LAND NORTH OF LITTLE CHEVENEY FARM, SHEEPHURST LANE, MARDEN, KENT

AGRICULTURAL EVIDENCE ON BEHALF OF THE APPELLANT

BY

TONY KERNON BSc(Hons), MRICS, MBIAC

LPA Reference: 22/501335/FUL

April 2023

KERNON COUNTRYSIDE CONSULTANTS LIMITED

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Authorised By APK 04/23

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CONTENTS

1 INTRODUCTION

Scope of Evidence

1.1 The development proposed is the installation of ground-mounted PV solar arrays, associated infrastructure, fences, gates etc together with the creation of woodland and biodiversity enhancements. The total site area is 74.5 ha.

1.2 The application was refused on 28th October 2022. Reason for Refusal No 1 states:

> "**The site includes a significant proportion of the best and most versatile agricultural land which has economic and other benefits that NPPF requires to be recognised. The proposal is also contrary to National Energy policies and Planning Practice Guidance and policy DM24 of the Maidstone Borough Local Plan 2017 which direct solar farms towards lower grade agricultural land. The proposed use of the best and most versatile agricultural land has not been adequately demonstrated to be necessary**".

1.3 This Statement addresses the issues raised in the reason for refusal and the policy implications.

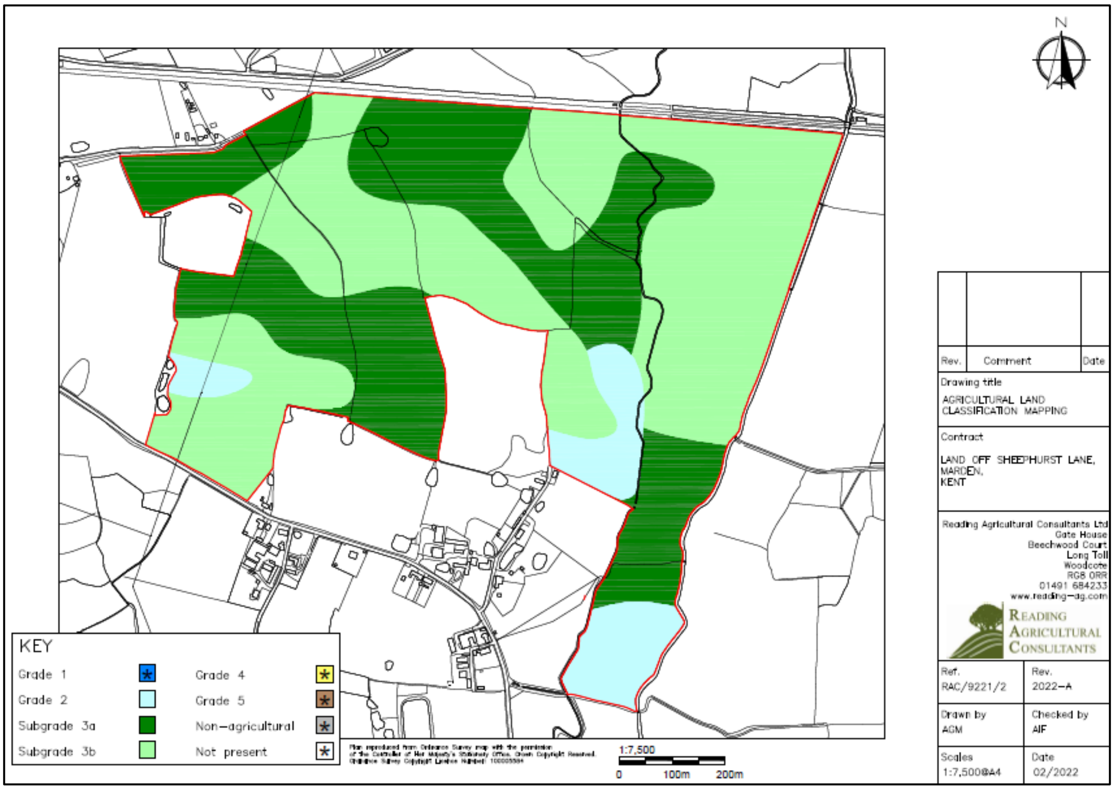
Summary of Conclusions

1.4 The Appeal site comprises six fields in agricultural use.

1.5 A detailed Agricultural Land Classification (ALC) survey identified that 43% of the site comprised land in ALC Grades 2 and 3a, which fall within the definition of the "best and most versatile" agricultural land (BMV). Poorer quality land accounts for 53% of the site.

1.6 This BMV land does not form a large block, however. It is mixed in a complex pattern with land of Subgrade 3b, which is moderate quality land, as shown below (being the ALC plan for the site).

Insert 1: The ALC Distribution Plan



1.7 The installation of solar PV arrays does not adversely affect the land quality. It will not result in damage to soils. Only a small area of land will be adversely affected, being the area required for tracks, inverters and the substation.

1.8 There was no objection from Natural England.

1.9 There should be no reason to reject the proposal based on the inclusion of BMV land within the proposed area.

<u>Structure of Evidence</u>

1.10 This Statement sets out my analysis in the following order:

(i) section 2 sets out the relevant planning policy and guidance;

(ii) section 3 describes the proposals, information provided and the officer analysis;

(iii) section 4 describes the land quality and farming circumstances of the Appeal site;

(iv) section 5 sets out an analysis of the potential effects on agricultural land and the reason for refusal;

(v) section 6 assesses other agricultural considerations, including the land quality in the wider area and the availability of alternative areas;

(vi) ending with a summary and conclusions in section 7.

The Author

1.11 This Statement has been prepared by Tony Kernon of Kernon Countryside Consultants Ltd. I am a rural Chartered Surveyor and a Fellow of the British Institute of Agricultural Consultants. I have specialised in assessing the effects of development proposals on agricultural land and rural businesses since 1987. My Curriculum Vitae is at **Appendix KCC1**.

1.12 As a Chartered Surveyor I am bound by the RICS Practice Statement "Surveyors acting as Expert Witnesses, 4th Edition. A declaration is provided at the end of my Statement.

Note

1.13 My assessment is based on the plans and layout set out in this report. The conclusions are not significantly affected by the detail of the layout, so if there were variations that would not invalidate the opinions set out in this evidence.

2 PLANNING POLICY AND GUIDANCE OF RELEVANCE

2.1 This section of my Statement:

(i) describes the ALC system;

(ii) considers national planning policy;

(iii) considers related guidance;

(iv) considers local planning policy.

<u>The ALC System</u>

2.2 Agricultural land is measured under a system of Agricultural Land Classification (ALC). This grades land based on the long-term physical limitations of land for agricultural use, including climate (temperature, rainfall, aspect, exposure and frost risk), site (gradient, micro-relief and flood risk) and soil (texture, structure, depth and stoniness) criteria, and the interactions between these factors determining soil wetness, droughtiness and utility. The system is described in Natural England's Technical Information Note TIN049 (2012) (**Appendix KCC2**).

2.3 Land is divided into five grades, 1 to 5. Grade 3 is divided into two subgrades. Land falling into ALC Grades 1, 2 and Subgrade 3a is the "**best and most versatile**" (BMV) (as defined in the National Planning Policy Framework (2021), Annex 2). Natural England estimate that 42% of agricultural land in England is of BMV quality (see TIN049 in **Appendix KCC2**).

2.4 The site comprises a mixture of Grades 2, 3a and 3b. Each grade is defined in the ALC Guidelines, an extract from which is reproduced as **Appendix KCC3**. The description highlights variability of production possibilities within each of the grades, so that the grading may reflect yield, or versatility, but not necessarily both.

2.5 The definitions of Grade 2 and Subgrades 3a and 3b are as follows:

- Grade 2: "**land with minor limitations that affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown. On some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops, such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than grade 1**";

- Subgrade 3a: "**land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide**

range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops";

- Subgrade 3b: **"land capable of producing moderate yields of a narrow range of crops, principally:**
  - **cereals and grass;**
  - **lower yields of a wider range of crops;**
  - **high yields of grass which can be grazed or harvested over most of the year**".

NPPF

2.6 The National Planning Policy Framework (NPPF) (2021) sets out, in paragraph 174 (b), that the economic benefits of BMV land should be recognised. Footnote 58, in the context of plan making in paragraph 175, advises that where significant development of agricultural land is involved, poorer quality land should be used in preference.

Guidance

2.7 There is no definition of what is "significant" development in the context of footnote 58 of the NPPF. The threshold for consultation with Natural England is where there will be the loss (by sealing-over or downgrading rather than a change of use) of more than 20 ha of BMV agricultural land (as set out in Appendix 4 (y) of the Town and Country Planning (Development Management Procedure) (England) Order 2015) (DMP Order).

2.8 There is no definition of what is meant by "loss" in the DMP Order. The IEMA Guide "A New Perspective on Land and Soil in Environmental Impact Assessment" (February 2022) defines impacts for EIA purposes as "**permanent, irreversible loss of one or more soil functions or soil volumes (including permanent sealing or land quality downgrading)** …" (Table 3, page 49).

2.9 The IEMA Guide notes that this can include "**effects from temporary developments**", which is defined as follows: "**temporary developments can result in a permanent impact if resulting disturbance or land use change causes permanent damage to soils**".

2.10 Therefore, in respect of the guidance, the "loss" of agricultural land is where there is an irreversible loss of agricultural land or a downgrading of ALC value through permanent damage to soils.

2.11 The Planning Practice Guidance suite section on "Renewable and Low-carbon energy" advises at 5-013-20150327 that particular factors a local planning authority will need to consider include whether the proposed use of agricultural land has been shown to be necessary and poorer quality land has been used in preference, and the proposed use allows for continued agricultural use.

Local Plan

2.12 The Maidstone Local Plan was adopted in October 2017. There is no development management policy that specifically addresses development involving agricultural land.

2.13 Reason for Refusal No 1 refers to policy DM24 "Renewable and Low-Carbon Energy Schemes". This sets out under criterion (1) that applications will need to demonstrate that they have taken account of criteria (i) to (vi), none of which refer to agricultural land.

2.14 The policy then sets out two development management considerations:

"**2. Preference will be given to existing commercial and industrial premises, previously developed land, or agricultural land that is not classified as the best and most versatile.**

3. Provision for the return of the land to its previous use must be made when the installations have ceased operation".

2.15 The Council produced a Planning Policy Advice Note on Solar development over 50KW. This contains a flow chart, which is reproduced in **Appendix KCC4**. Page 9 of the document, with the flow chart, sets out that if land is of Grades 1 and 2 "**the Council would not normally support development on the best agricultural land**". If the site is Subgrade 3a, the flow chart requires (in summary):

- an explanation of why poorer quality land cannot be used;
- information about the availability of land at the same classification locally;
- information about the effect on farm viability;
- consideration of the cumulative impact of solar farms on Subgrade 3a land.

2.16 No additional information is needed for land of Subgrade 3b.

2.17 The Policy Advice Note goes on in section I to advise on grazing around panels by sheep, geese or pigs, as reproduced in **Appendix KCC4**.

3 THE PROPOSALS AND THE CONSTRUCTION PROCESS

The Site

3.1 The site involves agricultural land, as outlined in red on the aerial image below (taken from plan 27899/150 Rev C).

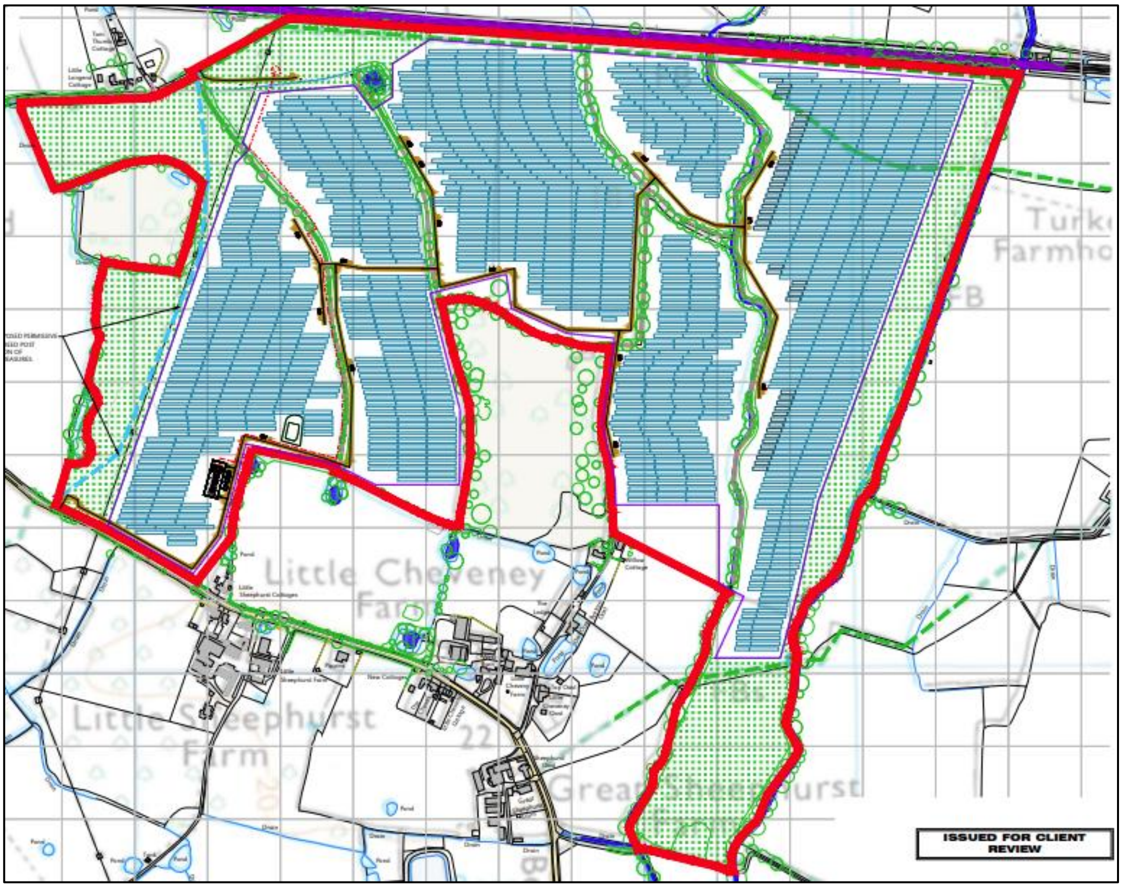
Insert 2: The Application Site

3.2 The boundary of the site includes 74.5 ha of agricultural land.

The Proposals

3.3 It is proposed to install solar PV arrays across part of the site. These would be installed with an east-west orientation. There will be a need for 15 no. transformer stations and related facilities as shown on plan 27899/050 Rev E. Part of this is reproduced below.

Insert 3: Extract from the Application Plan



3.4 It will be noted that extensive areas, estimated at 19.9 ha, are proposed for biodiversity areas and will not involve the installation of PV arrays. These are areas outside the site fences.

<u>The Construction Process</u>

3.5 My Statement now considers the works involved in developing a solar farm, with a particular focus on how it might affect agricultural land.

3.6 A Construction Method and Decommissioning Statement forms one of the application documents.

3.7 This Statement now describes the construction process, with the installation of the solar PV arrays considered first, then the fixed infrastructure including tracks, inverters and the substation.

3.8 The solar PV arrays are installed in five key stages:

(i) marking out;

(ii) piling-in of legs;

(iii) bolting together of frames;

(iv) bolting-on of panels;

(v) cabling and trenching.

3.9 Marking-out is done on foot and is not damaging to soils, as shown below.

Photo 1: Marking Out in Progress

3.10 The next stage is to insert the legs. These are carried out and laid out as marked. This stage is non-instrusive. It does involve machinery carrying the legs, however, and should ideally take place when soils are suitably dry. Typically a tractor and farm trailer are used to transport the legs to the fields, then each leg is lifted off by hand.

3.11 A team then arrives to knock the stanchions / legs in. From operations we have observed it takes a little over a minute per pole to knock the pole into the ground and move the machine to the next pole[1]. This operation is shown in the photograph below. This was inserting legs into a clay soil.

Photo 2: Legs Being Installed

[1] This observation was made on clay soils at the Purton Solar Farm, Wiltshire, in 2015. Ground conditions will inevitably affect installation speed.

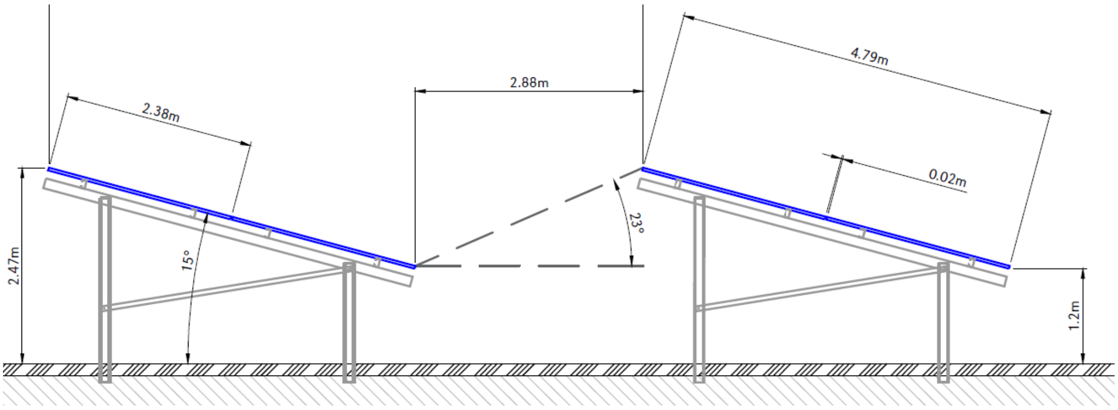
3.12 The design varies between sites, but the limited impact of installing legs on the underlying land is illustrated below. It can be seen that there is no evidence of damage to the soils, even with the works taking place in winter.

Photo 3: Legs Installed (this at Bentham Farm, Purton, Summer 2015)

Photo 4: Legs Being Installed (this at Tiln Farm, Retford, in Janaury 2023)

3.13 The panel design at this site will be taller than the Bentham example shown above, and this will enable sheep to be grazed. An excerpt from the panel design plans is shown below. This is taken from Plan 27899/105 Rev A.

Insert 4: Excerpt Showing Panel Design



3.14 The minimal damage, if carried out in dry conditions, of bolting-on the panels is shown below. It can be seen that the ground has not been affected.

Photo 5: After Panels Bolted-on

3.15 The British weather can be difficult and soils can sometimes become wet and hence easily damaged when trafficked. They are normally easily repaired, with no lasting damage, however. In wet weather the situation can change. The following photograph shows panels installed in winter, on a site with clayey soils and when ground conditions were generally poor. The soil was easily restored following installation, as shown in photo 7. This photograph is included to show that rectification is possible. This kind of surface damage should be avoided so far as possible during construction.

Photo 6: Panels Installed in Poorer Conditions

Photo 7: The Same Site Restored and Seeded (taken a few rows down from the previous picture)

3.16 The area recovered well, and is shown below 7 years later. There was no evidence of any compaction or deterioration in land quality.

Photo 8: The Same Area 7 Years Later

3.17 It is necessary to connect electric cables between the panels and to run the cables back to the substation. This involves trenches, dug with a machine. Immediately after digging these look disruptive to the soil, but they are installed in a similar way to field drainage pipes. Typically topsoil and subsoil are separated, as below.

Photos 9 and 10: Cabling Channels During Cable Installation

3.18 The installation of cables is one of the few operations that involves digging whereby the soil structure could potentially be affected. The trenches are always narrow, but soil does have to be dug up to install the cable. In this country utility operators have been burying services (water, oil, gas, telecomms) for many years. In areas where there is a clear subsoil and topsoil distinction, the topsoil should be placed on one side of the trench, and the subsoil on the other. Then once the cable has been laid the subsoil can be added back first, then the topsoil second, to reinstate the soil structure to its original order and state.

3.19 Soils are restored and settle within days, and return to grass growth rapidly.

Photo 11: The Area Two Weeks Later

This photo was taken 14 days after the trench was first dug.

3.20 Overall, therefore, the panel installation will not result in adverse effects on soils or agricultural land quality.

3.21 Agricultural land generally, depending upon the soil type, is susceptible to damage when trafficked in wet conditions, such as shown below. So far as possible travelling across the land in wet conditions should be avoided, and panels should be installed when ground conditions are suitable.

Photos 12 and 13: Soils Being Affected by Winter Vehicle Travel

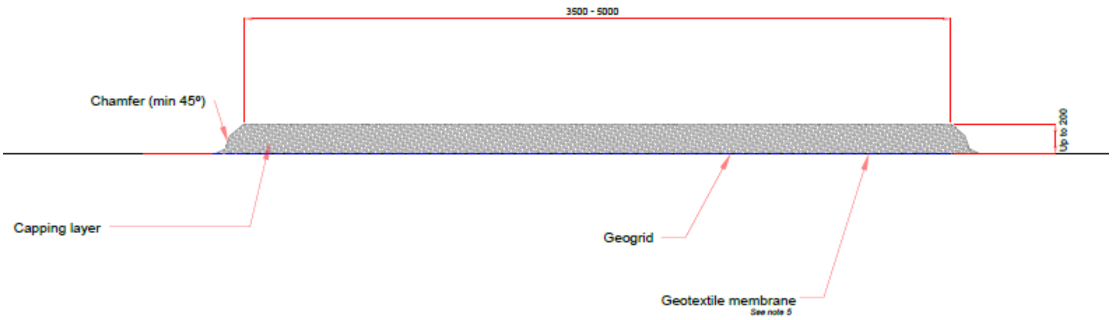
3.22 I walked the farm on 28th February 2023. The farmer was spreading manure that day with the following machinery, which shows that even in winter the ground conditions can be suitable for large machinery.

Photo 14: Farm Muck Spreading Machinery

Fixed Equipment

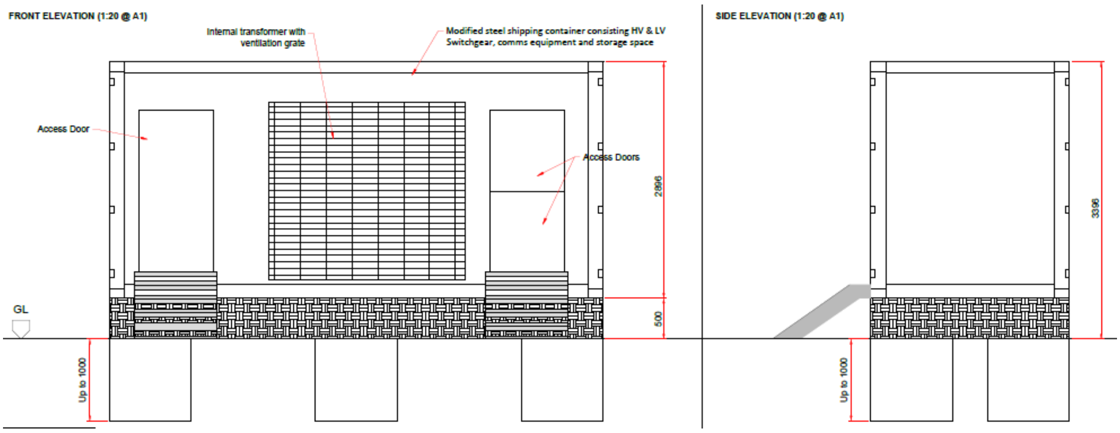
3.23 The tracks will be created by placing a capping layer onto a geotexture membrane on top of the existing soil, as shown below. Consequently there will be no removal of soil, and no need to disturb soil profiles.

Insert 5: Proposed Track



3.24 The transformers are expected to measure about 6.1m by 2.5m, and with a concrete base will involve an area of about 7m by 3m (circa 21 sqm each). There will be some removal of soil to insert the foundations.

Insert 6: Proposed Inverter Transformer (front elevation)



3.25 The HV compound energy storage area involves an area of just under 0.1 ha and are shown on the planning application plans. This is shown below, with the area shown in the photograph that follows, looking south towards the site.

Insert 7: Proposed HV Compound from 27899/050 Rev E)

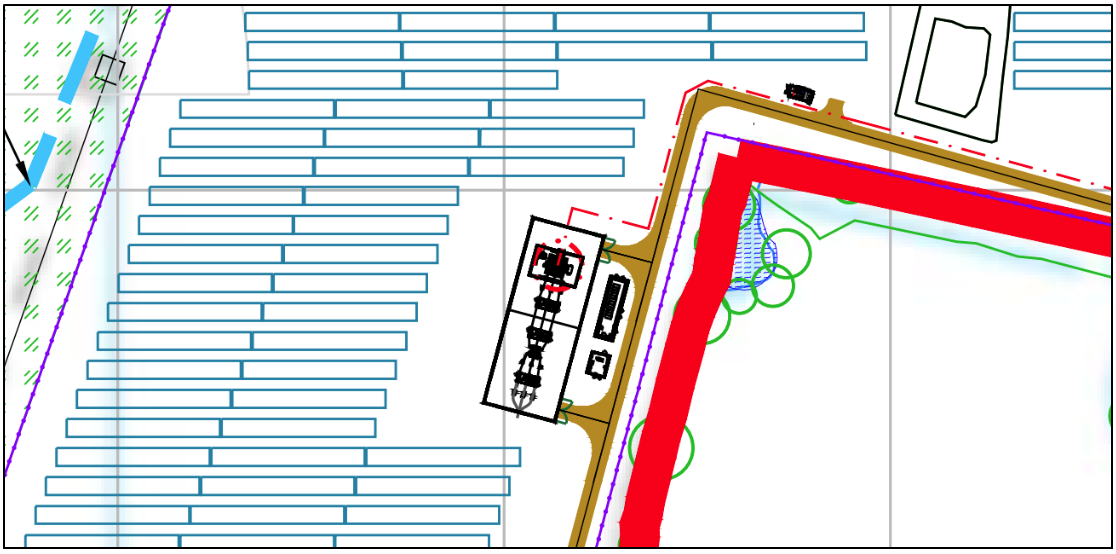


Photo 15: Looking South at HV Compound

Land Loss

3.26 The area involved with the fixed equipment is approximately estimated below, allowing for passing bays.

Table 1: Estimate of Fixed Equipment

Component	No/length	Dimensions	Area (sqm)	Area (ha)
HV compound	1	-	940	0.09
Switchgear	1	-	80	0.01
Monitoring cabin	1	-	30	0.00
Transformer stations (with base)	15	7m x 3m	21	0.03
Tracks	3400m	3.5m wide	11,900	1.19
Total				**1.32**

3.27 The areas involved, by ALC grade, are as follows, rounded up to the nearest 0.1 ha.

Table 2: Fixed Equipment by ALC Grade

Component	ALC Grade				Total
	2	**3a**	**2 + 3a (BMV)**	**3b**	
HV compound	0.0	0.0	0.0	0.09	0.09
Switchgear	0.0	0.0	0.0	0.01	0.01
Monitoring cabin	0.0	0.0	0.0	0.0	0.0
Transformer stations	0.0	0.01	0.01	0.02	0.03
Tracks	0.0	0.34	0.34	0.85	1.19
Total	**0.0**	**0.35**	**0.35**	**0.97**	**1.32**

3.28 Therefore the fixed equipment (excluding panels) where land is disturbed, including bases, involves:

- a total area of 1.32 ha;
- of which 0.35 ha is Subgrade 3a;
- such that only 0.35 ha of BMV land is affected.

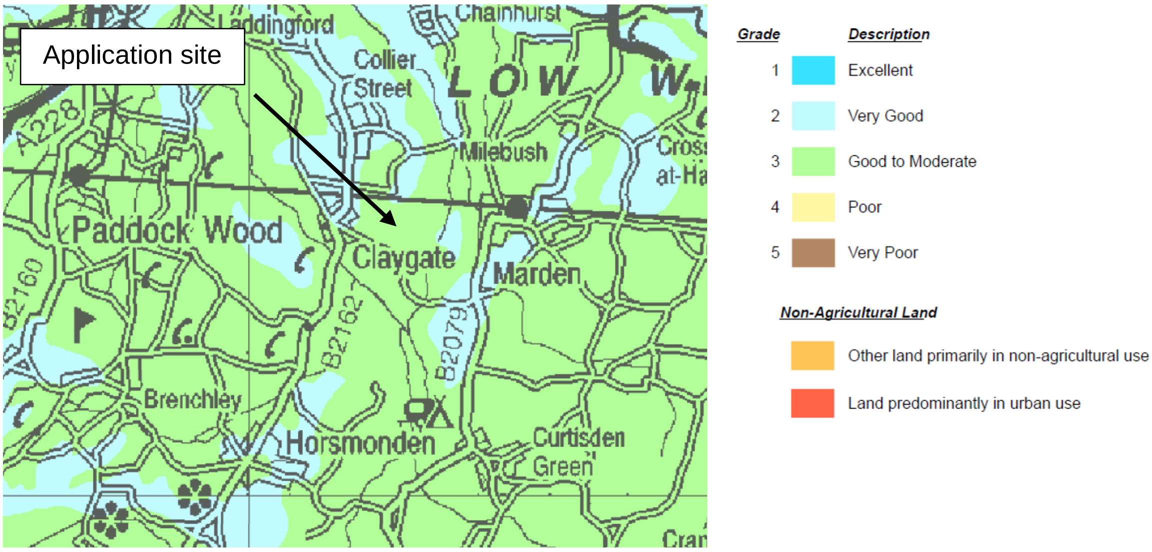
3.29 These areas will be capable of being restored to comparable quality at the decommissioning phase.

4 LAND QUALITY AND FARMING CIRCUMSTANCES

<u>Land Quality</u>

4.1 The site lies in an area shown on the "provisional" ALC maps produced by MAFF in the 1970s as undifferentiated Grade 3. These maps cannot be used for site-specific use, as described in Natural England's TIN049.

Insert 8: Provisional ALC (site indicated)

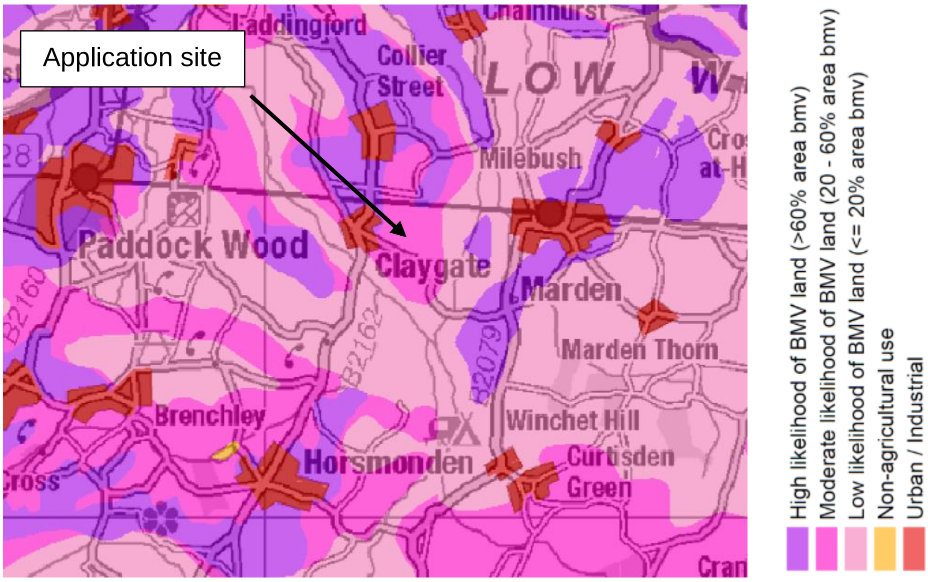


4.2 In 2017 Natural England produced a series of Predictive Best and Most Versatile maps, dividing the country into three areas:

- low likelihood (<20% area BMV);
- moderate likelihood (20 – 60% area BMV);
- high likelihood (>60% area BMV).

4.3 The site is shown as falling into the low (eastern part) and moderate (western part) likelihood of BMV, as shown below, all edged in blue.

Insert 9: Predictive BMV Map Extract



4.4 A detailed ALC survey was carried out by Reading Agricultural Consultants in March 2022 and their report forms one of the application documents. They examined the land at 93 locations. Their report describes the soils, identifying medium, heavier and clayey topsoils in a complex pattern across the site. See plate 1 at 3.7 of their report, reproduced (text and plans only) for ease of reference at **Appendix KCC5**.

4.5 The RAC survey graded the 74.5 ha as follows (Table 3 of their report).

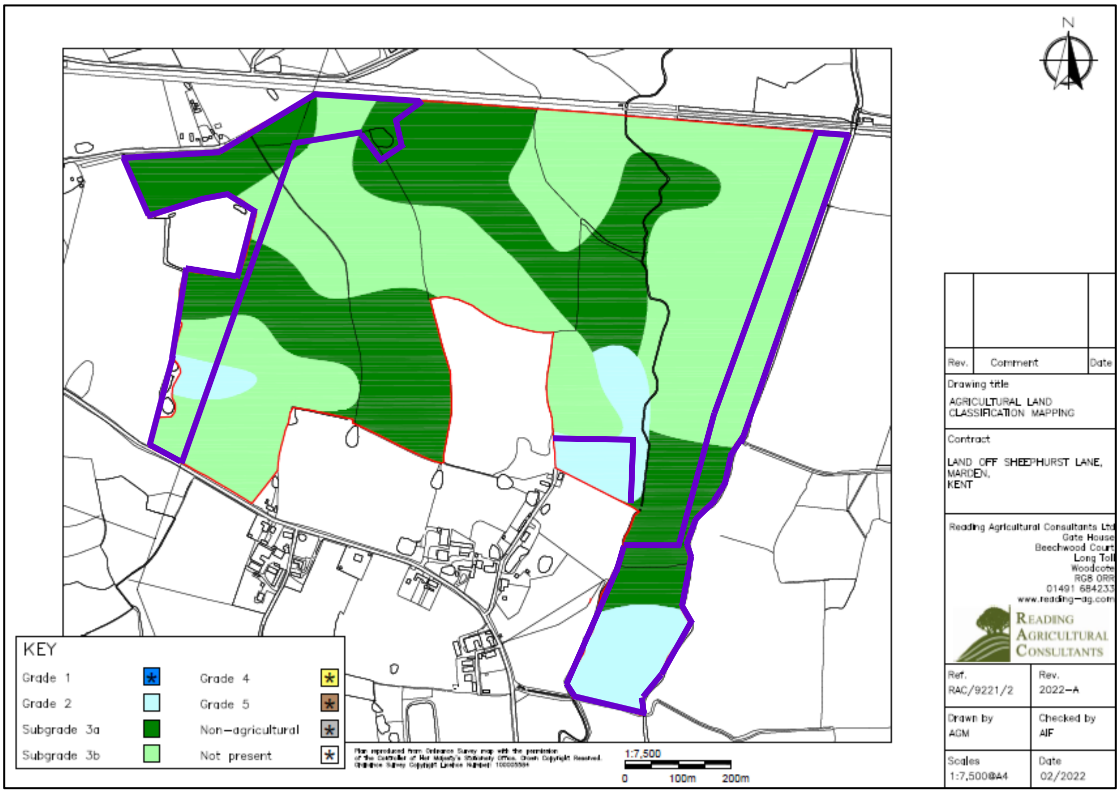
Insert 10: Results of RAC ALC

Table 3: ALC areas

Grade	Description	Area (ha)	%
Grade 2	Very good quality	6.9	9
Subgrade 3a	Good quality	28.2	38
Subgrade 3b	Moderate quality	39.4	53
Total		74.5	100

4.6 The distribution of the grades is shown below, being their ALC map. A larger copy is at **Appendix KCC5**. On the map I have marked the areas proposed for biodiversity areas, all edged in purple.

Insert 11: RAC ALC, with Biodiversity and Excluded Areas Edged



4.7 The application site includes the biodiversity areas and the breakdown of the whole site is provided above. In terms of panel areas and biodiversity areas, the breakdown has been remeasured as follows.

Table 3: ALC Breakdown (total to 74.5 ha)

Grade	Panel Area (ha)	Biodiversity and Excluded Areas (ha)	Total area (ha)
2	2.2	4.7	6.9
3a	21.0	7.2	28.2
3b	31.4	8.0	39.4
Total	**54.6**	**19.9**	**74.5**

4.8 Within the fence for the panel areas, the breakdown is therefore:

- total area 54.6 ha;
- BMV area 23.2 ha;
- BMV proportion 42.5%.

Farming Circumstances

4.9 The planning application was accompanied by an "Agricultural Land Use Statement" by Bidwells, March 2022. This describes Eckley Farms in section 6. The site comprises 7.5% of the arable area of the farm.

4.10 I visited the farm in February 2023. The farm comprises approximately 600 ha of land, of which 497 ha is cropped. The farm has three principal blocks of land. The main unit is at Saynden Farm, Staplehurst, with outlying blocks of land near Leeds Castle and at Little Cheveney Farm.

4.11 The farm runs an all-arable cropping rotation with winter wheat the principal crop rotated with winter beans, spring oats and oilseed rape, and with spring linseed grown as a spring crop if other winter crops have failed.

4.12 The farm uses inorganic fertilisers and incorporates poultry manure and compost from nearby fruit farms to build organic matter. The farm operates a minimum-tillage farming system, and has been experimenting with applying foliar fertilisers.

4.13 The farm is run by one man with some part-time help.

4.14 Approximately 120 ha of the farm are within agri-environmental schemes, including field margins, and works to hedges and ditches.

4.15 The application site covers 74.5 ha. Within that site area, 68.1 ha is currently cropped, and 6.4 ha are field margins, grassed headland etc. These include grassland margins around most fields, such as those shown below.

Photos 16 and 17: Field Margins

4.16 A further 60.9 ha of land forming part of Little Cheveney Farm will continue to be farmed. The farmyard comprises four agricultural buildings, shown below, including a 500 tonne crop store. That will continue to be fully used by the agricultural land retained at Little Cheveney Farm.

Photo 18 – 21: Farm Buildings, Little Cheveney Farm

4.17 The land under and around the panels will be kept as grassland and used for grazing sheep.

5 AGRICULTURAL LAND QUALITY CONSIDERATIONS

Council's Reason for Refusal

5.1 Reason for Refusal No 1 states:

> "**The site includes a significant proportion of the best and most versatile agricultural land which has economic and other benefits that NPPF requires to be recognised. The proposal is also contrary to National Energy policies and Planning Practice Guidance and policy DM24 of the Maidstone Borough Local Plan 2017 which direct solar farms towards lower grade agricultural land. The proposed use of the best and most versatile agricultural land has not been adequately demonstrated to be necessary**".

5.2 The reason for refusal (RR1) references the economic and other benefits that the NPPF refers to. RR1 also refers to directing solar farms towards lower grade land and that the use of BMV land has not been demonstrated to be necessary. The reason does not state that the land quality will be affected, or that the land will be lost to agricultural use, now or in the future.

5.3 The officer's report to Committee refers to the land quality, noting that 47% of the site is of BMV quality (6.10). It is noted in 6.11 that sheep could graze the site but the proposals would cause "**the loss of full productive capacity of BMV land for a considerable period of time**".

5.4 In paragraphs 6.12 and 6.13 the officer criticises the Appellant's evidence about the availability, or otherwise, of land of poorer quality. Reference is made to other solar farm developments, and it is noted that this site "**performs very poorly in comparison to those examples**" (6.12).

Analysis Undertaken

5.5 In this section of my evidence I assess the land quality considerations. I do so in the following order:

(i) is land quality affected?
(ii) is the BMV land capable of full exploitation?
(iii) will there be benefits for the land?
(iv) what is the land quality in the wider area?
(v) what is the policy position?

5.6 In section 6 of my evidence I go on to consider the comments in the officer report about the economic and food producing aspects of BMV and other land.

Is the Land Quality Affected?

5.7 With the exception of the area under the proposed tracks and fixed infrastructure, the land quality is not adversely affected by the installation of the panels. The legs are inserted by machines in minutes, and are rammed in without the need to dig up or otherwise disturb soils. That was shown in the earlier photos, with one reproduced below.

Photo 22: Legs Installed

5.8 The installation process would not normally result in topsoils becoming churned up and rutted, but in some circumstances that is inevitable. As shown in the photographs in section 3, even where land becomes churned up and muddy, that is surface damage that can easily be rectified by mechanical means once the soils dry. Therefore there will be no long-term damage to soils, and no consequential downgrading of the land quality, other than for areas of fixed equipment.

5.9 Therefore the "loss" of land of BMV quality is limited to those fixed infrastructure areas, which as calculated earlier amounts to 0.35 ha of Subgrade 3a. That is not a "significant" loss in terms of the NPPF footnote 58.

5.10 There is now a widespread acceptance that the installation of solar panels does not negatively affect land quality. For example:

(i) in the decision on the Nationally Significant Infrastructure Project at Little Crow, Lincolnshire, which included 36.6 ha of Subgrade 3a, the Secretary of State agreed with his Inspector that the effect would be "**medium term, reversible, local in extent and of negligible significance during the operational phase with a moderate beneficial effect for the quality of soils because intensive cropping would be replaced with the growing of grass**" (para 4.50);

(ii) in the appeal decision for the solar farm at Bramley, Hampshire (APP/H1705/W/22/3304561) the Inspector, noting that 53% of the site was of BMV, noted (para 58) "**The agricultural land would not be permanently or irreversibly lost, particularly as pasture grazing would occur between the solar panels. This would allow the land to recover from intensive use, and the soil condition and structure to improve. The use of the soils for grassland under solar panels should serve to improve soil health and biodiversity and the proposed LEMP, which could be secured by a condition attached to any grant of planning permission, includes measures to improve the biodiversity of the land under and around the panels**".

5.11 Natural England did not object to the use of BMV land in this application. That is consistent with other responses they have provided. For example in an application at Thaxted, Essex, which involved 19 ha of Grade 2 and 35.9 ha of subgrade 3a BMV land, they commented: "**the proposed development would not appear to lead to the loss of over 20 ha 'best and most versatile' agricultural land) para 170 and 171 of the National Planning Policy Framework). This is because the solar panels would be secured to the ground with limited soil disturbance and could be removed in the future with no permanent loss of agricultural and quality likely to occur. Therefore, we consider that the proposed development is unlikely to lead to significant and irreversible long-term loss of best and most versatile agricultural land, as a resource for future generations**".

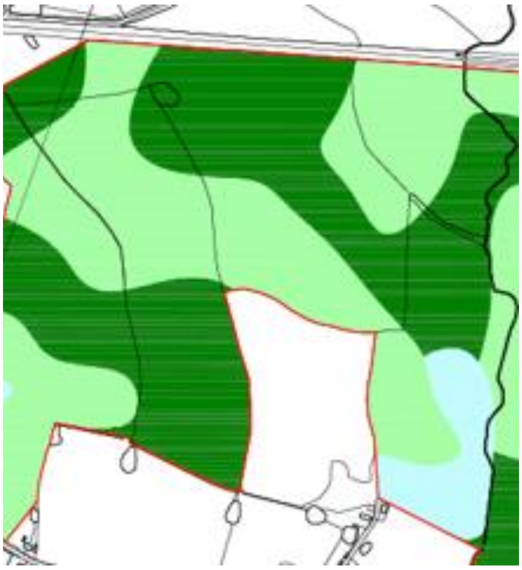
5.12 Accordingly there will be no loss of BMV agricultural land under the panels. The losses are restricted to the small areas for fixed equipment, as set out in Table 2 above, and involves 0.35 ha of Subgrade 3a.

Is the BMV Land Capable of Full Exploitation?

5.13 The site comprises a mixture of mostly Subgrade 3a and Subgrade 3b, but from a farming perspective the two are not capable of being farmed separately.

5.14 The following extract from the ALC plan, adjacent to an aerial photograph showing patchy crop establishment (oilseed rape, 5th May 2018) show that in practical terms the fields are farmed, and are farmable, only as whole fields, with no separation of cropping between Subgrades 3a and 3b land.

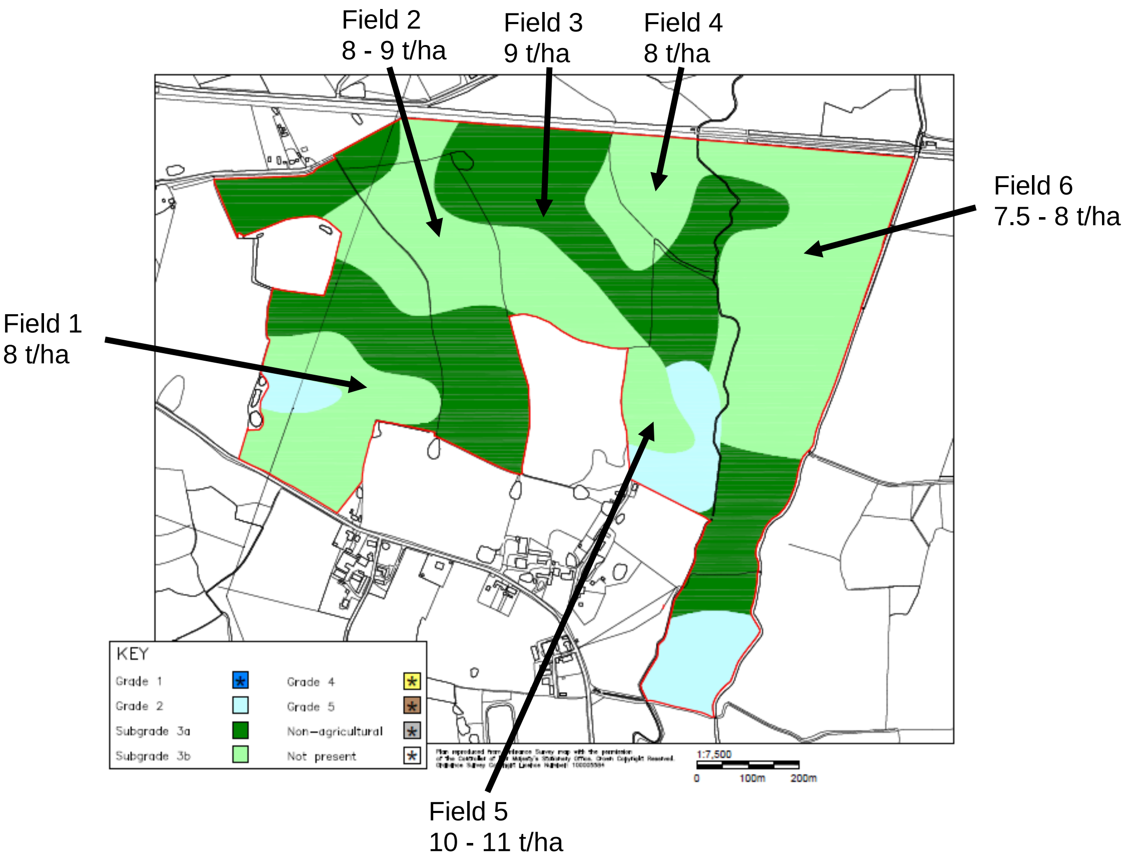
Inserts 12 and 13: Comparison of ALC Map and 2018 Cropping



5.15 The type of crop grown is dictated by the Subgrade 3b land within each field.

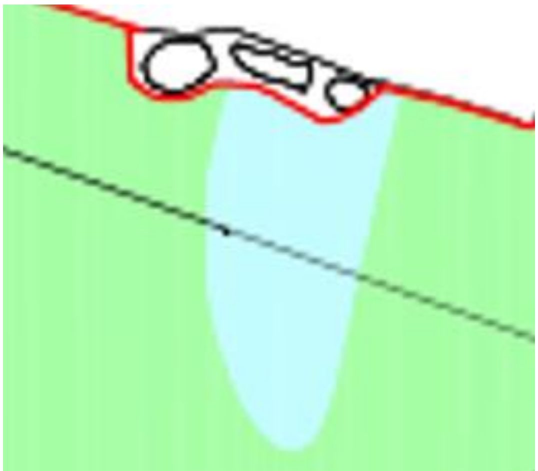
5.16 I set out a field by field analysis below, based on information provided by the farmer. This identifies, for winter wheat, a typical average yield per hectare across each field as shown below, superimposed on the ALC plan.

Insert 14: Likely Yield Per Hectare



5.17 Field 1 contains a patch of Grade 2 on the western side, but that is indistinguishable on the ground, and the farmability of this area is also affected by a powerline pole. The area is shown below, with the ALC map adjacent looking in the same direction.

Insert 15 and Photo 23: Grade 2 in Field 1



5.18 The patchy establishment of oilseed rape in 2018 in field 2 was clear in the aerial photograph earlier. There is similar patchy establishment in 2023, as shown below looking north and south over the field.

Photo 24: Looking North Over Field 2

Photo 25: Looking South over Field 2

5.19 The soil profiles do not vary greatly between the Subgrade 3a and Subgrade 3b land, as compared below.

Photos 26 and 27: Comparison of Grades

5.20 Field 3 is similarly a mix of subgrades, with mixed crop establishment success. The following photograph was taken looking north-west along the Subgrade 3a land, with Subgrade 3b to left and right. There was no evident difference in crop growth at this stage.

Photo 28: Looking NW in Field 3

5.21 Field 4, which is mostly Subgrade 3b, has however established better, as shown below. The bare patches in the foreground are from wet lying land next to the ditches.

Photo 29: Looking NE over Field 4

5.22 Field 5 contains a mix of Subgrade 3b with Subgrade 3a and Grade 2. It generally, overall, yields the best on this part of the farm. The crop, looking south over the Grade 2 land, is shown below, followed by a soil profile.

Photo 30: Looking South in Field 5

Photos 31 and 32: Soil Pit in Field 5

5.23 Field 6 is in wheat, and is shown below, looking north over Subgrade 3b then south over Subgrade 3a towards Grade 2.

Photo 33 and 34: Field 6

5.24 None of the fields are significantly different to each other, and as described in the ALC report the determining factor of wetness or droughtiness depends upon the Wetness Class. In practical terms this is land that is suited only to combinable crops, not root crops, and the ALC grade will affect little other than potential yield.

5.25 The objective in presenting this evidence is not to question the ALC results. Parts of the site are of BMV quality. However the variation in soils is not particularly marked and all the land is suited really only for combinable cropping or grassland. The BMV land is not significantly different to the non-BMV land with which it is mixed in a complex pattern.

5.26 Accordingly the only benefit that can be achieved from the BMV land within the site will relate to yields (ie production) rather than a wider range of cropping opportunities. The production of food, or industrial crops, is not a focus of Government policy, and there is no requirement for land to be farmed, or at any level of intensity. I consider that in section 6 of my evidence.

5.27 Accordingly the BMV land, mixed as it is with land of poorer quality in all the fields, is not capable of separate exploitation.

Will There Be Benefits from the Proposals for Soils?

5.28 There is increasing recognition of the need to look after our soils and that continuous arable production is generally having a negative effect on soils.

5.29 In their report “The State of the Environment: Soil” (2019), the Environment Agency identified that UK soils store about 10 billion tonnes of carbon, equal to about 80 years of annual greenhouse gas emissions. They identified that almost 4 million ha are at risk of compaction and 2 million ha are at risk of erosion.

5.30 The report identified that most arable soils have lost 40% to 60% of their organic matter. The organic matter levels of the Appeal site are poor, being described by Reading Agricultural Consultants (section 3.3) as “**suboptimal for heavier soils**”.

5.31 In the Food Security Report 2021 (Defra, 2022) it was noted that whilst growing wheat is the most efficient way to produce calories, it has a significant environmental impact “**due to the lack of biodiversity in conventional grain fields, damage to soil through ploughing, environmental harms caused by fertilisers and pesticides, and the use of oil embedded in fertilisers and field operations**”.

5.32 The role of soil organic carbon in soils is complex, as described in the British Society of Soil Science Note “Soil Carbon” (2021), reproduced at **Appendix KCC6**. As described under the heading “Soil Carbon Functions” on page 4:

> “**In general therefore, a soil with a greater SOC content has a more stable structure, is less prone to runoff and erosion, has greater water infiltration and retention, increased biological activity and improved nutrient supply compared to the same soils with a smaller SOC content. Even small increases in SOC can markedly influence and improve these properties**”.

5.33 It is noted at the top of page 5 that “**Significant long-term land use change (e.g. conversion of arable land to grassland or woodland) has by far the biggest impact on SOC, but is unrealistic on a large scale because of the continued need to meet food security challenges**”. I review this latter point in section 6.

5.34 The SOC level can be increased in other ways, and regenerative farming and minimal tillage practices are being trialled around the country, including on this land. There is a clear potential benefit for the soils from the conversion of arable land to grassland, however, which will result from the proposed development.

5.35 Additionally there will be no need for heavy machinery to traffic the soils during the operation phase. Accordingly there will be no compacting of soils. The combination of increasing organic matter levels and lack of machinery activity will allow a natural enhancement of the soil.

<u>What is the Land Quality in the Wider Area?</u>

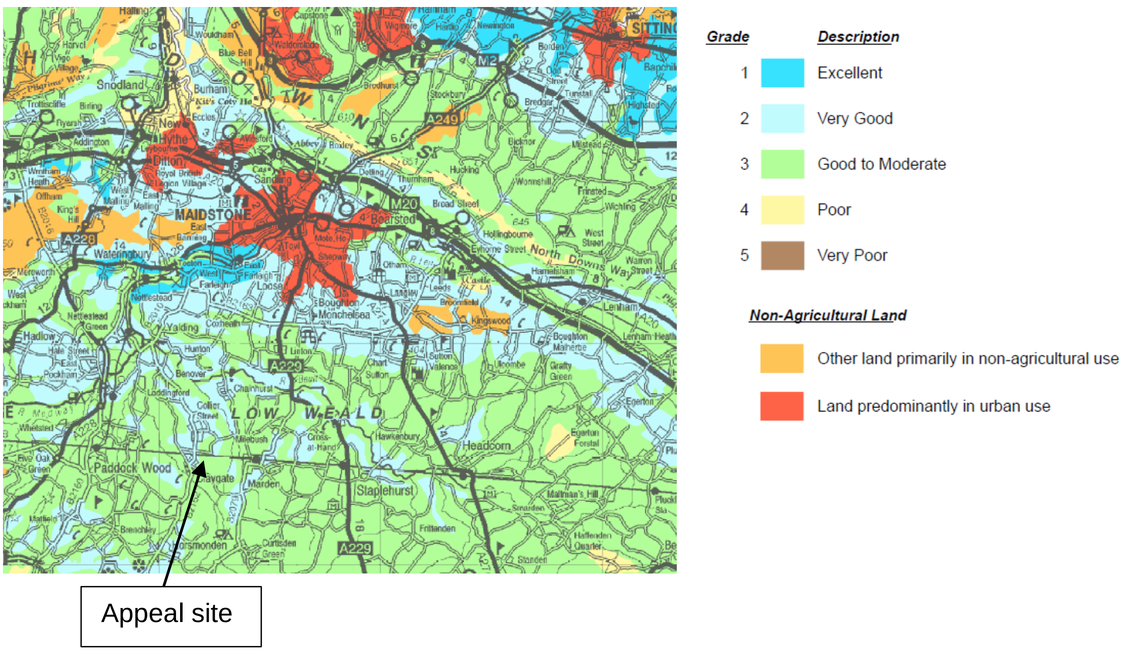
5.36 The provisional ALC maps from the 1970s are of limited use, but provide the only measured estimates available. The statistics for Maidstone, which was recorded as having an area of 39,335 ha, are shown below compared to the England figures.

Table 4: Provisional ALC Breakdown

Grade	England (%)	Maidstone (%)
1	2.7	1.6
2	14.2	27.4
3	48.2	60.4
4	14.1	2.0
5	8.4	0.0
Non-agricultural	5.0	2.9
Urban	7.3	5.9

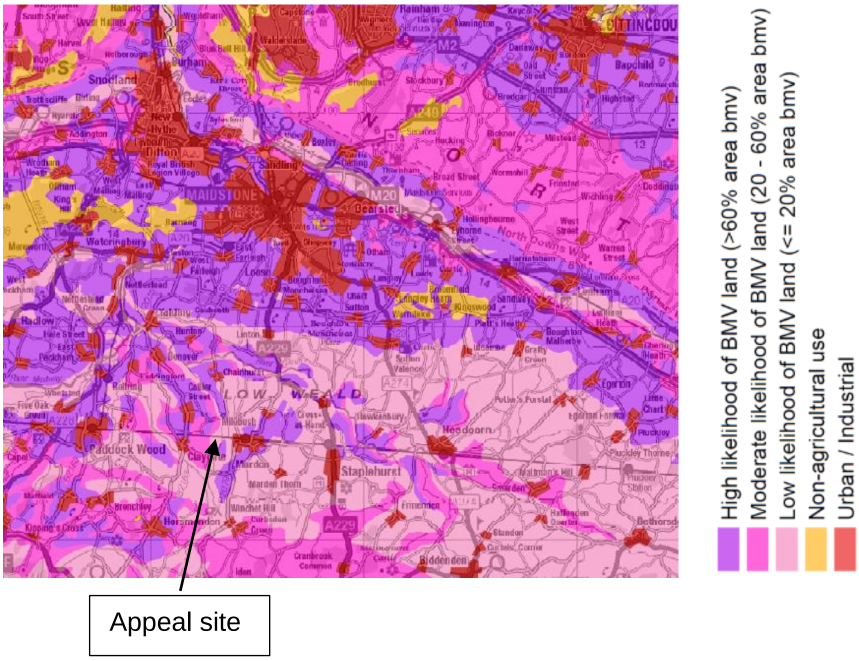
5.37 The land quality of the Borough is better than the England average. The amount of Grade 2 in the Borough is about twice the national average. This is mostly in the north of the Borough, and the pattern becomes more mixed in the southern part of the Borough, where the Appeal site is located. This is shown below.

Insert 16: Provisional ALC



5.38 The predictive likelihood BMV map for the same area is reproduced below. The site is identified. It is evident that the Appeal site lies in the area of generally poorer quality land within the Borough.

Insert 17: Predictive Likelihood of BMV



5.39 Therefore based on the available land quality data, and the evidence from the provisional and predictive BMV maps, where the area is shown as falling into the low and moderate likelihood of BMV, the site is some of the poorest quality available.

<u>What is the Policy Position?</u>

5.40 There is no policy bar on using land of BMV quality for solar farms. That is clear in the Secretary of State and Inspector decisions quoted from earlier.

5.41 Policy in the NPPF requires, in the context of plan making, that where significant quality of land is demonstrated to be necessary, poorer quality land should be used in preference. That trigger point is not reached here. Only 0.35 ha of BMV land is affected by the tracks, transformers etc. This is not "**significant development**".

5.42 Local Plan Policy DM24 does not bar the use of BMV land. Criterion 2 sets out that "**preference will be given to …. agricultural land that is not classified as the best and most versatile**". "**Preference**" is not equivalent to "**policy does very explicitly require avoidance of the BMV agricultural land, even if still farmed to a lower type of production**", as the case officer report to Committee stated at 6.15.

5.43 Therefore neither the NPPF (2021) nor the Local Plan DM24 (2017) require avoidance of BMV land.

5.44 The case officer report refers to the Planning Practice Guidance on the subject. This is dated back to 2015 and sets out that factors a local planning authority will need to consider include "**whether (i) the proposed use of any agricultural land has been shown to be necessary and poorer quality land has been used in preference to higher quality land: and (ii) the proposal allows for continued agricultural use where applicable and/or encourages biodiversity improvements around arrays**" (5-013-20150327). That is not policy "**very explicitly requiring avoidance of BMV agricultural**" land, as the case officer report alleges.

5.45 Nor does the Council's Planning Policy Advice Note "Large Scale Solar PV Arrays" (2014) require the avoidance of BMV land. The Note sets out in 3.18 that the presence of BMV land "**will therefore be a significant issue**". The flow chart on page 9 clearly allows for development of Subgrade 3a if there is an explanation of why the development needs to be located on such land (**see Appendix KCC4**).

5.46 The Appeal site is a mix of mostly Subgrades 3a and 3b, with some Grade 2. The Council's own Planning Practice Guidance allows for solar farm development on Subgrade 3a. The officer report to committee does not represent the Council's own position accurately.

5.47 The explanation above provides an explanation about the availability of lower quality land and the relative abundance of BMV land in the area. Farming considerations required in the flow chart are covered in section 6.

Conclusions

5.48 There will be only a small amount of BMV lost, some 0.35 ha. This is capable of restoration at decommissioning, but a cautious approach is taken in this assessment.

5.49 The BMV land involved is Subgrade 3a and is all mixed with Subgrade 3b such that it is not capable of being cropped and farmed differently.

5.50 Policy does not "**very clearly require avoidance of BMV land**", as the report to committee alleges. Indeed it does not require avoidance at all.

5.51 There is no policy objection to the use of BMV and, as set out in the decisions above, it is recognised that the land is not affected.

6 AGRICULTURAL LAND USE CONSIDERATIONS

Council's Reason for Refusal

6.1 Reason for Refusal No 1 states:

> "**The site includes a significant proportion of the best and most versatile agricultural land which has economic and other benefits that NPPF requires to be recognised. The proposal is also contrary to National Energy policies and Planning Practice Guidance and policy DM24 of the Maidstone Borough Local Plan 2017 which direct solar farms towards lower grade agricultural land. The proposed use of the best and most versatile agricultural land has not been adequately demonstrated to be necessary**".

6.2 The reason for refusal references the economic and other benefits of BMV agricultural land. As established in section 5 of my evidence above, there is no adverse effect on land quality (except for the small areas for fixed equipment), and there will be benefits for the soils.

6.3 The officer's report to Committee refers to the land being used for grazing by sheep thereby continuing agricultural use of the land "**but causing the loss of full productive capacity of BMV land for a considerable period of time**" (paragraph 6.11 refers). The report at 6.12 notes that the Appellants argue that the site would remain in agricultural use and that biodiversity benefits would be delivered, but that (6.13) this argument is not accepted.

6.4 The case officer's position seems to be that BMV agricultural land must be avoided for economic reasons and that it must be capable of being used for its full productive capacity.

Analysis Undertaken

6.5 In this section of my evidence I assess the land use considerations, in the following order:

(i) is there policy requiring agricultural land to be farmed?
(ii) is there policy requiring BMV agricultural land to be farmed to its full productive capacity?
(iii) is there a need for farmland to be used to its full productive capacity?
(iv) what are the economic and employment considerations from changing from arable to sheep grazing?
(v) are there other benefits?

Is There Policy Requiring Agricultural Land to be Farmed?

6.6 There is no Government, or local, policy that requires agricultural land to be farmed.

6.7 **The Definition of "Agriculture"**. The use of land for "agriculture", which is defined in the Town and Country Planning Act 1990 (s336), is not "development" (as defined in s55 (2) (e). You do not need planning consent to use land for agriculture, or to change between any different agricultural enterprises.

6.8 The definition of agriculture allows a wide range of agricultural uses. Some relate to food production, others do not. There is no requirement to use land for food production, or to use it for any particular intensity of use. Consequently the considerable interest and push for "rewilding" or regenerative agriculture, which encourages low intensity use with a focus on biodiversity, which was widely reported in recent years, is still an agricultural use.

6.9 It follows that a landowner can do what he or she wants with their land within the definition of agriculture. They could rewild and graze it unintensively, they could graze it with horses, plant short-rotation coppice, plant ancillary woodland, or fallow it. They could farm it intensively, subject to limits on nutrient loading (covered by other legislation and rules), or farm it organically. They could grow industrial crops, energy crops, or food for human consumption. Food production is not an obligation.

6.10 **National Policy**. The NPPF paragraph 174 refers to the "economic and other benefits" of BMV land. Natural England drew the Council's attention to paragraph 174, which requires the economic and unspecified "other benefits" of BMV land to be recognised. It is not a food production policy.

6.11 Nor is footnote 58 of the NPPF a food production policy. The footnote attaches to a sentence requiring plans to "**allocate land with the least environmental or amenity value**". BMV land has no particular environmental or amenity value over non-BMV land.

6.12 On 22nd December 2022 the Government published a consultation amendment to the NPPF. This proposed adding the following to footnote 58 (which would be renumbered):

> "**The availability of agricultural land used for food production should be considered, alongside the other policies in this Framework, when deciding what sites are most appropriate for development**".

6.13 This is not a proposed new policy to require land to be farmed, or farmed to its full productive capacity. This proposed amendment was explained in the parallel, and related, "Levelling-up and Regeneration Bill: reforms to national planning policy", 22nd December 2022. The explanatory text at SS6 paragraphs 10 and 11 states the following:

"**10. The government 's food strategy highlights that the UK maintains a high degree of food security. The strategy sets out an aim to broadly maintain domestic production at current levels to build the UK's resilience to future crisis and shocks. We have some of the best performing farms in the world, with 57% of agricultural output coming from just 33% of the farmed land area. To emphasise the important role that our best performing farms have on food security, alongside imperatives such as energy security, we are seeking initial views on increasing the consideration given to the highest value farmland used for food production in the Framework for both plans and decision making.**

11. The Framework currently expects that planning policies and decisions should contribute to and enhance the natural and local environment by recognising the wider benefits from natural capital and ecosystem services including the economic and other benefits of the best and most versatile agricultural land. Best and Most Versatile land is defined as grades 1-3a in the Agricultural Land Classification. To build on this, we propose a change to the current Framework footnote 58 by adding detail on the consideration that should be given to the relative value of agricultural land for food production, where significant development of higher quality agricultural land is demonstrated to be necessary, compared to areas of poorer quality land. This should not prevent the achievement of government's objectives in relation to nature recovery and creation of ecosystem services to enable and offset development elsewhere".

6.14 This change would not have any effect on the use of land for food production. It is not a food-growing policy, as the rest of the consultation sets out, and will not change how farmers and landowners use their land.

6.15 **Local Plan Policy**. In common with national policy, the Local Plan makes no reference to the use of agricultural land in their renewable energy policy.

<u>Is There Policy Requiring BMV Land to be Farmed?</u>

6.16 Just as there is no policy requiring farmland per se to be farmed, there is also no policy that requires BMV land to be farmed, or farmed to any level of intensity.

<u>Is There a need for Farmland to be Used to its Full Productive Capacity?</u>

6.17 The Council's reason for refusal is seemingly based around the alleged loss of use of land for full capability food production as a consequence of the installation of panels.

6.18 Government policy and initiatives do not require or even seek to encourage food production.

6.19 Prior to the invasion of Ukraine, Government policy and financial incentives were focused on enhancing biodiversity and tackling the loss of environmental diversity. The position of Government has not changed since.

6.20 The Sustainable Farming Incentive, the full guidance for which was updated on 2nd September 2022, is one of three new environmental schemes post Brexit. The SFI aims to improve water quality, biodiversity, climate change mitigation and animal health and welfare. There is no mention of food production.

6.21 The SFI, the guide advises, aims to:

- encourage actions to improve soil health;
- recognise how moorland provides benefits to the public;
- improve animal health and welfare by helping farmers with the costs of veterinary advice for livestock.

6.22 The Government Food Strategy (June 2022) does not seek to increase food production. The "Foreword" recognises near self-sufficiency in wheat, most meat, eggs and some vegetables, but not in soft fruit although the trend is favourable. But the strategy does not seek to alter that in the main commodities. The Strategy states:

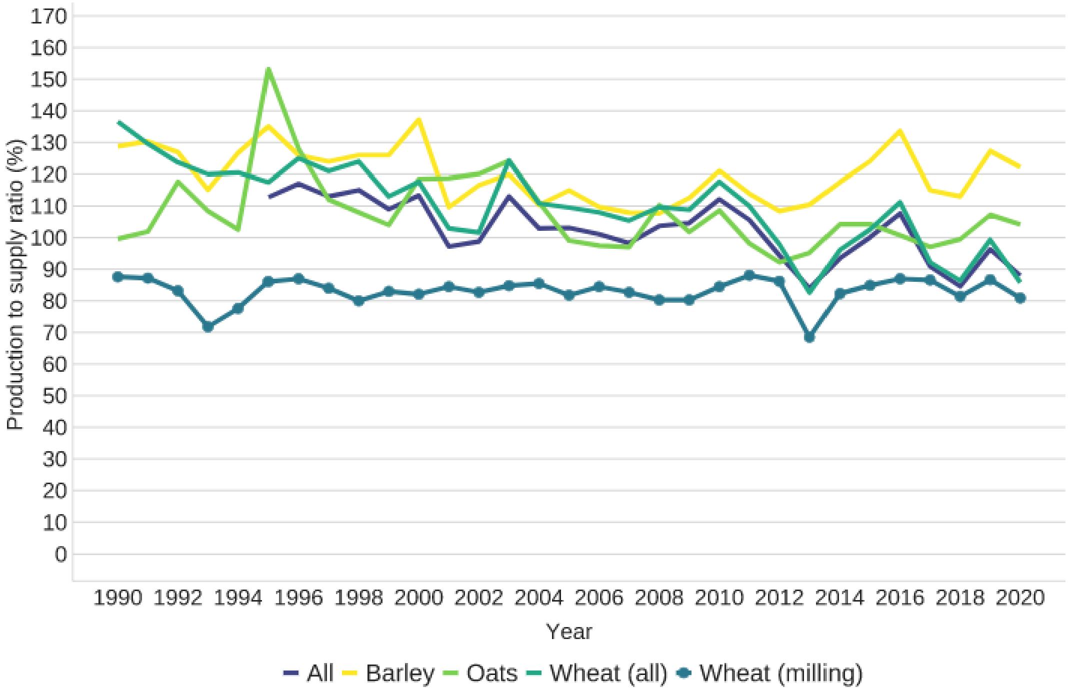
> "**Overall, for the foods that we can produce in the UK, we produce around 75% of what we consume. That has been broadly stable for the past 20 years and in this food strategy we commit to keep it at broadly the same level in future**".

6.23 Paragraphs 1.2.2 and 1.2.3 amplify this. There is no push for increased food production from arable or grassland, but rather a focus on Net Zero, biodiversity, and animal health and welfare.

6.24 The Growth Plan 2022 (HM Treasury, September 2022) sets out in paragraph 3.48 that agricultural production growth has been weak for many years, and this needs to change. A review is underway of frameworks for regulation, innovation and investment, with plans which were then stated to be set out later in the autumn. In context, however, the whole of section 2 of The Growth Plan is about tackling energy prices, with a drive for development of home-grown renewable technologies (2.10 refers). Farming by contrast warrants one paragraph.

6.25 The Bidwells' report section 5 refers to the UK's position on arable crops. In terms of grains, domestic production generally exceeds consumption, as shown below. It is only in hard wheats that we produce less than we consume, because hard wheats are not suited to growing well in our climate. Hence we export other grains and import hard grains.

Insert 18: Domestic UK Grain Production as Percentage of Consumption



6.26 The Food Security Report notes that grain alone does not provide a healthy and nutritious diet or meet consumer demand for a varied diet. The analysis shows, however, that in terms of calories, we are self-sufficient. The report notes:

> "**However, from a purely calorific perspective, the (below average) grain yield in 2020 of 19 million tonnes would be sufficient to sustain the population. It is equivalent to 283kg per person, 0.8 kilos per day. A kilo of wheat provides 3,400 calories (and barley slightly more at 3520 calories), making 0.8 kilos of grain over 2,600 calories, compared to recommended calorie intake of 2 to 2500 for adults. From these figures it is easy to demonstrate that, even without accounting for other domestic products like potatoes, vegetables, grass-fed meat and dairy, and fisheries, current UK grain production alone could meet domestic calorie requirements if it was consumed directly by humans in a limited choice scenario**".

6.27 Self-sufficiency in livestock products is also high. In meat, milk and eggs the UK produces a roughly equivalent volume to what it consumes. In 2020 production per person equated to:

- 61kg meat;
- 227 litres of milk;
- 172 eggs.

6.28 There is no need for farmland to be used to is full productive capacity. The position is made clearly by Government, and the SFI clearly intends to encourage non-intensive farming practices with a focus on soil health and biodiversity.

<u>What are the Economic and Employment Considerations?</u>

6.29 The land is used for a rotation of wheat, barley, oilseed rape, beans, oats and linseed. Yields, as set out in section 4, are variable. The average yield of the fields within the Appeal site if growing wheat were set out earlier. The various fields averaged yields between 7.5 t/ha and 10-11 t/ha. The average yield across England in 2022 was 8.6 t/ha ("Provisional cereal and oilseed production estimates for England 2022, Defra") (21 December 2022).

6.30 Yield maps for the fields within the Appeal site show considerable variation. There are wet areas, areas where establishment was poor, shaded areas and some high yielding areas.

6.31 The Appeal site, based on 2022 production, produces about average yields on the whole, with a couple of fields yielding slightly above average.

6.32 If we take, for the purposes of attempting an economic and productivity assessment, the "average" and "high" performance budgets from the Pocketbook for Farm Management 2023 (September 2022), to represent non-BMV and BMV land respectively, we can crudely quantify the benefits. The table below shows a per hectare yield and gross margin for two crops, being winter wheat and winter oilseed rape.

Table 5: Assessment of Economic and Production Differences

Item	**Winter Wheat**		**Oilseed Rape**	
	Average	High	Average	High
Yield (t/ha)	8.6	10.0	3.5	4.0
Difference (t/ha)	**-**	**1.4**	**-**	**0.5**
Gross Margin (£/ha)	1,200	1,515	1,066	1,323
Difference (£)	**-**	**315**	**-**	**257**

John Nix Pocketbook for Farm Management, September 2022

6.33 Within the Appeal site, some 35.1 ha is Grade 2 and Subgrade 3a (see Table 3). 91% of the area is actually cropped (68.1 ha out of 74.5 ha, see section 4). However if we assumed all the BMV land was fully cropped, the implications of the 35.1 ha of BMV within the Appeal site are as follows:

- yield uplift of 49 tonnes of wheat or 17.5 tonnes of oilseed rape;
- economic Gross Margin (ie output minus direct variable costs) of £9,000 - £11,000 per annum.

6.34 We know that this is a greater impact than would be expected in reality, but nevertheless it shows that in terms of economic and food productivity terms the effects are modest.

6.35 If it was determined that solar panels must not be placed on BMV land but only on non-BMV land, and if the above crude estimate is accepted for the comparison, then the effect of moving the 35.1 ha of panels from the BMV land within the site to non-BMV land, would be a maximum production benefit of 49 tonnes of wheat.

6.36 Defra estimate that England, in 2022, produced almost 21 million tonnes of cereal and oilseeds, of which 14.4 million tonnes was wheat (Provisional cereal and oilseed production estimates for 2022, Defra (21 December 2022)). Clearly the effect of moving the proposed panels from the BMV land within the Appeal site to poorer quality land would be insignificant in terms of England's production.

6.37 The land will continue to be used, being used for sheep production. An agricultural land use will continue and food will be produced.

6.38 The economic and other benefits have thus been considered, and are modest.

Are There Other Benefits?

6.39 The benefits for soil and soil biodiversity were described in section 5. There will be other biodiversity benefits. These were referred to in the Bidwell's report, but do not seem to have been referred to by the case officer.

6.40 The State of Nature Report 2019 (The State of Nature Partnership, 2019) reported increases and decreases in different species, but overall a decline in the abundance and distribution of the UK's species since 1970, continuing a trend started hundreds of years earlier. The Food Security Report 2021, referred to earlier, noted that wheat production has a significant environmental impact including "**due to the lack of biodiversity in conventional grain fields**".

6.41 The Secretary of State and Inspectors have recognised that there are other benefits from converting arable land to grassland.

6.42 There will also be an increased need for farm labour. The Pocketbook for Farm Management labour estimates for cereals and lowland sheep production are compared below.

Table 6: Labour Estimates

Crop	**Hours/ha/year**
Winter cereals, including hauling straw	14
Winter oilseed rape	9
Sheep – 4 hours per ewe at 10 ewes/ha	40

Conclusions

6.43 The reason for refusal seems to be based on an assumption that arable land should be used for its full productive capabilities and a misunderstanding that policy seeks to avoid its use for solar panels.

6.44 The reason for refusal is wrong on this. Policy does not seek to avoid BMV agricultural land. Policy does not require such land to be farmed, or farmed to its productive capabilities. The land affected is a mix of mostly Subgrade 3a and 3b. The Council's Planning Guidance Note differentiates between Grade 1 and 2, and Subgrade 3a. There is no bar on using Subgrade 3a.

6.45 There is no emerging policy of which we are aware that changes the emphasis to food production (see 6.12 to 6.14 above).

6.46 There is no evidence that we need to farm land intensively for food production. The statistics indicate otherwise. There will continue to be food production from the land and there will be biodiversity benefits.

6.47 There is no food production policy, guidance or need to locate solar development only on non-BMV land.

7 SUMMARY AND CONCLUSIONS

7.1 The reason for refusal followed the officer's report to Committee. That report set out that policy "**very explicitly requires avoidance of the BMV agricultural land, even if still farmed to a lower type of production**" (officer report 6.15).

7.2 That is not a correct or accurate interpretation of planning policy. Nowhere in Government policy, Local Plan policy, the Planning Practice Guidance suite or the Council's Policy Note is there a policy or requirement to avoid using BMV land for solar panels.

7.3 With the exception of the limited areas of land required for tracks and infrastructure, which cover 0.35 ha of Subgrade 3a land, the agricultural land will not be adversely affected. It will not be downgraded. This is widely recognised in planning decisions.

7.4 Nor is there a policy, or incentive, to use land for its full productive capabilities. There is no food security concern and no requirement to farm land intensively. Emerging schemes encourage the opposite.

7.5 There will be clear benefits for soil health and biodiversity and wider biodiversity from converting arable land to grassland.

7.6 The economic and food production implications, were the BMV land within the Appeal site to be retained for arable use and the panels deployed to lower quality land instead, would be modest.

7.7 The agricultural issues should be given limited weight as very little BMV land is affected. There are clear benefits from the land being put to grassland for the duration of the scheme.

8 DECLARATION

8.1 In accordance with the requirements of the Royal Institution of Chartered Surveyors Practice Statement, “Surveyors acting as expert witnesses” (4th edition, 2014):

(i) I confirm that my report includes all facts which I regard as being relevant to the opinions which I have expressed and that attention has been drawn to any matter which would affect the validity of those opinions.

(ii) I confirm that my duty to this Appeal as an expert witness overrides any duty to those instructing or paying me, that I have understood this duty and complied with it in giving my evidence impartially and objectively, and that I will continue to comply with that duty as required.

(iii) I confirm that I am not instructed under any conditional fee arrangement.

(iv) I confirm that I have no conflicts of interest of any kind other than those already disclosed in my report.

(v) I confirm that my report complies with the requirements of the Royal Institution of Chartered Surveyors (RICS), as set down in *Surveyors acting as expert witnesses*: RICS practice statement.

Signed:

(Tony Kernon)

Dated: 4th April 2023

Appendix KCC1

Curriculum Vitae

KERNON
COUNTRYSIDE
CONSULTANTS
LIMITED

CURRICULUM VITAE

ANTHONY PAUL KERNON

SPECIALISMS

- Assessing the impacts of development proposals on agricultural land and rural businesses
- Agricultural building and dwelling assessments
- Equestrian building and dwelling assessments (racing, sports, rehabilitation, recreational enterprises)
- Farm and estate diversivification and development
- Inputs to Environmental Impact Assessment
- Expert witness work

SYNOPSIS

Tony is a rural surveyor with 35 years experience in assessing agricultural land issues, farm and equestrian businesses and farm diversification proposals, and the effects of development proposals on them. Brought up in rural Lincolnshire and now living on a small holding in Wiltshire, he has worked widely across the UK and beyond. He is recognised as a leading expert nationally in this subject area. Married with two children. Horse owner.

Tony's specialism is particularly in the following key areas:

- assessing the need for agricultural and equestrian development, acting widely across the UK for applicants and local planning authorities alike;
- farm development and diversification planning work, including building reuse and leisure development, Class Q, camping etc;
- assessing development impacts, including agricultural land quality and the policy implications of losses of farmland due to residential, commercial, solar or transport development, and inputs to Environmental Assessment;
- and providing expert evidence on these matters to Planning Inquiries and Hearings, court or arbitrations.

QUALIFICATIONS

Bachelor of Science Honours degree in Rural Land Management, University of Reading (BSc(Hons)). 1987. Awarded 2:1.
Diploma of Membership of the Royal Agricultural College (MRAC).
Professional Member of the Royal Institution of Chartered Surveyors (MRICS) (No. 81582). (1989).

OTHER PROFESSIONAL ACTIVITIES

Co-opted member of the Rural Practice Divisional Council of the Royal Institution of Chartered Surveyors. (1994 - 2000)
Member of the RICS Planning Practice Skills Panel (1992-1994)
Member of the RICS Environmental Law and Appraisals Practice Panel (1994 - 1997).
Fellow of the British Institute of Agricultural Consultants (FBIAC) (1998 onwards, Fellow since 2004).
Secretary of the Rural Planning Division of the British Institute of Agricultural Consultants (BIAC) (1999 – 2017).
Vice-Chairman of the British Institute of Agricultural Consultants (2019 – 2020)
Chairman of the British Institute of Agricultural Consultants (2020 – 2022)

Greenacres Barn, Stoke Common Lane,
Purton Stoke, Swindon SN5 4LL
T: 01793 771333 Email: info@kernon.co.uk
Website: www.kernon.co.uk

EXPERIENCE AND APPOINTMENTS

1997 ------>	**Kernon Countryside Consultants.** Principal for the last 25 years of agricultural and rural planning consultancy specialising in research and development related work. Specialisms include essential dwelling and building assessments, assessing the effects of development on land and land-based businesses, assessing the effects of road and infrastructure proposals on land and land-based businesses, and related expert opinion work. Tony specialises in development impact assessments, evaluating the effects of development (residential, solar, road etc) on agricultural land, agricultural land quality, farm and other rural businesses.
1987 - 1996	**Countryside Planning and Management**, Cirencester. In nearly ten years with CPM Tony was involved in land use change and environmental assessment studies across the UK and in Europe. From 1995 a partner in the business.
1983 - 1984	**Dickinson Davy and Markham**, Brigg. Assistant to the Senior Partner covering valuation and marketing work, compulsory purchase and compensation, and livestock market duties at Brigg and Louth.

RECENT RELEVANT EXPERIENCE

TRAINING COURSES

Landspreading of Non Farm Wastes. Fieldfare training course, 24 – 25 November 2009
Foaling Course. Twemlows Hall Stud Farm, 28 February 2010
Working with Soil: Agricultural Land Classification. 1 – 2 November 2017

TRANSPORT ENVIRONMENTAL ASSESSMENT CONTRIBUTIONS

1992	**Port Wakefield Channel Tunnel Freight Terminal, Yorkshire**
1993	**A1(M) Widening, Junctions 1-6 (Stage 2)**
1994 - 1995	**A55 Llanfairpwll to Nant Turnpike, Anglesey (Stage 3)**
1994 - 1995	**A479(T) Talgarth Bypass, Powys (Stage 3)**
1995	**Kilkhampton bypass (Stage 2)**
1997	**A477 Bangeston to Nash improvement, Pembroke**
2000	**Ammanford Outer Relief Road**
2001	**A421 Great Barford Bypass**
2001	**Boston Southern Relief Road**
2003	**A40 St Clears - Haverfordwest**
2003	**A470 Cwmbrach – Newbridge on Wye**
2003	**A11 Attleborough bypass**
2003 - 2008	**A487 Porthmadog bypass (Inquiry 2008)**
2004	**A55 Ewloe Bypass**
2004	**A40 Witney – Cogges link**
2005 – 2007	**A40 Robeston Wathen bypass (Inquiry 2007)**
2005 – 2007	**East Kent Access Road (Inquiry 2007)**
2006	**M4 widening around Cardiff**
2007 – 2008	**A40 Cwymbach to Newbridge (Inquiry 2008)**
2007	**A483 Newtown bypass**
2008 – 2009	**A470/A483 Builth Wells proposals**
2009 – 2017	**A487 Caernarfon-Bontnewydd bypass (Inquiry 2017)**
2009 – 2010	**North Bishops Cleeve extension**
2009 – 2010	**Land at Coombe Farm, Rochford**
2009 – 2011	**A477 St Clears to Red Roses (Inquiry 2011)**
2010 – 2011	**Streethay, Lichfield**
2010 – 2012	**A465 Heads of the Valley Stage 3 (Inquiry 2012)**
2013 – 2016	**A483/A489 Newtown Bypass mid Wales (Inquiry 2016)**
2013 - 2016	**High Speed 2 (HS2) rail link, Country South and London: Agricultural Expert for HS2 Ltd**

2015 – 2017 **A487 Dyfi Bridge Improvements**
2016 – 2018 **A465 Heads of the Valley Sections 5 and 6 (Inquiry 2018)**
2017 - 2018 **A40 Llanddewi Velfrey to Penblewin**
2017 – 2018 **A4440 Worcester Southern Relief Road**
2019 – 2020 **A40 Penblewin to Red Roses**
2019 – 2020 **A55 Jn 15 and 16 Improvements**

NSIP/DCO SOLAR INPUTS

2020 – 2022 **Heckington Fen, Lincolnshire**
Mallards Pass, Lincolnshire/Rutland
Penpergwm, Monmouthshire
Parc Solar Traffwll, Anglesey
Alaw Mon, Anglesey
Parc Solar Caenewydd, Swansea

EXPERT EVIDENCE GIVEN AT PUBLIC INQUIRIES AND HEARINGS

1992	**Brooklands Farm**: Buildings reuse	**Bonehill Mill Farm**: New farm building
	Chase Farm, Maldon: Romoval of condition	
1993	**Haden House**: Removal of condition	**Manor Farm**: New farm dwelling
1994	**Brooklands Farm**: 2nd Inquiry (housing)	**Cameron Farm**: Mobile home
	Barr Pound Farm: Enforcement appeal	**Land at Harrietsham**: Enforcement appeal
	Fortunes Farm Golf Course: Agric effects	
1995	**Village Farm**: New farm dwelling	**Attlefield Farm**: Size of farm dwelling
	Claverdon Lodge: Building reuse	**Bromsgrove Local Plan**: Housing allocation
	Harelands Farm: Barn conversion	**Lichfield Local Plan**: Against MAFF objection
	Castle Nurseries: Alternative site presentation	**Hyde Colt**: Mobile home / glasshouses
1996	**Church View Farm**: Enforcement appeal	**Highmoor Farm**: New farm dwelling
	Flecknoe Farm: Second farm dwelling	**Gwenfa Fields**: Removal of restriction
1997	**Basing Home Farm**: Grain storage issue	**Yatton**: Horse grazing on small farm
	Viscar Farm: Need for farm building / viability	**Newbury Local Plan**: Effects of development
	Lane End Mushroom Farm: Need for dwelling	
1998	**Moorfields Farm**: New farm dwelling	**Two Burrows Nursery**: Building retention
	Maidstone Borough LPI: Effects of dev'ment	**Dunball Drove**: Need for cattle incinerator
	Glenfield Cottage Poultry Farm: Bldg reuse	
1999	**Holland Park Farm**: Farm dwelling / calf unit	**Lambriggan Deer Farm**: Farm dwelling
	Northington Farm: Existing farm dwelling	
2000	**Twin Oaks Poultry Unit**: Traffic levels	**Coldharbour Farm**: Buildings reuse
	Meadows Poultry Farm: Farm dwelling	**Heathey Farm**: Mobile home
	Hazelwood Farm: Beef unit and farm dwelling	**Wheal-an-Wens**: Second dwelling
	Shardeloes Farm: Farm buildings	**Apsley Farm**: Buildings reuse
	Aylesbury Vale Local Plan: Site issues	**Home Farm**: Size of grainstore
	Deptford Farm: Buildings reuse	**A34/M4 Interchange**: Agricultural evidence
2001	**Lambriggan Deer Farm**: Farm dwelling	**Weyhill Nursery**: Second dwelling
	Blueys Farm: Mobile home	**Mannings Farm**: Farm dwelling
2002	**A419 Calcutt Access**: Effect on farms	**Land Adj White Swan**: Access alteration
	Cobweb Farm: Buildings reuse / diversification	**Happy Bank Farm**: Lack of need for building
	Philips Farm: Farm dwelling	**Lower Park Farm**: Building reuse / traffic
	West Wilts Local Plan Inquiry: Dev site	**Stourton Hill Farm**: Diversification
	Manor Farm: Building reuse	
2003	**Fairtrough Farm**: Equine dev and hay barn	**Darren Farm**: Impact of housing on farm
	Hollies Farm: Manager's dwelling	**Greenways Farm**: Farm diversification
	Land at Springhill: Certificate of lawfulness	**Land at Four Marks**: Dev site implications
	Oak Tree Farm: Mobile home	
2004	**Chytane Farm**: Objector to farm dwelling	**Oldberrow Lane Farm**: Relocation of buildings
	Crown East: Visitor facility and manager's flat	**Forestry Building, Wythall**: Forestry issues
	Swallow Cottage: Widening of holiday use	**Lower Dadkin Farm**: Mobile home

	Etchden Court Farm: New enterprise viability	**Villa Vista**: Viability of horticultural unit
	Attleborough Bypass: On behalf of Highways Agency	
2005	**Howells School**: Use of land for horses	**Newton Lane**: Enforcement appeal
	Otter Hollow: Mobile home	**Manor Farm**: Change of use class
	Springfield Barn: Barn conversion	**South Hatch Stables**: RTE refurbishment
	Ashley Wood Farm: Swimming pool	**Trevaskis Fruit Farm**: Farm dwelling
	The Hatchery: Mobile home	**Tregased**: Enforcement appeal
	Stockfields Farm: Building reuse	
2006	**Manor Farm**: Replacement farmhouse	**Bhaktivedanta Manor**: Farm buildings
	Sough Lane: Farm dwelling	**Military Vehicles**: Loss of BMV land
	Whitewebbs Farm: Enforcement appeal	**Ermine Street Stables**: Enforcement appeal
	Land at Condicote: Farm dwelling	**Featherstone Farm**: Replacement buildings
	Rye Park Farm: Enforcement appeal	**Flambards**: Mobile home and poultry unit
	Woodrow Farm: Buildings reuse	**Manor Farm**: Effect of housing on farm
	Rectory Farm: Retention of unlawful bldg	**Goblin Farm**: Arbitration re notice to quit
	Walltree Farm: Retention of structures	**Terrys Wood Farm**: Farm dwelling
	Weeford Island: Land quality issues	**Etchden Court Farm**: Mobile home
	College Farm: Relocation of farmyard	**Hollowshot Lane**: Farm dwelling and buildings
2007	**Woolly Park Farm**: Manager's dwelling	**Barcroft Hall**: Removal of condition
	Park Gate Nursery: Second dwelling	**Kent Access Road**: Effect on farms
	Penyrheol las: Retention of bund	**Greys Green Farm**: Enforcement appeal
	Hucksholt Farm: New beef unit in AONB	**A40 Robeston Wathen bypass**: Underpass
	The Green, Shrewley: Mobile home	**Woodland Wild Boar**: Mobile homes
	Brook Farm: Retention of polytunnels	
2008	**Weights Farm**: Second dwelling	**Whitegables**: Stud manager's dwelling
	Hill Farm: Mobile home	**Balaton Place**: Loss of paddock land
	Relocaton of Thame Market: Urgency issues	**Point to Point Farm**: Buildings / farm dwelling
	Spinney Bank Farm: Dwelling / viability issues	**Norman Court Stud**: Size of dwelling
	Higham Manor: Staff accommodation	**High Moor**: Temporary dwelling
	Robeston Watham bypass: Procedures Hearing	**Land at St Euny**: Bldg in World Heritage Area
	Monks Hall: Covered sand school	**Baydon Meadow**: Wind turbine
	Porthmadog bypass: Road scheme inquiry	
2009	**Claverton Down Stables**: New stables	**Meadow Farm**: Building conversion
	Hailsham Market: Closure issues	**Bishop's Castle Biomass Power Station**: Planning issues
	Gambledown Farm: Staff dwelling	**Foxhills Fishery**: Manager's dwelling
	Oak Tree Farm: Farm dwelling	**Bryn Gollen Newydd**: Nuisance court case
	A470 Builth Wells: Off line road scheme	**Swithland Barn**: Enforcement appeal
	Hill Top Farm: Second dwelling	**Woodrow Farm**: Retention of building
	Sterts Farm: Suitability / availability of dwelling	
2010	**Poultry Farm, Christmas Common**: Harm to AONB	**Stubwood Tankers**: Enforcement appeal
	Wellsprings: Rention of mobile home	**Meridian Farm**: Retention of building
	Redhouse Farm: Manager's dwelling	**Swithland Barn**: Retention of building
	Lobbington Fields Farm: Financial test	
2011	**Fairtrough Farm**: Enforcement appeal	**A477 Red Roses to St Clears**: Public Inquiry
	Etchden Court Farm: Farm dwelling	**Upper Bearfield Farm**: Additional dwelling
	Trottiscliffe Nursery: Mobile home	**North Bishops Cleeve**: Land quality issues
2012	**Tickbridge Farm**: Farm dwelling	**Langborrow Farm**: Staff dwellings
	Blaenanthir Farm: Stables and sandschool	**Heads of the Valley S3**: Improvements
	Land at Stonehill: Eq dentistry / mobile home	**Seafield Pedigrees**: Second dwelling
	Cwmcoedlan Stud: Farm dwelling with B&B	**Beedon Common**: Permanent dwelling
2013	**Barnwood Farm**: Farm dwelling	**Upper Youngs Farm**: Stables / log cabin
	Spring Farm Barn: Building conversion	**Tithe Barn Farm**: Enforcement appeal
	Baydon Road: Agricultural worker's dwelling	**Lower Fox Farm**: Mobile home / building

	Stapleford Farm: Building reuse	**Tewinbury Farm**: Storage barn
	Meddler Stud: Residential development	**Church Farm**: Solar park construction
	Deer Barn Farm: Agricultural worker's dwelling	
2014	**Land at Stow on the Wold**: Housing site	**Land at Elsfield**: Retention of hardstanding
	Allspheres Farm: Cottage restoration	**Queensbury Lodge**: Potential development
	Land at Stonehill: Equine dentistry practice	**Kellygreen Farm**: Solar park development
	Spring Farm Yard: Permanent dwelling	**Spring Farm Barn**: Building conversion
	Land at Valley Farm: Solar park	**Land at Willaston**: Residential development
	Land at Haslington: Residential development	**Bluebell Cottage**: Enforcement appeal
	Manor Farm: Solar farm on Grade 2 land	**Clemmit Farm**: Mobile home
	Penland Farm: Residential development	**Honeycrock Farm**: Farmhouse retention
	Sandyways Nursery: Retention of 23 caravans	**The Mulberry Bush**: Farm dwelling
2015	**The Lawns**: Agricultural building / hardstanding	**Redland Farm**: Residential dev issues
	Harefield Stud: Stud farm / ag worker's dwelling	**Emlagh Wind Farm**: Effect on equines
	Newtown Bypass: Compulsory purchase orders	**Fox Farm**: Building conversion to 2 dwellings
	Barn Farm: Solar farm	**Wadborough Park Farm**: Farm buildings
	Hollybank Farm: Temporary dwelling renewal	**Delamere Stables**: Restricted use
	Five Oaks Farm: Change of use of land and temporary dwelling	
2016	**Clemmit Farm**: Redetermination	**Meddler Stud**: RTE and up to 63 dwellings
	The Lawns: Replacement building	**Land off Craythorne Road**: Housing dev
	Land at the Lawns: Cattle building	**Berkshire Polo Club**: Stables / accomm
2017	**Low Barn Farm**: Temporary dwelling	**Harcourt Stud**: Temporary dwelling
	High Meadow Farm: Building conversion	**Clemmit Farm**: Second redetermination
	Windmill Barn: Class Q conversion	**Stonehouse Waters**: Change of use of lake
	Land at Felsted: Residential development	
2018	**Thorney Lee Stables**: Temporary dwelling	**Watlington Road**: Outline app residential
	Benson Lane: Outline app residential	**A465 Heads of the Valley 5/6**: Agric effects
	Park Road, Didcot: Outline app residential	**The Old Quarry**: Permanent dwelling
	Coalpit Heath: Residential development	**Chilaway Farm**: Removal of condition
2019	**Mutton Hall Farm**: Agric worker's dwelling	**Leahurst Nursery**: Temporary dwelling
	Clemmit Farm: Third redetermination	**Icomb Cow Pastures**: Temp mobile home
	Ten Acre Farm: Enforcement appeal	**Forest Faconry**: Construction of hack pens
	Harrold: 94 Residential dwellings	
2020	**Stan Hill**: Temp dwelling/agric. buildings	**Hazeldens Nursery**: Up to 84 extra care units
	Allspheres Farm: Enlargement of farm dwelling	**Leahurst Nursery**: Agricultural storage bldg
2021	**Ruins:** Dwelling for tree nursery	**Sketchley Lane, Burbage**: Industrial and residential development
2022	**Little Acorns**: Agricultural worker's dwelling	

Appendix KCC2

Natural England Technical Information Note TIN049

Natural England Technical Information Note TIN049

Agricultural Land Classification: protecting the best and most versatile agricultural land

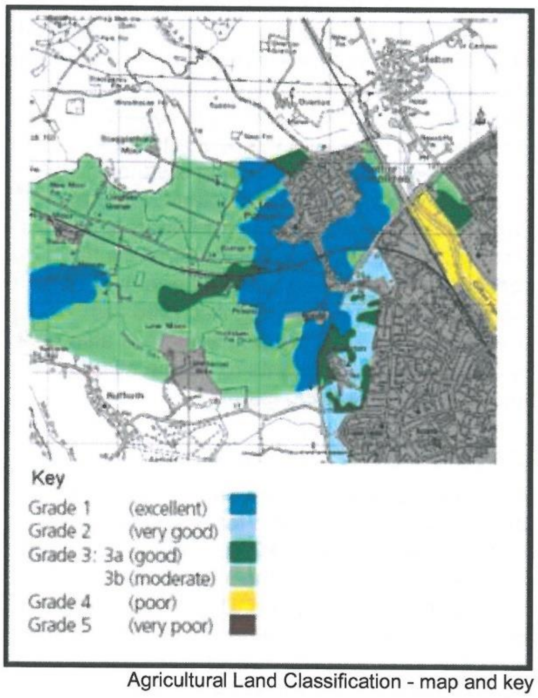
Most of our land area is in agricultural use. How this important natural resource is used is vital to sustainable development. This includes taking the right decisions about protecting it from inappropriate development.

Policy to protect agricultural land

Government policy for England is set out in the National Planning Policy Framework (NPPF) published in March 2012 (paragraph 112). Decisions rest with the relevant planning authorities who should take into account the economic and other benefits of the best and most versatile agricultural land. Where significant development of agricultural land is demonstrated to be necessary, local planning authorities should seek to use areas of poorer quality land in preference to that of higher quality. The Government has also re-affirmed the importance of protecting our soils and the services they provide in the Natural Environment White Paper The Natural Choice:securing the value of nature (June 2011), including the protection of best and most versatile agricultural land (paragraph 2.35).

The ALC system: purpose & uses

Land quality varies from place to place. The Agricultural Land Classification (ALC) provides a method for assessing the quality of farmland to enable informed choices to be made about its future use within the planning system. It helps underpin the principles of sustainable development.



Agricultural Land Classification - map and key

Second edition 19 December 2012
www.naturalengland.org.uk

NATURAL ENGLAND

Agricultural Land Classification: protecting the best and most versatile agricultural land

The ALC system classifies land into five grades, with Grade 3 subdivided into Subgrades 3a and 3b. The best and most versatile land is defined as Grades 1, 2 and 3a by policy guidance (see Annex 2 of NPPF). This is the land which is most flexible, productive and efficient in response to inputs and which can best deliver future crops for food and non food uses such as biomass, fibres and pharmaceuticals. Current estimates are that Grades 1 and 2 together form about 21% of all farmland in England; Subgrade 3a also covers about 21%.

The ALC system is used by Natural England and others to give advice to planning authorities, developers and the public if development is proposed on agricultural land or other greenfield sites that could potentially grow crops. The Town and Country Planning (Development Management Procedure) (England) Order 2010 (as amended) refers to the best and most versatile land policy in requiring statutory consultations with Natural England. Natural England is also responsible for Minerals and Waste Consultations where reclamation to agriculture is proposed under Schedule 5 of the Town and Country Planning Act 1990 (as amended). The ALC grading system is also used by commercial consultants to advise clients on land uses and planning issues.

Criteria and guidelines

The Classification is based on the long term physical limitations of land for agricultural use. Factors affecting the grade are climate, site and soil characteristics, and the important interactions between them. Detailed guidance for classifying land can be found in: *Agricultural Land Classification of England and Wales: revised guidelines and criteria for grading the quality of agricultural land* (MAFF, 1988):

- **Climate:** temperature and rainfall, aspect, exposure and frost risk.
- **Site:** gradient, micro-relief and flood risk.
- **Soil:** texture, structure, depth and stoniness, chemical properties which cannot be corrected.

The combination of climate and soil factors determines soil wetness and droughtiness. Wetness and droughtiness influence the choice of crops grown and the level and consistency of yields, as well as use of land for grazing livestock. The Classification is concerned with the inherent potential of land under a range of farming systems. The current agricultural use, or intensity of use, does not affect the ALC grade.

Versatility and yield

The physical limitations of land have four main effects on the way land is farmed. These are:

- the range of crops which can be grown;
- the level of yield;
- the consistency of yield; and
- the cost of obtaining the crop.

The ALC gives a high grading to land which allows more flexibility in the range of crops that can be grown (its 'versatility') and which requires lower inputs, but also takes into account ability to produce consistently high yields of a narrower range of crops.

Availability of ALC information

After the introduction of the ALC system in 1966 the whole of England and Wales was mapped from reconnaissance field surveys, to provide general strategic guidance on land quality for planners. This Provisional Series of maps was published on an Ordnance Survey base at a scale of One Inch to One Mile in the period 1967 to 1974. These maps are not sufficiently accurate for use in assessment of individual fields or development sites, and should not be used other than as general guidance. They show only five grades: their preparation preceded the subdivision of Grade 3 and the refinement of criteria, which occurred after 1976. They have not been updated and are out of print. A 1:250 000 scale map series based on the same information is available. These are more appropriate for the strategic use originally intended and can be downloaded from the Natural England **website**. This data is also available on 'Magic', an interactive, geographical information website **http://magic.defra.gov.uk/**.

Since 1976, selected areas have been re-surveyed in greater detail and to revised guidelines and criteria. Information based on detailed ALC field surveys in accordance with current guidelines (MAFF, 1988) is the most definitive source. Data from the former Ministry of Agriculture, Fisheries and Food (MAFF) archive of more detailed ALC survey information (from 1988) is also available on **http://magic.defra.gov.uk/**. Revisions to the ALC guidelines and criteria have been limited and kept to the original principles, but some assessments made prior to the most recent revision in 1988 need to be checked against current criteria. More recently, strategic scale maps showing the likely occurrence of best and most versatile land have been prepared. Mapped information of all types is available from Natural England (see *Further information* below).

New field survey

Digital mapping and geographical information systems have been introduced to facilitate the provision of up-to-date information. ALC surveys are undertaken, according to the published Guidelines, by field surveyors using handheld augers to examine soils to a depth of 1.2 metres, at a frequency of one boring per hectare for a detailed assessment. This is usually supplemented by digging occasional small pits (usually by hand) to inspect the soil profile. Information obtained by these methods is combined with climatic and other data to produce an ALC map and report. ALC maps are normally produced on an Ordnance Survey base at varying scales from 1:10,000 for detailed work to 1:50 000 for reconnaissance survey

There is no comprehensive programme to survey all areas in detail. Private consultants may survey land where it is under consideration for development, especially around the edge of towns, to allow comparisons between areas and to inform environmental assessments. ALC field surveys are usually time consuming and should be initiated well in advance of planning decisions. Planning authorities should ensure that sufficient detailed site specific ALC survey data is available to inform decision making.

Consultations

Natural England is consulted by planning authorities on the preparation of all development plans as part of its remit for the natural environment. For planning applications, specific consultations with Natural England are required under the Development Management Procedure Order in relation to best and most versatile agricultural land. These are for non agricultural development proposals that are not consistent with an adopted local plan and involve the loss of twenty hectares or more of the best and most versatile land. The land protection policy is relevant to all planning applications, including those on smaller areas, but it is for the planning authority to decide how significant the agricultural land issues are, and the need for field information. The planning authority may contact Natural England if it needs technical information or advice.

Consultations with Natural England are required on all applications for mineral working or waste disposal if the proposed afteruse is for agriculture or where the loss of best and most versatile agricultural land agricultural land will be 20 ha or more. Non-agricultural afteruse, for example for nature conservation or amenity, can be acceptable even on better quality land if soil resources are conserved and the long term potential of best and most versatile land is safeguarded by careful land restoration and aftercare.

Other factors

The ALC is a basis for assessing how development proposals affect agricultural land within the planning system, but it is not the sole consideration. Planning authorities are guided by the National Planning Policy Framework to protect and enhance soils more widely. This could include, for example, conserving soil resources during mineral working or construction, not granting permission for peat extraction from new or extended mineral sites, or preventing soil from being adversely affected by pollution. For information on the application of ALC in Wales, please see below.

Agricultural Land Classification: protecting the best and most versatile agricultural land

Further information

Details of the system of grading can be found in: *Agricultural Land Classification of England and Wales: revised guidelines and criteria for grading the quality of agricultural land* (MAFF, 1988).

Please note that planning authorities should send all planning related consultations and enquiries to Natural England by e-mail to **consultations@naturalengland.org.uk**. If it is not possible to consult us electronically then consultations should be sent to the following postal address:

Natural England
Consultation Service
Hornbeam House
Electra Way
Crewe Business Park
CREWE
Cheshire
CW1 6GJ

ALC information for Wales is held by Welsh Government. Detailed information and advice is available on request from Ian Rugg (**ian.rugg@wales.gsi.gov.uk**) or David Martyn (**david.martyn@wales.gsi.gov.uk**). If it is not possible to consult us electronically then consultations should be sent to the following postal address:

Welsh Government
Rhodfa Padarn
Llanbadarn Fawr
Aberystwyth
Ceredigion
SY23 3UR

Natural England publications are available to download from the Natural England website: **www.naturalengland.org.uk**.

For further information contact the Natural England Enquiry Service on 0300 060 0863 or e-mail **enquiries@naturalengland.org.uk**.

Appendix KCC3

Extracts from the ALC Guidelines

MAFF

Ministry of Agriculture, Fisheries and Food

Agricultural Land Classification of England and Wales

Revised guidelines and criteria for grading the quality of agricultural land

OCTOBER 1988

CONTENTS

Agricultural Land Classification of England and Wales

TABLES

TEXT FIGURES

PREFACE

This report provides revised guidelines and criteria for grading the quality of agricultural land using the Agricultural Land Classification (ALC) of England and Wales. The ALC was devised and introduced in the 1960s and Technical Report 11 (MAFF, 1966) outlined the national system, which forms the basis for advice given by the Ministry of Agriculture, Fisheries and Food (MAFF) and Welsh Office Agriculture Department (WOAD) on land use planning matters. Following a review of the system, criteria for the sub-division of Grade 3 were published in Technical Report 11/1 (MAFF, 1976). The classification is well established and understood in the planning system and provides an appropriate framework for determining the physical quality of the land at national, regional and local levels.

Experience gained has shown that some modifications to the ALC system can usefully be made to take advantage of new knowledge and data, to improve the objectivity and consistency of assessments and standardise terminology. The revised guidelines and criteria in this report have been developed and tested with the aim of updating the system without changing the original concepts. A further aim has been to calibrate the revised criteria with those used previously to maintain as far as possible the consistency of grading. The guidelines and methods used to define grades and subgrades are based on the best and most up to date information available but future revisions may be necessary to accommodate new information and technical innovation.

There is a continuing need to distinguish between the better land in Grade 3 and other land in this Grade but it is no longer considered necessary to maintain a threefold division. Two subgrades are now recognised: Subgrade 3a and Subgrade 3b, the latter being a combination of the previous Subgrades 3b and 3c.

Technical Report 11 included proposals for the development of an economic classification system linked to the physical classification. It also identified a number of significant disadvantages for a national system of economic classification, especially the problems associated with the acquisition of objective, up to date, accurate and consistent farm output data. No satisfactory means have been found of overcoming these problems and for this reason economic criteria for grading land have not been adopted. Similarly site specific crop yield data are not regarded as a reliable indication of land quality, because it is not possible to consistently make allowances for variables such as management skill, different levels of input and short-term weather factors.

The principal changes in this revision concern the criteria used to assess climatic limitations and the main limitations involving a climate-soil interaction, namely soil wetness and droughtiness. The revised methods have been developed and evaluated by the Agricultural Development and Advisory Service (ADAS) in close collaboration with the Soil Survey and Land Research Centre (SSLRC, incorporating the Soil Survey of England and Wales) and the Meteorological Office. A number of new and improved climatic datasets have been compiled on the same collaborative basis and these base data are held in LandIS, a computer information system funded by MAFF and developed by SSLRC. The datasets will also be published by the Meteorological Office (in press) and are described in Appendix 1.

The revised system incorporates some features of the 7-class Land Use Capability Classification formerly used by the Soil Survey of England and Wales (Bibby and Mackney, 1969) in which Classes 5, 6 and 7 broadly correspond to Grade 5 of the ALC system. In common with the Scottish Land Capability Classification for Agriculture (Bibby et al, 1982) some of the concepts now introduced originated from the ADAS Land Capability Working Party which met between 1974 and 1981. Although there are similarities with the Scottish system, the Agricultural Land Classification has been developed and calibrated specifically for use in England and Wales. This report describes the criteria and assessment methods which will be used by MAFF and WOAD to classify land. Wherever possible, definitions and methods common to both ADAS and SSLRC have been used.

Acknowledgements

The Ministry is indebted to the Meteorological Office and Soil Survey and Land Research Centre for their assistance, information and advice provided over a period of years. The climate-related components of the system were revised by a working group chaired by A J Hooper (ADAS) and the contributions of J H Minhinick and J F Keers (Meteorological Office), Dr R J A Jones and J M Hollis (SSLRC), D Hewgill, M R Watson and Dr I P Jones (ADAS) are gratefully acknowledged. Valuable assistance was also provided by F Broughton (ADAS). Evaluations and testing of the revised criteria were co-ordinated by M R Watson and carried out by regional staff of the Resource Planning Group, ADAS.

Ministry of Agriculture, Fisheries and Food
October 1988

SECTION 1

INTRODUCTION

The 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. The limitations can operate in one or more of four principal ways: they may affect the range of crops which can be grown, the level of yield, the consistency of yield and the cost of obtaining it. The classification system gives considerable weight to flexibility of cropping, whether actual or potential, but the ability of some land to produce consistently high yields of a somewhat narrower range of crops is also taken into account.

The principal physical factors influencing agricultural production are climate, site and soil. These factors together with interactions between them form the basis for classifying land into one of five grades; Grade 1 land being of excellent quality and Grade 5 land of very poor quality. Grade 3, which constitutes about half of the agricultural land in England and Wales, is now divided into two subgrades designated 3a and 3b. General descriptions of the grades and subgrades are given in Section 2.

Guidelines for the assessment of the physical factors which determine the grade of land are given in Section 3. The main climatic factors are temperature and rainfall although account is taken of exposure, aspect and frost risk. The site factors used in the classification system are gradient, microrelief and flood risk. Soil characteristics of particular importance are texture, structure, depth and stoniness. In some situations, chemical properties can also influence the long-term potential of land and are taken into account. These climatic, site and soil factors result in varying degrees of constraint on agricultural production. They can act either separately or in combination, the most important interactive limitations being soil wetness and droughtiness.

The grade or subgrade of land is determined by the most limiting factor present. When classifying land the overall climate and site limitations should be considered first as these can have an overriding influence on the grade. Land is graded and mapped without regard to present field boundaries, except where they coincide with permanent physical features.

A degree of variability in physical characteristics within a discrete area is to be expected. If the area includes a small proportion of land of different quality, the variability can be considered as a function of the mapping scale. Thus, small, discrete areas of a different ALC grade may be identified on large scale maps, whereas on smaller scale maps it may only be feasible to show the predominant grade. However, where soil and site conditions vary significantly and repeatedly over short distances and impose a practical constraint on cropping and land management a 'pattern' limitation is said to exist. This variability becomes a significant limitation if, for example, soils of the same grade but of contrasting texture occur as an extensive patchwork thus complicating soil management and cropping decisions or resulting in uneven crop growth, maturation or quality. Similarly, a form of pattern limitation may arise where soil depth is highly variable or microrelief restricts the use of machinery. Because many different combinations of characteristics can occur no specific guidelines are given for pattern limitations. The effect on grading is judged according to the severity of the limitations imposed by the pattern on cropping and management, and is mapped where permitted by the scale of the survey.

The guidelines provide a consistent basis for land classification but, given the complex and variable nature of the factors assessed and the wide range of circumstances in which they can occur, it is not possible to prescribe for every possible situation. It may sometimes be necessary to take account of special or local circumstances when classifying land. For this reason, the physical criteria of eligibility in this report are regarded as guidelines rather than rules although departures from the guidance should be exceptional and based on expert knowledge. Physical conditions on restored land may take several years to stabilise; therefore, the land is not normally graded until the end of the statutory aftercare period, or otherwise not until 5 years after soil replacement.

To ensure a consistent approach when classifying land the following assumptions are made:

1. Land is graded according to the degree to which physical or chemical properties impose long-term limitations on agricultural use. It is assessed on its capability at a good[1] but not outstanding standard of management.

2. Where limitations can be reduced or removed by normal management operations or improvements, for example cultivations or the installation of an appropriate underdrainage system, the land is graded according to the severity of the remaining limitations. Where an adequate supply of irrigation water is available this may be taken into account when grading the land (Section 3.4). Chemical problems which cannot be rectified, such as high levels of toxic elements or extreme subsoil acidity, are also taken into account.

3. Where long-term limitations outside the control of the farmer or grower will be removed or reduced in the near future through the implementation of a major improvement scheme, such as new arterial drainage or sea defence improvements, the land is classified as if the improvements have already been carried out. Where no such scheme is proposed, or there is uncertainty about implementation, the limitations will be taken into account. Where limitations of uncertain but potentially long-term duration occur, such as subsoil compaction or gas-induced anaerobism, the grading will take account of the severity at the time of survey.

4. The grading does not necessarily reflect the current economic value of land, land use, range of crops, suitability for specific crops or level of yield. For reasons given in the preface, the grade cut-offs are not specified on the basis of crop yields as these can be misleading, although in some cases crop growth may give an indication of the relative severity of a limitation.

5. The size, structure and location of farms, the standard of fixed equipment and the accessibility of land do not affect grading, although they may influence land use decisions.

[1] Previously described as 'satisfactory'; no change in the assumed standard of management is intended.

SECTION 2

DESCRIPTION OF THE GRADES AND SUBGRADES

The ALC grades and subgrades are described below in terms of the types of limitation which can occur, typical cropping range and the expected level and consistency of yield. In practice, the grades are defined by reference to physical characteristics and the grading guidance and cut-offs for limitation factors in Section 3 enable land to be ranked in accordance with these general descriptions. The most productive and flexible land falls into Grades 1 and 2 and Subgrade 3a and collectively comprises about one-third of the agricultural land in England and Wales. About half the land is of moderate quality in Subgrade 3b or poor quality in Grade 4. Although less significant on a national scale such land can be locally valuable to agriculture and the rural economy where poorer farmland predominates. The remainder is very poor quality land in Grade 5, which mostly occurs in the uplands.

Descriptions are also given of other land categories which may be used on ALC maps.

Grade 1 - excellent quality agricultural land
Land with no or very minor limitations to agricultural use. A very wide range of agricultural and horticultural crops can be grown and commonly includes top fruit, soft fruit, salad crops and winter harvested vegetables. Yields are high and less variable than on land of lower quality.

Grade 2 - very good quality agricultural land
Land with minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1.

Grade 3 - good to moderate quality agricultural land
Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in Grades 1 and 2.

Subgrade 3a - good quality agricultural land
Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops.

Subgrade 3b - moderate quality agricultural land
Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass or lower yields of a wider range of crops or high yields of grass which can be grazed or harvested over most of the year.

Grade 4 - poor quality agricultural land
Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.

Grade 5 - very poor quality agricultural land
Land with very severe limitations which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.

Descriptions of other land categories used on ALC maps

Urban
Built-up or 'hard' uses with relatively little potential for a return to agriculture including: housing, industry, commerce, education, transport, religious buildings, cemeteries. Also, hard-surfaced sports facilities, permanent caravan sites and vacant land; all types of derelict land, including mineral workings which are only likely to be reclaimed using derelict land grants.

Non-agricultural
'Soft' uses where most of the land could be returned relatively easily to agriculture, including: golf courses, private parkland, public open spaces, sports fields, allotments and soft-surfaced areas on airports/ airfields. Also active mineral workings and refuse tips where restoration conditions to 'soft' after-uses may apply.

Woodland
Includes commercial and non-commercial woodland. A distinction may be made as necessary between farm and non-farm woodland.

Agricultural buildings
Includes the normal range of agricultural buildings as well as other relatively permanent structures such as glasshouses. Temporary structures (e.g. polythene tunnels erected for lambing) may be ignored.

Open water
Includes lakes, ponds and rivers as map scale permits.

Land not surveyed
Agricultural land which has not been surveyed,

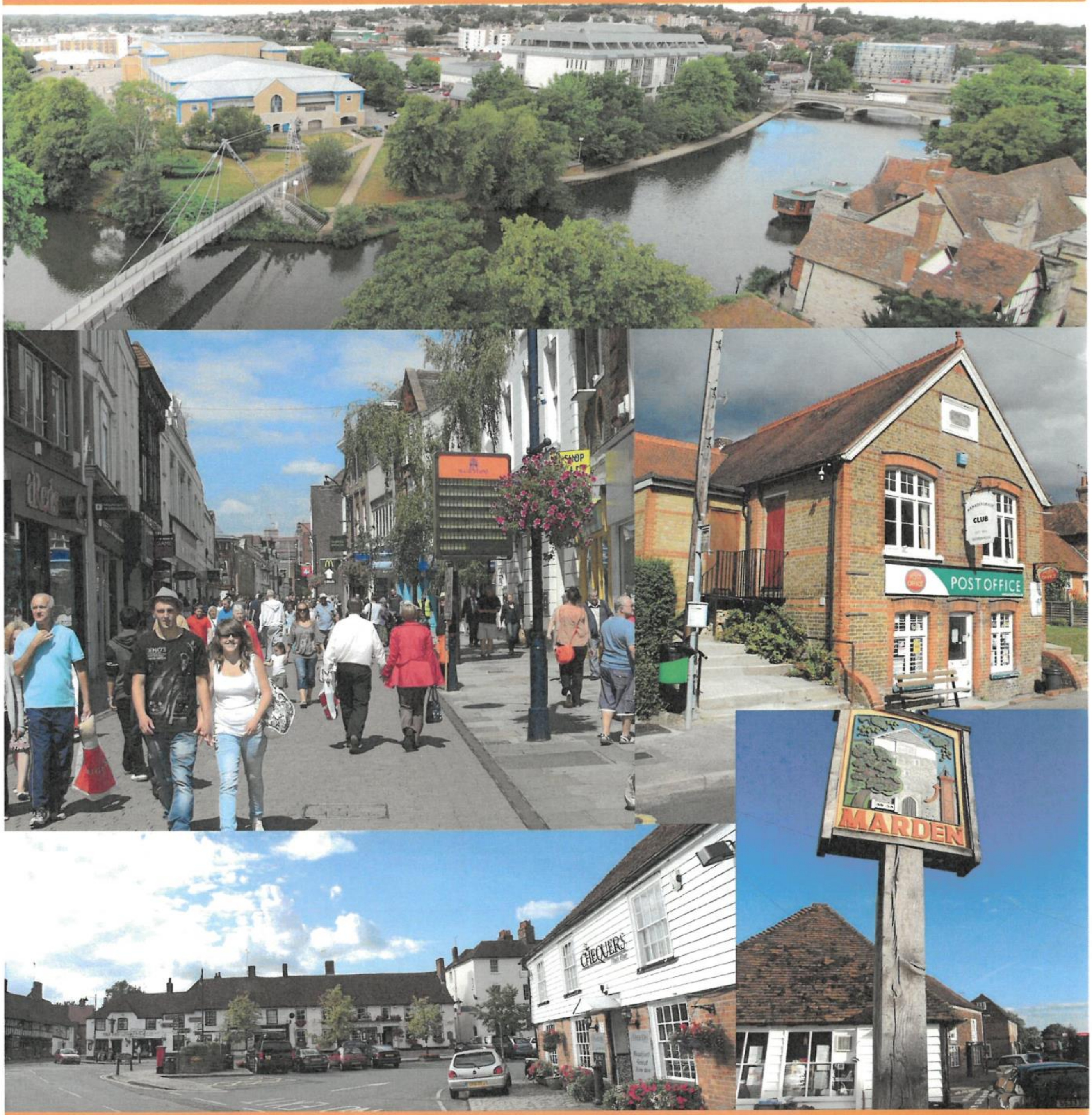
Where the land use includes more than one of the above land cover types, e.g. buildings in large grounds, and where map scale permits, the cover types may be shown separately. Otherwise, the most extensive cover type will usually be shown.

APPENDIX KCC4

MBC Policy Advice Note (2014)

Maidstone Borough Council

Planning policy advice note: Large scale (>50kW) solar PV arrays



www.maidstone.gov.uk/localplan

MAIDSTONE
Borough Council
Great People, Great Place, Great Opportunity

The development of a 1.4 MW solar PV farm on land adjacent to the Hendra Holiday Park, Newquay will assist in meeting the demand of this facility. Images courtesy of Hendra Holiday Park.

H - Assessment of the impact on agricultural land

3.17 The National Planning Policy Framework indicates that

"Local planning authorities should take into account the economic and other benefits of the best and most versatile agricultural land. Where significant development of agricultural land is demonstrated to be necessary, local planning authorities should seek to use areas of poorer quality land in preference to that of a higher quality."

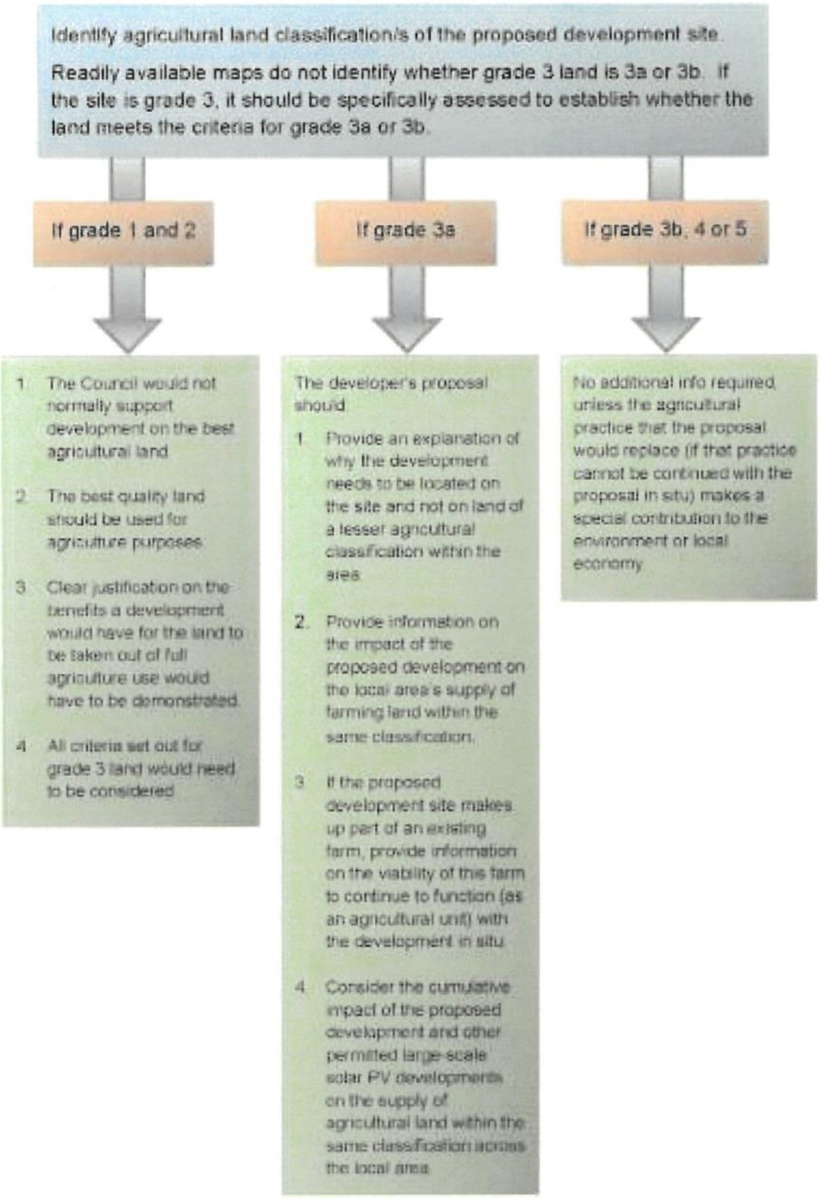
3.18 The presence of the best and most versatile agricultural land (defined as land in grades 1, 2 and 3a of the agricultural land classification) will therefore be a significant issue in the determination of applications to be taken into account alongside other sustainability considerations.

3.19 This position should be taken into account when identifying sites for large scale solar photovoltaic development. The following steps should be undertaken by the developer when considering locating a large scale solar photovoltaic development on agricultural land. If a planning application is subsequently submitted it should be accompanied by the relevant information detailed in the steps below.

3 . Planning application considerations

Construction of a 1.4MW solar PV farm at the former tin mine site at Wheal Jane, Cornwall. Such sites should generally be considered for development in preference to agricultural land.

3 . Planning application considerations



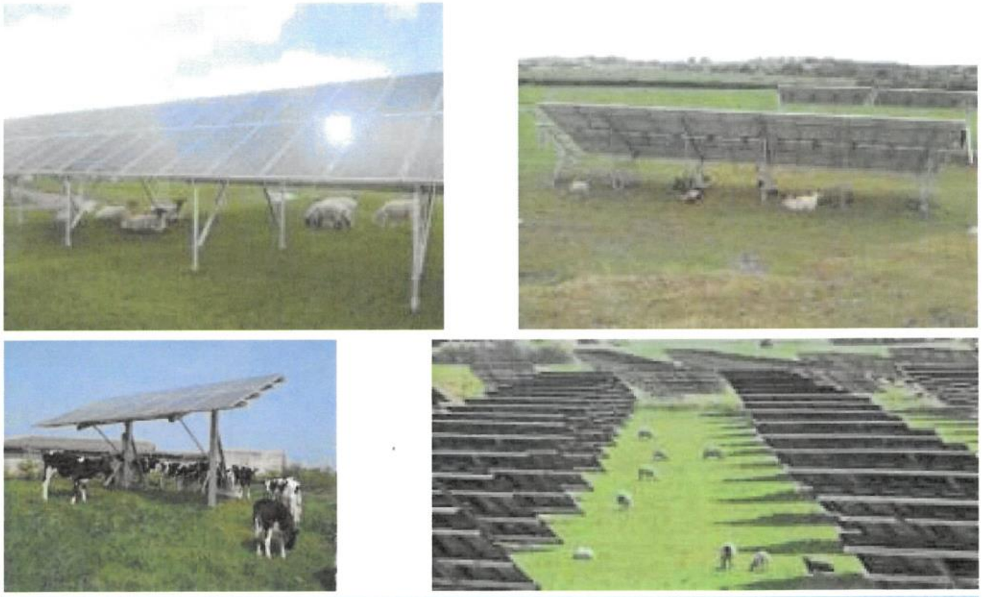
Maidstone Borough Council's steps for developers on agricultural land classification.

I - Ground maintenance

3.20 Vegetation will grow under the solar panels and this will require management, particularly to avoid the site becoming overgrown with noxious weeds and assist with the eventual restoration of the site, normally to agriculture. There are various techniques for managing the vegetation, these include mowing, strimming, spraying or mulching.

3.21 Spraying should be avoided wherever possible and mulching large areas is likely to present technical challenges and may add to the landscape/visual impact of a development proposal. Few of these management techniques are regarded as sustainable, particularly on sites up to 15ha, and there is a desire, both in terms of food production and the rural scene, to continue an agricultural use on the site.

3.22 Grazing is therefore to be encouraged wherever practicable. Cattle, horses, pigs and goats are likely to be too 'physical' with the solar PV arrays but sheep, chickens or geese should be acceptable. In order to facilitate grazing within the solar farm it is advised that solar panels are positioned at least 900mm above ground level and all cabling etc. is suitably protected.



Sheep and cattle grazing under solar PV arrays. Support structures and the height of panels would need to be substantial in order to allow cattle grazing and would not ordinarily be recommended. Images courtesy of Steve Edmunds, Mole Valley Renewables.

APPENDIX KCC5

Agricultural Land Classification,

Reading Agricultural Consultants

(text and plans)

READING
AGRICULTURAL
CONSULTANTS

March 2022

Statkraft UK Limited
Agricultural Land Classification and Soil Resources

of

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Table of Contents

1 Introduction

1.1 Reading Agricultural Consultants Ltd (RAC) is instructed by Statkraft UK Limited to investigate the Agricultural Land Classification (ALC) and soil resources of land off Sheephurst Lane, Marden, Kent, by means of a detailed survey of soil and site characteristics.

1.2 Guidance for assessing the quality of agricultural land in England and Wales is set out in the Ministry of Agriculture, Fisheries and Food (MAFF) revised guidelines and criteria for grading the quality of agricultural land (1988)[1], and summarised in Natural England's Technical Information Note 049[2].

1.3 Agricultural land in England and Wales is graded between 1 and 5, depending on the extent to which physical or chemical characteristics impose long-term limitations on agricultural use. The principal physical factors influencing grading are climate, site and soil which, together with interactions between them, form the basis for classifying land into one of the five grades.

1.4 Grade 1 land is excellent quality agricultural land with very minor or no limitations to agricultural use. Grade 2 is very good quality agricultural land, with minor limitations which affect crop yield, cultivations or harvesting. Grade 3 land has moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield, and is subdivided into Subgrade 3a (good quality land) and Subgrade 3b (moderate quality land). Grade 4 land is poor quality agricultural land with severe limitations which significantly restrict the range of crops and/or level of yields. Grade 5 is very poor quality land, with very severe limitations which restrict use to permanent pasture or rough grazing.

1.5 Land which is classified as Grades 1, 2 and 3a in the ALC system is defined in Annex 2 of the NPPF[3] as best and most versatile (BMV) agricultural land.

1.6 As explained in Natural England's TIN049, the whole of England and Wales was mapped from reconnaissance field surveys in the late 1960s and early 1970s, to provide general strategic guidance on agricultural land quality for planners. This Provisional Series of maps was published

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[1] **MAFF (1988).** *Agricultural Land Classification of England and Wales. Revised guidelines and criteria for grading the quality of agricultural land.* http://publications.naturalengland.org.uk/file/5526580165083136
[2] **Natural England (2012).** *Technical Information Note 049 - Agricultural Land Classification: protecting the best and most versatile agricultural land.* http://publications.naturalengland.org.uk/file/4424325
[3] **Ministry of Housing, Communities and Local Government (2021).** *National Planning Policy Framework.* https://www.gov.uk/government/publications/national-planning-policy-framework--2

on an Ordnance Survey base at a scale of One Inch to One Mile (1:63,360). The Provisional ALC map shows the site undifferentiated Grade 3. However, TIN049 explains that:

> *"These maps are not sufficiently accurate for use in assessment of individual fields or development sites, and should not be used other than as general guidance. They show only five grades: their preparation preceded the subdivision of Grade 3 and the refinement of criteria, which occurred after 1976. They have not been updated and are out of print. A 1:250 000 scale map series based on the same information is available. These are more appropriate for the strategic use originally intended ... "*

1.7 TIN049 goes on to explain that a definitive ALC grading should be obtained by undertaking a detailed survey according to the published guidelines, at an observation density of one boring per hectare. This survey follows the detailed methodology set out in the ALC guidelines.

1.8 The site has not been surveyed previously, and the nearest detailed survey data to the north and east of Marden show that land in this locality has been classified as a mix of Grades 2, 3a and 3b.

2 Site and climatic conditions

General features, land form, drainage and flood risk

2.1 The site extends to approximately 74.5ha, comprising seven arable fields to the north of Sheephurst Lane and south of a railway line to the west of Marden. At the time of survey, the fields were cropped in winter beans or wheat with some grass margins in Countryside Stewardship.

2.2 Topography is level apart from a slight rise on land adjoining Sheephurst Lane. The land is 18m to 20m above Ordnance Datum (AOD). There are no gradient limitations to agricultural land quality.

2.3 Most of the land lies on or adjacent to a floodplain, though groundwater is well controlled by a network of quite deep functioning ditches.

Agro-climatic conditions

2.4 Agro-climatic data have been interpolated from the Meteorological Office's standard 5km grid point dataset at a representative altitude of 18m AOD, and are given in Table 1. The site is warm and drier than much of Kent, with large crop moisture deficits possible. The number of days when soil is at Field Capacity is slightly below average for lowland England (150) which makes the land favourable for agricultural field work. There is no overriding climatic limitation to agricultural land quality.

Table 1: Local agro-climatic conditions

Parameter	
Grid Reference	TQ 572495 144693
Average Annual Rainfall	671 mm
Accumulated Temperatures >0°C	1,492 day
Field Capacity Days	139 days
Average Moisture Deficit, wheat	124 mm
Average Moisture Deficit, potatoes	122 mm

Soil parent material and soil type

2.5 The underlying geology is mapped by the British Geological Survey[4] as Weald Clay described as dark grey, thinly-bedded mudstones (shales) and mudstones with subordinate siltstones and fine- to medium-grained sandstones, which include some shelly limestone layers. The last is shown on the rising land in the south-west of the site.

2.6 All the flat land within the site is shown as covered by superficial deposits, either of River Terrace clay and silt or Alluvium in the east.

2.7 The Soil Survey of England and Wales soil mapping[5] (1:250,000 scale) shows Shabbington association in the west of the site and Fladbury 3 association in the east. Shabbington association soils are fine loamy or silty passing to sandy or gravelly base, and are naturally subject to seasonal fluctuating waterlogging (Wetness Class (WC) III or IV). However, installation of effective drainage schemes can improve them to WC II or I. Fladbury 3 soils can have issues of slow permeability limiting improvement to WC III.

3 Agricultural land quality

Soil survey methods

3.1 In total, 93 soil profiles were examined using an arable gouge auger at an observation density of more than one per hectare which is greater than the established recommendations for ALC surveys[2]. Five soil pits were also excavated to examine structure and stone content. The locations of observations are indicated on Figure RAC/9221/1. At each observation point the

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[4] **British Geological Survey (2021).** *Geology of Britain viewer*, http://mapapps.bgs.ac.uk/geologyofbritain/home.html

[5] **Soil Survey of England and Wales (1984).** *Soils of South East England* (1:250,000), Sheet 6

following characteristics were assessed for each soil horizon up to a maximum of 120cm or any impenetrable layer:

- soil texture
- significant stoniness
- colour (including localised mottling)
- consistency
- structural condition
- free carbonate; and
- depth.

3.2 Six topsoil samples (composites 0-25cm depth) were submitted for laboratory determination of particle size distribution, pH, organic matter content and nutrient contents (P, K, Mg). Results are given in Appendix 1.

3.3 Soil nutrient levels are low in the west of the site and good in the east. Organic matter levels are mostly suboptimal for heavier soils. All the land has alkaline pH. These factors can be ameliorated and are not a basis for classifying the land. Minimal tillage is improving the structure in the surface but causing firmer blockier structures in the *lower* topsoil (14-28cm), Appendix 3.

3.4 Soil Wetness Class (WC) was determined from the matrix colour, presence or absence of, and depth to, greyish and ochreous gley mottling, and slowly permeable subsoil layers at least 15cm thick, in relation to the number of Field Capacity Days at the location.

3.5 Soil droughtiness was investigated by the calculation of moisture balance equations (given in Appendix 2). Crop-adjusted Available Profile Water (AP) is estimated from texture, stoniness and depth, and then compared to a calculated moisture deficit (MD) for the standard crops wheat and potatoes. The MD is a function of potential evapotranspiration and rainfall. Grading of the land is affected if the AP is insufficient to balance the MD and droughtiness occurs.

Agricultural land classification

3.6 Assessment of agricultural land quality has been carried out according to the MAFF revised ALC guidelines (1988)[1]. Soil profiles have been described according to Hodgson (1997)[6] which is the

[6] **Hodgson, J. M. (Ed.) (1997).** *Soil survey field handbook.* Soil Survey Technical Monograph No. 5, Silsoe.

recognised source for describing soil profiles and characteristics according to the revised ALC guidelines.

3.7 Plate 1 below shows soils according to superficial geology, differentiating between those formed on River Terrace deposits (C), on Alluvium (Y) and on Weald Clay (G). Medium topsoil textures for each type are shown as 2; heavier topsoil textures as 3; and clayey topsoil textures as 4.

Plate 1: Soil Types

3.8 The soil types are summarised below in the following table.

Table 2: Description of soil types

Code C2	Medium textured topsoil on River Terrace deposits
Topsoil	At least 28cm of stoneless or very slightly stony medium clay loam, brownish (2.5Y5/4 in the Munsell soil colour charts[7]).
Upper Subsoil	Clay loam, greyish brown or brown (2.5Y5/3 or 5/4) with some mottles overlying more compact manganiferous clay loam or clay starting at 35-45cm, which has restricted permeability.
Lower Subsoil	Friable permeable clay loam or sandy clay loam starts at 50-60cm, slightly stony with many manganese and grey mottles, dominant colour can be strong brown (7.5YR6/8). Passes to stonier sandy material within 1m.

[7] **Munsell Color (2009).** *Munsell Soil Color Book*. Grand Rapids, MI, USA

Limitations	The compact layer may be as little as 15cm thick and should respond to subsoiling. WC is II or III which, coupled with medium topsoil, sets ALC Grade at 2 or 3a. Droughtiness limits some profiles to 3a. See Appendix 3 pit F.
Code C3	**Heavier topsoil on River Terrace deposits**
Topsoil	At least 28cm of stoneless heavy (silty) clay loam, brownish (2.5Y4/4 or 5/4). Friable in top 10cm, firmer blocky beneath.
Upper Subsoil	Heavy clay loam, greyish brown (2.5Y5/3) with some mottles overlying a compact manganiferous clayey layer starting at 35-45cm, which is slowly permeable.
Lower Subsoil	Permeable clay loam or sandy clay loam starts at 50-60cm, slightly stony with many manganese and grey mottles, dominant colour can be strong brown (7.5YR6/8). Passes to stonier sandy material within 1m, locally clayey.
Limitations	Slowly permeable layer often less than 15cm thick which acts as a barrier to rooting (to beans) but could be remedied by subsoiler. WC is II which, coupled with heavy loam topsoil, gives ALC Grade 3a. See Appendix 3 pit E. Where the subsoil clay is thicker or in lower lying areas, profiles are WCIII and ALC Grade 3b.
Code Y3c	**Calcareous loam on Alluvium**
Topsoil	At least 25cm of heavy clay loam, brownish (10YR4/3). Slightly stony with small ironstones and limestones. Slightly calcareous. Friable.
Upper Subsoil	Below 35cm is silty clay loam without stones. Greyish brown (2.5Y5/3) with some mottles and manganese layers.
Lower Subsoil	Slowly permeable starting 80-105cm: heavy silty clay loam or grey calcareous (Weald) clay.
Limitations	WC is II which, coupled with calcareous heavy clay loam topsoil, sets ALC Grade at 2. Drought limits to Grade 2.
Code Y2	**Medium silt on Alluvium**
Topsoil	At least 28cm of stoneless medium silty clay loam, brownish (2.5Y4/4). Friable.
Upper Subsoil	Heavy silty clay loam, greyish brown (2.5Y5/2-5/6) with some mottles or manganese below 35cm. Locally contains a compact silty clay layer within 60cm.
Lower Subsoil	Friable mottled strong-brown ochreous + manganiferous (silty) clay loam, locally dark brown (mainly manganese). Heavy (silty) clay loam below 80cm.
Limitations	WC is II or III which, coupled with medium topsoil, sets ALC Grade at 2 or 3a. Drought limits to Grade 2.
Code Y3	**Heavier silt on Alluvium**
Topsoil	At least 28cm of heavy silty clay loam, brownish (2.5Y4/4 or 5/4). Stoneless (locally a few hard stones). Friable with firmer blocks in lower topsoil.
Upper Subsoil	Medium silty clay loam, greyish brown (2.5Y5/3-5/6) with some mottles over a compact manganiferous clayey layer starting at 35-45cm.
Lower Subsoil	Friable mottled strong-brown ochreous + manganiferous (silty) clay loam. Denser greyer clayey layers occur below 70cm. Locally, Weald Clay within 1m.
Limitations	The compact slowly permeable layer in upper subsoil is often < 15cm deep and can be subsoiled. WC is usually II but III where the clayey layers are more extensive. Coupled with heavier topsoil this sets ALC Grade at 3a, sometimes 3b.
Code Y4	**Clayey land on Alluvium**
Topsoil	About 25cm of stoneless silty clay, brownish (2.5Y4/4 or 5/4). Firm blocky structures, except in drill rows.
Upper	Clay or silty clay, varying from slightly mottled to common mottles (colour

Subsoil	2.5Y5/3-7/1). Slowly permeable within 35cm but of variable thickness (10 to 30cm).
Lower Subsoil	Friable mottled strong-brown (7.5YR6/8) manganiferous (silty) clay loam overlying within 80cm silty clay or greenish grey (7.5GY7/1) Weald clay, especially along north.
Limitations	Where compact slowly permeable in upper subsoil is < 15cm it can be subsoiled. According to clay depths, WC varies from II to IV but because of the clayey topsoil the land cannot be rated higher than ALC Grade 3b. See Appendix 3, pits A and B.
Code G2	**Medium soils on Weald Clay and limestone**
Topsoil	About 28cm of slightly stony medium clay loam, brownish (10YR4/4). Very friable.
Upper Subsoil	Clay start depth varies from 30 to 70cm, overlain by heavy silty clay loam. Upper subsoil is olive-brown (2.5Y5/6) with a few mottles, locally slightly calcareous.
Lower Subsoil	Clay, light (greenish) grey (10-7.5GY-7/1) with many ochreous/ manganese mottles. Slowly permeable; can contain very stony (limestone) layers within 80cm.
Limitations	WC III or II. Bean growth seems unrestricted. ALC Grade limited to 3a or 2 due to wetness and/or droughtiness. See Appendix 3 pit D.
Code G3	**Heavy land on Weald Clay (and Limestone)**
Topsoil	At least 25cm of stoneless heavy (silty) clay loam locally silty clay, brownish (2.5Y4/4 or 5/4). Friable breaking into subangular blocks.
Upper Subsoil	Clay start depth varies from 20 to 60cm, overlain by silty clay loam or silty clay - grey (2.5Y5/3) to yellowish-brown (5/6) with common iron or manganese mottles. Very slightly calcareous.
Lower Subsoil	Firm clay, light (greenish) grey (10-7.5GY-7/1) with many ochreous and some manganese. Slowly permeable, passes to very dense mudstone within 1m. Locally calcareous.
Limitations	WC III (locally IV) due to slowly permeable subsoil within 45cm. Bean growth seems restricted by compaction; patches of weed or no establishment. Heavier topsoil sets Grade at 3b (wetness). See Appendix 3 pit C.

3.9 The main limitations to agricultural land quality at the site are soil wetness, droughtiness and flooding/groundwater.

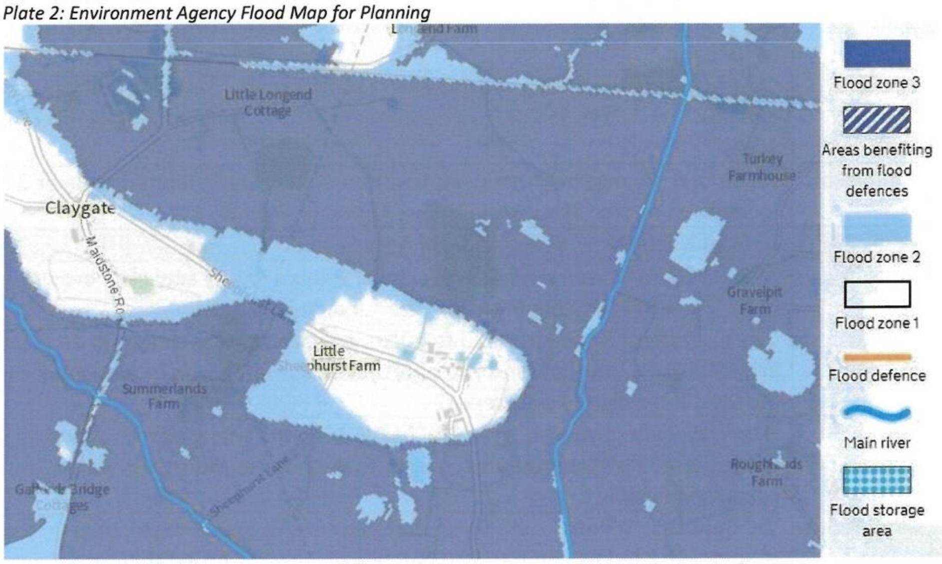
3.10 **Wetness/Workability.** Many of the River Terrace and Alluvial soils are characterised by thin clayey or compact layers in the upper subsoil overlying looser material below 50cm (see Appendix 3 Pits A, E and F). These compact layers can be remedied by subsoiling and are not a grade limitation unless they are at least 15cm thick. Profiles classified as Subgrade 3b either have silty clay topsoil or are WC III with heavy silty clay loam topsoil. Profiles with medium clay loam topsoils are limited to Grade 2 or 3a depending on WC.

3.11 The Weald clay subsoils are slowly permeable, although the presence of traces of carbonate in the clay upper subsoil assist soil structure (Appendix III, pit C) but cannot rate higher than WC III.

3.12 **Droughtiness.** Most soils have good water reserves for deep rooted crops, and are limited to Grade 2 (3a on some deep clay profiles). Other profiles are downgraded to Subgrade 3a because of limited water supply to 70cm for shallower rooted crops (Appendix 2).

3.13 **Flood risk.** As shown in Plate 2, most of the site is shown as being at moderate risk of flooding (Flood Zone 3), with the main river running along the eastern edge of the site. Groundwater was not encountered in any of the profiles. The high concentrations of manganese fragments in the lower subsoil indicate fluctuating groundwater but much is relic historical, since most fields now have functioning deep ditches to lower the water table.

Plate 2: Environment Agency Flood Map for Planning

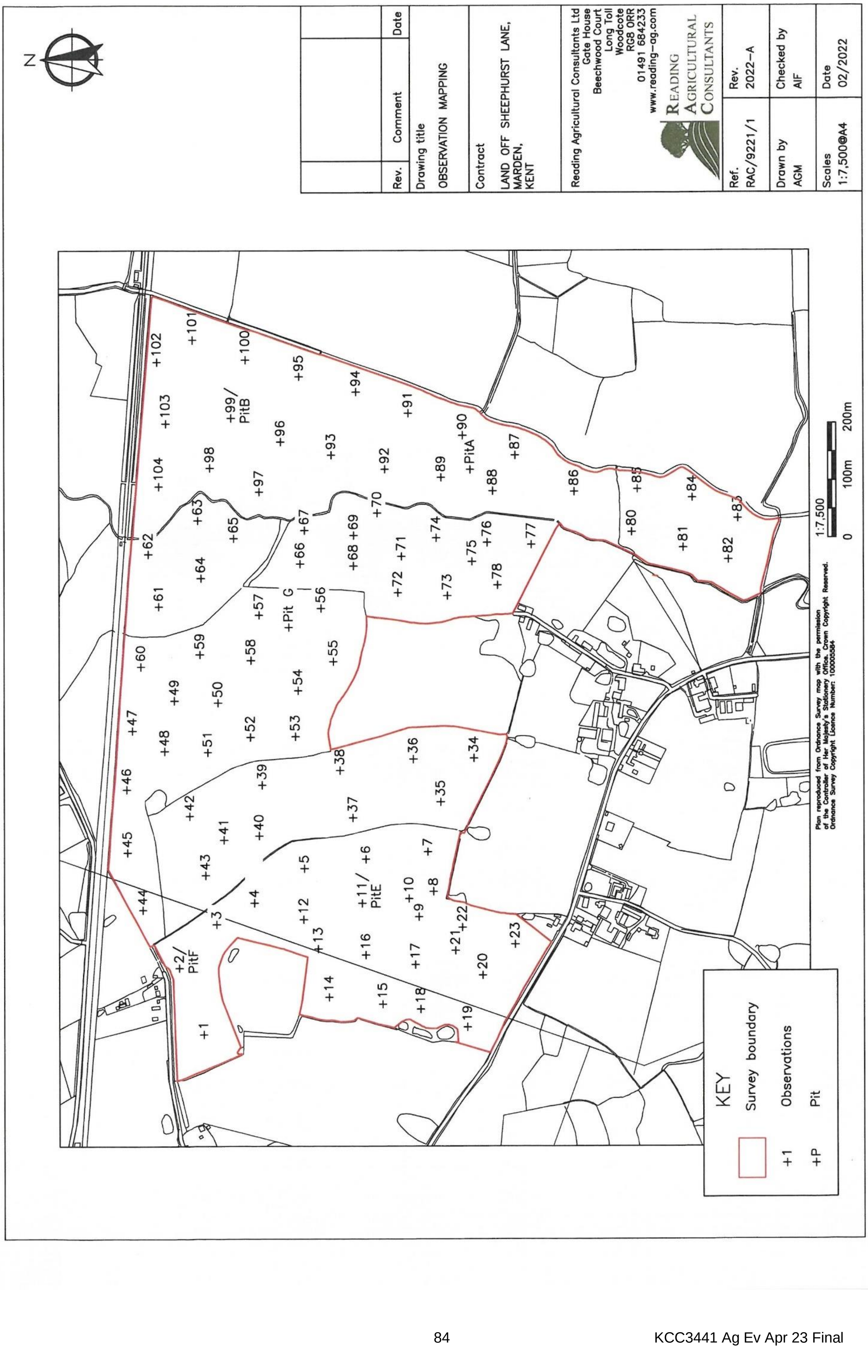


3.14 According to one local source, the land is usually dry but floods seriously in about one year in twenty. Unless this happens in summer, Grade cannot be lowered to less than 2 on flood risk. There were however some areas of poor crop establishment noted during the survey which correspond with water collecting hollows, and which are downgraded to Subgrade 3b. Some problem patches in the south-eastern field (shown as Flood Zone 2) might be related to spring-line effects as well as from the restricted permeability of the Weald clay.

3.15 The areas of each ALC grade are given in Table 3 and their distribution is shown in Figure RAC/9221/2.

Table 3: ALC areas

Grade	Description	Area (ha)	%
Grade 2	Very good quality	6.9	9
Subgrade 3a	Good quality	28.2	38
Subgrade 3b	Moderate quality	39.4	53
Total		74.5	100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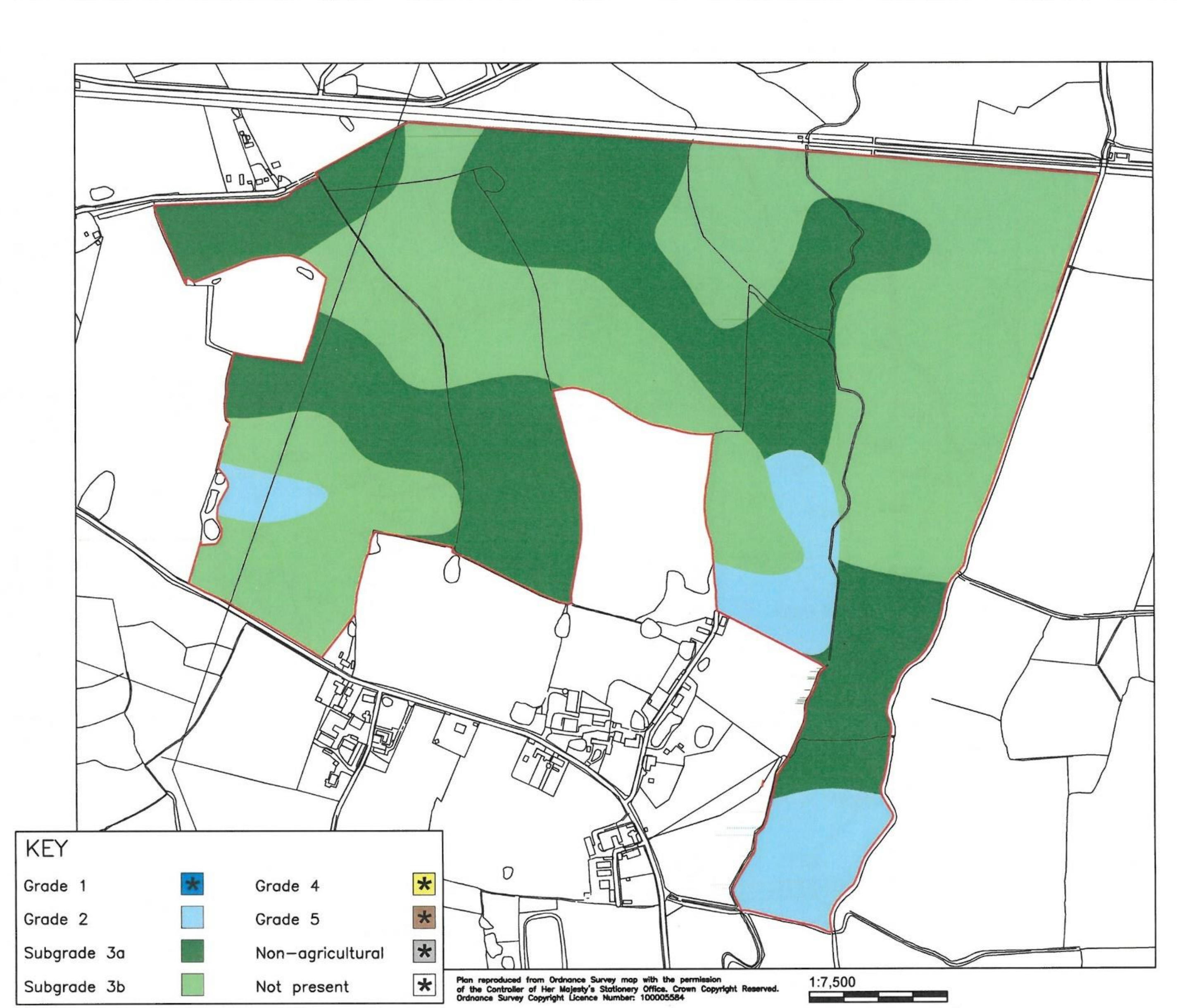

Rev.	Comment	Date

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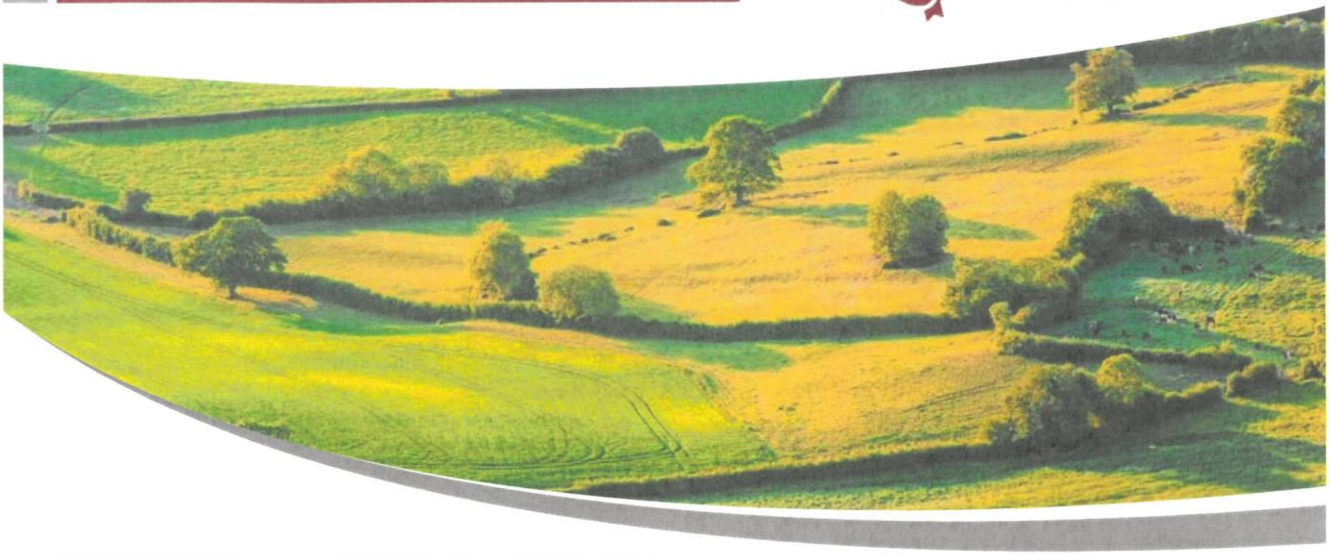
APPENDIX KCC6

BSS Publication Soil Carbon (2021)

SCIENCE NOTE: SOIL CARBON

BRITISH SOCIETY OF SOIL SCIENCE



Highlights

- **There is an urgent need to reduce atmospheric carbon dioxide (CO_2) concentrations.**
- **Supporting natural and agricultural systems to sequester carbon (C) can help achieve this.**
- **Many soils have the capacity to sequester C from the atmosphere, however the process is slow, easily-reversible and time-limited.**
- **The greatest and most rapid soil C gains can be achieved through land use change (e.g. conversion from arable land to grassland or woodland), but this can have implications for food production and the displacement or exporting of emissions.**
- **Increasing soil organic C contents through sustainable soil management (SSM) practices can improve soil health, the efficiency of food production and the delivery of multiple public goods and services.**
- **Where financial incentives are developed to encourage SSM practices and sequester C it is essential that funders provide ongoing support to these schemes.**
- **Given the uncertainties around the amount of additional C that can be sequestered in future, and the ease with which C gains can be lost, it is essential that the carbon stores in existing permanent grasslands, moorlands, peatlands, wetlands and woodlands are protected.**

Introduction

Recent reports from the Intergovernmental Panel on Climate Change (IPCC) highlight how human activity is changing the climate in unprecedented and sometimes irreversible ways.

The reports make it clear that action to tackle climate change is an urgent priority. The 26th United Nations Climate Change conference (COP26) is due to take place in Glasgow in November 2021 and is seen as critical for establishing a robust path to future zero or negative emissions of greenhouse gases (GHG's) at a global scale. There is an urgent need to reduce fossil fuel emissions to near zero, while supporting natural systems to sequester and store carbon (C). Soils contain more C than in the atmosphere and vegetation combined and are therefore an essential *carbon store*. Under certain conditions with careful management they can act as an important *carbon sink*.

Increasing the amount of C stored in soil is beneficial from a climate change mitigation perspective, but how much C can be stored in this way?

This science note aims to:

- Set out the importance of C in soils, how it behaves, and the role it plays in supporting soil functions, delivering vital public goods and services, and helping societies adapt to and reduce the rate of climate change.
- Raise awareness of the main issues surrounding soil C and the actions that governments, communities and individuals can take.

Carbon sequestration
A net transfer of carbon (C) from the atmosphere to land (either into soil or vegetation).

Carbon store
A medium that stores C. Over a given period of time, the amount of C in the store may be increasing, decreasing or static.

Carbon sink
Any reservoir or medium that over a given period of time accumulates and stores more C than it loses.

Carbon source
Any reservoir or medium that over a given period of time loses more C than it accumulates.

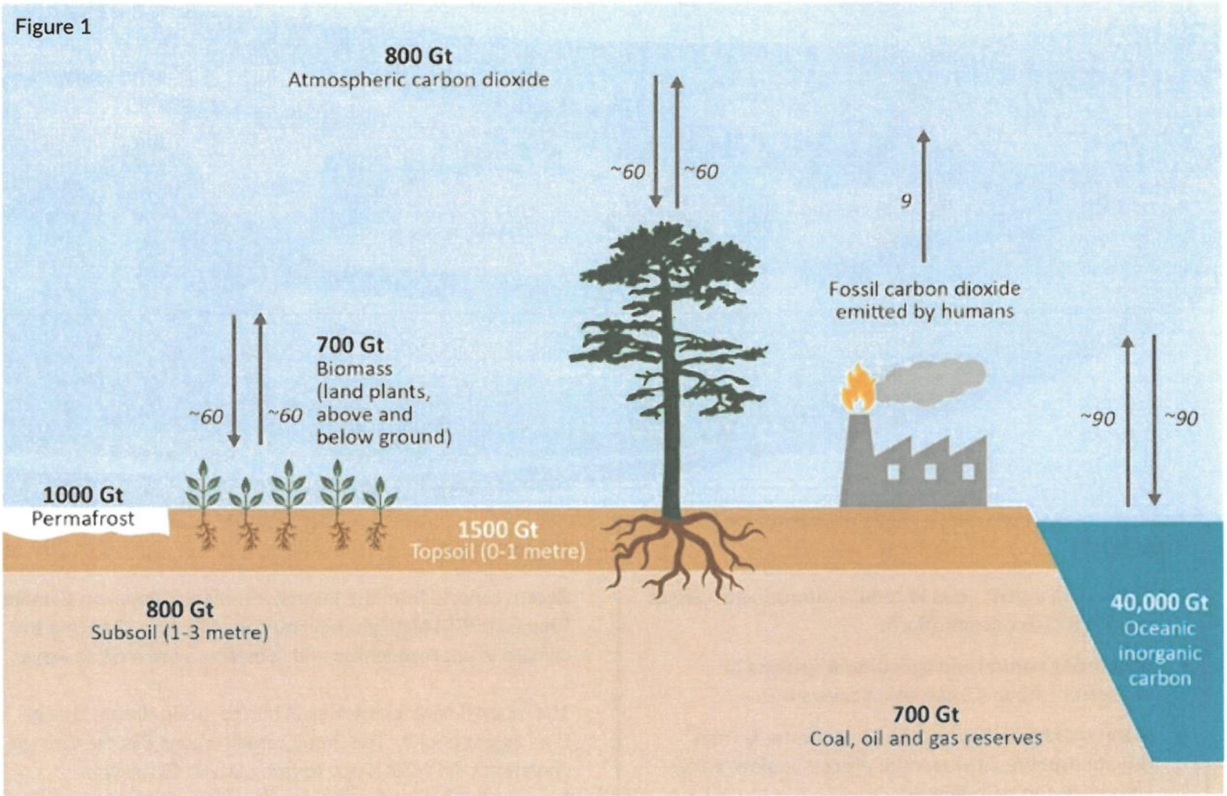


Figure 1: Carbon stocks and flows on land and in the oceans (adapted from Jenkinson, 2010 [1]). The numbers in bold are stocks in Gigatonnes (Gt) C: those in italics are flows in Gt C per year. Topsoil and subsoil stocks exclude peatlands.

What is soil carbon?

C is the fourth most abundant element in the universe by mass after hydrogen, helium and oxygen, and is the primary basis of life on Earth.

The ability of C to form many bonds allows it to form large complex molecules that attach to other elements that are essential to life, such as nitrogen (N), phosphorus (P) and sulphur (S). These bonds also trap energy as a source of fuel for microorganisms.

The soil C stock is around three times that of the atmosphere, at around 2,300 Gt (2.3 trillion tonnes) to three metres depth and 1,500 Gt in the top metre

When plants, animals and microorganisms die and decompose, their remains form organic matter of which about half is C, and on land this combines with weathered minerals from rock (inorganic material) to form soil.

After the world's oceans, soil is the world's largest active C store, holding 80% of terrestrial C, which is almost three times the amount held in the world's atmosphere [2] [Figure 1].

Carbon concentrations are usually smaller in sandy (light) soils and larger in clay (heavy) soils.

Soil organic carbon (SOC) content varies enormously from less than 1% in desert soils to over 50% in peats but is typically less than 5% in most agricultural soils [3].

Deforestation and cultivation can reduce SOC by exposing it to the process of oxidation and conversion to CO_2 which is emitted into the atmosphere. Within soil ecosystems there is a constant exchange of C between SOC and the atmosphere, and these interactions and transformations are part of the global C cycle (Figure 2, page 3).

C is found in soils in two forms:

- **Soil organic carbon (SOC)** – the living and dead components of organisms, including fine plant roots, root exudates, fungi, microbes and decomposing organic matter from plant litter or animal products such as manure.

- **Soil inorganic carbon (SIC)** – chemical compounds such as calcite or chalk (calcium carbonate: $CaCO_3$) [4]. SIC is generally more stable than SOC and accounts for approximately 38% of the total soil C pool. It is much more abundant in the low rainfall regions than in moist, temperate regions of the globe. SIC can also be added to soils in the form of amendments such as rock dust and could be a means of storing more SIC in soils. However, the full cycle and cost-benefit analysis of this emerging technique needs further consideration.

SIC is predominantly controlled by the weathering of C-based rock minerals (mostly underlying chalk and limestone in the UK) and it can essentially be considered to be a fixed constant for most temperate zone soils, notwithstanding the application of lime and other carbonate-containing mineral amendments in agriculture. For this reason, it is SOC that is the more dynamic fraction, being more responsive to management, and it is SOC that is the focus of this scientific note.

Soil organic carbon (SOC) levels can be increased (or decreased) through changes in management, although it normally takes years to decades to bring about measurable change. Where SOC stocks are currently large e.g. under old grassland or forest, it is important to keep them and not lose them through changing land use. Long-term historical loss of SOC, (particularly in arable soils) offers a potential route for future C storage increases.

Soil carbon stocks and flows

Carbon dioxide (CO_2) in the air is absorbed by plants through photosynthesis, creating biomass that is eventually deposited on or in soil as wood, leaf litter, root exudates and root material [Figure 1, page 2]. In well-aerated soils, most of the C in this plant debris is converted back to CO_2 by the activities of soil organisms (fungi, bacteria, etc.) through soil respiration, but a fraction is retained in soil and becomes stabilised to varying degrees. In temperate climates about one third of plant C entering soil is still present after one year. Integrated with the cycling of C is the cycling of important plant nutrients, which enhances soil fertility. As organic matter enters the soil, the soil organisms process it to mineralise the key nutrients into forms that are available to plants [5].

Soil conditions vary and in more extreme environments (such as very acidic, dry or wet) soil C turnover is reduced. For example, in waterlogged soils, with very low oxygen levels, decomposition is slow to non-existent and peat forms along with other 'saturated soil' (anaerobic) decomposition products, including methane (CH_4), an important GHG [2]. Where these conditions are maintained for centuries, such as on upland bogs and lowland fens, peat accumulates over time. However, if these peats are drained, allowing air to enter, microbial respiration is reactivated and the peat C is emitted as CO_2 at rates in excess of 30 t CO_2/ha/yr [6], although it will take many decades to lose all this stored C.

Plants also respire all the time (Figure 2) and use the sugar produced through photosynthesis to drive their metabolism in

Figure 2

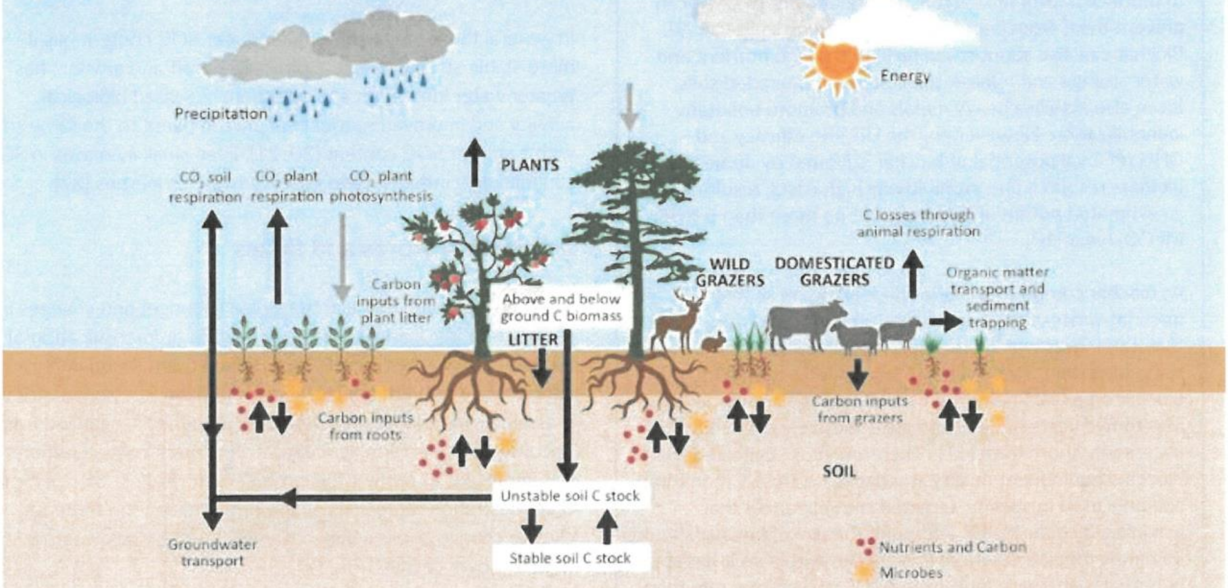


Figure 2: A simplified representation of the carbon cycle in terrestrial ecosystems (adapted from Garnett *et al.*, 2017 [7]).

a process known as plant respiration. In stable ecosystems, and in many agricultural systems, which have not changed for decades, photosynthesis and plant/microbial respiration are in balance, with the overall effect on atmospheric CO_2 being zero.

However within these systems, in addition to respiration, C is removed through harvested crops and livestock products, and also through animal respiration and fermentation from ruminating cattle, sheep, goats and domesticated deer; and in addition to photosynthesis, C is returned to the land as crop residues, livestock manure (Figure 1), human sewage and food waste. Organic C can also be added to soils as biochar, a stable form of C that is a category of charcoal (See Biochar box). If the rate of C input is greater than the rate of decomposition, then the amount of C in the soil increases. The opposite is true where the rate of decomposition exceeds C input [5].

Humans have therefore had an important influence on the C cycle through the burning of fossil fuels (Figure 1), breeding of domesticated livestock on a large scale and replacing natural ecosystems with agricultural and urban land. All these activities have altered the balance of the *natural* C cycle to such an extent that in many agricultural systems the amount of plant and microbial respiration (due to a combination of bare soils and cultivation) exceeds the amount of photosynthesis, resulting in a gradual depletion of SOC. However, this depletion can be reversed through land use change and sustainable soil management (SSM) practices [8].

Biochar

Biochar is the organic and inorganic C remains of organic material that has been heated in the absence of air (oxygen) to produce a form of charcoal. This heating or *pyrolysis* can prevent the C from degrading and returning to the air [9]. Biochar can also support soil fertility through nutrient and water storage and release, particularly in degraded soils. It can also stabilise heavy metals and promote pollutant immobilization. However, for the UK, the efficacy and GHG removal potential of biochar is limited by domestic biomass resource and prohibitively high costs, resulting in an estimated potential for biochar of no more than 6 to 41 Mt CO_2/year [10].

As biochar composition varies depending on source material, processing, local climate and soil type, the timeframe over which biochar-C remains sequestered in the soil is uncertain. There is also a lack of long-term data, e.g. biochar crop yield response field experiments provide only four to five years of data, and glasshouse experiments are necessarily short-term [11]. Therefore, it is suggested that biochar should meet quality standards, be closely monitored and only used in specific targeted circumstances that maximise its benefits [9]. Although the use of biochar should be tightly regulated, where it is applied with care it has the potential to increase long-term soil C, at a greater rate than any other treatment or management technique [12].

Soil carbon functions [13]

There are many reasons why we should be concerned about protecting or increasing the stock of C within soils [14, 15]. SOC has a profound influence on soil properties and functions that affect the production of food and fibre. It also impacts on the functions that soils perform for the wider environment such as regulating the flow and quality of water, providing clean air, filtering pollutants and contaminants, and supporting biodiversity. All functions which are often termed 'soil ecosystem services' (SES) are reliant on the turnover of SOC and are closely related to 'soil health' [15,16,17].

Soil organic C is an essential component of soil structure, function and soil life

SOC is the energy supply that enables soil organisms to carry out their functions in a healthy soil. Together with soil microorganisms, SOC is a key factor in the formation and stabilisation of soil structure – the system of aggregates (units of sand, silt and clay particles bound together) and the surrounding pore network (containing air and water) [18]. SOC can interact with soil particles (notably clay) to form small aggregates through various chemical and biological processes. The processing by soil microorganisms of organic matter that enters the soil from leaf litter or from roots produces substances which act as a glue (glomalin) to combine smaller aggregates into larger aggregates, making the aggregates more stable and resistant to external forces such as raindrop impact and cultivation [19]. The greater resilience of soil aggregates also stabilises the soil pore network, allowing the soil to carry out its functions of retaining water for plants, transmitting water down to the groundwater and, in the topsoil, allowing plant roots to grow without restriction and to access nutrients.

In general therefore, a soil with a greater SOC content has a more stable structure, is less prone to runoff and erosion, has greater water infiltration and retention, increased biological activity and improved nutrient supply compared to the same soil with a smaller SOC content [20, 21]. Even small increases in SOC can markedly influence and improve these properties [22].

Soil carbon stores and fluxes

SOC is a key component of the global C budget and changes in stocks have implications for the mitigation or intensification of climate change. The largest stocks of soil C are found in non-agricultural soils with a peaty surface horizon (e.g. semi-natural grasslands, moorlands and wetlands), woodlands, peatlands, and uncultivated long-term agricultural permanent pasture, where it is important to protect the existing C stores [23, 24, 25]. Soil C sequestration represents an important mitigation route for climate change and is achieved largely by stabilisation rather than turnover of SOC.

Although soils used for arable agriculture (annually cultivated) typically have smaller SOC contents than grassland or woodland soils, they are potentially more amenable to alteration through direct management interventions. Soil C stocks can be increased by either increasing inputs (e.g. crop residues, cover crops, use of organic materials, inclusion of grass leys in arable rotations) or decreasing losses (i.e. reducing oxidative losses to CO_2, or particulate and dissolved organic content), via improved management such as reduced intensity tillage [26]. Significant long-term land use change (e.g. conversion of arable land to grassland or woodland) has by far the biggest impact on SOC, but is unrealistic on a large scale because of the continued need to meet food security challenges.

More practical approaches could be the inclusion of grass leys into arable rotations (i.e. arable soils being under grass for several years in a crop rotation). This may result in a more sustainable system with healthier soil, although the cycling of C will result in some GHG emissions, and the whole rotation crop productivity is decreased since there is no human-edible crop during ley years. Integrating livestock may displace some human edible crop production, emit more CH_4 (if ruminant livestock numbers are not reduced elsewhere), and the change in soil C stocks is small compared with that of land use change.

Since changes to soil C occur over periods of many years, the financial benefits of soil C sequestration are normally based on modelled future soil C levels. Such models need to be relevant to individual soil types, land use and climate, and need to be accurately baselined through field measurements.

Nevertheless, relatively small changes in C stock per unit area in arable agricultural soils may translate into substantial stock increases at the national or regional scale [27, 28]. There has been much discussion of the possibility of mitigating climate change through soil C sequestration [27]. However, changes in SOC are generally slow to occur and, because of the large background C in soils and the inherent variation, it is difficult to measure accurately.

Moreover, the process of soil C sequestration is often misunderstood, and can lead to an overestimation of the climate change mitigation achievable by using this route [28]. This is primarily because the quantity of C that can be stored in any soil is finite. After a positive change in management practice, soil C levels increase (or decrease) towards an equilibrium value (after 20-100 years or more) that is characteristic of the 'new' land use, management system and climate [21]. The relatively large annual rate of soil C accumulation in the early years after a major change in land use or management (such as a change from a conventional cultivated arable rotation to a reduced tillage system incorporating grass leys and cover cropping) cannot be maintained indefinitely and the annual rate of increase will decline (eventually to zero) as the soil approaches its new equilibrium. The use of organic amendments in arable agriculture, such as composts and manures, is a practice that can increase SOC, but the supply is finite and there are costs incurred with such practices. It is therefore unlikely that the initial rate of increase in soil C following a change in land use /management practice will be sustained over the longer term (>20 years), as the new equilibrium level is reached.

When increased over time through altered management, soil C concentrations will reach an equilibrium state beyond which, no further increases are (naturally) possible.

Beneficial soil management approaches need to be continued beyond the equilibrium point to prevent returns to prior low C status.

In addition, C sequestration is reversible. Maintaining a soil at an increased soil C level, due to a change in management practice, is dependent on continuing that practice indefinitely. Indeed, soil C is lost more rapidly than it accumulates [29]. Also, to increase soil C levels, inputs of other elements such as nitrogen (N) and phosphorus (P) are needed. [30] The soil C, N and P cycles are intimately linked, and increasing soil C may affect the release of diffuse water pollutants (nitrate-NO_3 & phosphate-P) and GHGs considerably more potent than CO_2 (e.g. nitrous oxide (N_2O) & CH_4).

In other words, there is a risk of 'pollution swapping' where the reduction of one form of pollution increases another. Land use changes such as reafforestation and wetland creation may also result in deforestation and cultivation elsewhere to grow the food that is not produced in the C sequestration project (i.e. displacement) [31].

Despite these risks and limitations, there is scope for soil C sequestration to contribute to climate change mitigation, particularly on low C, degraded landscapes. It is equally important that this C sequestration is allied with retention of existing SOC stocks in non-agricultural and long-term permanent pasture soils. Maintaining or enhancing SOC levels can deliver a range of benefits not only for climate change mitigation, but also for soil quality and functioning which can make soils more resilient to the impacts of climate change (e.g. ability to cope with extreme events such as droughts and floods) and other global change factors [32].

Measurement, Monitoring, Reporting, Verification (MRV) and Valuing

Sequestering additional C in agricultural soils is attracting interest from governments and industry as a way to meet climate change objectives and is leading to the development of schemes to pay farmers to adopt SSM practices. Such soil-focussed schemes do not yet exist in the UK, but equivalents have been running in Australia and Canada for a number of years [33] and the European Commission's Carbon Farming Initiative is due in 2021. The Australian Emission Reductions Fund (ERF) and Carbon Farming Initiative encourage the adoption of a number of land management strategies that result in either the reduction of GHG emissions or the sequestration of atmospheric CO_2, while the Conservation Cropping Protocol in Canada provides payment for no-till cropping [34].

> Any financial mechanism based on soil C status needs to include mechanisms to accommodate situations where soil C:
> - has declined over an agreed sequestration period
> - has increased (relative to other soils of a similar type) prior to an agreed sequestration period.

Setting up robust monitoring, reporting and verification (MRV) platforms for soil C is very challenging, due not just to variations in how changes in soil C are influenced by climate, land use and management in different agro-climatic regions, but also because it can be difficult to determine the baseline soil C content against which to judge (and pay for) the success of any sequestration initiatives [35]. The potential for future land management changes to cause captured C to be re-released from soils also means that monitoring has to be robust for the lifetime of any payment scheme.

Existing MRV protocols for soil C credits take different approaches to quantifying soil C and net removals of GHGs from the atmosphere. Some rely on soil sampling, some combine sampling with process-based modelling, while others rely on combinations of modelling and remote sensing [35]. Differences in the way protocols and C markets estimate sequestration make it difficult to be confident that climate benefits have actually been achieved – but the costs associated with direct measurement of soil C make it impractical as a long-term monitoring option [2], meaning that models and remote sensing become essential once a ground-truthed soil C baseline has been established. Ground truthing needs to take account of the high degree of variability between soil C contents even where soils are apparently similar across a field. An alternative is to simply link specific management practices to mean C sequestration potential within a set of given contexts.

Soil C sequestration provides a useful tool in global efforts to tackle GHG emissions, but the slow rate of change, the relatively small amounts that can be sequestered (e.g., in 2010 it was calculated that even the most extreme land use change scenarios in Great Britain would account for only c. 2% of national GHG emissions [36]), and the ease of reversibility in soil C gains present significant challenges with respect to measurement, monitoring and verification [5]. Stakeholders must be aware that a focus on soil C can have unintended consequences and should not be perceived as a 'quick fix'.

Conclusions and recommendations

Climate Change is arguably the greatest challenge facing humanity and efforts are underway globally to reduce GHG emissions and to capture those that continue to be emitted.

The counterbalancing need, on the one hand, to remove C from the atmosphere and, on the other, to add C to soils, presents an obvious confluence. Soils are a significant reservoir of C, but land use changes over centuries have resulted in a proportion of that C being lost from many soils. Although present in both organic and inorganic forms, it is SOC and (more specifically) soil organic matter that is critical to the functioning and resilience of soils in countries such as the UK. This is why addressing historic C losses provides clear potential for improving soil quality and for future C sequestration in soils, which is leading to the development of monetised soil C sequestration schemes that can be built into governmental or corporate strategies to offset residual GHG emissions.

Increasing the SOC of degraded soils can significantly improve productivity and resilience, and SSM techniques such as reduced intensity tillage, residue management to maintain ground cover, the use of cover crops, and the application of bulky organic manures (e.g. compost) are commonly used to achieve this. Changing SOC concentrations with such techniques can however take decades, and gains can be rapidly reversed in the event of further land management changes. Further, increases in soil C will not continue indefinitely; rather C concentrations will reach new equilibria, which can themselves only be maintained by continuation of the favourable management practices. Equilibrium concentrations of C will vary depending on soil type, land use and climatic conditions. It is possible that in some circumstances the natural SOC store can be augmented to some extent through use of basalt minerals or biochar, which offer potential for longer term inorganic or organic C storage - but the whole life cycle C costs of such techniques need to be considered with care before genuine sequestration benefit can be claimed. The source and chemical characteristics of biochars and rock dusts can also be problematic from both regulatory and environmental perspectives.

In the UK context, it is essential that historic SOC declines are addressed if soils are to function effectively, improving their resilience to increased temperatures, increased intensity of rainfall events and other inevitable effects of climate change. However, this essential requirement creates significant potential for abuse at a time when governments, corporations and individuals are increasingly keen to offset their C emissions through sequestration initiatives.

Although this Science Note is based on a UK perspective, we recognise that the same issues apply internationally and there is a need for action on a global scale.

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Based on the available scientific evidence, we recommend that:

- The C stores in existing permanent grasslands, moorlands, peatlands, wetlands and woodlands are protected.
- SSM practices are more widely adopted to increase SOC, to help mitigate existing GHG emissions, to improve soil health and resilience, and to protect and enhance the multiple public goods and services provided by soil.
- Where financial incentives are developed to encourage SSM practices it is essential that funders provide ongoing support to these schemes. This recommendation applies equally to any scheme claiming C sequestration in soils.
- Soil C concentrations should be periodically monitored. While modelling can be used to estimate future C stocks in specific soils, it is essential that these estimates are validated through soil testing at a network of representative field sites.
- Sequestering C in soils and vegetation, although important, must not distract from the urgent need to reduce CO2 emissions from the burning of fossil fuels. Failure to address the latter will render the former irrelevant.
- Attempts to overcome natural soil C equilibria through application of materials such as rock dust or biochar must consider the whole life C costs of such practices as well as ensuring that they do not impact negatively on soil quality through pH change, chemical contamination or other undesirable characteristics.

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BRITISH SOCIETY OF SOIL SCIENCE

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