

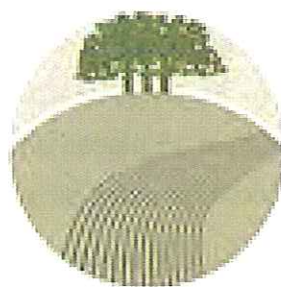
Revised

Anwyl Construction Limited
Land off Ash Lane, Mancot, Flintshire

Agricultural Land Quality and the Soil Resource

Reading Agricultural Consultants Ltd

May 2010



1. Introduction

- 1.1 Reading Agricultural Consultants Ltd (RAC) is instructed by Anwyl Construction Ltd to carry out a definitive assessment of the quality of agricultural land of approximately 6 hectares of land off Ash Lane, Mancot that has been identified for residential development in the Flintshire Unitary Development Plan.
- 1.2 This assessment of land quality has been carried out by an experienced soil surveyor in accordance with MAFF's revised guidelines and criteria for grading the quality of agricultural land (1988). An intensive survey took place on 30 April 2010, and involved observations of the soil profile using an auger and six pits dug by a local contractor. In addition, twelve soil samples were taken for laboratory analysis.
- 1.3 The soil profile was examined at eighteen locations, using a 1 cm² gouge auger to assess soil horizons for texture, colour/mottling, packing density and stones down to a depth of 1200mm. Twelve of the observations lie within the site identified for residential development in the Flintshire UDP (see Plan RAC/4913/1), with data provided in Appendix 1.
- 1.4 At six locations (also shown on Plan RAC/4913/1), a pit about 1m wide was dug to 800 mm depth. The following characteristics were assessed for each soil horizon in each pit: texture; stoniness; colours (including gley mottling, indicating seasonal wetness); density, degree of fissuring and macro-porosity (together indicating structural condition); organic matter content; presence of roots; and thickness. Data are in Appendix 2.
- 1.5 From the pits, samples of upper subsoil (250-500 mm) or lower subsoil (>500mm) were taken and analysed for pH and the nutrients, potassium, phosphate and magnesium. In areas surrounding the pits, the topsoil was sampled to a depth of 250mm in 15 places and the composite sent for analysis also of organic matter and three for sand, silt and clay.
- 1.6 Gradients were measured using a direct-reading clinometer.
- 1.7 The land is currently let out for grazing sheep and cattle. An aerial photo indicates that the eastern section was under cultivation (or reseeded) in 2006. The tenant farmer reported that there had been coal workings locally and indicated three small areas of subsidence along the western side.

2. Site and Climatic Characteristics

Pasture quality

- 2.1 The area comprises two small paddocks to the north and a larger field to the south subdivided by a temporary fence. The paddocks are permanent grass with ryegrass, unimproved grasses and weeds; the surface is badly poached. In contrast, the southern field is a good quality ryegrass-clover ley, with little indication of weeds or poaching except in the south-east (a feeding area with some bare patches). The southern boundary of the south field is a hedge; beyond is an arable field.

General features and land form

- 2.2 The site occupies a gentle (2°) north-east slope with slight undulations. The paddocks are almost level apart from a 2° slope into the south-eastern corner. The western section of the main field contains three hollows (see RAC/4913/2), though these are not wet nor currently a problem for agricultural machinery. The altitude of the land increases from 25 to 35m in the south.

Soil parent materials and permeability

- 2.3 The British Geological Society map shows complex Solid Geology overlain by *Glacial Till 'stony clay'* on the north of the site and *River Terrace Sand and Gravel* along the south. The soil survey found the red Glacial Till at undulating depth but generally within 400mm along the north-west increasing to below 1m in the south. The Till is overlain by medium loamy fairly stony and locally coarse sand.
- 2.4 To the east of the site, the subsoil is heterogeneous - interbedded red Till, grey loam and layers of coal – which suggests disturbance (possibly from previous mining operations).
- 2.5 The Till is a stiff heavy red clay with few stones, locally calcareous within 80cm. It has very firm coarse prismatic (or massive) structure. It is slowly permeable with paler ped faces and manganese mottles. The overlying yellow-brown subsoil is permeable but also shows distinct mottling/manganese. Variations in depth to Till are shown on Figure RAC/4913/5. These alter the drainage and ALC grade.

Climatic factors

- 2.6 Climatic factors affecting land quality have been interpolated from the Meteorological Office's standard 5 km gridpoint dataset at location SJ 316 665, at an altitude of 30m.

Average annual rainfall	(AAR):	740 mm
Accumulated temperature	>0°C (AT0):	1436°
Field Capacity Days	(FCD):	170 days
Moisture deficit - winter wheat	(MDw):	99 mm
Moisture deficit – potatoes	(MDp):	89 mm

- 2.7 This locality has moderate rainfall and is sufficiently warm for no direct climatic limitation on production. The potential moisture deficits in summer are lower than average but because of lower altitude, compared to other surveys carried out in the locality, this site is slightly drier (reduced FCD and increased moisture deficits).

3. Agricultural Land Quality

Limitations

- 3.1 **Wetness** Augur and pit observations indicate distinct mottling in the upper subsoil. Unless artificially drained, periodic wetness in the upper subsoil results from water accumulation above a slowly permeable layer (SPL) - which comprises either the red Till or the junction sandy clay layer overlying it. The cut off between Wetness Classes (WC) III and IV is whether a slowly permeable layer (SPL) of more than 150mm depth starts below or above 460mm [MAFF ALC guidelines, Table 8]. Pits are fully described in Appendix 2. In pit A, the SPL started at ~400mm; in pit B at 550mm; in pit C there was no SPL (thick layer of coal at 300mm); in pit D sandy loam was over an SPL at >1m; in pit E, the SPL varied from 400-600mm; and pit F, the SPL was at 300mm.
- 3.2 Where WC IV, the ALC is set as Subgrade 3b; where WC III as Subgrade 3a (or Grade 2 if the topsoil contains <18% clay, sandy loam). Where there is no SPL

within 800mm, the WC is I or II (the assumption is that the land will respond very well to under-drainage).

- 3.3 Wetness limits the Subgrade to 3b for the land along the west and north where the Till occurs at 300-500mm. The paddocks show topsoil mottling and need drain improvement. The deeper loamy soil area in the east paddock is a wet collecting zone, practically drainable and so is included with Subgrade 3b.
- 3.4 Subgrade 3a is ascribed to land in the centre where the heavy clay (Till) is deeper (up to 750mm) and, although locally it occurs within 450mm, the lack of mottling in the topsoil suggests WC III is more appropriate.
- 3.5 The remaining small area is limited to Grade 2 because of wetness and droughtiness.
- 3.6 **Drought risk** Each profile observation was subject to a calculation based on textures and stones to 1200mm, and give 105-150mm water available to wheat or 80-120mm for potatoes. Some soils to the south have stony sandy layers in the subsoil which lower the water and limit ALC to Grade 2 (see Pit D description). In pit C (east) organic topsoil overlies coal at 300-650mm. The roots appeared unable to penetrate the coal layer which restricts available water capacity to 80mm and limits the land to Subgrade 3a.
- 3.7 **Disturbance** Aerial photos suggest land disturbance in the eastern area. However, soil profiles are not obviously compacted and are locally unmottled with only thin clay layers; suggesting that a grading of Subgrade 3a is reasonable. On the western side the sinking areas are a more serious issue, although they do not prevent present utilisation (as grassland). They are incorporated into the Subgrade 3b area.
- 3.8 **Toxicity** If high levels of Potentially Toxic Elements were found in the topsoil or upper subsoil of coal affected area (east), this might cause the land to be downgraded further. However, the additional costs of laboratory analysis have not been incurred.

Agricultural Land Classification (ALC)

- 3.9 The site is classified as Subgrades 3a (good quality land) and 3b (moderate quality land), with a small tongue of Grade 2 (very good quality land), as indicated in the Table below and on Plan RAC/4913/2.

Table 1: Quality of Agricultural Land

Grade	Approximate Area (ha)	%
2	0.3	5
3a	3.0	49
3b	2.7	44
Non-agricultural	0.1	2
Total	6.1	100

- 3.10 According to the definitions of the grades within the MAFF guidelines, Subgrade 3b land is capable of producing high yields of grass or moderate yields of cereals and Subgrade 3a is capable of producing moderate to high yields of cereals (assuming that land drains are maintained). Grade 2 land is capable of growing higher value crops, but it is impractical to utilise such a small area.

4. The Soil Resource

- 4.1 The soil resource is described in terms of its potential for beneficial re-use and to inform decisions about its handling. Re-use can be in terms of environmental mitigation and/or restoration of construction sites to agricultural use, following the guidance in the recently published 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' (DEFRA, 2009).
- 4.2 For purposes of evaluation and description, soil resource is defined as topsoil and subsoil. The properties considered most relevant as indicators of 'soil quality' and constraining the future handling and beneficial re-use of soils on this land are particle-size class, organic matter (OM) content, pH and major nutrients (phosphate

(P), potassium (K) and magnesium (Mg)).

Topsoil

4.3 The topsoil is the most valuable element of the soil resource. The sand content tends to increase slightly further south but the main variation is in organic matter. Topsoil resources are shown on Plan RAC/4913/3:

- Good physical quality Type A topsoil is 250-300mm of (very) slightly stony very dark brown, granular/friable sandy clay loam or medium clay loam texture. Organic matter is high (>6% in A1 areas, slightly lower in west, A2).
- Very good physical quality Type B topsoil is 250mm of very friable, brownish-black organic clay loam (OM >10%).

4.4 The analytical results indicating "fertility" are set out at Table 2 below.

Table 2: Topsoil fertility indicators

Type	Location	% OM	pH	mg/l (available)			Index		
				P	K	Mg	P	K	Mg
A1	Pit A	6.9	5.7	14	30	147	1+	0-	3+
A1	Pit B	7.0	5.7	14	68	77	1+	1-	2+
B	Pit C	10.6	5.9	17	71	89	2-	1-	2+
A1	Pit D	7.4	6.0	21	149	78	2+	2-	2+
A2	Pit E		6.1	13	40	73	1+	0+	2-
A2	Pit F	5.3	6.2	14	88	109	1+	1+	3-

Shading : **extremely low** **very low** **lowish** **excessive**

Discussion of topsoil results

4.5 Organic matter contents are high (>5.3%) and organic (>7.5%) on the east. This results in good soil structure and nitrogen supply. pHs are slightly acid (grass should be limed to pH 6.2-6.5). Available magnesium concentrations are good but available phosphate is slightly low (except in the east) and potassium levels vary

from extremely low to low. The grass is at risk of potassium deficiency with inadequate potassium fertiliser used on this land. A PK index <2 relegates the material to 'Low Fertility Topsoil' according to the BS3882 standards (although additional laboratory tests are needed if the material is to be BS3882 certified).

Table 3: Particle Size Analysis of Topsoil

Type	Location around	Depth mm	Particle size %			Description
			Sand	Silt	Clay	
A1	Pit B	0 - 250	48	31	21	medium Clay Loam
A1	Pit D	0 - 250	53	27	20	Sandy Clay Loam
A2	Pit F	0 - 250	55	28	17	Sandy Loam *

* Hand texturing suggests sandy loam along the south but in pits A and F the topsoil hand-texture was clearly medium Clay Loam.

- 4.6 This confirms that the topsoil mainly is classed as medium textured - sandy clay loam or clay loam (in the north and west).

Estimated volumes of topsoil resource

- 4.7 The site is estimated to contain approximately 12,200 – 14,700 m³ of Type A and 2,900 m³ of Type B topsoils.

Subsoil

- 4.8 Subsoils are shown on Plan RAC/4913/4. Vigilance is needed to keep the red clay (Till) separate from the loamier or stonier material. Depths from surface to the clay can be inferred from Plan RAC/4913/5:

- Type A: Better physical quality between 200mm and 450mm of slightly or moderately stony, sandy clay loam or sandy loam. Deeper excavation will bring up clay (A2) or sand & gravel (A1 south). Type A material has potential to drain adequately if relaid with care.
- Type B: Moderate physical quality interbedded clay, loam and coal. This soil has some potential for reuse if it is well homogenised and does not contain toxins.

- Type C: Poor physical quality; red clay (few stones), with no potential for reuse. Uppermost subsoil (50 to 150mm) may be loamier but is difficult to separate.

Table 4: Subsoil fertility indicators: the first three samples are red clay, the others stony sandy clay loam except D 500-800mm which is sand and gravel.

Depth sampled mm	Location	% OM	pH	Mg/l (available)			Index		
				P	K	Mg	P	K	Mg
250-500	Pit A		6.0	5.4	44	274	0+	0+	5
600-800	Pit B		6.5	3.0	56	271	0-	0+	5
300-600	Pit F		7.3	2.2	66	372	0-	1-	6
250-500	Pit D	1.5	7.0	4	70	71	0-	1-	2-
500-800	Pit D		6.5	3.4	21	62	0-	0-	2-
250-500	Pit E		6.9	3.6	40	64	0-	0+	2-

All indices subdivided into upper (+) and lower (-) halves

Discussion of subsoil results

- 4.8 The upper subsoil contains a small percentage of organic matter. Subsoils are neutral or only slightly acid. Available potassium is extremely low. Magnesium is very high in the clay. Available phosphate is low and below 7.0 mg/l which is regarded as optimal for successful establishment of species rich (nutrient poor) vegetation.

Reuse of Soil Resource

- 4.9 The valuable elements of the soil resource identified above should be conserved and re-used in a suitable manner where possible. Segregation of different materials is essential.
- 4.10 It is suggested that topsoil be segregated as in Plan RAC/4913/3. The topsoil is of very good physical quality and high organic matter, but is slightly acid and has poor PK fertility. If ever seeded, the soil should be limed and basal PK fertiliser is

essential. However in order to raise the low indices, large amounts of PK applied over several years would be needed.

- 4.11 The subsoil must be graded into separate stockpiles of the loamy soil, red clay, sand and gravel, and coal-contaminated areas (Plan RAC/4913/4). The clay is very heavy massive, very high in magnesium and should not be re-used. The other materials have potential as reinstated upper subsoil, if the appropriate balance is achieved of loamy, sandy and stony material. Excessively sandy or stony soil will be droughty. Drains may be needed with medium-textured material. The coal-shale material should be checked for potential toxins before it is used.

References

British Geological Society map for Flint (Solid and Drift)

MAFF 1988 Agricultural Land Classification of England and Wales

Soil Survey of England and Wales, Bulletin 12 (1984). Soils and their Use in Wales.

APPENDIX 1: auger corings

Using a thin 1 cm² auger. Hand-textures, stone estimate, colour and dampness.

Hand Textures

SL	sandy loam
SCL	sandy clay loam
mCL	medium clay loam
hCL	heavy clay loam
Clay	subsoil clay

Stone (estimates only)

vsl flinty	up to 5% by volume
sl. flinty	6 - 15 %
mod. flinty	16-35%
very flinty	35%+

Subsoil descriptors:-

Mottling is the degree of colour variation red/orange and pale/grey indicative of intermittent wetness, as do manganese concretions (Mn).

IMP impenetrable to corer

SPL probably slowly permeable (dense)

1	0° Rough grass with weeds; poached
0 – 20 cm	Sl stony mCL; dark-brown. Prominent mottles at 10cm
20 – 33 cm	vsl stony yellow brown mCL; mottled
33 - 60 cm	Dense red clay with manganese and grey mottles (SPL)
60 – 100cm	Very dense heavy clay

2	1° (SE) Rough grass with weeds; poached
0 – 25 cm	vsl stony organic mCL; many rusty mottles below 5cm
25 – 40 cm	Sl stony mCL (organic)
40 - 60 cm	Grey SL or SCL
60 – 110 cm	Red heavy clay (SPL)

3	2° (NE) Improved grassland (ryegrass & clover)
0 – 25 cm	sl stony SZL-mCL dark-brown
25 – 45 cm	sl stony cSL with coal fragments
45 – 60 cm	vsl stony SL or SCL (prominently mottled)
60 - 90 cm	vsl stony dense red clay (SPL)

4	1° (N) Improved grassland (ryegrass & clover)
0 – 25 cm	Sl stony SL-SCL; dark brown
25 – 40 cm	vsl stony SL or SCL; slightly mottled
40 – 120 cm	vsl stony red clay with much manganese (SPL) very dense below 65cm

5	1° (N) Improved grassland (ryegrass & clover)
0 – 24 cm	sl stony (h)CL (organic?)
24 – 50 cm	Dense red clay with layers of looser pale grey mCL
50 – 110cm	Mod stony yellow red mottled SCL (SPL at 80cm?)
110 – 120cm	Mod stony SL (wet)

6	3° (NW) Improved grassland (ryegrass & clover)
0 – 30 cm	sl stony (organic) SCL
30 – 95 cm	pale grey mCL with much fine stone; unmottled, non-calcareous
95 – 120 cm	vsl stony SCL; prominently mottled (SPL)

7	1-2o (NE) Improved grassland (ryegrass & clover)
0 – 27 cm	vsl stony SL; brown
27 –60 cm	sl stony SL becoming SCL; much manganese and grey mottles
60 –80 cm	mod stony mSL (wet)
80 -120 cm	sl stony LS (wet)

14	2° (NE) improved grassland (ryegrass & clover)
0 – 28 cm	vsl stony mCL
28 – 69 cm	vsl mCL or SCL; strongly mottled below 35cm
69– 120 cm	vsl red clay with a few pockets of yellow SL (SPL)

15	hollow (sinking zone)
0 – 35 cm	vsl stony mCL
35 – 52 cm	vsl stony hCL, slightly mottled
52– 100cm	Dense red hCL (SPL)

16	2° (NE) improved grassland (ryegrass & clover)
0 – 28 cm	vsl stony mCL
28 – 70 cm	vsl red clay; slightly mottled, manganese at top (SPL)
70– 90 cm	vsl red clay is calcareous

17	3° (NE) improved grassland (ryegrass & clover)
0 – 25 cm	vsl stony (m)CL
25 – 40 cm	sl stony yellow hCL with mottles
40– 60 cm	vsl red clay with manganese (SPL)
60– 115 cm	vsl red clay is calcareous (no stones)

18	2° (NE) improved grassland (ryegrass & clover)
0 – 25 cm	vsl stony mCL; dark brown
25 – 60 cm	sl stony SCL much manganese
60– 75 cm	sl stony hSCL; prominent mottling (SPL?)
75– 110 cm	dense red clay (non-calcareous) SPL

APPENDIX 2: DESCRIPTION PROFILE PITS

Pits dug to ~80cm and augured deeper

sa blocky = sub-angular blocky (loose-fitting) as opposed to angular blocky (tight fitting).

Stones are pebbles.

Pit A: rough grass and weeds (poached surface) 30th April 2010

0-27 cm	A p	Very slightly stony brownish black (10YR 3/1) medium Clay Loam; granular structure with abundant roots 0-15cm. Ochreous mottles.
27-40 cm	Eg	Very slightly stony heavy Clay Loam; dull reddish brown with 20% ochreous mottles (5YR 5/3 & 5/8). Weak medium sa blocky structure with roots.
40-50 cm	Btg1	As above but denser - loamy clay; weak medium prismatic structure.
45/55 cm-	BCtg	Reddish clay (massive structure). Wavy upper boundary. Little stone.

Salop series; slowly permeable within 45cm depth. Poorly drained (either no drains or not working). Wetness Class IV (max.)

Pit B: grazed (good quality ryegrass & clover ley) 30th April 2010

0-30cm	A p	(very) slightly stony brownish black (10YR 3/1) Sandy Silt Loam – Clay loam; granular or fine sab blocky with abundant roots (0-10cm).
30-50 cm	Eg	Slightly stony Sandy Clay Loam; yellow brown (10YR 3/4) with 50% grey mottles and coal fragments. Weak medium sa blocky, some roots.
50-60 cm	Btg1	As above but denser - sandy clay; fine medium prismatic. A few roots
55/65- cm	BCtg	Red Clay. Coarse prismatic structure. Slightly wavy upper boundary. Clay to at least 90cm

Flint series; imperfectly drained - slowly permeable within 60cm. Some evidence of disturbance (coal fragments). Wetness Class III

Pit C: grazed (good quality ryegrass & clover ley) 30th April 2010

0-30cm	A p	very slightly stony brownish black (10YR 2/1) organic medium clay loam. Fine sab blocky with abundant roots 0-15cm.
30-65 cm	Cu	Coal (moderately stony coarse sand). Black (2/N). No evidence of roots.
65/70- cm	Cg	Mod stony (fine stone) sandy clay loam. Mottled. To at least 110cm

Disturbed land; drains moderately well but lack of subsoil rooting implies a drought limitation.

Pit D: grazed (good quality ryegrass & clover ley) 30th April 2010

0-25cm	A p	slightly (fine) stony dark brown (10YR 3/2) Sandy Loam – Sandy Clay Loam abundant root 0-10cm
25-50 cm	Bt(g)	Slightly stony Sandy Clay Loam; brown with 30% ochreous mottles (7.5 YR 4/4 & 6/8) and manganese. Medium sa blocky, some roots.
50-65 cm	Bg	Mod stony sandy loam
65-115 cm	BCg1	Reddish brown (5 YR 5/6) mod to very stony coarse sand. Wet at 90cm
115cm-	Cg	Red Clay.

Upper subsoil drainage is not that good, but does not qualify as "slowly permeable". Sharp change to sandy-stony material at 50cm. Wetness Class I if average subsoil texture is 'coarse loamy'.

Pit E: grazed (good quality ryegrass & clover ley) 30th April 2010

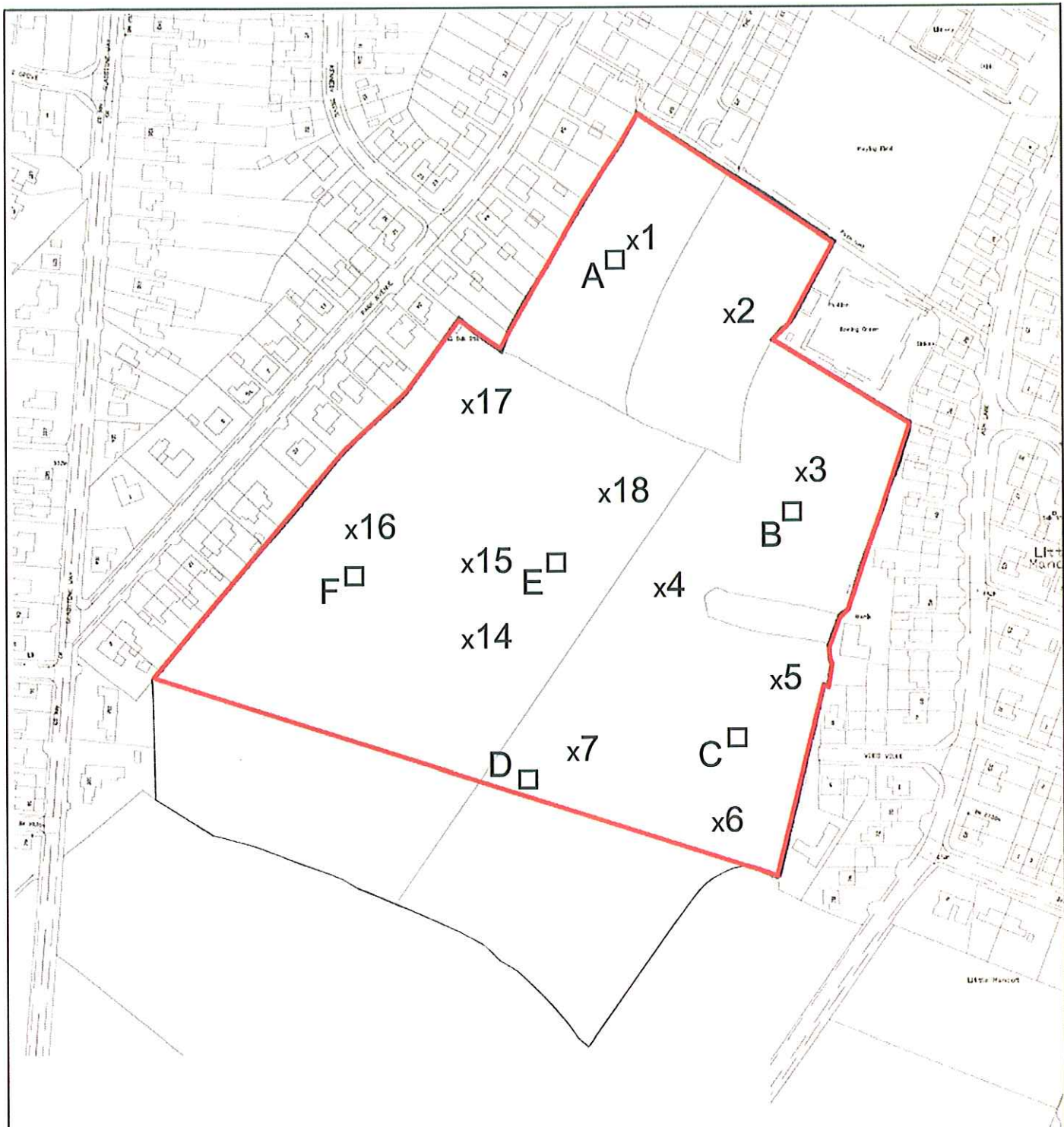
0-28cm	Ap	slightly (fine) stony greyish brown (10YR 4/2) Sandy Clay Loam; granular and fine sub blocky with abundant roots.
28-50 cm	E(g)	Mod to very stony Sandy Clay Loam; yellow brown with a few ochreous mottles (7.5 YR 4/4 & 7/8) and manganese. Some roots
40/60- cm	BCtg	Red Clay very slightly stony. Coarse angular blocky. Wavy upper boundary. Very dense Clay from 70cm

Salop series; red clay is slowly permeable with depth varying from 40cm in left of pit to 60cm on right, but topsoil drainage is assisted by the overlying stony permeable material and gentle slope. Wetness class III rather than IV.

Pit F: grazed (good quality ryegrass & clover ley) 30th April 2010

0-28 cm	A p	Very slightly stony dark brown (10YR 3/2) medium Clay Loam (unmottled).
28-50 cm	Bg1	Red brown Clay with grey mottles (5 YR 4/6 & 5/3) and manganese. Coarse prismatic structure; some roots. Distinct and constant upper boundary
50 cm-	BCg	Reddish clay is calcareous

Crewe series; upper subsoil would be classed as slowly permeable and red (therefore Wetness Class IV), although the topsoil shows no evidence of mottling (drains working well?).



x1 Auger boring*

□ Pit

*Auger borings 8-13 outside development area

0m 100m

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DRAWING TITLE

OBSERVATION POINTS

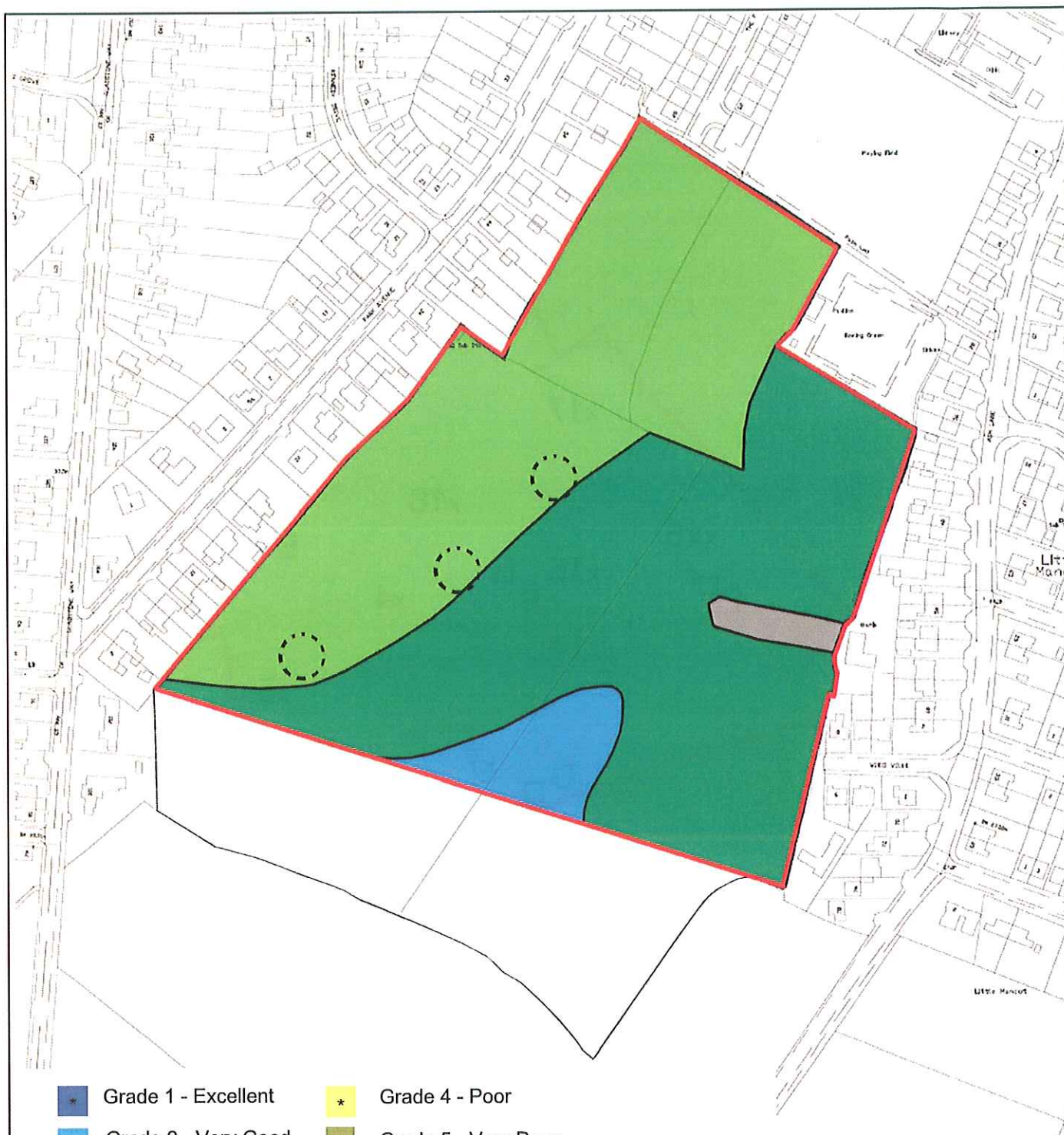
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MK		REVISION	DATE	Drawn	Chk'd.	Date	Rev.
				AL	AIF		
				Scale			
				1:2,500@A4		MAY 2010	
							RAC/4913/1



- | | |
|---------------------|--|
| Grade 1 - Excellent | Grade 4 - Poor |
| Grade 2 - Very Good | Grade 5 - Very Poor |
| Grade 3a - Good | Other land |
| Grade 3b - Moderate | Approx location of small areas of subsidence |

* Land in this category not included at this site

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DRAWING TITLE

AGRICULTURAL LAND
CLASSIFICATION (ALC)

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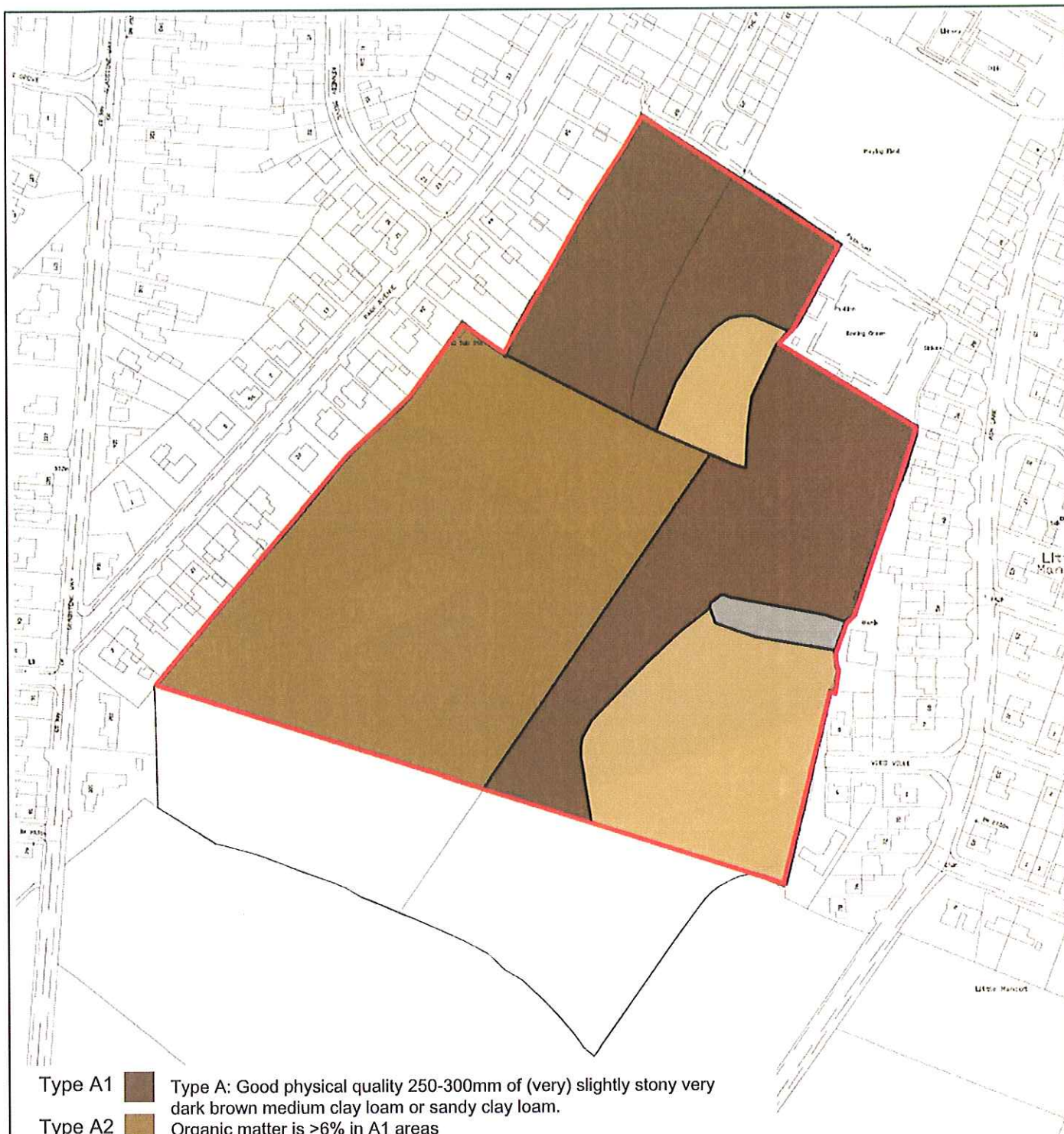
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Drawn AL	Ch'd. AIF	Rev.
Scales 1:2,500@A4	Date MAY 2010	RAC/4913/2



- Type A1 Type A: Good physical quality 250-300mm of (very) slightly stony very dark brown medium clay loam or sandy clay loam.
- Type A2 Organic matter is >6% in A1 areas
- Type B Type B: Very Good physical quality 250-300mm of brownish-black organic clay loam of >10% OM
- Other land

0m 100m

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TOPSOIL RESOURCE

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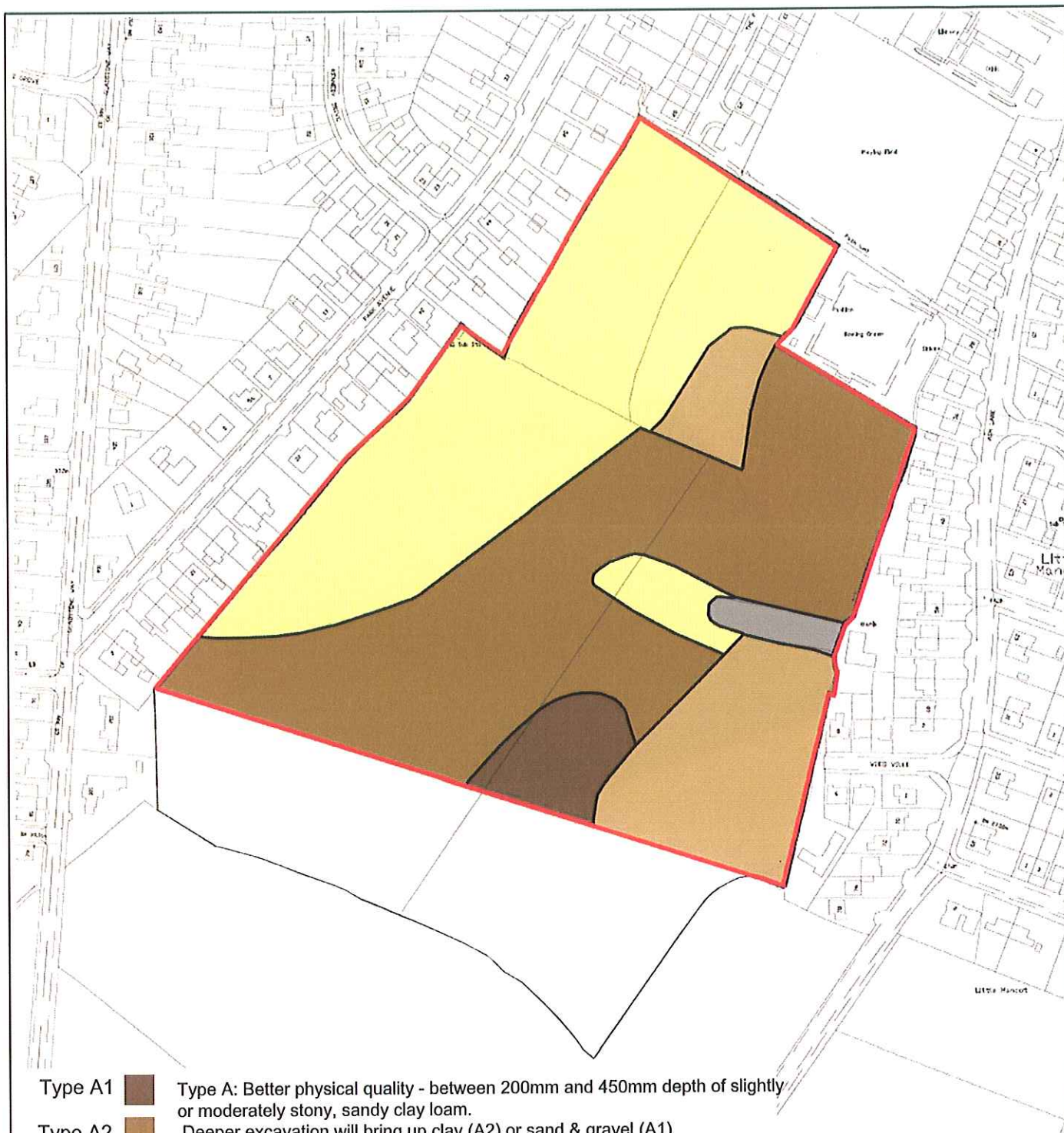
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Drawn	Chk'd	Date	Rev.
AL	AIF		
1:2,500@A4	MAY 2010		

RAC/4913/3



- Type A1 Type A: Better physical quality - between 200mm and 450mm depth of slightly or moderately stony, sandy clay loam.
- Type A2 Deeper excavation will bring up clay (A2) or sand & gravel (A1).
- Type B Type B: Moderate physical quality interbedded clay, loam and coal.
- Type C Type C: Poor physical quality; red heavy clay. Uppermost subsoil (50 to 150mm) may be loamier.
- Other land

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DRAWING TITLE

SUBSOIL RESOURCE

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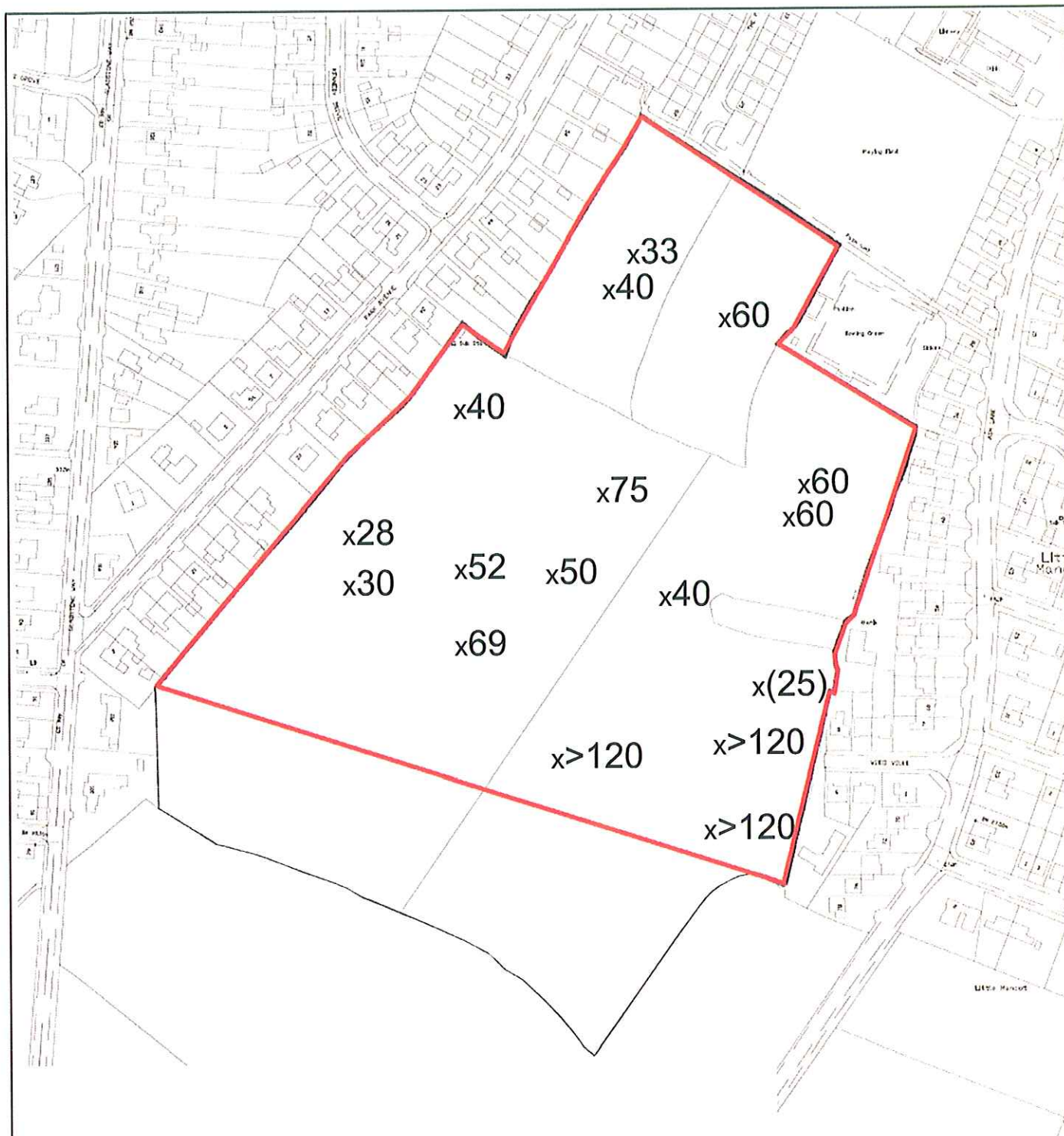
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x75 Depth to red Till (clay) in cm

0m 100m

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DRAWING TITLE

DEPTH TO RED TILL

CONTRACT

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Drawn	Chkd.	Date	Rev.
AL	AIF		
Scale	1:2,500@A4	MAY 2010	
REVISION		DATE	
MK			
RAC/4913/5			

