numerous rusty root channels. The topsoil overlies a clay textured upper subsoil which is mottled and gleyed with a moderately developed coarse to very coarse angular blocky structure and hence constitutes a slowly permeable layer. The upper subsoil overlies a further clay textured lower subsoil which is also mottled and gleyed. This lower subsoil also constitute a slowly permeable layer having a moderately developed very coarse prismatic structure. The colours within

the subsoil horizons was very variable but always indicated that the horizons were gleyed and mottled. Therefore soil profiles of this soil type are generally poorly drained and are assessed as Wetness Class IV.

#### **4.2** *Soil Type 2*

*Soil Type 2* comprises a very slightly stony, usually mottled or with rusty root channels, variably textured topsoil which was predominantly sandy clay loam or medium sandy loam. A very slightly stony, sandy clay loam upper subsoil was gleyed and mottled but did not constitute a slowly permeable layer having a moderately developed coarse to very coarse sub-angular blocky structure with sufficient pores and fissures to allow drainage. This upper subsoil overlay a clay textured lower subsoil which had a moderately developed coarse prismatic structure and few bio-pores and so constituted a slowly permeable layer. Hence soil profiles of this soil type were generally assessed as Wetness Class III.

#### **4.3** *Soil Type 3*

This soil type was limited in extent and has a medium clay loam or sandy clay loam topsoil which overlies an upper subsoil similar to Soil Type 2. This upper subsoil in turn overlies a further sandy clay loam lower subsoil horizon. The upper subsoil was found to be permeable but the lower subsoil was weakly developed with very coarse sub-angular peds with few bio-pores and hence constituted a slowly permeable layer. Therefore profiles of this soil type were generally assessed as Wetness Class III.

#### **4.4** *Soil Type 4*

Soil Type 4 was also limited in extent within the survey area and was generally sandier than all other soil types. A very slightly stony sandy loam topsoil overlies a medium sandy loam or loamy medium sand upper subsoil which in turn overlies a medium sand lower subsoil. Therefore this soil type was better drained than the other soil types and was assessed as Wetness Class I or II.

## 5. AGRICULTURAL LAND CLASSIFICATION

The quality of the agricultural land within the proposed site was assessed using the revised guidelines and criteria for grading the quality of agricultural land issued by the Ministry of Agriculture, Fisheries and Food (MAFF, 1988). Agricultural Land Classification provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use. Land is graded on a scale of 1 to 5 with Grade 3 being sub-divided into Subgrades 3a and 3b. The descriptions of the different grades of land used by MAFF are:

Grade 1 - excellent quality agricultural land

Grade 2 - very good quality agricultural land

Subgrade 3a - good quality agricultural land

Subgrade 3b - moderate quality agricultural land

Grade 4 - poor quality agricultural land

Grade 5 - very poor quality agricultural land

Land of Grades 1, 2 and Subgrade 3a are described as 'Best and Most Versatile' land.

Auger boring information for each sample point (Figure 1) is shown at Appendix I and soil pit profile descriptions are given at Appendix II. The agricultural land classification and extent of each grade or subgrade is shown at Figure 2.

The main limiting factor for the quality of the agricultural land within the survey area is wetness and workability but at a few sample points droughtiness was found to limit land quality. Additionally in a few locations slopes in excess of 7° were found and hence gradient in these areas was limiting for the quality of the land.

### 5.1 Subgrade 3a (Good quality agricultural land)

Land of Subgrade 3a quality is mainly associated with *Soil Types 2, 3 and 4*. *Soil Types 2 and 3* are generally assessed as Wetness Class III which together with the prevailing climate and the topsoil textures results in a moderate wetness and workability limitation restricting such profiles to Subgrade 3a quality (Figure 2).



Profiles of *Soil Type 4* have a moderate droughtiness limitation which restricts such soil profiles to Subgrade 3a quality. Within areas mapped as Subgrade 3a there may be some small areas of better quality land, however, these areas were too small to be mapped separately.

**5.2 Subgrade 3b** (Moderate quality agricultural land)

Profiles of *Soil Type 1* have slowly permeable subsoil horizons which are gleyed and mottled and are poorly drained. These profiles are assessed as Wetness Class IV which together with the prevailing climate and the topsoil textures results in a significant wetness and workability limitation restricting such profiles to Subgrade 3b quality (Figures 2).

**5.3 Grade 5** (Very poor quality agricultural land)

Land of Grade 5 quality is mapped in the north east where soil mounds with complicated micro-topography preclude the use of the land for any other purpose than grazing (Figure 2).

**5.4 Non-agricultural**

Areas mapped as non-agricultural land (Figure 2) are woodlands and woodland with a pond in the north and along the Warren Dingles in the south. Additionally an area of stones laid for hard standing in the north east during the construction of the roundabout is also mapped as non-agricultural land.

**6. REFERENCES**

Meteorological Office (1989)

Climatological Data for Agricultural Land Classification. Meteorological Office:  
Bracknell.

Ministry of Agriculture, Fisheries and Food (1988)

Agricultural Land Classification of England and Wales: Revised guidelines and  
criteria for grading the quality of agricultural land. MAFF: London.

Soil Survey of England and Wales (1983)

Sheet 2, Soils of Wales. 1 : 250 000 Scale. SSEW: Harpenden.

**APPENDIX I**

**Field Data: Hand Auger Borings**

Field data : Hand auger borings

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
1	0 – 22	FSL	10YR4/3	Rusty root channels	3	Soil Type 4 Wetness Class I/II Drought
	22 - 53	SCL	10YR5/3, 7.5YR4/6	MPOM	5	
	53 - 60 60+ Impenetrable	MSL	10YR5/3	MPOM	5	
2						Non-agricultural Disturbed, stone hard standing
3	0 – 32	SCL/MSL	10YR4/3	-	3	Soil Type 4 Wetness Class I Drought
	32 - 50 50+ Impenetrable	LMS	10YR6/2	CDOM	5	
4	0 – 32	MCL	7.5YR4/2	Rusty root channels	1	Soil Type 1 Wetness Class IV Wetness Few Mn
	32 - 120	HCL	10YR5/3, 5/6	VMPOM	2	
5	0 – 25	HCL	10YR4/3	Rusty root channels	1	Soil Type 1 Wetness Class IV Wetness Few Mn
	25 - 120	C	5YR5/6, 5/2	CDOM	2	
6	0 – 32	MSL	10YR4/3	Rusty root channels	3	Soil Type 2 Wetness Class II/ III Wetness
	32 - 75 75 - 120	SCL C(S)	10YR6/4, 5/6 10YR5/3, 7.5YR4/6	VMPOM VMPOM	5 5	
7	0 – 30	MSL	10YR4/3	Rusty root channels	4	Soil Type 2 Wetness Class III Wetness Few Mn Few Mn
	30 - 60 60 - 120	SCL C	10YR5/3, 5/6 10YR5/2, 7.5YR4/6	VMPOM VMPOM	5 5	
8						Non-agricultural Disturbed, excavation and rubble
9	0 – 35	SCL	10YR4/3	Rusty root channels	3	Soil Type 1 Wetness Class IV Wetness Few Mn
	35 - 120	C	5YR5/3, 5/6	VMPOM	5	
10	0 – 30	SCL	10YR4/2	Rusty root channels	1	Soil Type 2 Wetness Class IV Wetness
	30 - 45 45 - 120	SCL/MSL C + MS inclusions	10YR5/3, 6/4 10YR6/4, 7.5YR4/6	MPOM VMPOM	2 2	

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
11	0 – 25	C	10YR4/2	Rusty root channels	1	Soil Type 1 Wetness Class IV Wetness Few Mn
	25 - 60 60+ Impenetrable	C	10YR6/2, 5/6	VMPOM	5	
12	0 – 29	MCL	10YR4/3	Rusty root channels	2	Soil Type 3 Wetness Class III Wetness
	29 - 52 52 - 120	SCL SCL	10YR5/3 10YR5/3, 5/6	CDOM MPOM	2 2	
13	0 – 26	FSL/MCL	7.5YR4/3	Rusty root channels	2	Soil Type 2 Wetness Class III Wetness Few Mn
	26 - 58 58 - 120	SCL C	10YR5/3, 5/6 7.5YR4/6, 10YR5/2	VMPOM VMPOM	5 5	
14	0 – 22	MSL	7.5YR4/3	Rusty root channels	3	Soil Type 1 Wetness Class IV Wetness Few Mn
	22 - 70 70+ Impenetrable	C	7.5YR6/2, 4/6	VMPOM	5	
15						Disturbed. Soil Mound
16	0 – 26	SCL	10YR4/3	Rusty root channels	3	Soil Type 1 Wetness Class IV Wetness Few Mn
	26 - 55 55+ Impenetrable	C	10YR5/2, 4/6	VMPOM	8	
17	0 – 27	SZL/SCL	10YR4/3	CDOM	3	Soil Type 2 Wetness Class III Wetness
	27 - 55 55 - 120	SCL C + MS inclusions	10YR6/4, 5/6 7.5YR5/6, 5/3, 5YR4/4	VMPOM VMPOM	5 5	
18	0 – 30	MSL	10YR4/3	-	5	Soil Type 2 Wetness Class III Drought
	30 - 40	SCL	10YR5/3, 5/6	VMPOM	5	
	40 - 62	LMS	10YR5/3	MPOM	10	
	62 - 90 90+ Impenetrable	C	7.5YR5/6, 10YR6/4	VMPOM	5	
19						Non-agricultural Woodland
20						Non-agricultural Woodland

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
21	0 – 23	HCL	10YR4/3	Rusty root channels	2	Soil Type 1 Wetness Class IV Wetness
	23 - 62	C	10YR6/2, 5/6	VMPOM	2	
	62 - 120	LMS	10YR6/2	VMPOM	2	
22						Non-agricultural Woodland and pond
23						Non-agricultural Woodland and pond
24	0 – 32	MCL	10YR4/2	Rusty root channels	5	Soil Type 3 Wetness Class IV Wetness
	32 - 63	HCL	10YR5/2, 5YR4/6	VMPOM	5	
	63 - 72	SCL	10YR5/6	CDOM	10	
	72+ Impenetrable					
25	0 – 25	MCL	10YR4/3	Rusty root channels	3	Soil Type 3 Wetness Class III Wetness Signs of disturbance
	25 - 50	SCL/MCL	10YR5/2, 5/6	MPOM	5	
	50 - 60	SCLHCL	10YR5/2	MPOM	10	
	60+ Impenetrable					
26	0 – 35	MSL/MCL	10YR4/3	-	3	Soil Type 1 Wetness Class IV Wetness
	35 - 120	C	5YR5/3, 5/6	VMPOM	5	
27	0 – 26	MSL/SCL	7.5YR4/3	-	3	Soil Type 2 Wetness Class III Wetness and Drought
	26 - 56	SCL	10YR6/4	CDOM	5	
	56 - 80	C	10YR6/4, 7.5YR5/6, 5/2	VMPOM	5	
	80+ Impenetrable					
28	0 – 28	MSL	7.5YR4/2	-	4	Soil Type 4 Wetness Class I Drought
	28 - 50	MSL	10YR6/4, 7.5YR3/4	-	5	
	50 - 60	Small stones	7.5YR3/4	-	85	
	60+ Impenetrable					

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
29	0 – 30	SCL	10YR5/3	Rusty root channels	5	Soil Type 3 Wetness Class III Wetness and Drought
	30 - 55	SCL + gravel	5YR3/4, 7.5YR5/6	CDOM	50	
	55 - 80 80+ Impenetrable	SCL	10YR5/3, 5/6	VMPOM	10	
30						Non-agricultural Woodland
31	0 – 36	MSL	7.5YR4/4	Rusty root channels	4	Soil Type 4 Wetness Class II Drought
	36 - 64	MSL	10YR5/3	MDOM	5	
	64 - 80 80+ Impenetrable	LMS	10YR5/2	CDOM	5	
32	0 – 25	HCL	10YR4/3, 5/6	MPOM	2	Soil Type 1 Wetness Class IV Wetness Few Mn
	25 - 92 92+ Impenetrable	C/HCL	10YR6/2, 5/6	VMPOM	5	
33	0 – 30	MCL	7.5YR4/3	Rusty root channels	2	Soil Type 3 Wetness Class III Wetness
	30 - 55	SCL	10YR5/3	CDOM	2	
	55 - 120	SCL	7.5YR5/2, 5/6	MDOM	2	
34	0 – 35	MSL/MCL	10YR4/3	Rusty root channels	2	Soil Type 2 Wetness Class III Wetness Few Mn
	35 - 50	SCL	10YR5/3, 5/6	MDOM	2	
	50 - 120	C	7.5YR5/2, 5/6	VMPOM	2	
35	0 – 30	SCL	10YR4/2	Rusty root channels	5	Soil Type 2/3 Wetness Class II Drought
	30 - 80 80+ Impenetrable	SCL	10YR5/3	CDOM	10	
36	0 – 30	SCL/MCL	10YR4/2	Rusty root channels	3	Soil Type 2 Wetness Class III Wetness Few Mn
	30 - 48	SCL	10YR5/3, 5/6	VMPOM	5	
	48 - 120	C(S)	5YR4/6, 5/2	VMPOM	5	
37	0 – 28	MCL	10YR4/3	Rusty root channels	4	Soil Type 1 Wetness Class IV Wetness Few Mn
	28 - 60	C	10YR5/3, 5/6	VMPOM	8	
	60 - 120	C	5YR4/4, 5/2	VMPOM	5	

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Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
38	0 – 35	MSL	10YR4/3	-	3	Soil Type 4 Wetness Class I Drought
	35 - 65	LMS	10YR5/2	-	3	
	65 - 120	MS	10YR5/2	-	3	
39	0 – 24	SZL/SCL	10YR5/4	-	2	Soil Type 2 Wetness Class III Wetness
	24 - 70	SCL	10YR6/4, 6/6	VMPOM	8	
	70 - 88	C	5YR4/4, 5/2, 7.5YR5/6	VMPOM	10	
	88+ Impenetrable					
40	0 – 27	MCL	10YR5/3	CDOM	2	Soil Type 1 Wetness Class IV Wetness
	27 - 60 60 - 120	C C	10YR6/3, 6/6 10YR5/1	VMPOM CDOM	Stoneless Stoneless	
41	0 – 31	MSL	7.5YR4/3	CDOM	3	Soil Type 1 Wetness Class IV Wetness
	31 - 90 90+	C	10YR6/3, 6/6	VMPOM	3	
	Impenetrable					
42	0 – 29	SZL/SCL	7.5YR4/3	CDOM	3	Soil Type 2 Wetness Class III Wetness
	29 - 78 78 - 120	SCL/C C	10YR5/3, 5/6 5YR4/4, 5/2, 7.5YR5/6	VMPOM VMPOM	5 5	
43	0 – 28	MCL	10YR5/3	CDOM	2	Soil Type 1 Wetness Class IV Wetness
	28 - 65	C	7.5YR5/6, 10YR6/4	VMPOM	Stoneless	
	65 - 120	C	5YR4/4, 5/2	VMPOM	5	
44	0 – 30	SCL	10YR4/2	CDOM	8	Soil Type 2 Wetness Class III Wetness
	30 - 62	SCL	10YR5/2	CDOM	3	
	62 - 75	SC	7.5YR5/6, 10YR5/2	MPOM	3	
	75 - 120	C	5YR4/4, 5/2, 7.5YR5/6	VMPOM	5	
45	0 – 33	SCL/MSL	7.5YR4/2	Rusty root channels	5	Soil Type 2/3 Wetness Class II Drought
	33 - 85 85+	SCL	10YR5/3	CDOM	10	
46	0 – 32	MCL	10YR4/2	Rusty root channels	2	Soil Type 1 Wetness Class IV Wetness Few Mn
	32 - 70	C	10YR5/6, 5/2	VMPOM	5	
	70 - 120	C	10YR5/3	MDOM	2	



Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
47	0 – 28	MSL	10YR4/3	Rusty root channels	2	Soil Type 1 Wetness Class IV
	28 - 60	C	10YR5/3, 5/6	VMPOM	5	Wetness Few Mn
	60 - 120	C	5YR4/4, 5/2	VMPOM	10	Few Mn
48						Non-agricultural Woodland
49	0 – 28	SCL/MCL	10YR5/3	CDOM	2	Soil Type 1 Wetness Class IV
	28 - 50	C	10YR6/3, 6/6	VMPOM	3	Wetness Few Mn
	50+ Impenetrable					
50	0 – 28	MSL	7.5YR4/3	-	2	Soil Type 4 Wetness Class I
	28 - 55	LMS	7.5YR4/4	-	2	Drought
	55 - 120	MS	7.5YR4/6	-	2	
51	0 – 28	SZL/MCL	10YR5/3	CDOM	2	Soil Type 2 Wetness Class III
	28 - 62	SCL	7.5YR5/3, 5/6	VMPOM	5	Wetness
	62 - 90	C	5YR4/4, 5/2, 7.5YR5/6	VMPOM	5	
	90+ Impenetrable					
52	0 – 30	HCL	10YR5/3	CDOM	2	Soil Type 1 Wetness Class IV
	30 - 65	C	10YR6/4, 6/6	VMPOM	2	Wetness Few Mn
	65 - 120	C	5YR4/4, 5/2, 7.5YR5/6	VMPOM	2	Few Mn
53	0 – 30	MCL	10YR4/2	CDOM	2	Soil Type 1 Wetness Class IV
	30 - 45	C	10YR6/4, 5/6	MDOM	5	Wetness Few Mn
	45 - 120	C	5YR4/4, 5/2, 7.5YR5/6	VMPOM	5	Few Mn
54	0 – 28	MCL	10YR4/3	Rusty root channels	3	Soil Type 1 Wetness Class IV
	28 - 70	C	10YR6/4, 5/6	VMPOM	5	Wetness Few Mn
	70 - 120	C	5YR4/4, 5/2	VMPOM	5	Few Mn
55	0 – 23	MCL	10YR4/3	Rusty root channels	2	Soil Type 1 Wetness Class IV
	23 - 45	C	10YR6/4, 5/6	VMPOM	3	Wetness Few Mn
	45 - 80	C	5YR4/4, 5/2	VMPOM	5	Few Mn
	80 - 120	C(FS)	10YR7/1, 7/6	VMPOM	2	

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
56	0 – 28	MCL	10YR4/3	Rusty root channels	3	Soil Type 1 Wetness Class IV Wetness Few Mn
	28 - 80	C	10YR6/4, 7.5YR5/6	VMPOM	3	
	80+ Impenetrable					
57						Non-agricultural Woodland
58	0 – 32	SCL	7.5YR4/3	CDOM	2	Soil Type 1 Wetness Class IV Wetness Few Mn
	32 - 120	C	5YR4/4	MPOM	5	
59	0 – 26	SCL/HCL	10YR4/3	CDOM	2	Soil Type 1 Wetness Class IV Wetness Few Mn
	26 - 120	C	10YR6/4, 6/6	VMPOM	2	
60						Non-agricultural Woodland
61	0 – 30	HCL	10YR5/3	CDOM	3	Soil Type 1 Wetness Class IV Wetness Few Mn
	30 - 50	C	5YR5/4, 7.5YR5/6	VMPOM	Stoneless	
	50 - 120	C	5YR4/4, 5/2, 7.5YR5/6	VMPOM	Stoneless	
62	0 – 35	MCL	10YR4/3	-	2	Soil Type 2 Wetness Class III Wetness
	35 - 65 65 - 120	SCL C	10YR5/4 10YR5/3, 5/6	- VMPOM	2 2	
63	0 – 37	SCL	10YR4/3	CDOM	2	Soil Type 2 Wetness Class III Wetness
	37 - 57	SZL/SCL	10YR5/4	CDOM	2	
	57 - 80 80+ Impenetrable	C/HCL	10YR5/3	MPOM	5	
64	0 – 30	FSL/MCL	10YR4/3	CDOM	2	Soil Type 2 Wetness Class III Wetness
	30 - 65 65 - 120	SCL C(S)	10YR5/3 10YR5/3	CDOM MPOM	2 2	
65	0 – 36	SCL	10YR4/3	-	5	Soil Type 1 Wetness Class IV Wetness
	36 - 90 90+ Impenetrable	C(S)	10YR6/4, 7.5YR5/6	VMPOM	5	

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
66	0 – 32	SCL/HCL	10YR4/3	CDOM	5	Soil Type 1 Wetness Class IV Wetness
	32 - 75	C	7.5YR5/6, 10YR6/4	VMPOM	3	
	75 - 120	C	5YR4/4, 5/2	VMPOM	5	Few Mn
67	0 – 32	SCL	10YR4/3	-	2	Soil Type 2 Wetness Class III Wetness
	32 - 50	SCL	10YR5/3	MDOM	2	
	50 - 120	C	7.5YR5/6, 10YR6/4	VMPOM	5	Sandy inclusions from 75 cm
68	0 – 28	MCL	10YR5/3	CDOM	2	Soil Type 1 Wetness Class IV Wetness
	28 - 65	C	10YR6/4, 7.5YR5/6	VMPOM	2	
	65 - 120	C	5YR4/4, 5/2	VMPOM	2	Few Mn
69						Non-agricultural Woodland
70	0 – 32	MSL/SCL	10YR4/3	-	2	Soil Type 2 Slope 9° Gradient
	32 - 75	SCL	10YR5/4	-	2	
	75+ Impenetrable					
71	0 – 30	MSL/SCL	10YR4/4	CDOM	2	Soil Type 2 Wetness Class III Wetness and Drought
	30 - 50	SCL	10YR5/3	MDOM	2	
	50 - 80	C	7.5YR5/6, 10YR6/4	VMPOM	5	Few Mn
	80+ Impenetrable					
72	0 – 30	MCL/HCL	10YR4/3	CDOM	3	Soil Type 1 Wetness Class IV Wetness
	30 - 120	C	10YR6/4, 7.5YR5/6	VMPOM	2	
73	0 – 30	MSL	10YR4/3	-	2	Soil Type 4 Wetness Class I Drought
	30 - 120	MS	10YR5/3, 4/6	CDOM	Stoneless	
74	0 – 29	MCL	10YR4/3	CDOM	2	Soil Type 1 Wetness Class IV Wetness
	29 - 65	C	10YR6/4, 7.5YR5/6	VMPOM	2	
	65 - 120	C	5YR4/4, 5/2	VMPOM	5	Few Mn
75	0 – 24	SCL	10YR4/4	CDOM	2	Soil Type 1 Wetness Class IV Wetness
	24 - 50	C	10YR6/4, 7.5YR5/6	VMPOM	2	
	50 - 120	C	5YR4/4, 5/2	VMPOM	2	Few Mn

Boring No.	Depth (cm)	Texture	Colour	Mottles	Stone content (%)	Comments
76	0 – 24	SCL	10YR4/4	CDOM	4	Soil Type 1 Wetness Class IV Wetness
	24 - 50	C	10YR6/4, 7.5YR5/6	VMPOM	5	
	50 - 120	C	5YR4/4, 5/2	VMPOM	5	Few Mn
77	0 – 35	SCL	10YR4/4	-	3	Soil Type 2 Wetness Class III Wetness
	35 - 68	SCL	10YR5/3	MDOM	5	
	68 - 90	C(S)	7.5YR5/6, 10YR6/4	VMPOM	10	Few Mn
	90+ Impenetrable					
78	0 – 24	MSL/SCL	10YR4/4	CDOM	2	Soil Type 1 Wetness Class IV Slope 8° Wetness and Gradient
	24 - 70	C	10YR6/4, 7.5YR5/6	VMPOM	2	
	70 - 120	C	5YR4/4, 5/2	VMPOM	2	Few Mn
79	0 – 28	SCL	10YR4/2	CDOM	3	Soil Type 1 Wetness Class IV Wetness
	28 - 65	C	10YR6/4, 7.5YR5/6	VMPOM	2	
	65 - 120	C	5YR4/4, 5/2	VMPOM	5	Few Mn
80	0 – 24	SCL	10YR4/4	CDOM	2	Soil Type 1 Wetness Class IV Wetness
	24 - 120	C	10YR6/4, 7.5YR5/6	VMPOM	5	Wetness Few Mn

**Appendix I: Key**

Textures:	C	Clay
	HCL	Heavy clay loam
	MCL	Medium clay loam
	SCL	Sandy clay loam
	SZL	Sandy silt loam
	MSL	Medium sandy loam
	FSL	Fine sandy loam
	LMS	Loamy medium sand
	MS	Medium sand
	(S)	Sandy
Colours:	All colours are defined according to the Munsell soil colour system (Munsell Colour Company Inc. Baltimore, Maryland 21218, USA)	
Mottles:	CDOM	Common distinct ochreous mottles
	MDOM	Many distinct ochreous mottles
	MPOM	Many prominent ochreous mottles
	VMPOM	Very many prominent ochreous mottles
Stones:	Stones were small to medium with occasional large quartzite pebbles and sandstone fragments.	
Mn:	Mn refers to ferri-manganiferous concentrations	

**APPENDIX II**

**Soil Pit Data**

**Pit 1:** Slope - 5° North  
Land use – Grass

Depth (cm)	Texture	Colour	Mottles	Stone Content	Structure	Pores	Consistence	Structural Condition	Roots	Calcium Carbonate Content	Manganese	Horizon Boundary
0 – 29	Medium clay loam	10YR4/3 (Brown)	Common rusty root channels	2% small to medium rounded quartzite plus sub-angular sandstone fragments	-	-	-	-	Abundant very fine to fine	Non-calcareous	-	Clear, smooth
29 - 52	Sandy clay loam	10YR5/3 (Brown)	Common distinct ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	Moderately developed coarse to very coarse sub-angular blocky	>0.5%	Friable	Moderate	Common very fine to fine	Non-calcareous	-	Clear, smooth
52 -80+	Sandy clay loam	10YR5/3, 5/6 (Brown, yellowish brown) Ped faces 10YR5/2 (greyish brown)	Many prominent ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	Weakly developed very coarse sub-angular blocky	<0.5%	Firm	Poor	Few very fine to fine	Non-calcareous	-	

Soil Type 3

Wetness Class III

ALC Grade: Subgrade 3a

Main limiting factor: Wetness and workability

**Pit 2:** Slope - 1° South east  
Land use – Grass

Depth (cm)	Texture	Colour	Mottles	Stone Content	Structure	Pores	Consistence	Structural Condition	Roots	Calcium Carbonate Content	Manganese	Horizon Boundary
0 – 35	Medium sandy loam	10YR4/3 (Brown)	None	3% small to medium rounded quartzite plus sub-angular sandstone fragments	-	-	-	-	Abundant very fine to fine	Non-calcareous	-	Clear, smooth
35 - 65	Loamy medium sand	10YR5/2 (Greyish brown)	None	3% small to medium rounded quartzite plus sub-angular sandstone fragments	Weakly developed medium sub-angular blocky	>0.5%	Firm	Moderate	Common very fine to fine	Non-calcareous	-	Clear, smooth
65 - 80+	Medium sand	10YR5/2 (Greyish brown)	None	3% small to medium rounded quartzite plus sub-angular sandstone fragments	Single grain	-	Loose	Moderate	Non-calcareous	Slightly calcareous	-	

Soil Type 4

Wetness Class I

ALC Grade: Subgrade 3a

Main limiting factor: Droughtiness



**Pit 3:** Slope - 5° South  
Land use – Grass

Depth (cm)	Texture	Colour	Mottles	Stone Content	Structure	Pores	Consistence	Structural Condition	Roots	Calcium Carbonate Content	Manganese	Horizon Boundary
0 – 30	Medium clay loam/Heavy clay loam	10YR5/3 (Brown)	Common distinct ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	-	-	-	-	Abundant very fine to fine	Non-calcareous	-	Abrupt, smooth
30 - 65	Clay	10YR6/4, 6/6 (Light yellowish brown, brownish yellow)	Very many prominent ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	Moderately developed coarse to very coarse angular blocky	<0.5%	Firm	Poor	Common very fine to fine	Non-calcareous	Few Mn	Clear, smooth
65 -80+	Clay	5YR4/4, 5/2, 7.5YR5/6 (Reddish brown, reddish grey, strong brown)	Very many prominent ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	Moderately developed very coarse prismatic	<0.5%	Firm	Poor	Few very fine to fine	Non-calcareous	Few Mn	

Soil Type 1

Wetness Class IV

ALC Grade: Subgrade 3b

Main limiting factor: Wetness and workability

**Pit 4:** Slope - 2° South  
Land use – Grass

Depth (cm)	Texture	Colour	Mottles	Stone Content	Structure	Pores	Consistence	Structural Condition	Roots	Calcium Carbonate Content	Manganese	Horizon Boundary
0 – 30	Fine sandy loam/Medium clay loam	10YR4/3 (Brown)	Common distinct ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	-	-	-	-	Abundant very fine to fine	Non-calcareous	-	Clear, smooth
30 - 65	Sandy clay loam	10YR5/3 (Brown)	Common distinct ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	Moderately developed coarse to very coarse sub-angular blocky	>0.5%	Firm	Moderate	Common very fine to fine	Non-calcareous	-	Clear, smooth
65 -80+	Clay + sandy lenses	10YR5/3 (Brown)	Many prominent ochreous mottles	2% small to medium rounded quartzite plus sub-angular sandstone fragments	Moderately developed coarse prismatic	<0.5%	Firm	Poor	Few very fine to fine	Non-calcareous	-	

Soil Type 2

Wetness Class III

ALC Grade: Grade 2/Subgrade 3a

Main limiting factor: Wetness and workability

**APPENDIX III**

**Statement of Soil Physical Characteristics**

## Statement of Soil Physical Characteristics

### Soil Type 1

#### Topsoil

Texture	Variable, mainly medium clay loam or sandy clay loam
Colour	Variable, mainly 10YR4/3, brown or 10YR5/3, brown
Mottles	Common rusty root channels or common distinct ochreous mottles
Stones	Very slightly stony (typically 2%, range 1 - 5%), small to occasionally large quartzite plus sandstone fragments
Roots	Abundant very fine to fine
Calcium carbonate	Non-calcareous
Boundary	Abrupt, smooth
Depth	28 cm (Median thickness 28 cm, range 22 - 36 cm)

#### Upper Subsoil

Texture	Clay
Colour	Variable, mainly 10YR6/4, light yellowish brown plus 7.5YR5/6, strong brown
Mottles	Very many prominent ochreous mottles
Stones	Very slightly stony (typically 3%, range 0 - 8%), small to occasionally large quartzite plus sandstone fragments
Structure	Moderately developed coarse to very coarse angular blocky
Consistence	Firm
Structural Condition	Poor
Pores	<0.5%
Roots	Common very fine to fine
Calcium carbonate	Non-calcareous
Manganese	Few
Boundary	Clear, smooth
Depth	66 cm (Median thickness 38 cm, range 15 - 96 cm)

#### Lower Subsoil

Texture	Clay
Colour	5YR4/4, 5/2 reddish brown, reddish grey
Mottles	Very many prominent ochreous mottles
Stones	Very slightly stony (typically 5%, range 0 - 10%), small to occasionally large quartzite plus sandstone fragments
Structure	Moderately developed very coarse prismatic
Consistence	Firm
Structural Condition	Poor
Pores	<0.5% biopores
Roots	Few very fine to fine
Calcium carbonate	Non-calcareous
Manganese	Few

**Soil Type 2****Topsoil**

Texture	Variable, mainly sandy clay loam or medium sandy loam
Colour	Variable, mainly 10YR4/3, brown or 10YR4/2, dark greyish brown
Mottles	None to common rusty root channels or common distinct ochreous mottles
Stones	Very slightly stony (typically 2%, range 1 - 8%), small to occasionally large quartzite plus sandstone fragments
Roots	Abundant very fine to fine
Calcium carbonate	Non-calcareous
Boundary	Abrupt, smooth
Depth	30 cm (Median thickness 30 cm, range 24 - 37 cm)

**Upper Subsoil**

Texture	Sandy clay loam
Colour	Variable, mainly 10YR5/3, brown or 10YR6/4, light yellowish brown
Mottles	Common to very many prominent ochreous mottles
Stones	Very slightly stony (typically 5%, range 2 - 8%), small to occasionally large quartzite plus sandstone fragments
Structure	Moderately developed coarse to very coarse sub-angular blocky
Consistence	Firm
Structural Condition	Moderate
Pores	>0.5%
Roots	Common very fine to fine
Calcium carbonate	Non-calcareous
Manganese	None
Boundary	Clear, smooth
Depth	60 cm (Median thickness 30 cm, range 15 - 49 cm)

**Lower Subsoil**

Texture	Clay
Colour	Variable, 7.5YR5/2, 5/6, brown, strong brown or 5YR4/4, reddish brown
Mottles	Very many prominent ochreous mottles
Stones	Very slightly stony (typically 5%, range 0 - 10%), small to occasionally large quartzite plus sandstone fragments
Structure	Moderately developed coarse prismatic
Consistence	Firm
Structural Condition	Poor
Pores	<0.5% biopores
Roots	Few very fine to fine
Calcium carbonate	Non-calcareous
Manganese	None to few

**Soil Type 3****Topsoil**

Texture	Medium clay loam occasionally sandy clay loam
Colour	Variable, mainly 10YR4/3, brown
Mottles	Common rusty root channels
Stones	Very slightly stony (typically 3%, range 2 - 5%), small to occasionally large quartzite plus sandstone fragments
Roots	Abundant very fine to fine
Calcium carbonate	Non-calcareous
Boundary	Clear, smooth
Depth	30 cm (Median thickness 30 cm, range 25 - 32 cm)

**Upper Subsoil**

Texture	Sandy clay loam
Colour	Variable, mainly 10YR5/3, brown
Mottles	Common to very many prominent ochreous mottles
Stones	Very slightly stony (typically 5%, range 2 - 50%), small to occasionally large quartzite plus sandstone fragments
Structure	Moderately developed coarse to very coarse sub-angular blocky
Consistence	Friable
Structural Condition	Moderate
Pores	>0.5%
Roots	Common very fine to fine
Calcium carbonate	Non-calcareous
Manganese	None
Boundary	Clear, smooth
Depth	55 cm (Median thickness 25 cm, range 23 - 31 cm)

**Lower Subsoil**

Texture	Sandy clay loam
Colour	Variable, mainly 10YR5/3, 5/6, brown, yellowish brown
Mottles	Common to very many prominent ochreous mottles
Stones	Slightly stony (typically 10%, range 2 - 10%), small to occasionally large quartzite plus sandstone fragments
Structure	Weakly developed very coarse sub-angular blocky
Consistence	Firm
Structural Condition	Poor
Pores	<0.5% biopores
Roots	Few very fine to fine
Calcium carbonate	Non-calcareous
Manganese	None

**Soil Type 4****Topsoil**

Texture	Medium sandy loam occasionally fine sandy loam
Colour	Variable, mainly 10YR4/3, brown
Mottles	None to common rusty root channels
Stones	Very slightly stony (typically 3%, range 2 - 4%), small to occasionally large quartzite plus sandstone fragments
Roots	Abundant very fine to fine
Calcium carbonate	Non-calcareous
Boundary	Clear, smooth
Depth	30 cm (Median thickness 30 cm, range 22 - 36 cm)

**Upper Subsoil**

Texture	Loamy medium sand or medium sandy loam
Colour	Variable, mainly 10YR5/3, brown
Mottles	None to many prominent ochreous mottles
Stones	Very slightly stony (typically 5%, range 0 - 5%), small to occasionally large quartzite plus sandstone fragments
Structure	Weakly developed medium sub-angular blocky
Consistence	Firm
Structural Condition	Moderate
Pores	>0.5%
Roots	Common very fine to fine
Calcium carbonate	Non-calcareous
Manganese	None
Boundary	Clear, smooth
Depth	58 cm (Median thickness 28 cm, range 18 - 90 cm)

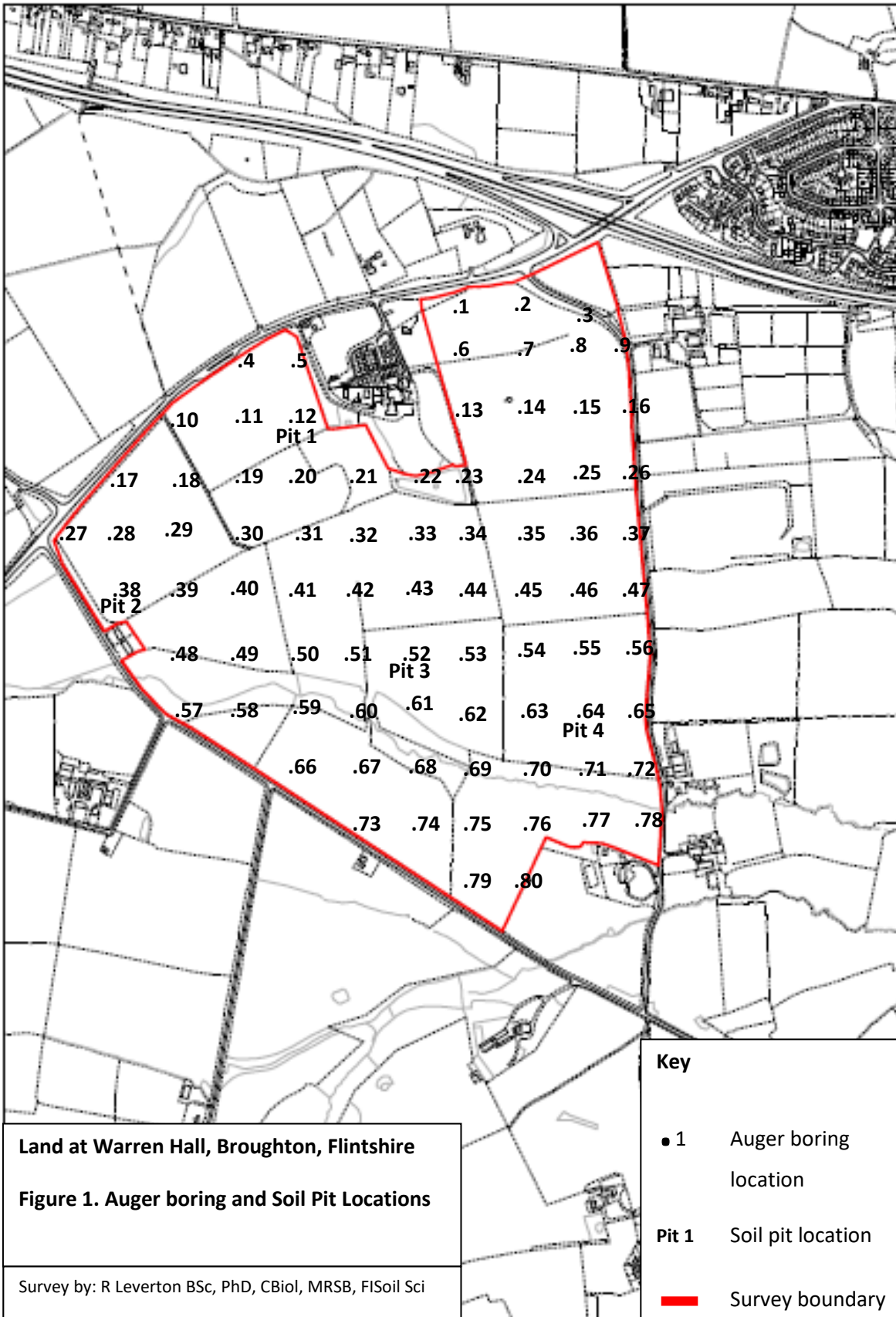
**Lower Subsoil**

Texture	Medium sand or loamy medium sand
Colour	Variable, mainly 10YR5/2, greyish brown
Mottles	None to many prominent ochreous mottles
Stones	Very slightly stony (typically 4%, range 2 - 5%), small to occasionally large quartzite plus sandstone fragments
Structure	Single grain
Consistence	Loose
Structural Condition	Moderate
Roots	Few very fine to fine
Calcium carbonate	Non-calcareous
Manganese	None

**FIGURE 1**

**Auger Boring and Soil Pit Locations**





**Figure 2**

**Agricultural Land Classification**

