

PHYSICAL CHARACTERISTICS REPORT INCORPORATING AGRICULTURAL LAND CLASSIFICATION

LAND AT NEEDINGWORTH QUARRY, CAMBRIDGESHIRE

1.0 INTRODUCTION

- 1.1 A Soil and Agricultural Land Classification (ALC) survey was carried out over 628 hectares of land at Needingworth Quarry, Cambridgeshire in connection with a planning application by ARC Central, to extract sand and gravel.
- 1.2 The eastern part of the site, comprising approximately 105 ha of land between the *Fifteenth Public Drain and the eastern edge of the site at Bridge Farm*, was the subject of a previous planning application in 1988 and was surveyed in detail in 1987. Within this area, a total of 99 auger borings were made on a sample grid, together with 3 soil inspection pits, giving an overall density of approximately one observation per hectare.
- 1.3 The remaining 523 ha of land was surveyed on a reconnaissance basis with the field work being undertaken during April 1993. On the remainder of the site, a total of 118 auger borings were made together with 5 soil inspection pits, giving a density of observations on this area of approximately one observation per four hectares.
- 1.4 The site is located on the low-lying floodplain of the River Great Ouse to the north of the village of Over and is currently in arable use. The majority of the area is cropped with oilseed rape and winter cereals, with small areas of field beans and potatoes, the latter being generally restricted to the more organic soils on the site.
- 1.5 On the published Provisional ALC map, Sheet number 135 (MAFF, 1971) the site is shown as predominantly Grade 3 with a small area of Grade 2 to the east.

2.0 **PHYSICAL FACTORS AFFECTING LAND QUALITY**

Climate

- 2.1 Climatic information for the site has been interpolated from the 5 km grid dataset produced by the Meteorological Office (Met Office, 1989). The average annual rainfall for the site is 539 mm making this one of the driest areas of the country. The number of days that the soils are likely to be at field capacity in this area is 89.
- 2.2 The accumulated temperature for the site is approximately 1456 degrees Celsius. This parameter indicates the cumulative build up of warmth available for crop growth and in conjunction with rainfall has an influence on the development of soil moisture deficits and susceptibility to drought. The moisture deficits for wheat and potatoes are 118 mm and 113 mm respectively.
- 2.3 Although there is no climatic limitation to the agricultural use of the site, the low rainfall and high moisture deficits may impose droughtiness restrictions due to the interactions between climate and soils.

Relief

- 2.4 The site is predominantly flat with some very minor undulations within the fields. On the central part of the southern boundary and at the extreme eastern edge of the site at Bridge Farm, the land rises imperceptibly onto the surrounding river terrace. The altitude of the site ranges between 2 and 4 m AOD. The land is crossed by a series of deep ditches which control the water table in the fields, and these are pumped into the adjacent rivers at the north and east of the site.

3.0 AGRICULTURAL LAND CLASSIFICATION

3.1 The land has been classified in accordance with the guidelines of the Agricultural Land Classification of England and Wales (MAFF, 1988). A breakdown of the individual grades is given below:

| Grade | Area (ha) | % |
|------------------|-----------|-------|
| 2 | 42 | 7.0 |
| 3a | 9 | 1.0 |
| 3b | 565 | 90.0 |
| Non Agricultural | 12 | 2.0 |
| TOTAL | 628 | 100.0 |

Grade 2

3.2 An area of grade 2 land has been mapped at the eastern side of the site which correlates with the area occupied by the former Willingham Mere, where the soils are medium silty clay loams or sandy silt loams overlying a highly calcareous, shelly, low density subsoil of fine sandy loam, sandy silt loam or silt loam. This area corresponds to the soils mapped as Soil Type 3 which are described in more detail in paragraph 4.7.

3.3 These soils have a moderately high available water capacity and despite the low rainfall of the area, there will only be a slight droughtiness restriction associated with this land. Occasionally the water table makes these profiles wet at depth, which results in a Wetness Class assessment of II. At these locations the land is also limited by slight wetness/workability restrictions.

3.4 The very high calcium carbonate content in these soils may impose a slight constraint on cropping and could cause deficiencies of certain trace elements.

Grade 3a

3.5 Two small areas of grade 3a have been mapped, one on the southern boundary and the other at the extreme eastern edge of the site, which correspond to the soils developed on the river terrace deposits as described in paragraph 4.8 (Soil Type 4). Slow permeability or the presence of the water table at depth results in a

Wetness Class assessment of II. This combined with the fine textured topsoils limits the land to 3a. Furthermore, during the drier periods of the year, these soils will be susceptible to a moderate droughtiness restriction due to the presence of slightly stony lighter textured subsoils and underlying sand and gravel deposits.

Grade 3b

- 3.6 The majority of the site has been classified as grade 3b and correlates with the areas mapped as Soil Types 1 and 2 (see paragraphs 4.4–4.6). Both these soil types have extremely heavy textured topsoils with clay contents in the range of 80–90%. This high clay content will make these soils intractable during the wetter periods of the year and hard and cloddy during the drier periods. Cultivations and harvesting therefore need to be carefully controlled to prevent serious soil structural damage.

Soil type 1

- 3.7 Within the area mapped as Soil Type 1, profiles which have been classified as predominantly Wetness Class II or III have been mapped. The latter occur where the slowly permeable alluvial clay subsoils lie directly below the topsoil and extend to 50 cm depth or more. Interspersed with these are profiles with subsoils which comprise organic clays which tend to be more permeable and better drained (i.e. wetness Class II). Soils which are classified as Wetness Class III are restricted to a grade 3b, whilst the better drained land will result in a grade 3a classification.

Soil type 2

- 3.8 In the area mapped as Soil Type 2 the topsoils are generally slightly more organic, although most had organic matter contents of less than 10% and are thus classified as mineral soils.
- 3.9 The subsoils were peaty and in many profiles were extremely acid (pH 5/4.5 or less). Soil pits indicated that these acid layers prevented effective rooting. As a result crops are unable to utilise the reserves of water held at depth and are therefore susceptible to drought. Since acid conditions below depths of 40/45 cm are not easily corrected by management operations this factor limits land quality to subgrade 3b. Locally, where the acid layers occur at greater depths, or are absent, then the land is mapped as grade 3a, with wetness (Wetness Class II) and

droughtiness being equally limiting. The survey revealed that the area in the centre of the site around Potash Farm was generally acid at shallow depths, whilst towards the edges of the site these layers were sometimes slightly deeper and more variable in occurrence.

Summary

- 3.10 Whilst some 3a land occurs within this large area of 3b, the reconnaissance scale of mapping prevents the delineation of the better quality areas. This factor, together with the extremely high clay contents found in the upper layers of these soils, has resulted in the entire area being classified as grade 3b.

4.0 SOIL PHYSICAL CHARACTERISTICS

Geology

- 4.1 The 1:50,000 geological map sheets 187 and 188 (Geol. Survey, 1975 and 1981), show the site as *mainly alluvium*. These maps also indicate an area of shell marl on the eastern side of the site which is associated with the bed of the former Willingham Mere. In the centre of the site to the south of Potash Farm an area of peaty alluvium has been identified. At the extreme eastern edge of the site and also along the central part of the southern boundary, the land is mapped as first level river terrace deposits. Mineral Assessment Report No. 54 (IGS, 1981) indicates that the entire area overlies gravels at depth with Ampthill clay forming the bedrock.

Soils

- 4.2 The 1:63,360 scale soil survey map (Soil Survey, 1976) shows the site to comprise mainly soils of the Midelney Association (*1) with some Clayhithe Association (*2) to the east of the site. However on an earlier map of the area (Soil Survey, 1966) the extreme eastern edge of the site is mapped as the Willingham series (*3).

(*1) Midelney Association: Groundwater gley soils comprising clayey river alluvium on peat or terrace drift.

(*2) Clayhithe Association: Humic gley soils developed on loamy terrace drift.

(*3) Willingham series: Silty soils developed in lake marl over peat.

- 4.3 Four soil types were distinguished during the 1987 and 1993 surveys and their distribution is shown on the soil map. Soil Types 1 and 2 comprise the heavy textured alluvial soils which occupy the majority of the site, whilst Soil Type 3 correlates with the area of the former Willingham Mere to the east. Two small areas of Soil Type 4 have been mapped at the edge of the site where the land rises slightly on to the surrounding river terrace deposits.

Soil Type 1 (refer to Appendix 1 and Soil Types Map)

- 4.4 These heavy textured alluvial soils have been mapped extensively at the southern end of the site and also toward the eastern side, with two small areas at the northern end thus effectively forming a halo surrounding the more organic soils of Soil Type 2. The soils typically comprise a stoneless, heavy clay topsoil (80–90% clay) which is non calcareous over a similar textured strongly mottled, pale grey upper subsoil. Both these horizons are generally not organic having organic matter levels in the range of 3–7%. Below 50/60 cm depth (or less often 45 cm), organic clay layers are found with occasional thin peaty loam bands. At depth (generally below 1 m depth) the soil becomes a silty clay loam which is often calcareous and extremely wet. The majority of the soils have slowly permeable upper subsoils and are therefore classified at Wetness Class III. Where the upper subsoil is thinner and the better structured more organic layers are found at a shallower depth (i.e. 45cm+), then the soils have been classified as Wetness Class II.

Soil Type 2 (refer to Appendix 1 and Soil Types Map)

- 4.5 This soil type is found extensively in the central and northern part of the site. These soils are similar to those described above but are generally more organic and contain acid peaty horizons in the subsoil. A typical soil profile comprises a slightly organic or occasionally organic heavy clay topsoil (organic matter in the range 7–12%, although typically less than 10%) over a peaty loam or loamy peat upper subsoil. This peaty layer is often very acid (pH <4.5) with some gypsum crystals evident. Below the peaty horizons the lower subsoil comprises an organic, gleyed silty clay loam which is generally slightly calcareous with some shell fragments. At the time of the November survey this material was soft and wet. This land is more typically found in the middle of the site, to the south and north of Potash Farm.

- 4.6 In some profiles, especially toward the eastern and western edges of the mapping unit, the topsoil was underlain by a layer of alluvial clay similar to that described in Soil Type 1. The presence of very acid horizons was also more variable. To the east, acid layers were less evident and to the west they occurred slightly depth.

Soil Type 3 (refer to Appendix 1 and Soil Types Map)

- 4.7 These soils equate with the area of the former Willingham Mere and are shown as shell marl on the geology map. The soils have a medium silty clay loam or sandy silt loam topsoil which is calcareous and stoneless. This overlies an upper subsoil which is very pale in colour and has a fine sandy loam, sandy silt loam or occasionally silt loam texture. The material has a very low density due to abundant shell fragments and a high proportion of pore space. Beneath this layer the soil may become an organic or very slightly organic silt loam, with occasional peaty bands. These soils are affected by fluctuating groundwater which is controlled by pump drainage.

Soil Type 4 (refer to Appendix 1 and Soil Types Map)

- 4.8 Two small areas of this soil type have been mapped, where the site rises on to the surrounding river terrace deposits. These soils typically comprise heavy clay loam topsoils which may be slightly calcareous and very slightly stony (3-5% small flints). These overlie a subsoil which has a sandy clay loam or sandy loam texture which may become heavier with depth. Beneath this, sand and gravel was typically encountered.

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REFERENCES

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- INSTITUTE OF GEOLOGICAL SCIENCES (1981). Mineral Assessment Report 54, Sand and Gravel Resources of TL16 Huntingdon and St Ives, Cambridgeshire.
- MAFF (1988). Agricultural Land Classification of England and Wales - Revised guidelines and criteria for grading the quality of agricultural land.
- METEOROLOGICAL OFFICE (1989). Climatological Data for Agricultural Land Classification.
- SOIL SURVEY OF ENGLAND AND WALES (1966). *The soils of the district around Cambridge* (Sheet 188) 1:63,360 scale.
- SOIL SURVEY OF ENGLAND AND WALES (1976). Soil survey map sheet no. 135 (Cambridge and Ely) 1:63,360 scale.
- MAFF (1971) Agricultural Land Classification map (provisional) sheet 135, 1:63,360.

APPENDIX 1

SOIL PHYSICAL CHARACTERISTICS

NEEDINGWORTH QUARRY, CAMBRIDGESHIRE

SOIL TYPE 1 (287 ha)

| | | | |
|--------------------------|-------------------|---|--|
| Topsoil | Texture | : | clay |
| | Colour | : | 10YR4/2 grey brown |
| | Organic matter | : | 3-7% |
| | CaCO ₃ | : | non calcareous |
| | Depth | : | 28/35 cm, typically 30 cm |
| Subsoil 1 | Texture | : | clay |
| | Colour | : | 10YR6/2 pale grey brown |
| | Mottles | : | many prominent ochreous |
| | Structure | : | coarse angular blocky |
| | Consistence | : | firm |
| | Porosity | : | <0.5% |
| | Depth | : | 45/60 cm, typically 50/60 cm + |
| Subsoil 2 | Texture | : | organic clay with occasional thin peaty lenses |
| | Colour | : | 10YR3/2 dark grey brown |
| | Structure | : | medium and coarse angular blocky |
| | Consistence | : | friable |
| | Porosity | : | >0.5% |
| | Depth | : | 90/120 |
| Subsoil 3 (when present) | Texture | : | silty clay loam |
| | Structure | : | massive |
| | Consistence | : | plastic and very wet |

Wetness Class III, sometimes II where organic subsoils occur within 45 cm depth.
Soil profile stoneless throughout.

SOIL TYPE 2 (288 ha)

| | | | |
|-----------|-------------------|---|--|
| Topsoil | Texture | : | clay |
| | Colour | : | 10YR3/3 dark grey brown |
| | Organic matter | : | 7-12% |
| | CaCO ₃ | : | non calcareous |
| | Depth | : | 28-35 cm typically 30 cm |
| Subsoil 1 | Texture | : | peaty loam or loamy peat |
| | Colour | : | 10YR2/1 black |
| | Structure | : | coarse platy occasionally blocky |
| | Consistence | : | firm or very firm occasionally friable |
| | Porosity | : | >0.5% |
| | pH | : | typically 4.5/5 or less, sometimes greater |
| | Depth | : | 45-80 cm variable across site |
| Subsoil 2 | Texture | : | organic clay or silty clay loam, often silt loam at depth. |
| | Colour | : | 2.5Y4/2 dark grey brown |
| | Mottles | : | common distinct ochreous |
| | Structure | : | massive |
| | Porosity | : | >0.5% |
| | Consistence | : | soft and plastic, very wet |

Wetness Class Typically II due to ground water or slow permeability at depth

In many profiles especially toward the eastern and western edges of the site, a thin horizon (10-15 cm thick) similar to the subsoil 1 of Soil Type 1 was present.

SOIL TYPE 3 (43 ha)

| | | | |
|-----------|-------------------|---|---|
| Topsoil | Texture | : | medium silty clay loam or sandy silt loam |
| | Colour | : | 10YR4/3 grey brown |
| | CaCO ₃ | : | calcareous |
| | Depth | : | 30-35 cm |
| Subsoil 1 | Texture | : | fine sandy loam, fine sandy silt loam or silt loam. |
| | Colour | : | 2.5Y7/2 pale grey brown |
| | Mottles | : | common distinct ochreous |
| | Structure | : | weakly developed coarse platy (laminations) or blocky |
| | Consistence | : | friable |
| | Porosity | : | >0.5% |
| | CaCO ₃ | : | very calcareous, many shell fragments |
| | Depth | : | 60-90 cm |
| Subsoil 2 | Texture | : | organic/slightly organic silty loam |
| | Colour | : | 10YR2/2 very dark brown |
| | Structure | : | massive |
| | Consistence | : | soft, slightly plastic, wet |
| | Porosity | : | >0.5% |
| | CaCO ₃ | : | calcareous |

Wetness Class Typically I, occasionally II.

Subsoil 1 has a low density and high pore space. Stoneless throughout. Sand and gravel occasionally encountered within 100 cm depth.

SOIL TYPE 4 (10 ha)

| | | | |
|---------|---------|---|---|
| Topsoil | Texture | : | heavy clay loam |
| | Colour | : | 10YR4/3 grey brown |
| | Stones | : | 2-5% small and medium flints |
| | Depth | : | 30 cm |
| Subsoil | Texture | : | sandy clay loam or medium sandy loam, clay loam at depth. |
| | Colour | : | 10YR6/3 yellowish brown |
| | Mottles | : | common distinct ochreous |
| | Stones | : | slightly stony c.5% flints |

Wetness Class II due to slow permeability or water table at depth.

Due to the limited extent of this soil type, no soil pit was dug and therefore no information is available on subsoil structure etc. Underlying sands and gravels was encountered within 1 m depth in some profiles.