# GROUND-MOUNTED SOLAR PANELS, BATTERY STORAGE, PLANT AND INFRASTRUCTURE, TYDD ST GILES/SUTTON ST EDMUND, LINCOLNSHIRE

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## OUTLINE SOIL MANAGEMENT PLAN

**Fenland District Council: F/YR24/0457/F**
**South Holland District Council: H19-0329-24**

**October 2025**

KERNON
COUNTRYSIDE CONSULTANTS LIMITED

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**Appendices**

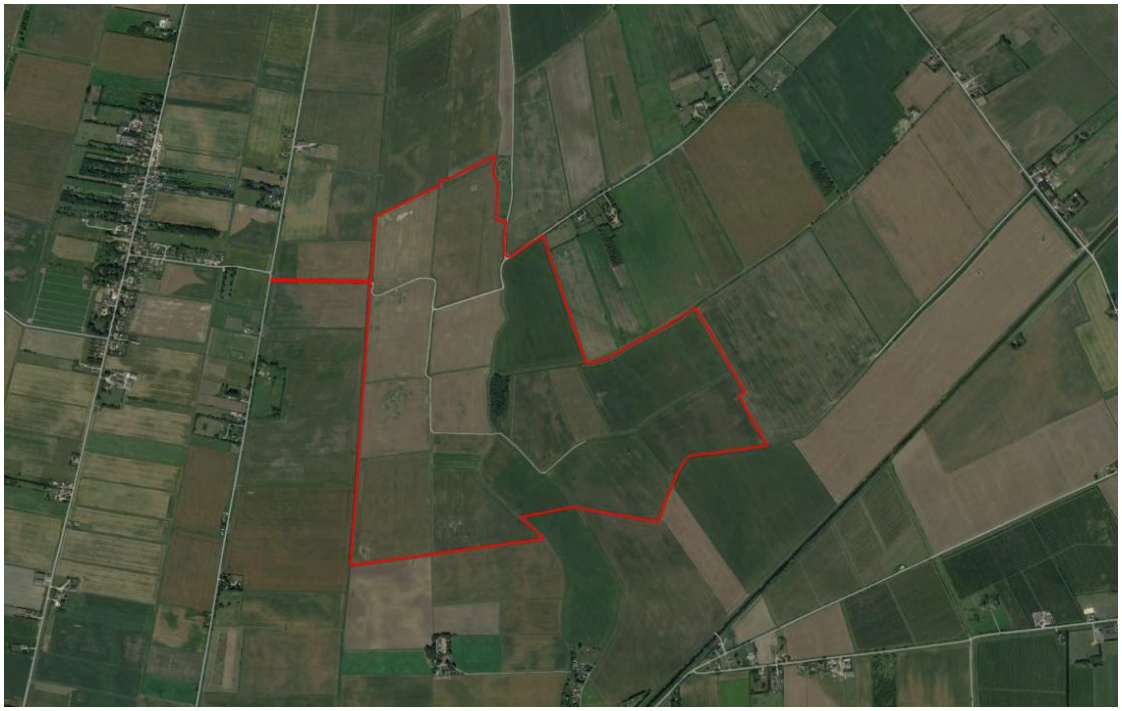

SMP1 ALC Report (Bateman Rural Associates Ltd)
SMP2 Extracts from the Code of Practice for the Sustainable use of Soils on Construction Sites
SMP3 BSSS Working with Soil Guidance Note
SMP4 Institute of Quarrying Field Tests for Soil Suitability
SMP5 Building on Soil Sustainability Cornwall Council and Others (September 2022)
SMP6 Planning Aftercare and Advice (Natural England, 2022)
SMP7 BRE Agricultural Good Practice Guide Extract

# 1 INTRODUCTION

1.1 This document sets out an outline Soil Management Plan (oSMP) for a proposed solar farm with related development on land at Tydd St Giles/Sutton St Edmund (the Site).

1.2 The agricultural land within the Site is shown edged red on the Google Earth image below.

*Insert 1: The Site*



1.3 As described in this oSMP, the land quality of the Site is a mixture, with some Grade 2 but mostly Subgrade 3a quality land. The soils, described in more detail in this oSMP, are a mixture of medium and heavy silty clay loam, or silty clay.

1.4 The purpose of this oSMP is to set out the key principles to minimise any adverse effects on soils or agricultural land quality.

1.5 The objective of this oSMP is to ensure, so far as possible, that good practice is followed and that none of the Site will be downgraded (in terms of agricultural land quality) or that soils will not be adversely affected.

1.6 Timing is the most important factor. This oSMP sets out a timing schedule to minimise effects on soil, as far as practicable.

1.7 This oSMP has been prepared by Tony Kernon of Kernon Countryside Consultants Ltd. It draws on a detailed Agricultural Land Classification and soil survey carried out by Bateman

Rural Associates Ltd, an interview with the farmer, and a survey of the site. The ALC report is at **Appendix SMP1**, including the appendices.

**Structure of Report**

1.8 This oSMP:

- describes the soil resource in section 2;
- describes and sets out the key principles of soil management in section 3;
- summarises the construction phasing and timing in section 4;
- sets out the soil handling methodology for construction compounds in section 5;
- sets out soil methodology for the access tracks and bases in section 6;
- sets out the soil methodology for the solar inverter cabins in section 7;
- sets out the soil methodology for the BESS Area in section 8;
- sets out the soil methodology for the substation area in section 9;
- sets out soil methodology for the solar PV arrays in section 10;
- sets out the on-site fencing in section 11;
- sets out operational phase soil management in section 12;
- and sets out the principles for decommissioning in section 13.

1.9 Implementation of this oSMP, and adherence to its principles, will be the responsibility of the site manager.

**Construction Key Points**

1.10 The key elements of the proposed construction programme are not known at this early stage in the planning process. However, so far as can be achieved given the various other considerations, this oSMP assumes that the key planned parameters of work will include:

(i) start date for construction of infrastructure early March;

(ii) initial works will be to create the construction compounds, then the fencing. In parallel the tracks will be created, then the panel installation can commence;

(iii) panel installation is expected to be complete by mid-October, with any uncompleted connection works then if necessary continuing over winter, such that minimal travel over or movement of soils will take place after early November;

(iv) the site works are scheduled to be completed within a maximum of 12 months;

(v) as necessary, restoration of construction compounds etc will take place the following year once ground conditions are suitable.

## 2 THE SOIL RESOURCE

**The Soil Resource**

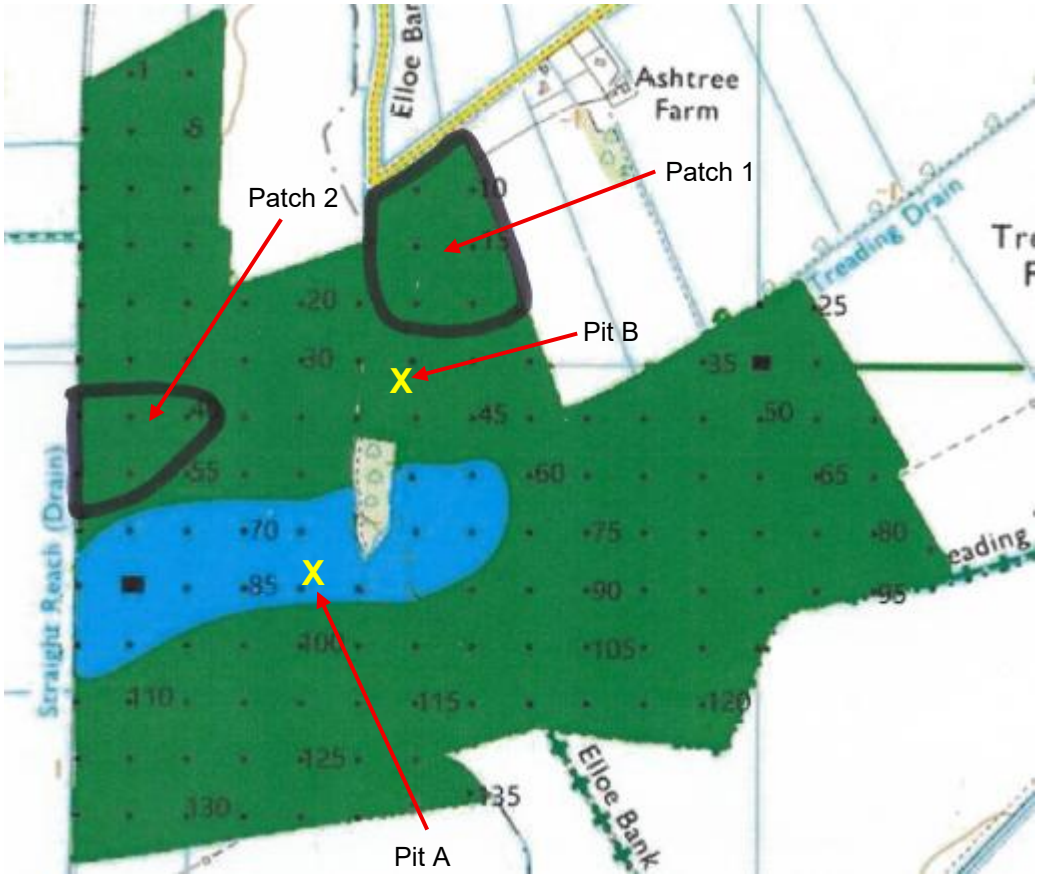
2.1 The soils are described in the Agricultural Land Classification (ALC) report, reproduced in full in **Appendix SMP1**.

2.2 The soils are described from the published soil maps in section 4.1 of the ALC. The ALC auger records in Appendix A of the ALC identify topsoils as heavy silty clay loam (HZCL) or medium silty clay loam (MZCL), or silty clay (ZC) across most of the Site.

2.3 The ALC records clay topsoils around auger points 9, 10, 14, 15, 22 and 23, which form Patch 1 (on the insert below) and 38, 39, 40, 53 and 54 (Patch 2 on the insert). These two areas are mapped on the ALC plan below.

2.4 Two small pits, intended to illustrate the Grade 2 and Subgrade 3a soils, are shown as Pits A and B, the locations of which are shown on the ALC plan below.

*Insert 2: ALC Plan Indicating Areas of Clay Soils and Pit Locations*



2.5 The Grade 2 soils from Pit A are shown below.

*Photos 1 and 2: Grade 2 Soils, Pit A*





2.6 The Subgrade 3a soils cover the majority of the Site. Photographs from Pit B are shown below.

*Photos 3 – 6: Grade 3a Soils, Pit B*









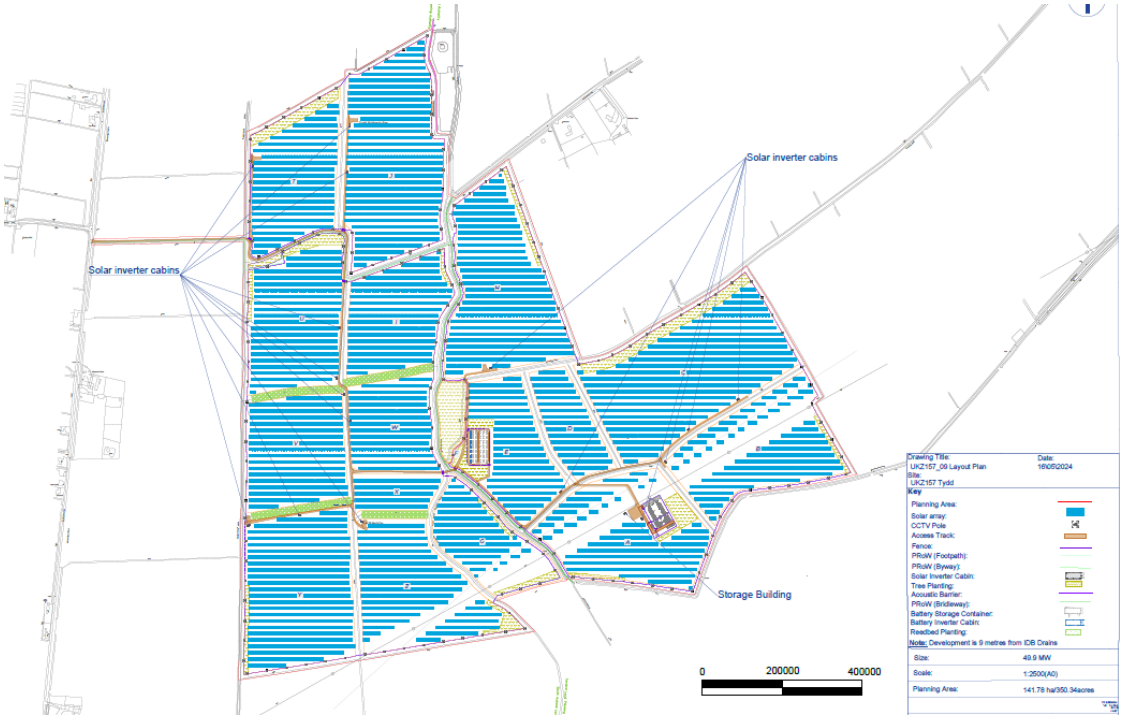
2.7 All the land is in arable use. The Site is very level. Variations in soil texture are very small and are not readily discernible from a walk-over of the Site.

# 3 KEY PRINCIPLES

## The Proposals

3.1 The proposals are illustrated on the plan below.

*Insert 3: The Proposals*




## Guidance

3.2 Soil management principles are set out in a number of documents, but those of most relevance are:

- Code of Practice for the Sustainable Use of Soils on Construction Sites, Defra (March 2011) (extracts in **Appendix SMP2)**;
- Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction, British Society of Soil Science (v 3 January 2022) (**Appendix SMP3**);
- Good Practice Guide for Handling Soils in Mineral Workings, The Institute of Quarrying (July 2021) (extracts in **Appendix SMP4**);
- Building on Soil Sustainability: principles for soils in planning and construction, Cornwall Council and others (September 2022) (**Appendix SMP5**);
- Planning and aftercare advice for reclaiming land to agricultural use, Natural England (April 2022), especially in respect of soil bund management (**Appendix SMP6**)

**Overview**

3.3 For much of the installation process there is no requirement to move or disturb soils. Soils will need to be moved and disturbed to create temporary working compounds, and to create the tracks and small fixed infrastructure bases. Soils will need to be disturbed to enable cables to be laid, but the soils will be reinstated shortly after they are lifted out (ie this is a swift process).

3.4 For those areas where soil needs to be disturbed to create tracks and bases, the soil will be stored in suitably-managed bunds on the site. The soil needs to be looked after because it will be needed at the decommissioning phase to restore the land under the tracks and bases back to agricultural use.

3.5 Subsoil will not need to be removed to create the shallow tracks and bases.

3.6 For the majority of the proposed development soils do not need to be disturbed. The effects on agricultural land quality and soil structure are therefore limited to the effects of vehicle passage. Therefore the key consideration is to ensure that soils are passed over by vehicles (trafficked) when the soils are in a suitable condition, and that if any localised damage or compaction occurs (which is common with normal farming operations too), it is ameliorated suitably.

3.7 The key principles for successfully avoiding damage to soils are:

- timing;
- retaining soil profiles;
- avoiding compaction;
- ameliorating compaction.

**Timing**

3.8 The most important management decision/action to avoid adverse effects on soils is the timing of works. If the construction work takes place when soil conditions are sufficiently dry, then damage from vehicle trafficking and trenching will be minimal.

3.9 Vehicle travel over soils creating limited impact is shown below. This is good practice and is to be aimed-for, so far as possible.

*Photo 7: Soils Suitable for Trafficking*



3.10 Poor practice is shown below. If this type of soil disturbance occurs it can be rectified, as set out below, but as a point of principle if soils are rutting as shown below they are not well suited to being trafficked. Work should, so far as possible, be delayed until soils dry out.

*Photo 8: Soils not Suitable for Trafficking*



3.11 The silty clay loam soils cover most of the Site and will be prone to this type of damage. Avoiding travel over soils from early November to early March in most years is recommended.

3.12 Two modest areas of clay topsoil have been identified and are shown on Insert 2 earlier. These soils may, when wet, be more susceptible to smearing. However there is no necessity to treat these areas any differently to the rest of the Site.

3.13 Accordingly the winter period, when travelling over unprotected soils or moving soils will be most at risk of causing structural damage to the soils, is early November to early March in a normal year.

3.14 Works within this period could exceptionally take place, but it will be necessary to carry out soil suitability tests in advance as there will be limited times within those periods when soils will be sufficiently dry to handle.

3.15 In localised instances where it is not possible to avoid undertaking construction activities when soils are wet and topsoil damage occurs then soils can be recovered by normal agricultural management, using normal agricultural cultivation equipment (subsoiler, harrows, power harrows etc) once soils have dried adequately for this to take place. There may be localised wet areas in otherwise dry fields, for example, which are difficult to avoid.

**Retaining Soil Profiles**

3.16 The successful installation of cabling at depths of >60cm requires a trench to be dug into the ground. Topsoils vary across the site but the coverage is generally about 30cm, with subsoils below that being generally similar to depth. As set out in the BRE Agricultural Good Practice Guidance for Solar Farms (extract at **Appendix SMP7**) at page 3:

> "**When excavating cable trenches, storing and replacing topsoil and subsoil separately and in the right order is important to avoid long-term unsightly impacts on soil and vegetation structure. Good practice at this stage will yield longer-term benefits in terms of productivity and optimal grazing conditions**".

3.17 In those areas where the soil is dug up (trenching and for compounds and access roads), the soils should be returned in as close to the same order, and in similar profiles, as it was removed.

**Avoiding Compaction**

3.18 This SMP sets out when soils should generally be suitable for being trafficked. There may be periods within this window, however, when periodic rainfall events result in soils becoming liable to damage from being trafficked or worked. In these (likely rare) situations, work should only continue with care, to minimise structural effects on the soils, until soils have dried, usually within 48 hours of heavy rain stopping.

**Ameliorating Compaction**

3.19 If localised compaction occurs during construction, it should be ameliorated. This can normally be achieved with standard agricultural cultivation equipment, such as subsoilers (if required), power harrows and rolls.

3.20 The amount of restorative work will vary depending upon the localised impact. Consequently where the surface has become muddy, for example in the photograph below,

this can be recovered once the soil has dried, with a tine harrow and, as needed, a roller or crumbler bar.

*Photos 9 - 10: Inter-row Localised Soil Disturbance and Subsequent Restoration*





3.21 If there are any areas where there has been localised damage to the soils due to vehicle passage, for example, a low wet area within a field which despite best efforts could not be avoided, this should be made good and reseeded at the end of the installation stage, when conditions are suitable. This is illustrated below

*Photo 11: Localised Restoration*



3.22 Accordingly the ground surface should be generally levelled prior to any seeding or reseeding. Reseeding should then take place at a suitable time of the year, usually March – April or September – October in most years.

# 4 CONSTRUCTION PHASING AND TIMING

**NOTE**: This is an outline Soil Management Plan. Planning consent is not yet in place and start dates cannot be known. This sets out the target dates to aim for.

4.1 Physical works involving travelling over or moving soils should be programmed to commence from early March.

4.2 Works will start with the construction of the access, then the construction compounds.

4.3 The access tracks will then be laid. It will be possible to construct the tracks from the highway in, minimising the need to travel over surrounding agricultural land, if the soils are still damp.

4.4 Works to install and connect the solar PV arrays will then take place. This will include trenching works back to the transformer stations.

4.5 The main works of installation of the solar PV panels and associated cabling should aim to be complete by mid-October.

4.6 It will be possible to continue installation works after early November, but works involving travelling over soils or moving soils should be avoided if possible. If soil movement is necessary, the advice of a soil surveyor should be sought to confirm that soils are suitably dry to be moved without significant impacts to soil structure.

# 5 CONSTRUCTION COMPOUNDS

**Construction Methodology**

5.1 It is expected that up to two temporary construction compounds will be created at the start of construction and reinstated at the end.

5.2 Construction compounds are built by stripping topsoil and storing that in a bund on the edge of the site. A matting is then laid down, and stone imported and levelled, as shown below.

*Photo 12: Newly-laid Construction Compound (Elsham-Lincoln Pipeline)*



5.3 The matting prevents the stone from mixing with the subsoil, as shown below.

*Photo 13: Matting*



5.4 Topsoil will need to be stored in a bund, as shown below. If soils are still wet when moved, the bund should be no higher than 1m, but otherwise temporary bunds can be up to 3m in height.

*Photo 14: Topsoil Storage Bund*



**Movement of Soils**

5.5 The soils need to be sufficiently dry to handle. The works should be scheduled to start in early March. Soils will generally be suitably dry to be dug up and moved by early to mid-March.

5.6 Testing of soils pre-commencement is appropriate.

5.7 Guidance on determining soils suitability to be handled is set out in the Good Practice Guide for Handling Soils, **Appendix SMP4**.

5.8 If you can roll soil into a ball or a sausage easily and the soil holds that shape, it is too wet to travel over or move soils. This is illustrated in the photograph below.

*Photo 15: Indication of When Soils are Too Wet (Not from this site)*



5.9 If, however, the “sausage” crumbles and does not hold its own weight, soils are generally suitable for being moved, as illustrated below (these are from a clayey site in May 2024).

*Photos 16 – 17: Soils Just Sufficiently Dry for Being Worked*





5.10 In the limited areas where topsoil stripping is necessary, the topsoils will be stripped to a depth of 30cm, and placed in bunds on the edge of the compound, as shown above.

5.11 Short term storage of soil is shown above. If the soil is likely to be stored for in excess of six months then, depending upon timing, it should be seeded with grass. This binds the soil together and minimises erosion.

5.12 Therefore if the construction compounds are not to be removed before the wet weather in the autumn, the bunds should be seeded with grass, as per the example below. The compound can then be reinstated after mid-April the following year.

Photo 18: *Grass-seeded Bund*



**Removal**

5.13 The removal of the construction compound should be timed for dry weather. That may be the following spring.

5.14 At the end of the construction process, the aggregate will be removed. This can be seen in progress below.

*Photo 19: Start of Restoration of Construction Compound*



5.15 The base area should be loosened when soils are dry and the topsoil then spread over the site to the original depth. This should be lightly cultivated.

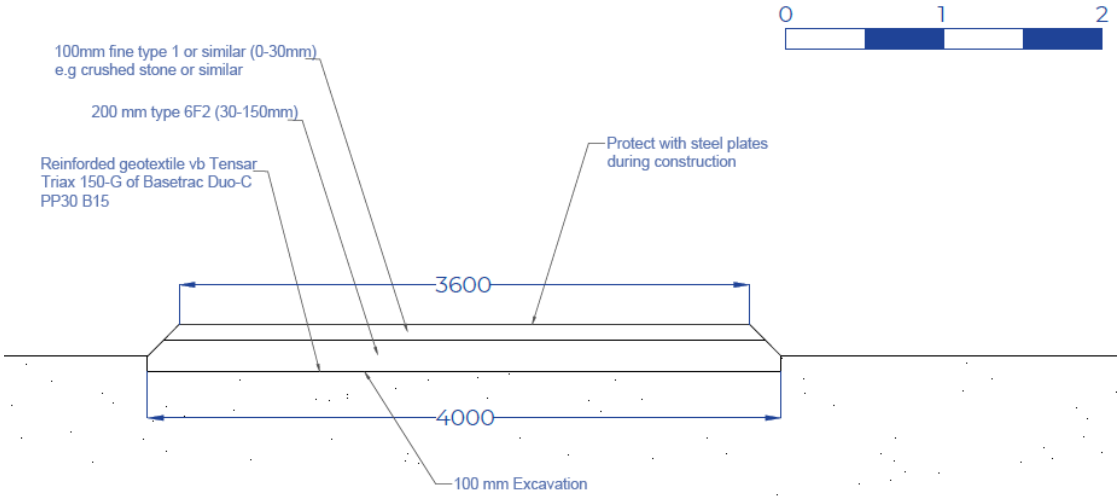
5.16 Panels can then be installed over the construction compound, or the area returned to agricultural use.

# 6 ACCESS TRACKS

**Construction Methodology**

6.1 The access tracks are mostly to be built up, with only a shallow excavation of 100mm, with a reinforced geotextile matting laid down before the aggregate is added. A cross section is shown below.

*Insert 4: Access Track Cross Section*




6.2 This will mean that for every metre length of track there is 0.4 cubic metres of soil to store, which can be left as a shallow mound adjacent to the track, ready for scraping back over the track on decommissioning.

**Soil Management**

6.3 Soil should be stripped when the soil is sufficiently dry and does not smear. This is a judgement that is easily made. If the soils can be rolled into a sausage shape in the hand which is not crumbly, or if rubbing a thumb across the surface causes a smudged smooth surface (a smear), the soil is generally too wet to strip or move without risk of structural damage. Topsoil depths are consistent across the site and a stripping depth of 30cm will be a suitable maximum depth for topsoil in most cases, although rarely will it need to be stripped to such a depth.

6.4 Soil stripping should be carried out in accordance with Defra's "Construction Code of Practice for the Sustainable Use of Soils on Construction Sites" (Defra, 2009). The removed soil should be stored in bunds in accordance with the Construction Code of Practice.

6.5 Some of the tracks will follow the existing network of field tracks across the Site. The estimated, rounded up to the nearest 0.1 ha, amount of soil disturbance for tracks is 0.9 ha,

so the volumes moved will be around 900 cubic metres, which can easily be stored adjacent to the tracks.

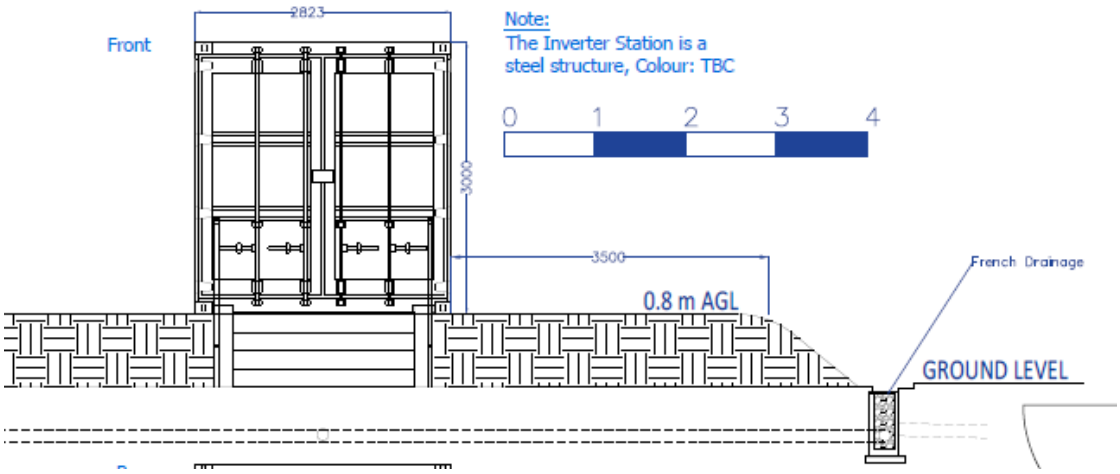
6.6 Topsoil will be stored in a shallow bund of not more than 20-30cm high beside the track. These bunds will remain for the operation phase, but are low and easily managed (sheep will graze them down adequately).

6.7 As a general rule soil should not be moved during or within 24 hours of heavy rain.

## 7 SOLAR INVERTER CABINS

7.1 A total of sixteen solar inverter cabins are proposed, as shown on the Site layout. These will be built up above ground level as shown on the plans, an extract from which is below.

*Insert 5: Solar Inverters*




7.2 A geo-textile matting will be laid across the surface at the outset, and the material to raise the area will be imported. This material will be retained for the duration of the operational phase, and will be removed fully at decommissioning.

7.3 A French Drain will be installed as required around the raised area.

7.4 The access for pedestrians will be via steps, and the walk-way from the steps to the access doors will be laid with stone chippings over a matting, but this will be light (it only needs to take pedestrian traffic).

7.5 As such no soil stripping is required for these areas.

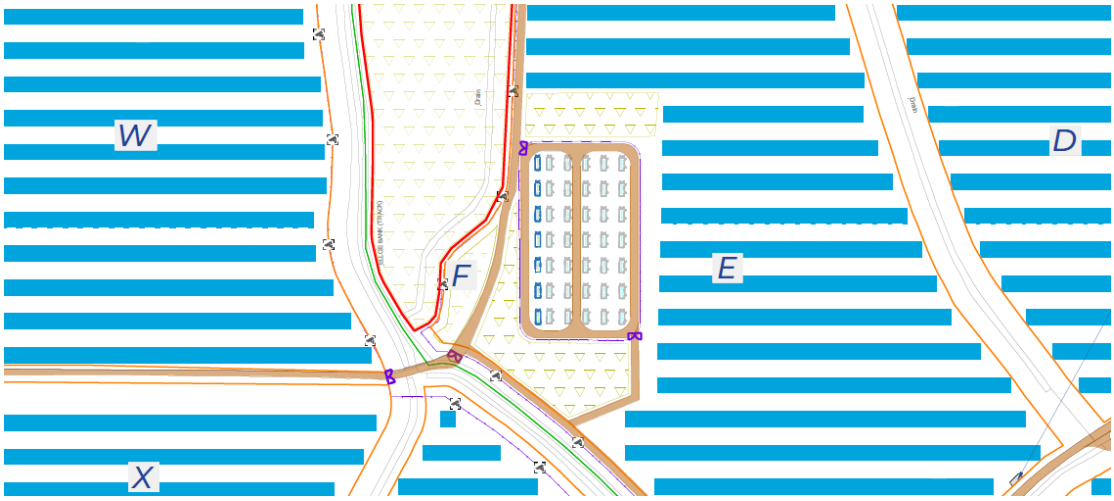
7.6 Topsoil movement to create the areas will be done when soils are in a suitably dry state. Once the raised bases have been built they will be seeded with grass seed in the next appropriate period (likely the autumn following construction) and the grass will be managed by mowing/strimming or by grazing.

# 8 BESS

## The Proposals

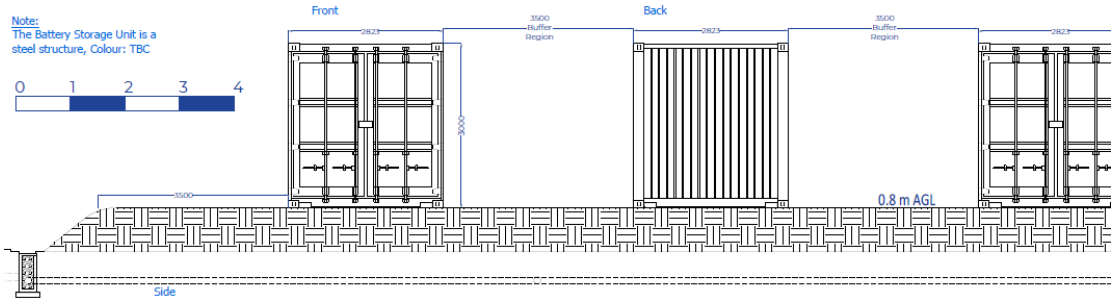
8.1 The proposed BESS area is shown on the plan insert below. The overall dimensions of the area are 73m by 56m.

*Insert 6: Proposed BESS Area*




8.2 The battery containers will stand on raised ground, as shown below.

*Insert 7: Battery Containers*




8.3 Prior to importation of material, matting will be laid over the topsoil. The base material will then be imported. Some of this may be subsoil from the works for the substation. If subsoil from within the Site is being used it will be recorded and marked clearly, so that it can be returned to the substation area on decommissioning.

## Soil Management

8.4 Physical works will take place when soils are suitably dry, as described in earlier sections.

## BESS Management

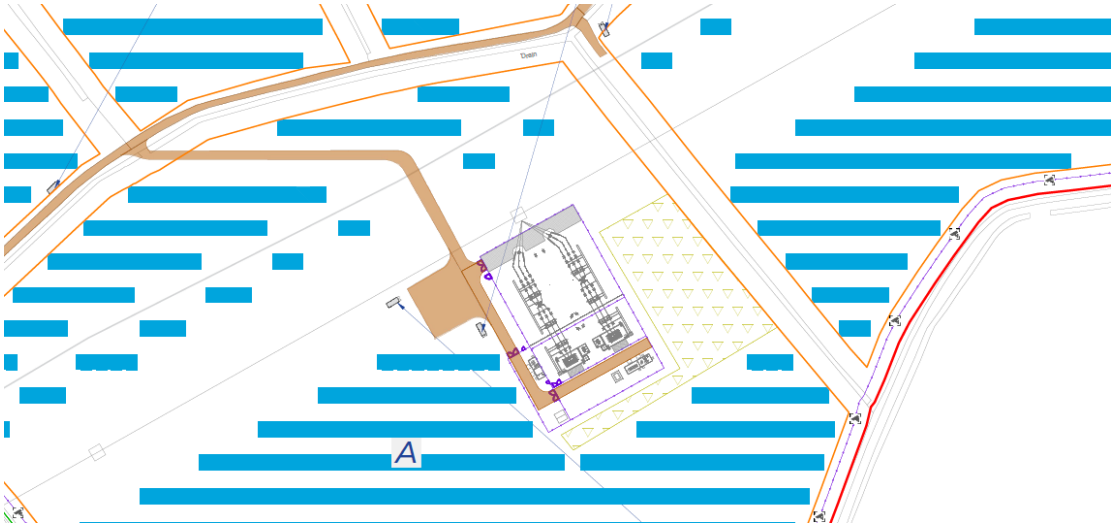
8.5 The raised ground will be managed. Where there is grassland, this will be cut at least once annually to prevent the growth of woody material.

# 9 SUBSTATION

**The Proposals**

9.1 The proposals for the substation are shown on the insert below.

*Insert 8: Proposals for the Substation*




**Soil Management**

9.2 The works for this area will involve moving soil, and in places subsoil, placing matting on the ground as appropriate and importing material to raise parts of the facility.

9.3 The soil and subsoil will be used in the BESS or will be stored on site for restoration on decommissioning. Any soil moved from this area will be carefully recorded and marked so that it can be returned to the original location on decommissioning of the facility.

## 10 SOLAR ARRAYS AND ON-SITE TRENCHING

**The Areas**

10.1 The PV Arrays will be distributed across the Solar PV Site as shown on the application plans.

**Construction Methodology**

10.2 The installation should be carried out when the ground conditions are suitable (ie the soil is not so wet that vehicles cause tyre marks, such as shown below, deeper than about 10cm when travelling across the land). This will normally be between early March and early November. If conditions are suitable, this stage of the installation should create no soil structural damage or compaction, as shown below. Construction should be scheduled to start from mid-March onwards with most installation works completed within 6 months.

*Photos 20 - 21: Ground After Construction*





**Soil Management**

10.3 With these clayey soils a soil suitability (sausage test) should be used to determine suitability of the soils for working or access. In simple terms, if the soil is so wet that vehicles cause tyre marks, such as shown below, deeper than about 10cm when travelling across the land, conditions are not yet suitable.

*Photo 22: Track Marks*



10.4 In most years work access to the land is not restricted between early March and the end of October. Between those periods the ground conditions will normally be resilient to vehicle trafficking.

10.5 In winter the soils are likely to be saturated and the propensity to being damaged, albeit in a way capable of rectification, is greatest. As a general rule, vehicular travel in these periods should be limited as much as possible. It is recognised that rainfall is the factor that wets the soils, so a dry spring will offer different conditions to a wet spring, and this may mean that soil structural damage will inevitably result. This is outside the projected construction period.

10.6 If works of panel installation are delayed and need to extend later than the end of October, a soil consultant will be brought in to advise. It may be that works need to be delayed to the following year, depending upon the season, but the soil consultant will advise on this at the time.

10.7 Occasionally in this country we experience prolonged rainfall in the summer months that saturate soils. If following a rainfall incident installation is causing rutting deeper than 10cm, activity should be minimised so far as possible to allow soils to dry.

10.8 It is very unlikely that trafficking during construction when soils are relatively dry will result in compaction sufficient to require amelioration. However, if rutting has resulted the soil should be levelled by standard agricultural cultivation equipment such as tine harrows, once the conditions suit, and prior to seeding. This can be done with standard agricultural machinery, or with small horticultural-grade machinery such as is shown below.

*Photos 23 - 24: Horticultural Machinery*





10.9 The objective is to get the surface to a level tilth for seeding/reseeding as necessary, as was shown earlier.

10.10 Grass growth will then recover or establish rapidly.

**Construction Methodology**

10.11 Cabling is done mostly with either a mini digger or a trenching machine. The cable routing areas are shown on the plans. Trenches will be at depths of up to 1.2m where soil depth permits, although the CCTV trenching around the periphery could be shallower. An example trench, with the topsoil, placed on one side (0-30cm) and subsoil on the other (below 30cm), is shown below, and with the soil put back after cable installation. This methodology should be followed.

*Photos 25 - 26: Cable Installation*





10.12 It is important that topsoils are placed separately to the subsoils, and that they are then put back in reverse order, ie subsoils first.

10.13 The type of machinery used for trenching is shown below, taken from the BRE National Solar Centre "Agricultural Good Practice Guidance for Solar Farms" (2013).

*Insert 9: Machinery Used (extract from BRE Good Practice Guidance)*



Cable trenching, showing topsoil stripped and set to one side, with subsoil placed on the other side ready for reinstatement (photo courtesy of British Solar Renewables)

10.14 The trenches are narrow (mostly 40-70cm, as shown on the application plans). If the topsoil was from grassland the grass will probably recover rapidly without the need to reseed. In bare soils the trench can be cultivated with the wider area for seeding to grass post installation.

*Photo 27: Grass After 4 Weeks (natural recovery)*



*(The photos in this section were taken on heavy, clay soils with poorly draining subsoil, and the work was photographed in July and August 2015)*

**Soil Management**

10.15 All trenching work will be carried out when the topsoil is dry and not plastic (ie it can be moulded into shapes in the hand).

10.16 The top 30-40cm (ie the full depth of topsoil) will be dug off and placed on one side of the trench, for subsequent restoration. There is no need to strip the grass first.

10.17 The subsoils will then be dug out and placed on the other side of the trench, as per the example below.

*Photo 28: Subsoils Dug out of the Trench*



10.18 Once the cable has been laid, the subsoils will be placed back in the trench. Where there is a clear colour difference within the subsoils, so far as practicable the lower subsoil will be put back first and the upper subsoil above that, which is likely to happen anyway as the lower soil is at the top of the pile.

10.19 If dry and lumpy the subsoils will be pressed down by the bucket to speed settlement. If the soils are settling well no pressing-down is required.

10.20 The topsoil will then be returned onto the top of the trench. It is likely, and right, that the topsoil will sit a few centimetres higher than the surrounding level. This should be left to allow it to settle naturally as the soils become wetter.

10.21 If there is a surplus of topsoil this may be because the lower subsoils were dry and blocky and there are considerable gaps in the soil. These will naturally restore once the lower soils become wet again. If the trench backfilling will result in the soil being more than 5-10cm proud of surrounding levels, which is unlikely but possible, the topsoil should not be piled higher. It should be left to the side, and the digger returned to add back the surplus soil once the trench has settled and add the rest of the topsoil onto the trench at that point.

10.22 Any excess topsoil should not be piled higher than 5 – 10cm above ground level.

10.23 If considered appropriate, a suitable grass seed mix could be spread by hand over any parts of the trenches that would seem likely to benefit from extra grass.

# 11 SITE FENCING

**The Areas**

11.1 Fence designs can vary, but they all involve a post being inserted into the ground. Pole mounted internal facing closed circuit television (CCTV) systems installed at a height of up to 3.5m are also likely to be deployed around the perimeter of the operational areas. Access gates will be of similar construction and height as the perimeter fencing.

**Construction Methodology**

11.2 The site fencing is likely to be metal mesh or deer fencing. This can be erected at any time, if soil conditions allow. The following photographs show fencing installed early in the process.

*Photos 29 - 30: The Fencing*





11.3 Similarly CCTV poles are inserted in the same way.

*Photos 31 - 32: CCTV Poles and Fencing*






**Soil Management**

11.4 If the movement of vehicles is not causing significant rutting (i.e. more than 10cm), then fencing could be erected outside of the key working period.

11.5 Any rutting that results from fencing can be made good with standard agricultural equipment.

# 12 OPERATIONAL PHASE: LAND MANAGEMENT

**Solar PV Arrays**

12.1 The land around the Solar PV Arrays will be managed including most probably by the grazing of sheep.

12.2 Panels grazed by sheep tend to be free of weeds, as shown below.

*Photo 33: Sheep Grazing Under Panels*



12.3 Any localised weed treatment can be carried out at the appropriate time of the year using a quad-mounted sprayer, or by hand using a strimmer or knapsack sprayer.

**Ongoing Maintenance**

12.4 There are many different cleaners on the market, some tractor based and some operated from smaller machines, such as below. This is usually carried out in early summer, to maximise cleanliness for the key generating period, and when soils are dry.

*Photo 34: Cleaning of Solar Arrays*



12.5 All the fields are wet in places, and therefore the cleaning should be timed so far as possible to avoid the early November to early March period for the site. The normal cleaning period is early summer, so that panels are clean for the maximum light period, so damage is unlikely.

12.6 If vehicles, including farm vehicles, cause ruts in the soil these will naturally repair in time, especially as the land is grazed by sheep and their feet are excellent at levelling land. Alternatively a light harrow or rolling will restore the ruts, when the soil is still soft enough to roll but hard enough to not rut more.

*Photo 35: Ruts Caused by Vehicles*



12.7 If vehicles have caused rutting it is probably, as per the example above, only localised. In the photograph above this is a wet spot, and on the land either side of the ruts within the row there is no evidence of wheel indentation. If these areas are not levelled they will tend to sit with water in them.

12.8 Localised, small rutting should be repaired by either treading-in the edges with feet, by light rolling or harrowing, or adding a small amount of soil simply to fill-in the depression so that water does not collect there.

12.9 Deeper rutting will require either light harrowing in the drier period, or some soil adding, or both, before reseeding.

**Emergency Repairs**

12.10 For the duration of the operational phase there should be only localised and infrequent need to disturb soils, such as for repair of a cable. Any works involving trenching should be carried out, ideally, when the soils are dry but recognising that any works will be those of emergency repair, that may not be possible.

12.11 Accordingly if new cabling is needed and has to be installed in wet periods, it can be expected that the trench will look unsightly initially, such as the example below.

*Photo 36: Trench During Wet Period*



12.12 Any area disturbed should be harrowed or raked level once the soils have dried, and be reseeded. These areas will be small, and this can probably be done by hand.

**Soil Bund Management**

12.13 Ongoing maintenance should ensure that the bunds remain free from woody vegetation (eg brambles, elder) and that the soil bunds do not erode. For this reason the bunds should be seeded with a grassland mix, as the roots of the grasses will help bind the surface and prevent water channels forming.

12.14 At least once per year the bund should be managed, ideally by mowing or strimming.

12.15 An example of a bund that is seven years old, is shown below, from a solar farm in Monmouthshire.

*Photo 37: Soil Bund Example*



## 13 DECOMMISSIONING PRINCIPLES

13.1 Given the length of time before decommissioning it is likely that the ALC methodology will have been amended by then. Further, unless we are successful as a world, climate change may have altered the seasons and rainfall patterns. Therefore this guidance is prefaced with a requirement for a suitably qualified soil scientist to revisit the site prior to decommissioning, and to update the guidance and timing.

13.2 The objective is to remove panels and restore all fixed infrastructure areas to return the land to the same ALC grade and condition as it was when the construction phase commenced.

**Removal of Panels**

13.3 A qualified soil scientist should advise prior to decommissioning time. The effects of climate change in 40 years' time may mean that these dates, applicable in 2024, are no longer applicable.

13.4 Once the panels have been unbolted and removed, the framework will then be a series of legs, as shown below.

*Photos 38 - 39: The Framework*





13.5 These will be removed by low-ground pressure machines, in a reverse operation to the installation. These machines will provide a pneumatic tug-tug-tug vertically upwards. This will break the seal between soil and leg, and once that surface tension is released the leg will come out easily.

13.6 The legs will be loaded onto trailers and removed.

13.7 There will be no significant damage to the soils, and no significant compaction.

**Removal of Cables**

13.8 Cables buried less than 1 metre deep will be removed. This is likely to need a trench to be dug. This will be done is done mostly with either a mini digger or a trenching machine. Cabling will mostly be at depths of 0.8m where soil depth permits, although the CCTV trenching around the periphery could be shallower. An example trench, with the topsoil placed one side (0-30cm) and subsoil on the other (below 30cm), is shown below, and with the soil put back after cable installation.

*Photo 40: Example Trench*



*Photo 41: Topsoil Replaced*



13.9 The type of machinery used for trenching is shown below, taken from the BRE National Solar Centre "Agricultural Good Practice Guidance for Solar Farms" (2013).

*Insert 10: Machinery Used for Trenching*



Cable trenching, showing topsoil stripped and set to one side, with subsoil placed on the other side ready for reinstatement (photo courtesy of British Solar Renewables)

13.10 Once the trench has been backfilled it can be left for cultivation with the rest of the field post removal of panels.

**Removal of Fixed Infrastructure**

13.11 Switchgear, such as that shown below, will need to be removed.

*Photo 42: Switchgear*



13.12 Any concrete bases will need to be broken up. This will most likely involve breaking with a pneumatic drill to crack the concrete, after which it can be dug up and loaded onto trailers and removed.

13.13 The ground beneath the base may then benefit from being subsoiled, to break any compaction. This can be done by standard tractor-mounted equipment, such as the following examples.

*Photos 43 - 44: Example of Tractor Mounted Equipment*





**Tracks**

13.14 The tracks will be the last fixed infrastructure removed. The tracks will have been used for vehicle travel during the decommissioning stage. The tracks will also be used for removal of material from the tracks themselves, which will be removed from the furthest point first.

13.15 The stone will be removed and any matting removal. The base will then be loosened by subsoiler or deep tine cultivators, depending on specific advice given by the soil expert at the time following and analysis of soil compaction and condition.

**Reinstatement of Soils**

13.16 Topsoil from the storage bunds will then be returned and spread to the depth removed (typically 10-15cm). The area will then be cultivated, probably in combination with the whole of each field.

**Fences and Gates, and CCTV Cabling**

13.17 The cabling be removed in the summer months, after the panels have been removed. This will involve a tractor and trailer. The CCTV cabling is shallow buried and will probably pull out without the need for trenching, but if required tranches will be dug, as described above, and replaced in order once the cables have been removed.

13.18 Fences and gates will be rocked by machinery and pulled out. The holes are generally small and will fill in easily, but the bucket could be used to loosen the surface so that soil fills the void, if there is a risk of injury from the small holes.

**Cultivation**

13.19 The fields will be handed back to the farmers. Whether they are handed back as grassland or sprayed off and cultivated, will be determined in discussions with each landowner.

**Appendix SMP1**

**ALC Report (Bateman Rural Associates Ltd)**

BATEMAN RURAL ASSOCIATES LIMITED

# Agricultural Land Classification

of

Land at Ashtree Farm
Gorefield
Lincolnshire
PE13 4PL

For

Pathfinder Clean Energy

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DRAWING 1 ALC Grade and survey points

APPENDIX A Survey profile data sheet

GENERAL INFORMATION SOURCES

GLOSSARY

## 1. INTRODUCTION

An Agricultural Land Classification (ALC) has been carried out on 132 ha of land at Gorefield (Drawing 1). The site is centred on OS Grid Ref. 538416, 312822.

The survey was conducted on the 21st and 22nd June 2022 and classified the land into one or more of the below grades (see Drawing 1). On the survey date, the site was in agricultural use.

### 1.1 Methodology

Agricultural land is classified into the following grades according to the 1988 guidelines[1].

| Grade | Description |
|---|---|
| 1 | **Excellent quality agricultural land** with no or very minor limitations to agricultural use. |
| 2 | **Very good quality agricultural land** with minor limitations which affect crop yield, cultivation or harvesting. |
| 3a<br>3b | **Good quality agricultural land** capable of producing moderate to high yields of a narrow range of arable crops or moderate yields of a wider range of crops.<br>**Moderate quality agricultural land** capable of producing moderate yields of a narrow range of crops or lower yields of a wider range of crops. |
| 4 | **Poor quality agricultural land** with severe limitations which significantly restrict the range of crops and/or level of yields. |
| 5 | **Very poor quality agricultural land** with very severe limitations which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops. |

The classification includes an initial desktop investigation to examine previously mapped soil types and to note the drift and solid geology followed by the field survey consisting of auger borings at one every 100 m in general and a pit excavated in each of the main soil types to confirm the structures and stone content if needed. Laboratory analysis of soil textures is undertaken if needed in order to confirm textures such the *heavy/medium* clay and *medium/fine* sand categories or stone content. All site survey profile data is listed in Appendix A.

All of the potential limitations are assessed and then the most limiting factor dictating the ALC grade was determined for this site and is detailed in Table 2.

### 1.2 Previous ALC gradings

Grading on the MAFF (1983) 1: 250 000 provisional map indicated the site is mapped as Grade 2 land. No former detailed surveys have been undertaken for the site.

## 2. CLIMATIC LIMITATIONS

### 2.1 Overall climate

The climatological data for the site centre is detailed in Table 1.

**Table 1**
**Climatological information[3]**

| Factor | Units | Value |
|---|---|---|
| Altitude AOD | m | 0 |
| Accumulated temperature | day°C (Jan-June) | 1446.2 |
| Average Annual Rainfall | mm | 559.6 |
| Field Capacity Days | days | 97.0 |
| Moisture Deficit Wheat | mm | 122.4 |
| Moisture Deficit Potatoes | mm | 118.8 |
| Overall climate ALC Grade | Grade 1 | |

Climate will not result in the most significant limiting factor for the site.

### 2.2. Local climate

Local climate will not result in a significant limiting factor for this site.

# 3 SITE LIMITATIONS

## 3.1 Gradient

The gradient will not result in a significant limiting factor for this site.

## 3.2 Microrelief

The microrelief will not result in a significant limiting factor for this site.

## 3.3 Flooding

A low risk of flooding from surface waters and rivers has been identified for the site (https://flood-warning-information.service.gov.uk/long-term-flood-risk).

# 4 SOIL LIMITATIONS

## 4.1 Texture and structure

Over the majority of the site, clayey soils predominate. The textures noted across the site were mainly heavy silty clay loam over silty clay or clay subsoils. Subsoil structure was moderate coarse angular blocky and moderate coarse prismatic.

Wallasea and Newchurch soils are less permeable but respond to underdrainage; drained soils are occasionally waterlogged (Wetness Class II) (www.landis.org.uk). Numerous ditches and reed channels were noted on site. Profiles are stone free or very slightly stony and typically non or only very slightly calcareous throughout. The critical variation noted across the site was whether the topsoil heavy or medium silty clay loam.

The site has previously been mapped as having soils of the following Associations:
The Normoor Association soils over the majority of the site are mapped as: *Deep stoneless clayey soils in places with humose surface horizon, often very acid. Flat land crossed by low ridges with deep calcareous silty soils. Groundwater controlled by ditches and pumps. Slight risk of wind erosion* (www.landis.org.uk).
The Wallasea 2 Association soils over the north-west of the site are mapped as: *Deep stoneless clayey soils. Calcareous in places. Some deep calcareous silty soils. Flat land often with low ridges giving a complex soil pattern. Groundwater controlled by ditches and pumps* (www.landis.org.uk).

**Superficial Geology 1:50 000 scale superficial deposits description:**
*Tidal Flat Deposits, 1 - Clay and Silt.*
**Bedrock Geology 1:50 000 scale bedrock geology description:**
*West Walton Formation and Ampthill Clay Formation (undifferentiated) - Mudstone.*

**Table 1a - PSD Results**

| No | Percentages | | | | Textural Class |
|---|---|---|---|---|---|
| | Sand | Silt | Clay | Total | |
| 83 | 5.28 | 68.25 | 26.47 | 100.00 | MZCL |
| 36 | 4.62 | 61.46 | 33.92 | 100.00 | HZCL |

Method: BS1377 Pipette Method

### 4.2 Depth

Soil depth will not result in a significant limiting factor for this site.

### 4.3 Stoniness

Stoniness is not a direct significant limiting factor for soils noted on site.

### 4.4 Chemical

Chemical contamination will not result in a significant limiting factor for this site.

## 5. INTERACTIVE LIMITATIONS

### 5.1 Wetness

Mottling and gleying was noted within the soils from around 25 cm depth in the clayey soils.

The combination of a Wetness Class of II for the soils (see Appendix A) with Field Capacity Days of 97.0 and a topsoil texture of non-calcareous heavy silty clay loam or silty clay results in an ALC Grade of 3a. A small area of land to the west with light loamy soils resulted in an ALC Grading of 2.

### 5.2. Droughtiness

The Available Water Capacity which subsequently when considered with respect to the Moisture Deficit for wheat and potatoes resulted in a slight droughtiness limitation for soils on the site.

### 5.3 Erosion

Erosion will not result in a significant limiting factor for this site.

## 6. AGRICULTURAL LAND CLASSIFICATION

### 6.1 Most limiting factors

***Grade 3a land – Wetness Limitation***

The combination of a Wetness Class of II for the soils (see Appendix A) with Field Capacity Days of 97.0 and a topsoil texture of non-calcareous heavy silty clay loam or silty clay results in an ALC Grade of 3a.

***Grade 2 land – Wetness and Droughtiness Limitation***

The combination of a Wetness Class of II for the soils (see Appendix A) with Field Capacity Days of 97.0 and a topsoil texture of non-calcareous medium loamy soils results in an ALC Grade 2 for a small area of land to the west.

### 6.2 Current grading

This survey has resulted in an Agricultural Land Classification of the following grades (Drawing 1):

**Table 2. ALC gradings and limitations**

| Grade | ha | % | Limitation |
|---|---|---|---|
| **1** | | | |
| **2** | 15 | 11.36 | Wetness and droughtiness |
| **3a** | 117 | 86.66 | Wetness |
| **3b** | | | |
| **4** | | | |
| **5** | | | |
| **Non-agricultural land** | | | |
| **Total** | 132 | 100% | |

# DRAWING 1

## ALC Grade

Key

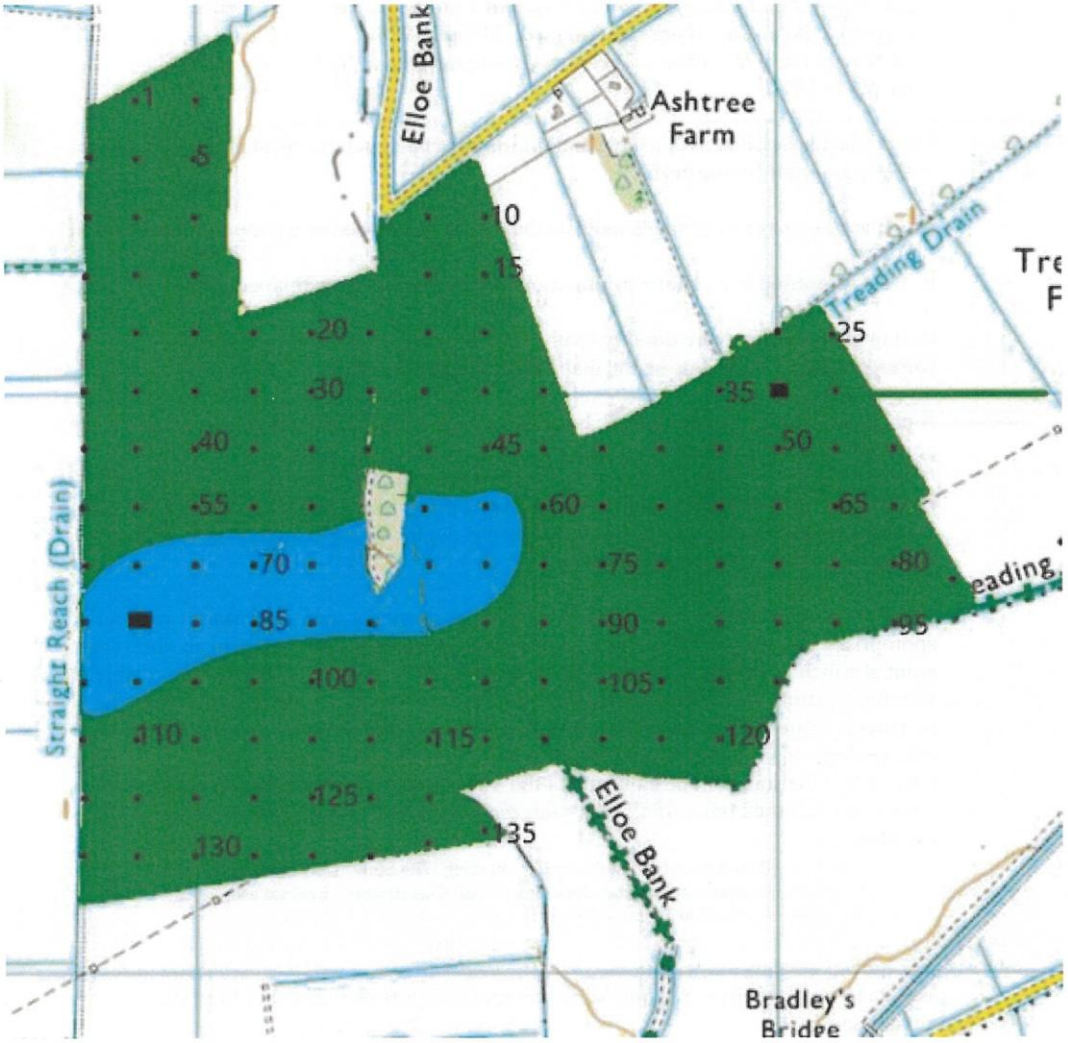
ALC Grades

- Grade 1
- Grade 2
- Grade 3a
- Grade 3b
- Grade 4
- Grade 5
- Non agricultural land

- Boring
- Pit

BATEMAN RURAL ASSOCIATES LIMITED

| Drawing Title: ALC Grade | Drawing No.: 1 |
|---|---|
| Scale: 1:10000 | Date:14/07/2022 |




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# APPENDIX A

## Soil profile data

**Notes**

1 All abbreviations relating to soil parameters are standard and derived from the guidance documents:

***Agricultural Land Classification of England and Wales***. Revised guidelines and criteria for grading the quality of agricultural land. MAFF. 1988.
***Soil Survey Field Handbook.*** Technical Monograph No.5. Soil Survey of England and Wales.1976.

2 The pit data is detailed in this table and information on structure and stone content copied to the appropriate boring profiles.

3 Any blanks or zeros in the cells indicate the data is not needed or appropriate for that cell.

4 If 'NA' is inserted in a cell the information is not appropriate on this occasion.

5. Boring or pit locations are directly (within 2 m accuracy) on the grid reference corresponding to the points on the map unless otherwise stated.

6 A point directly marked on a track, boundary or other feature will be moved 2-3 m off the point or omitted if surrounding points and soil types allow.

7. Borings that are potentially within 15 m of a gas pipeline are limited to 0.4 m depth and the strata description in the data table below this depth will be extrapolated from nearby borings and upper strata characteristics.

8. The *Observation Density* is 1 per ha on a 100 m grid using a semi *Free Survey* method if appropriate*. The letter 'B' in the second column of the data table refers to an observation point at which a boring may have been undertaken. In some situations it is not possible to visit the location due to for example crop status or animals in a field. In some cases the location is visited and observation of the soils at the surface is sufficient. In all cases the soil, geology, topography, flood risk and aerial crop patterns are assessed from published sources and the soils will be subject to a full 120 cm depth boring either side of a non-visited or non-bored point. If all data sources are agreeable, a soil pattern can be established.

* British Society of Soil Science. Working With Soil – The Professional Competency Scheme. Agricultural Land Classification: England and Wales. How2 sheet 4.2.4. 2018.

9. For moisture balance calculations, *strongly, moderately* and *well developed* structure will equate to *good, moderate* or *poor* structure terms respectively in Table 14 of the guidelines.

10. Pit information in addition to that listed in the table below will be detailed in Section 4.1 and 4.3 if needed.

| Obs point | Grid ref. if off intersection | Boring or Pit | Grad. (deg) | Base Depth (cm) | Text. | Calc | Matrix colour | Motts./ black ferro. conc. %/depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (/ F=firm consist ence) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grade (Drought WHEAT) | MBP | Grade (Drought POTATOES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 25 | HZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 1 | | B | ≤7 | 120 | ZC | | 10YR42 | 15/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 2 | | B | ≤7 | 120 | ZC | | 10YR42 | 20/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 3 | | B | ≤7 | 120 | ZC | | 10YR42 | 20/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | HZCL | N | 10YR43 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 4 | | B | ≤7 | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 13.15 | 2 | -8.03 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | HZCL | N | 10YR43 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 5 | | B | ≤7 | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 13.15 | 2 | -8.03 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | HZCL | N | 10YR43 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 6 | | B | ≤7 | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 13.15 | 2 | -8.03 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | HZCL | N | 10YR43 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 7 | | B | ≤7 | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 13.15 | 2 | -8.03 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 8 | | B | ≤7 | 120 | C | | 10YR42 | 20/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 14.38 | 2 | -4.89 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | C | N | 10YR31 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| 9 | | B | ≤7 | 60 | C | | 10YR42 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 16 | 8 | 1 | 0.5 | 8.19 | 2 | -10.21 | 3a |
| | | | | 120 | ZC | | 10YR41 | 25/60 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | C | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 10 | | B | ≤7 | 60 | C | | 10YR42 | 25/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 16 | 8 | 1 | 0.5 | 10.63 | 2 | -7.77 | 2 |
| | | | | 120 | ZC | | 10YR41 | 25/60 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 11 | | B | ≤7 | 120 | C | | 10YR42 | 25/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 14.38 | 2 | -4.89 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 12 | | B | ≤7 | 120 | C | | 10YR42 | 25/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 14.38 | 2 | -4.89 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 13 | | B | ≤7 | 120 | C | | 10YR42 | 25/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 16 | 8 | 1 | 0.5 | 15.24 | 2 | -4.04 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | C | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 14 | | B | ≤7 | 60 | C | | 10YR42 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 10.13 | 2 | -8.27 | 2 |
| | | | | 120 | ZC | | 10YR41 | 25/60 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | C | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 15 | | B | ≤7 | 55 | C | | 10YR42 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 9.63 | 2 | -10.27 | 3a |
| | | | | 120 | ZC | | 10YR41 | 25/55 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 16 | | B | ≤7 | 120 | C | | 10YR42 | 25/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 14.38 | 2 | -4.89 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 17 | | B | ≤7 | 120 | C | | 10YR42 | 20/25 | 10YR56 | | 0 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 18.88 | 2 | -1.52 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 18 | | B | ≤7 | 120 | C | | 10YR42 | 25/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 14.38 | 2 | -4.89 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | ZC | N | 10YR42 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| 19 | | B | ≤7 | 120 | C | | 10YR53 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 16 | 8 | 1 | 0.5 | 9.92 | 2 | -9.36 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | ZC | N | 10YR42 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| 20 | | B | ≤7 | 120 | ZC | | 10YR53 | 25/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 7.83 | 2 | -13.35 | 3a |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |

| Obs point | Grid ref. # eff intersection | Boring or Pit | Grad. (deg) | Base Depth (cm) | | Text. | Calc | Matrix colour | Motts/ black ferro. conc. %/ depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (/ if >1cm. consistence) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grade (Drought, Weight) | MBP | Grade (Drought, POTATOES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | | B | ≤7 | 28 | | ZC | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR53 | 20/28 | 10YR56 | | 0 | HR | P | CPR | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 14.23 | 2 | -8.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | | B | ≤7 | 28 | | C | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 55 | | C | | 10YR31 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 13 | 7 | 1 | 0.5 | 9.33 | 2 | -13.57 | 3a |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | B | ≤7 | 30 | | C | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 60 | | C | | 10YR42 | 25/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 13 | 7 | 1 | 0.5 | 9.63 | 2 | -13.77 | 3a |
| | | | | 120 | | ZC | | 10YR41 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | B | ≤7 | 35 | | ZC | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR41 | 25/35 | 10YR56 | | 0 | HR | P | CPR | MD | 35 | 35 | II | 3a | 15 | 8 | 1 | 0.5 | 15.63 | 2 | -6.77 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | | B | ≤7 | 30 | | ZC | N | 10YR31 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CPR | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 14.63 | 2 | -7.77 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | MZCL | | 10YR43 | 15/30 | 10YR56 | | 0 | HR | P | CPR | MD | 30 | 30 | II | 3a | 17 | 10 | 1 | 0.5 | 38.63 | 1 | 6.23 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | MZCL | | 10YR43 | 20/30 | 10YR56 | | 0 | HR | P | CPR | MD | 30 | 30 | II | 3a | 17 | 10 | 1 | 0.5 | 38.63 | 1 | 6.23 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | MZCL | | 10YR43 | 20/30 | 10YR56 | | 0 | HR | P | CPR | MD | 30 | 30 | II | 3a | 17 | 10 | 1 | 0.5 | 38.63 | 1 | 6.23 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | | B | ≤7 | 25 | | ZC | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR53 | 20/25 | 10YR56 | | 0 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 13.63 | 2 | -8.77 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | | B | ≤7 | 25 | | ZC | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR53 | 25/25 | 10YR56 | | 0 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 13.63 | 2 | -8.77 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | | B | ≤7 | 28 | | ZC | N | 10YR42 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | C | | 10YR53 | 25/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 16 | 8 | 1 | 0.5 | 9.92 | 2 | -9.36 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | | B | ≤7 | 25 | | ZC | N | 10YR42 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | C | | 10YR53 | 25/28 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 5.06 | 2 | -9.64 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | HZCL | | 10YR41 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 17 | 10 | 1 | 0.5 | 30.63 | 1 | -0.05 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | | B | ≤7 | 25 | | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | HZCL | | 10YR41 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 28 | 28 | II | 3a | 17 | 10 | 1 | 0.5 | 30.06 | 1 | -0.62 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 35 | | B | ≤7 | 35 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR41 | 25/35 | 10YR56 | | 0 | HR | P | CPR | MD | 35 | 35 | II | 3a | 15 | 8 | 1 | 0.5 | 22.63 | 2 | 0.23 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | | P | ≤7 | 35 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR41 | 25/35 | 10YR56 | | 0 | HR | P | CPR | MD | 35 | 35 | II | 3a | 15 | 8 | 1 | 0.5 | 22.63 | 2 | 0.23 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CPR | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 17.93 | 2 | -4.47 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 28 | | C | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 38 | | B | ≤7 | 50 | | C | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 16 | 8 | 1 | 0.5 | 9.43 | 2 | -11.97 | 3a |
| | | | | 120 | | ZC | | 10YR41 | 25/50 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 39 | | B | ≤7 | 28 | | C | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 50 | | C | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 16 | 8 | 1 | 0.5 | 9.43 | 2 | -11.97 | 3a |
| | | | | 120 | | ZC | | 10YR41 | 25/50 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | | B | ≤7 | 25 | | C | N | 10YR42 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| | | | | 50 | | C | | 10YR41 | 25/25 | 10YR56 | | 5 | HR | P | CAB | MD | 25 | 25 | II | 3a | 16 | 8 | 1 | 0.5 | 5.26 | 2 | -16.14 | 3a |
| | | | | 120 | | ZC | | 10YR41 | 25/50 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |

| Obs point | Clod no. if diff intervention | Boring or Pit | Grad. (deg) | Base Depth (cm) | Text. | Calc | Matrix colour | Motts / black ferro. conc. %/ depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (if F=firm, consist ence ) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grade (Drought index) | MBP | Grade (Drought POTATOES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | | B | ≤7 | 25 | ZC | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 30.06 | 1 | -0.62 | 2 |
| | | | | 120 | ZC | | 10YR53 | 25/25 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | | B | ≤7 | 25 | ZC | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 35.38 | 1 | 2.98 | 2 |
| | | | | 120 | ZC | | 10YR53 | 20/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | | B | ≤7 | 25 | ZC | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 35.38 | 1 | 2.98 | 2 |
| | | | | 120 | ZC | | 10YR53 | 20/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | | B | ≤7 | 35 | HZCL | N | 10YR31 | | | | 0 | HR | | | | 35 | 35 | II | 3a | 19 | | 1 | | 22.63 | 2 | 0.23 | 2 |
| | | | | 70 | ZC | | 10YR41 | 20/35 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | ZC | | 10YR42 | 25/70 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | | B | ≤7 | 35 | HZCL | N | 10YR31 | | | | 0 | HR | | | | 35 | 35 | II | 3a | 19 | | 1 | | 22.63 | 2 | 0.23 | 2 |
| | | | | 65 | ZC | | 10YR41 | 20/35 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | ZC | | 10YR42 | 20/65 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | | B | ≤7 | 30 | HZCL | N | 10YR31 | | | | 0 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | ZC | | 10YR41 | 20/35 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 47 | | B | ≤7 | 35 | HZCL | N | 10YR31 | | | | 0 | HR | | | | 35 | 35 | II | 3a | 19 | | 1 | | 22.63 | 2 | 0.23 | 2 |
| | | | | 65 | ZC | | 10YR41 | 20/35 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | ZC | | 10YR42 | 20/65 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 48 | | B | ≤7 | 28 | HZCL | N | 10YR43 | | | | 5 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 13.15 | 2 | -8.03 | 2 |
| | | | | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 49 | | B | ≤7 | 30 | HZCL | N | 10YR31 | | | | 0 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | ZC | | 10YR41 | 15/30 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | | B | ≤7 | 30 | HZCL | N | 10YR31 | | | | 0 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 51 | | B | ≤7 | 28 | HZCL | N | 10YR43 | | | | 5 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 13.15 | 2 | -8.03 | 2 |
| | | | | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 53 | | B | ≤7 | 25 | C | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 17 | | 1 | | 7.13 | 2 | -14.27 | 3a |
| | | | | 50 | C | | 10YR41 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | ZC | | 10YR41 | 25/50 | 10YR56 | | 0 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 54 | | B | ≤7 | 25 | C | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 17 | | 1 | | 2.98 | 3a | -17.24 | 3a |
| | | | | 50 | C | | 10YR41 | 25/25 | 10YR56 | | 5 | HR | P | CAB | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | ZC | | 10YR41 | 25/50 | 10YR56 | | 5 | HR | P | CPR | WK | | | | | 12 | 7 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 55 | | B | ≤7 | 25 | HZCL | N | 10YR43 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 56 | | B | ≤7 | 25 | ZC | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 30.06 | 1 | -0.62 | 2 |
| | | | | 120 | ZC | | 10YR53 | 25/25 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 57 | | B | ≤7 | 25 | ZC | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 35.38 | 1 | 2.98 | 2 |
| | | | | 120 | ZC | | 10YR53 | 20/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 58 | | B | ≤7 | 25 | MZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 2 | 17 | | 1 | | 45.13 | 1 | 8.73 | 2 |
| | | | | 50 | ZL | | 10YR52 | 5/25 | 10YR56 | | 0 | HR | P | M/F | MD | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 59 | | B | ≤7 | 25 | MZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 2 | 17 | | 1 | | 42.51 | 1 | 6.11 | 2 |
| | | | | 50 | ZL | | 10YR52 | 5/25 | 10YR56 | | 5 | HR | P | M/F | MD | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | SCL | | 10YR42 | 10/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |
| 60 | | B | ≤7 | 25 | HZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 32.63 | 1 | -3.77 | 2 |
| | | | | 120 | SCL | | 10YR31 | 15/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | |

| Obs point | Grid ref.: # eff intersection | Boring or Pit | Grad. (deg) | Base Depth (cm) | | Text. | Calc | Matrix colour | Motts./ black ferro. conc. %/ depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (P F=firm; consist ence ) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grade (Drought Vuln.) | MBP | Grade (Drought POTATOES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 55 | | ZC | | 10YR31 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 62 | | B | ≤7 | 25 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 55 | | ZC | | 10YR31 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 63 | | B | ≤7 | 25 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 55 | | ZC | | 10YR31 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 64 | | B | ≤7 | 25 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR31 | 15/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 66 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 55 | | ZC | | 10YR31 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 67 | | B | ≤7 | 25 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 50 | | ZC | | 10YR31 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 20/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 68 | | B | ≤7 | 45 | | MZCL | N | 10YR31 | | | | 5 | HR | | | | 45 | 45 | II | 2 | 19 | | 1 | | 41.22 | 1 | 9.13 | 2 |
| | | | | 55 | | ZL | | 10YR53 | 15/45 | 10YR56 | | 5 | HR | P | M/F | MD | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | | MZCL | | 10YR53 | 15/55 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 69 | | B | ≤7 | 25 | | MZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 2 | 17 | | 1 | | 45.13 | 1 | 8.73 | 2 |
| | | | | 50 | | ZL | | 10YR52 | 10/25 | 10YR56 | | 0 | HR | P | M/F | MD | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 70 | | B | ≤7 | 25 | | MZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 2 | 17 | | 1 | | 45.13 | 1 | 8.73 | 2 |
| | | | | 50 | | ZL | | 10YR52 | 5/25 | 10YR56 | | 0 | HR | P | M/F | MD | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 71 | | B | ≤7 | 28 | | MZCL | N | 10YR31 | | | | 0 | HR | | | | 40 | 40 | II | 2 | 19 | | 1 | | 46.73 | 1 | 14.33 | 1 |
| | | | | 45 | | ZL | | 10YR31 | | | | 0 | HR | P | M/F | | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | | MZCL | | 10YR41 | 10/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 72 | | B | ≤7 | 28 | | MZCL | N | 10YR31 | | | | 0 | HR | | | | 40 | 40 | II | 2 | 19 | | 1 | | 55.23 | 1 | 11.83 | 1 |
| | | | | 40 | | ZL | | 10YR31 | | | | 0 | HR | P | M/F | | | | | | 22 | 14 | 1 | 0.5 | | | | |
| | | | | 120 | | MZCL | | 10YR41 | 10/40 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 73 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 10 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 13.11 | 2 | -6.17 | 2 |
| | | | | 120 | | C | | 10YR42 | 10/28 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 74 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 10 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 12.72 | 2 | -6.56 | 2 |
| | | | | 120 | | C | | 10YR42 | 25/28 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 75 | | B | ≤7 | 25 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR31 | 25/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 76 | | B | ≤7 | 25 | | HZCL | N | 10YR32 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 16.38 | 2 | -6.02 | 2 |
| | | | | 120 | | ZC | | 10YR31 | 20/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 78 | | B | ≤7 | 30 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 20.63 | 2 | -1.77 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 15/30 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 79 | | B | ≤7 | 25 | | HZCL | Y | 10YR32 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR31 | 25/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 80 | | B | ≤7 | 25 | | HZCL | Y | 10YR42 | | | | 0 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR31 | 15/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |

| Obs point | Grid ref. if off intersection | Boring or Pit | Grad. (deg) | Base Depth (cm) | | Text. | Calc | Matrix colour | Motts / black ferro. conc. % / depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (p P=fem consist ence ) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grade (Drought WHEAT) | MBP | Grade (Drought POTATOES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 25 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 81 | | B | ≤7 | 120 | | ZC | | 10YR31 | 15/25 | 10YR56 | | 0 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | MZCL | N | 10YR32 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 82 | | B | ≤7 | 50 | | ZL | | 10YR52 | 10/25 | 10YR56 | | 0 | HR | P | M/F | MD | 25 | 25 | II | 2 | 22 | 14 | 1 | 0.5 | 45.13 | 1 | 8.73 | 2 |
| | | | | 120 | | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | MZCL | N | 10YR32 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 83 | | P | ≤7 | 50 | | ZL | | 10YR52 | 10/25 | 10YR56 | | 0 | HR | P | M/F | MD | 25 | 25 | II | 2 | 22 | 14 | 1 | 0.5 | 45.13 | 1 | 8.73 | 2 |
| | | | | 120 | | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | MZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 17 | | 1 | | | | | |
| 84 | | B | ≤7 | 55 | | ZL | | 10YR52 | 5/25 | 10YR56 | | 0 | HR | P | M/F | MD | 25 | 25 | II | 2 | 22 | 14 | 1 | 0.5 | 45.13 | 1 | 10.23 | 1 |
| | | | | 120 | | SCL | | 10YR42 | 15/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | MZCL | N | 10YR32 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 85 | | B | ≤7 | 50 | | ZL | | 10YR52 | 5/25 | 10YR56 | | 0 | HR | P | M/F | MD | 25 | 25 | II | 2 | 22 | 14 | 1 | 0.5 | 45.13 | 1 | 8.73 | 2 |
| | | | | 120 | | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 45 | | MZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 86 | | B | ≤7 | 55 | | ZL | | 10YR53 | 15/45 | 10YR56 | | 0 | HR | P | M/F | MD | 45 | 45 | II | 2 | 22 | 14 | 1 | 0.5 | 46.13 | 1 | 14.23 | 1 |
| | | | | 120 | | MZCL | | 10YR53 | 15/55 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 35 | | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 87 | | B | ≤7 | 120 | | C | | 10YR42 | 10/35 | 10YR56 | | 5 | HR | P | CPR | MD | 35 | 35 | II | 3a | 16 | 8 | 1 | 0.5 | 17.23 | 2 | -2.04 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 88 | | B | ≤7 | 60 | | ZC | | 10YR41 | 15/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 89 | | B | ≤7 | 120 | | C | | 10YR42 | 20/28 | 10YR56 | | 0 | HR | P | CPR | MD | 30 | 30 | II | 3a | 16 | 8 | 1 | 0.5 | 22.63 | 2 | 2.23 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 91 | | B | ≤7 | 55 | | ZC | | 10YR31 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 19.83 | 2 | -2.57 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR41 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 92 | | B | ≤7 | 60 | | ZC | | 10YR41 | 15/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 19.63 | 2 | -1.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | | HZCL | N | 10YR41 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 93 | | B | ≤7 | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 19.83 | 2 | -2.57 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 28 | | HZCL | N | 10YR41 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 94 | | B | ≤7 | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 19.83 | 2 | -2.57 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR32 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 95 | | B | ≤7 | 60 | | ZC | | 10YR41 | 20/25 | 10YR56 | | 0 | HR | P | CAB | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | MZCL | N | 10YR32 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 96 | | B | ≤7 | 50 | | ZL | | 10YR52 | 5/30 | 10YR56 | | 0 | HR | P | M/F | MD | 30 | 30 | II | 2 | 22 | 14 | 1 | 0.5 | 42.63 | 1 | 6.23 | 2 |
| | | | | 120 | | SCL | | 10YR42 | 15/50 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 35 | | MZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 97 | | B | ≤7 | 75 | | ZL | | 10YR53 | 15/35 | 10YR56 | | 0 | HR | P | M/F | MD | 35 | 35 | II | 2 | 22 | 14 | 1 | 0.5 | 57.13 | 1 | 24.73 | 1 |
| | | | | 120 | | MZCL | | 10YR42 | 20/75 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 17 | 10 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 98 | | B | ≤7 | 45 | | C | | 10YR41 | | | | 0 | HR | P | CAB | MD | 45 | 45 | II | 3a | 16 | 8 | 1 | 0.5 | 16.13 | 2 | -4.27 | 2 |
| | | | | 120 | | C | | 10YR42 | 20/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 99 | | B | ≤7 | 45 | | C | | 10YR41 | | | | 0 | HR | P | CAB | MD | 45 | 45 | II | 3a | 16 | 8 | 1 | 0.5 | 16.13 | 2 | -4.27 | 2 |
| | | | | 120 | | C | | 10YR42 | 20/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR41 | | | | 0 | HR | | | | | | | | 17 | | 1 | | | | | |
| 100 | | B | ≤7 | 45 | | C | | 10YR41 | | | | 5 | HR | P | CAB | MD | 45 | 45 | II | 3a | 16 | 8 | 1 | 0.5 | 14.63 | 2 | -5.77 | 2 |
| | | | | 120 | | C | | 10YR42 | 20/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |

| Obs point | Dist rel. # ref intersection | Boring or Pit | Grad. (deg) | Base Depth (cm) | | Text. | Calc | Matrix colour | Motts / black ferro. conc. % / depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (if F=firm consist once) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grade (Drought, WHEAT) | MBP | Grade (Drought, POTATOES) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | | B | ≤7 | 20 | | HCL | N | 10YR32 | | | | 5 | HR | | | | 20 | 20 | II | 3a | 18 | 10 | 1 | 0.5 | 14.86 | 2 | -6.32 | 2 |
| | | | | 55 | | HZCL | | 10YR53 | 20/28 | 10YR56 | | 5 | HR | P | CAB | MD | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 102 | | B | ≤7 | 20 | | HCL | N | 10YR32 | | | | 5 | HR | | | | 20 | 20 | II | 3a | 18 | 10 | 1 | 0.5 | 15.81 | 2 | -5.37 | 2 |
| | | | | 60 | | HZCL | | 10YR53 | 20/28 | 10YR56 | | 5 | HR | P | CAB | MD | | | | | 17 | | 1 | | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/50 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 104 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 105 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 20.63 | 2 | -1.77 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 15/30 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 106 | | B | ≤7 | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 30 | 30 | II | 3a | 19 | | 1 | | 20.63 | 2 | -1.77 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 15/30 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 107 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 108 | | B | ≤7 | 25 | | HZCL | N | 10YR32 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 15/25 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| 109 | | B | ≤7 | 120 | | | | | | | | | | | | | 25 | 25 | II | 3a | | | | | | | | |
| | | | | 25 | | HZCL | NN | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | 16.38 | 2 | -6.02 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 15/25 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 110 | | B | ≤7 | 20 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | 45 | 45 | II | 3a | 17 | | 1 | | 13.76 | 2 | -6.64 | 2 |
| | | | | 45 | | C | | 10YR41 | | | | 5 | HR | P | CAB | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | C | | 10YR42 | 25/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 111 | | B | ≤7 | 20 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | 45 | 45 | II | 3a | 17 | | 1 | | 15.63 | 2 | -4.77 | 2 |
| | | | | 45 | | C | | 10YR41 | | | | 0 | HR | P | CAB | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | C | | 10YR42 | 25/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 112 | | B | ≤7 | 25 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | 45 | 45 | II | 3a | 17 | | 1 | | 24.13 | 2 | -5.77 | 2 |
| | | | | 45 | | C | | 10YR41 | | | | 5 | HR | P | CAB | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | C | | 10YR42 | 20/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 113 | | B | ≤7 | 25 | | HZCL | N | 10YR42 | | | | 0 | HR | | | | 45 | 45 | II | 3a | 17 | | 1 | | 14.63 | 2 | -5.77 | 2 |
| | | | | 45 | | C | | 10YR41 | | | | 5 | HR | P | CAB | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | C | | 10YR42 | 25/45 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 16 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 116 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 117 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 118 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 119 | | B | ≤7 | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | 28 | 28 | II | 3a | 19 | | 1 | | 19.83 | 2 | -2.57 | 2 |
| | | | | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| 120 | | B | ≤7 | 25 | | HZCL | N | 10YR42 | | | | 5 | HR | | | | 25 | 25 | II | 3a | 19 | | 1 | | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | ZC | | 10YR53 | 20/25 | 10YR56 | | 5 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |

| Obs point | Grid ref. if off intersection | Boring or Pit | Grad. (deg) | Base Depth (cm) | | Text. | Calc | Matrix colour | Motts / black ferro. conc. %/ depth | Mott colour or FC if ferro. conc. | Ped face colour | Stns % | Stns type | Porosity | Struct (F=fine context only) | Degree of development | SPL depth (cm) | Gleying depth (cm) | SWC | Grade (wetness) | TAv | EAv | StTAv | StEAv | MBW | Grass Drought Vln(ET) | MBP | Grass Drought PC(ATCSB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 28 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 121 | | B | ≤7 | 60 | | ZC | | 10YR41 | 20/28 | 10YR56 | | 0 | HR | P | CAB | MD | 28 | 28 | II | 3a | 15 | 8 | 1 | 0.5 | 19.83 | 2 | -2.57 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR41 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 122 | | B | ≤7 | 55 | | ZC | | 10YR41 | 25/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 17.93 | 2 | -4.47 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR31 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 123 | | B | ≤7 | 55 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 17.93 | 2 | -4.47 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 124 | | B | ≤7 | 55 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR32 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 126 | | B | ≤7 | 120 | | ZC | | 10YR42 | 15/25 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR41 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 127 | | B | ≤7 | 50 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 17.93 | 2 | -4.47 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 128 | | B | ≤7 | 55 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR41 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 129 | | B | ≤7 | 55 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| GAS PIPE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 30 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 131 | | B | ≤7 | 55 | | ZC | | 10YR41 | 20/30 | 10YR56 | | 0 | HR | P | CAB | MD | 30 | 30 | II | 3a | 15 | 8 | 1 | 0.5 | 20.63 | 2 | -1.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 20/55 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR43 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 132 | | B | ≤7 | 120 | | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | -43.12 | 3b | -9.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR43 | | | | 5 | HR | | | | | | | | 19 | | 1 | | | | | |
| 133 | | B | ≤7 | 120 | | ZC | | 10YR42 | 20/28 | 10YR56 | | 5 | HR | P | CPR | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 12.01 | 2 | -9.17 | 2 |
| | | | | 120 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 134 | | B | ≤7 | 60 | | ZC | | 10YR41 | 20/25 | 10YR56 | | 0 | HR | P | CAB | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 25 | | HZCL | N | 10YR31 | | | | 0 | HR | | | | | | | | 19 | | 1 | | | | | |
| 135 | | B | ≤7 | 60 | | ZC | | 10YR41 | 25/25 | 10YR56 | | 0 | HR | P | CAB | MD | 25 | 25 | II | 3a | 15 | 8 | 1 | 0.5 | 18.63 | 2 | -3.77 | 2 |
| | | | | 120 | | ZC | | 10YR42 | 25/60 | 10YR56 | | 0 | HR | P | CPR | MD | | | | | 15 | 8 | 1 | 0.5 | | | | |
| | | | | 120 | | | | | | | | | | | | | | | | | | | | | | | | |

# GENERAL INFORMATION SOURCES


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3. ***Climatological Data for Agricultural Land Classification***, The Met. Office 1989

4. ***Soil Map of England and Wales: 1:250 000***. Soil Survey of England and Wales, Harpenden.

5. ***Soils and Their Use in Midlands and Western England.*** Soil Survey of England and Wales,

6. ***Agricultural Land Classification Map*** 1:250 000. MAFF 1983.

7. ***Risk of Flooding:*** https://flood-warning-information.service.gov.uk/long-term-flood-risk

8. ***Geology of Britain Viewer.*** *Reproduced with the permission of the British Geological Survey ©NERC. All rights Reserved*

9. ***Butler, B E.*** *Soil Classification for Soil Survey Monographs on Soil Survey (1980) Clarendon Press, Oxford*

10. ***Munsell Soil Colour Charts****, Munsell Colour, Grand Rapids* ***1994.***

# GLOSSARY

## ABBREVIATIONS AND TERMS USED IN SURVEY DATA

Soil pit and auger boring information collected during ALC survey is held on a computer database and is reproduced in this report. Terms used and abbreviations are set out below. These conform to definitions contained in the Soil Survey Field Handbook (Hodgson, 1997).

### 1. Terms used on computer database, in order of occurrence.

**GRID REF**: National 100 km grid square and 8 figure grid reference.

**LAND USE**: At the time of survey

| | | | | | |
|---|---|---|---|---|---|
| **WHT:** | Wheat | **SBT:** | Sugar Beet | **HTH:** | Heathland |
| **BAR:** | Barley | **BRA:** | Brassicas | **BOG:** | Bog or Marsh |
| **OAT:** | Oats | **FCD:** | Fodder Crops | **DCW:** | Deciduous Wood |
| **CER:** | Cereals | **FRT:** | Soft and Top Fruit | **CFW:** | Coniferous Woodland |
| **MZE:** | Maize | **HRT:** | Horticultural Crops | **PLO:** | Ploughed |
| **OSR:** | Oilseed Rape | **LEY:** | Ley Grass | **FLW:** | Fallow (inc. Set aside) |
| **POT:** | Potatoes | **PGR:** | Permanent Pasture | **SAS:** | Set Aside (where known) |
| **LIN:** | Linseed | **RGR:** | Rough Grazing | **OTH:** | Other |
| **BEN:** | Field Beans | **SCR:** | Scrub | | |

**GRDNT**: Gradient as estimated or measured by hand-held optical clinometer.

**GLEY, SPL:** Depth in centimetres to gleying or slowly permeable layer.

**AP (WHEAT/POTS):** Crop-adjusted available water capacity.

**MB (WHEAT/POTS):** Moisture Balance. (Crop adjusted AP - crop potential MD)

**DRT:** Best grade according to soil droughtiness.

If any of the following factors are considered significant, 'Y' will be entered in the relevant column.

| | | | | | |
|---|---|---|---|---|---|
| **MREL:** | Microrelief limitation | **FLOOD:** | Flood risk | **EROSN:** | Soil erosion risk |
| **EXP:** | Exposure limitation | **FROST:** | Frost prone | **DIST:** | Disturbed land |
| **CHEM:** | Chemical limitation | | | | |

**LIMIT:** The main limitation to land quality: The following abbreviations are used.

| | | | | | |
|---|---|---|---|---|---|
| **OC:** | Overall Climate | **AE:** | Aspect | **EX:** | Exposure |
| **FR:** | Frost Risk | **GR:** | Gradient | **MR:** | Microrelief |
| **FL:** | Flood Risk | **TX:** | Topsoil Texture | **DP:** | Soil Depth |
| **CH:** | Chemical | **WE:** | Wetness | **WK:** | Workability |
| **DR:** | Drought | **ER:** | Erosion Risk | **WD:** | Soil Wetness/Droughtiness |

**ST:** Topsoil Stoniness

**TEXTURE:** Soil texture classes are denoted by the following abbreviations:-

| | | | | | |
|---|---|---|---|---|---|
| **S:** | Sand | **LS:** | Loamy Sand | **SL:** | Sandy Loam |
| **SZL:** | Sandy Silt Loam | **CL:** | Clay Loam | **ZCL** | Silty Clay Loam |
| **ZL:** | Silt Loam | **SCL:** | Sandy Clay Loam | **C:** | Clay |
| **SC:** | Sandy clay | **ZC:** | Silty clay | **OL:** | Organic Loam |
| **P:** | Peat | **SP:** | Sandy Peat | **LP:** | Loamy Peat |
| **PL:** | Peaty Loam | **PS:** | Peaty Sand | **MZ:** | Marine Light Silts |

For the sand, loamy sand, sandy loam and sandy silt loam classes, the predominant size of sand fraction will be indicated by the use of the following prefixes:-

**F:** Fine (more than 66% of the sand less than 0.2mm)
**M:** Medium (less than 66% fine sand and less than 33% coarse sand)
**C:** Coarse (more than 33% of the sand larger than 0.6mm)

The clay loam and silty clay loam classes will be sub-divided according to the clay content: **M:** Medium (< 27% clay) **H:** heavy (27 - 35% clay)

**MOTTLE COL:** Mottle colour using Munsell notation.

**MOTTLE ABUN:** Mottle abundance, expressed as a percentage of the matrix or surface described.

**F:** few <2% **C:** common 2 - 20% **M:** many 20 - 40% **VM:** very many 40%+

**MOTTLE CONT:** Mottle contrast

**F:** faint - indistinct mottles, evident only on close inspection
**D:** distinct - mottles are readily seen
**P:** Prominent - mottling is conspicuous and one of the outstanding features of the horizon.

**PED. COL:** Ped face colour using Munsell notation.

**GLEY:** If the soil horizon is gleyed a 'Y' will appear in this column. If slightly gleyed, an 'S' will appear.

**STONE LITH:** Stone Lithology - One of the following is used.

| | | | |
|---|---|---|---|
| **HR:** | All hard rocks and stones | **SLST:** | Soft oolitic or dolimitic limestone |
| **CH:** | Chalk | **FSST:** | Soft, fine grained sandstone |
| **ZR:** | Soft, argillaceous, or silty rocks | **GH:** | Gravel with non-porous (hard) stones |
| **MSST:** | Soft, medium grained sandstone | **GS:** | Gravel with porous (soft) stones |
| **SI:** | Soft weathered igneous or metamorphic rock | | |

Stone contents are given in % by volume for sizes >2cm, >6cm and total stone >2mm.

**STRUCT:** The degree of development, size and shape of soil peds are described using the following notation

| | | | | |
|---|---|---|---|---|
| **Degree of development** | **WA:** | Weakly developed Adherent | **WK:** | Weakly developed |
| | **MD:** | Moderately developed | **ST:** | Strongly developed |
| **Ped size** | **F:** | Fine | **M:** | Medium |
| | **C:** | Coarse | **VC:** | Very coarse |
| **Ped Shape** | **S:** | Single grain | **M:** | Massive |
| | **GR:** | Granular | **AB:** | Angular blocky |
| | **SAB:** | Sub-angular blocky | **PR:** | Prismatic |
| | **PL:** | Platy | | |

**CONSIST:** Soil consistence is described using the following notation:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **L:** | Loose | **VF:** | Very Friable | **FR:** | Friable | **FM:** | Firm |
| **VM:** | Very firm | **EM:** | Extremely firm | | | **EH:** | Extremely Hard |

**SUBS STR:** Subsoil structural condition recorded for the purpose of calculating profile droughtiness: **G:** Good **M:** Moderate **P:** Poor

**POR:** Soil porosity. If a soil horizon has poor porosity with less than 0.5% biopores >0.5mm, a 'Y' will appear in this column.

**IMP:** If the profile is impenetrable to rooting a 'Y' will appear in this column at the appropriate horizon.

**SPL:** Slowly permeable layer. If the soil horizon is slowly permeable a 'Y' will appear in this column.

**CALC:** If the soil horizon is calcareous with naturally occurring calcium carbonate exceeding 1% a 'Y' will appear this column.

**2. Additional terms and abbreviations used mainly in soil pit descriptions.**

**STONE ASSESSMENT:**

| | | | | | |
|---|---|---|---|---|---|
| **V:** | Visual | **S:** | Sieved | **D:** | Displacement |

**MOTTLE SIZE:**

| | | | |
|---|---|---|---|
| **EF:** | Extremely fine <1mm | **M:** | Medium 5-15mm |
| **VF:** | Very fine 1-2mm> | **C:** | Coarse >15mm |
| **F:** | Fine 2-5mm | | |

**MOTTLE COLOUR:** May be described by Munsell notation or as ochreous (OM) or grey (GM).

**ROOT CHANNELS:** In topsoil the presence of 'rusty root channels' might also be noted as RRC.

**MANGANESE CONCRETIONS:** Assessed by volume

| | | | | | |
|---|---|---|---|---|---|
| **N:** | None | | **M:** | Many | 20-40% |
| **F:** | Few | <2% | **VM:** | Very Many | >40% |
| **C:** | Common | 2-20% | | | |

**POROSITY:**

**P:** Poor - less than 0.5% biopores at least 0.5mm in diameter
**G:** Good - more than 0.5% biopores at least 0.5mm in diameter

**ROOT ABUNDANCE:**

| The number of roots per 100cm$^2$: | | Very Fine and Fine | Medium and Coarse |
|---|---|---|---|
| **F:** | Few | 1-10 | 1 or 2 |
| **C:** | Common | 10.25 | 2 - 5 |
| **M:** | Many | 25-200 | >5 |
| **A:** | Abundant | >200 | |

**ROOT SIZE**

| | | | | | |
|---|---|---|---|---|---|
| **VF:** | Very fine | <1mm | **M:** | Medium | 2 - 5mm |
| **F:** | Fine | 1-2mm | **C:** | Coarse | >5mm |

**HORIZON BOUNDARY DISTINCTNESS:**

| | | | |
|---|---|---|---|
| **Sharp:** | <0.5cm | **Gradual:** | 6 - 13cm |
| **Abrupt:** | 0.5 - 2.5cm | **Diffuse:** | >13cm |
| **Clear:** | 2.5 - 6cm | | |

**HORIZON BOUNDARY FORM:** Smooth, wavy, irregular or broken.*

* See Soil Survey Field Handbook (Hodgson, 1997) for details.

## Appendix SMP2
## Extracts from the Code of Practice for the Sustainable Use of Soils on Construction Sites

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# Construction Code of Practice for the Sustainable Use of Soils on Construction Sites



BIS | Department for Business Innovation & Skills

wrap Material change for a better environment

defra Department for Environment Food and Rural Affairs

## 5.4 Soil stockpiling



### Why?

1. Soil often has to be stripped or excavated during the construction process. In order to enable its reuse on site at a later stage, soil needs to be stored in temporary stockpiles to minimise the surface area occupied, and to prevent damage from the weather and other construction activities.

### How?

2. The main aim when temporarily storing soil in stockpiles is to maintain soil quality and minimise damage to the soil's physical (structural) condition so that it can be easily reinstated once respread. In addition, stockpiling soil should not cause soil erosion, pollution to watercourses or increase flooding risk to the surrounding area.

3. When soil is stored for longer than a few weeks, the soil in the core of the stockpile becomes anaerobic and certain temporary chemical and biological changes take place. These changes are usually reversed when the soil is respread to normal depths. However, the time it takes for these changes to occur very much depends on the physical condition of the soil.

4. Handling soil to create stockpiles invariably damages the physical condition of the soil to a greater or lesser extent. If stockpiling is done incorrectly the physical condition of the soil can be damaged irreversibly, resulting in a loss of a valuable resource and potentially significant costs to the project. The Soil Resource Survey and Soil Resource Plan should set out any limitations that the soil may possess, with respect to handling, stripping and stockpiling.

5. The size and height of the stockpile will depend on several factors, including the amount of space available, the nature and composition of the soil, the prevailing weather conditions at the time of stripping and any planning conditions associated with the development. Stockpile heights of 3-4m are commonly used for topsoil that can be stripped and stockpiled in a dry state but heights may need to be greater where storage space is limited.

6. Soil moisture and soil consistency (plastic or non-plastic) are major factors when deciding on the size and height of the stockpile, and the method of formation. As a general rule, if the soil is dry (e.g. drier than the plastic limit) when it goes into the stockpile, the vast majority of it should remain dry during storage, and thereby enable dry soil to be excavated and respread at the end of the storage period. Soil in a dry and non-plastic state is less prone to compaction, tends to retain a proportion of its structure, will respread easily and break down into a suitable tilth for landscaping. Any anaerobic soil also usually becomes re-aerated in a matter of days.

7. Soil stockpiled wet or when plastic in consistency is easily compacted by the weight of soil above it and from the machinery handling it. In a compacted state, soil in the core of the stockpile remains wet and anaerobic for the duration of the storage period, is difficult to handle and respread and does not usually break down into a suitable tilth. A period of further drying and cultivation is then required before the soil becomes re-aerated and acceptable for landscaping.

**Stockpiling methods**

8. There are two principal methods for forming soil stockpiles, based on their soil moisture and consistency.

9. Method 1 should be applied to soil that is in a dry and non-plastic state. The aim is to create a large core of dry soil, and to restrict the amount of water that can get into the stockpile during the storage period. Dry soil that is stored in this manner can remain so for a period of years and it is reuseable within days of respreading.

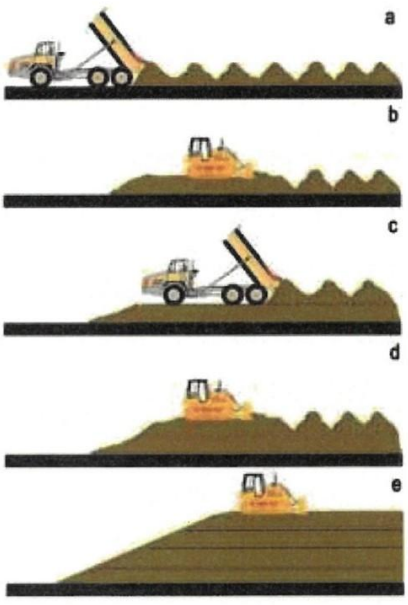
10. Method 2 should be applied if the construction programme or prevailing weather conditions result in soil having to be stockpiled when wet and/or plastic in consistency. This method minimises the amount of compaction, while at the same time maximising the surface area of the stockpile to enable the soil to dry out further. It also allows the soil to be heaped up into a 'Method 1' type stockpile, once it has dried out.

## Soil stockpiling

Soil should be stored in an area of the site where it can be left undisturbed and will not interfere with site operations. Ground to be used for storing the topsoil should be cleared of vegetation and any waste arising from the development (e.g. building rubble and fill materials). Topsoil should first be stripped from any land to be used for storing subsoil.

**Method 1 – Dry non-plastic soils**

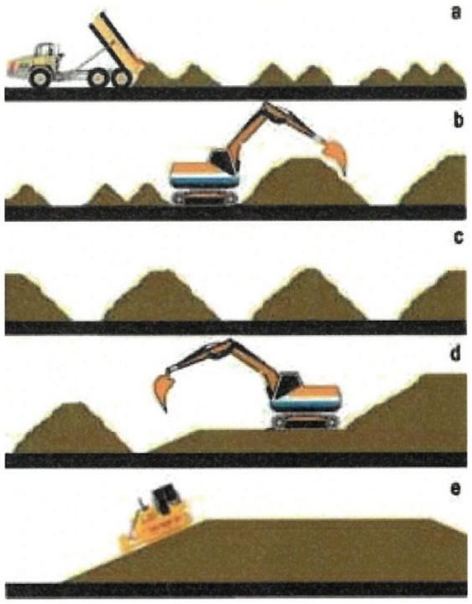
The soil is loose-tipped in heaps from a dump truck (a), starting at the furthest point in the storage area and working back toward the access point. When the entire storage area has been filled with heaps, a tracked machine (excavator or dozer) levels them (b) and firms the surface in order for a second layer of heaps to be tipped. This sequence is repeated (c & d) until the stockpile reaches its planned height. To help shed rainwater and prevent ponding and infiltration a tracked machine compacts and re-grades the sides and top of the stockpile (e) to form a smooth gradient.



**Method 2 – Wet plastic soils**

The soil is tipped in a line of heaps to form a 'windrow', starting at the furthest point in the storage area and working back toward the access point (a). Any additional windrows are spaced sufficiently apart to allow tracked plant to gain access between them so that the soil can be heaped up to a maximum height of 2m (b). To avoid compaction, no machinery, even tracked plant, traverses the windrow.

Once the soil has dried out and is non-plastic in consistency (this usually requires several weeks of dry and windy or warm weather), the windrows are combined to form larger stockpiles, using a tracked excavator (d). The surface of the stockpile is then regraded and compacted (e) by a tracked machine (dozer or excavator) to reduce rainwater infiltration.




**Stockpile location and stability**

11. Stockpiles should not be positioned within the root or crown spread of trees, or adjacent to ditches, watercourses or existing or future excavations. Soil will have a natural angle of repose of up to 40° depending on texture and moisture content but, if stable stockpiles are to be formed, slope angles will normally need to be less than that. For stockpiles that are to be grass seeded and maintained, a maximum side slope of 1 in 2 (25°) is appropriate.

**Stockpile protection and maintenance**

12. Once the stockpile has been completed the area should be cordoned off with secure fencing to prevent any disturbance or contamination by other construction activities. If the soil is to be stockpiled for more than six months, the surface of the stockpiles should be seeded with a grass/clover mix to minimise soil erosion and to help reduce infestation by nuisance weeds that might spread seed onto adjacent land.

13. Management of weeds that do appear should be undertaken during the summer months, either by spraying to kill them or by mowing or strimming to prevent their seeds being shed.



*Clearly defined stockpiling of different soil materials*



*Long term stockpile of stripped topsoil left with only weed vegetation*

# Landscape, habitat or garden creation

## 6.1 Soil placement

**Why?**

1. The establishment of new landscapes, gardens, or other greenscapes on construction sites often involves the respreading of stockpiled soil or the importation of soil. The manner in which this is carried out has a significant bearing on the soil's function, and particularly its ability to support new trees, shrubs and grass.

2. It is essential to provide a structured, uncompacted and well-aerated soil profile for the successful establishment and subsequent growth of plants and grass. However, where heavy machinery and large volumes of soil are excavated and stored, soil structure can easily be destroyed by over-compaction. This leads to problems of waterlogging and anaerobism, which are detrimental to plants in two main ways. Anaerobic bacteria produce ammonia and methane gases harmful to plant roots, and, without oxygen, plant roots are unable to take up water and nutrients. Restricted rooting increases the risk of trees being affected by wind throw (the uprooting of trees by wind).

3. The consequence of over-compacted soil is not only poor establishment or failure of plantings but also increased surface water runoff and surface ponding that reduces the visual and physical amenity of the landscape or garden and can contribute to localised flooding.



*The symptoms of over-compaction of soil on the amenity areas of new housing estates: struggling trees; poor grass growth; and surface ponding after heavy rain.*

**How?**

4. Almost all soil is physically degraded to a greater or lesser extent during soil stockpiling, handling and placement. The potential quality and the ultimate suitability of the soil depends on how well its soil structure is restored during placement.

5. Provided the soil is spread and prepared correctly, damage to soil structure can be kept to a minimum and the soil can usually recover to a healthy state quickly. In order to achieve this, it should be handled only when dry or slightly moist and using suitable machinery in an appropriate way. Multiple handling of soil materials increases the risk of damage to soil structure, so should be minimised.

6. The 'loose tipping' method, using dump trucks and hydraulic excavators to move and spread the topsoil, is the most appropriate method to use.

## Loose-tipping method

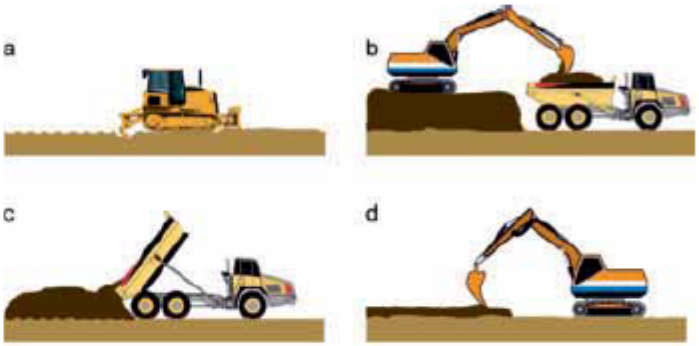
This method entails working to a strip system (the width of the strip determined by the reach of the excavator), and replacing soil sequentially across the soiling area. The receiving ground, whether a basal layer or compacted subsoil is first loosened with a wing-tine ripper.

A hydraulic excavator, fitted with a toothed-bucket to avoid excessive smearing, should be used to load the soil materials from the source area or stockpile into a dump truck which then discharges them onto the receiving surface. An excavator stands next to the newly dropped soil and spreads this to the required thickness. If there is to be more than one soil layer (i.e. if both topsoil and subsoil are being replaced) then the whole length of the strip is restored with subsoil before the process is repeated with topsoil. The topsoil is lifted onto the subsoil without the excavator travelling on the newly placed subsoil. Only when the strip has been completed is the next one started.

If soil is cloddy in structure, the excavator bucket can be used to break up the clods. Large stones can be removed during the operation.

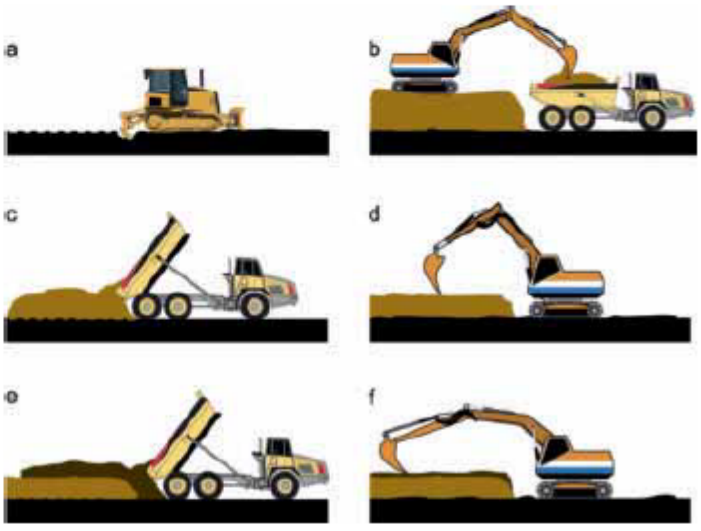
Modified versions of the loose-tipping method, for use when both subsoil and topsoil are to be placed, include spreading the subsoil as described above but then spreading the topsoil layer out using a low ground pressure dozer. Providing that soil conditions are suitably dry and dozer movements are minimised, this can gently consolidate the placed soil without causing over-compaction.

**The loose-tipping method (topsoil spreading only)**




*a) loosening the subsoil of the receiving ground*
*b) loading of topsoil from stockpile*
*c) backtipping topsoil onto loosened subsoil*
*d) levelling topsoil*

**The loose-tipping method (topsoil and subsoil spreading)**




*a) loosening the substrate of the receiving ground*
*b) loading of subsoil from stockpile*
*c) backtipping subsoil onto loosened substrate*
*d) levelling subsoil*
*e) backtipping topsoil*
*f) spreading topsoil over subsoil using excavator working on substrate*

**Relief of compaction**

7. On most construction sites, the receiving layer will have been compacted by vehicles, foot trafficking or the storage of building materials. Therefore, prior to spreading soil the substrate should be properly decompacted to break up any panning to reduce flood risk and to promote deeper root growth. A small (1-5 tonne) to medium sized (13 tonne) tracked excavator, fitted with a single rigid tine is effective in restricted areas, such as in planting beds and road verges. In more open areas, a tractor-drawn subsoiler is capable of loosening soil that is not too heavily or deeply compacted. In some instances, compressed air injection can be used to decompact the soil profile.

8. Deep compaction can only be effectively relieved using heavy duty ripper equipment, such as the single rigid tine device pictured below. For loosening to be most effective, it should be carried out when the soil is sufficiently dry to the full depth of working, otherwise the tine merely cuts and smears the subsoil rather than lifting, fracturing and loosening it. A toothed excavator bucket is not an appropriate tool for ripping soil.



***Top (from left to right):*** *Ripping by tractor-drawn tines, Large winged-tine ripper, Topsoil rake used on a 3 tonne excavator*
***Bottom:*** *Single ripper tooth used for relieving compaction to a depth of 600 mm*

### Topsoil thickness

9. Topsoil placement thickness will depend on the anticipated rooting depth of the plants to be established and the quality of the underlying subsoil. Trees and shrubs require a much greater rooting depth than grasses, though this does not have to be made up entirely of topsoil. Topsoil at least 150mm deep is desirable for lawns and mown amenity grass and can beneficially be placed more deeply (up to 400mm thick) for trees and shrubs. However, topsoil does not normally perform well below a depth of 400mm from the surface, where there is an increase in self-compaction and where the biochemical oxygen demand (BOD) often exceeds the rate of aeration. This often results in the development of anaerobic conditions that are detrimental to plant root functions. Subsoil, which has a lower BOD, should, therefore, always be used to create rooting depths in excess of 400mm.

### Topsoil cultivation

10. After respreading topsoil, any large, compacted lumps should be broken down by appropriate cultivation to produce a fine tilth suitable for planting (<50mm maximum aggregate size), turfing and seeding (<10mm maximum aggregate size).

11. Topsoil that has been stored in a stockpile is often compacted and anaerobic. It should therefore be cultivated to its full depth using appropriate tillage equipment to decompact and fully re-aerate. Only when the topsoil has been fully re-aerated will it be satisfactory for planting, turfing or seeding. More than one cultivation may be required to re-aerate the entire thickness of topsoil. Undesirable material (e.g. stones, fill materials and vegetation larger than 50mm in any dimension) brought to the surface during cultivation should be removed by picking or raking.

### Adverse weather

12. If sustained heavy rainfall (e.g. >10mm in 24 hours) occurs during soil handling operations, work must be suspended and not restarted until the ground has had at least a full dry day or agreed moisture criteria (such as 'drier than the plastic limit') can be met. Lighter soil can generally be moved at a higher moisture content without damage than a heavy soil.

13. The earlier or later in the year that soil is moved, the greater the risk of causing damage or having work suspended by adverse weather, although the period when soil can be safely handled is longer in the drier eastern parts of the UK than in the west. Where the soil handling technique is such that trafficking over the soil is minimal (e.g. the 'loose tipping method' described above) the period for soil stripping may be extended.

### Do

- ✓ Handle and place soil in the driest condition possible.
- ✓ Use tracked equipment wherever possible to reduce compaction.
- ✓ Decompact subsoil before placing topsoil.
- ✓ Fully re-aerate anaerobic topsoil before planting, turfing or seeding.
- ✓ Ensure that the physical condition of the entire soil profile (topsoil and subsoil) will promote sufficient aeration, drainage and root growth.

### Don't

- ✗ Place or cultivate soils during or after heavy rainfall or when soils are plastic.
- ✗ Take construction machinery over topsoil or subsoil that has been placed.
- ✗ Place topsoil too deeply – 'more' is not necessarily 'better'.
- ✗ Plant into anaerobic topsoil.

## Case Study 4: Decisions not to follow soil specifications cost company £25,000

1. Even where a good specification has been prepared for subsoil and topsoil management, there is seldom quality control of the works to ensure that desired outcomes are achieved.

2. An example is from a small development of 37 houses in Lancashire which necessitated the tipping of subsoil excavated from the development platform onto an adjacent field, which was then to be turned into public open space under a Section 106 agreement. A detailed specification was prepared by the developer's consulting landscape architect and stated that:
   - subsoil to receive topsoil should be thoroughly broken up to a depth of 150 mm and cleared of all roots, stones and debris with any one dimension greater than 75 mm;
   - subsoil should be graded after loosening but not traversed by heavy machinery;
   - topsoil should conform to 'BS3882:1994 fertile agricultural soils of uniform composition throughout, of light or medium texture with stones not exceeding 50 mm in any one dimension'.

3. Despite the detailed soil specification, including recommended quality control stages, neither the landscape architects nor other suitably qualified professionals were retained to supervise the contractors and check that the specifications were followed. Site clearance soil was used rather than fertile agricultural soil, the local planning authority was dissatisfied, refused to adopt the open space and legal action ensued. Investigation showed that the substrate was very compact and probably hadn't been loosened or stone picked, the topsoil had an excessive inclusion



*One of many items of debris encountered in the imported topsoil during remedial works*

## Appendix SMP3

## BSSS Working with Soil Guidance Note

Guidance Document 3

# Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction




The British Society of Soil Science (BSSS) exists to promote the study, public understanding and application of soil science. This guidance note is written for development planning and control professionals, site owners and developers to help promote the protection of soils and the important functions they support within the planning system and the development of individual sites.

## *Soils in the Planning System*

Soils are protected in development to varying degrees by UK national planning policies. However, specific 'calls to action' regarding soils are generally lacking, and therefore explicit requirements of developers relating to soils are relatively rare in the planning approval process. The result is that the nature of the soils on a site is often poorly understood before construction starts. This stems from a failure to appreciate the variability of soils within the landscape and what effect this has on their specific hydrology, habitat potential and sensitivity to damage in particular. The inappropriate use and management of soil resources is often responsible for costly programme delays, the failure of planting schemes and higher incidence of surface runoff. This can mean non-compliance with planning conditions related to biodiversity net gain, tree protection, landscape enhancement and storm water management for example. There is therefore a strong argument for considering the nature and management of existing soil resources on a site at the design stage of a development, in accordance with planning policy relating to other sustainability priorities.

## *Recommendations*

With the above in mind, **BSSS recommends** that planning consents for the development of green field sites are conditional on **the production and implementation of a comprehensive and site-specific Soil Resource Survey and Soil Management Plan,** the results of which are a consideration at the design stage of a development.

**The Soil Resource Survey and Soil Management Plan should:**

1. **be based on a detailed field survey of the soils of the proposed development site to bedrock or a depth of 1.2m.**
2. **be conducted by a professional soil scientist with the competencies set out in BSSS Working with Soil Professional Competency in Soil Science Documents 1 (Foundation skills in field soil investigation, description and interpretation), 4 (Soil science in soil handling and restoration), 5 (Soil science in land evaluation and planning) and 8 (Soil science in landscape design and construction) as appropriate.**

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3. **comprise a map at a suitable scale showing the distribution of each soil type present on the site and a detailed report describing the suitability and volume of each soil resource present for specific after-uses (as per the proposed development).**
4. **Site/soil specific management advice on stripping, stockpiling and restoration to ensure soils are protected.**
5. **Where semi-natural vegetation is to be established within a development, soils should be sampled and analysed for the major nutrients and advice should be given on the depth of topsoil to be reinstated and the suitability of each soils for different plant communities.**

## *Mitigation against Flooding*

Natural soils store large volumes of rainfall during storm events, which has a significant mitigating effect on flooding. Planning applicants are required to demonstrate that a built development will not increase risk of surface flooding, and any increase in runoff rates from built surfaces compared to baseline soils needs to be offset through sustainable urban drainage systems (SUDS). However, it is frequently assumed that baseline runoff from *non-built* surfaces (gardens, landscape areas and public green space) within the development are unaffected by construction. Compaction caused by soil handling activities and construction traffic can cause profound reductions in soil infiltration rates, but this extra surface runoff is seldom considered in SUDS design. The result can be that post-development surface flood risk is much higher than anticipated.

**BSSS recommends that Soil Management Plans include considerations of the runoff from natural and re-instated soils post development.**

## *Creation and Support of Habitats*

Increasingly, planning permission for built development is conditional on the provision of specific landscape planting schemes and/or the inclusion of habitat creation (e.g. species-rich meadow grassland). However, while planning conditions regularly include detailed planting specifications, it is rarely recognised that the success of this planting is highly dependent on appropriate soil being used as a planting medium. Soil resources on large development sites are often variable: some may be heavy (clayey), hard to handle and difficult to reuse in landscaping, while others are loamy or sandy, well-structured and easy to handle. Soils may also be acid or alkaline with a high lime content. Some have been used for intensive agriculture and are very high in nutrients and weed burden, while others are low in nutrients and well suited to use in habitat creation. If soil resources are not properly assessed at an early stage of the planning process, and appropriately re-used, there is a high probability that targeted landscaping and habitat creation will fail (and therefore planning conditions associated with landscape and ecology will not be satisfied), increasing project costs and delaying development completion.

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**BSSS recommends that the underlying soil conditions should be taken into account in the choice and establishment of semi-natural vegetation.**

## *Soil Biodiversity*

Soils that have remained undisturbed for lengthy periods of time develop rich and diverse below-ground flora and fauna. Old parkland soils provide good examples of this and support equally rich above ground insect, bird and bat communities. Soil fauna form the foundation of diverse food chains. Needless to say, such soils are increasingly rare and BSSS believes that every opportunity should be taken to protect and preserve them.

**BSSS recommends that where biologically-rich soils fall within a proposed development, they should be protected from any disturbance as far as is possible and be assigned to a future use as urban greenspace.**

## *Further Reading*

The Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[1] provides examples of good practice and highlights the need for detailed Soil Resource Assessment as part of a Soil Management Plan for the construction phase of built development.

*January 2022 – version 3*

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/716510/pb13298-code-of-practice-090910.pdf

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**Appendix SMP4**

**Institute of Quarrying Field Tests for Soils Suitability**



IQ

The Institute of Quarrying

# Good Practice Guide for Handling Soils in Mineral Workings

**Supplementary Note 4**
**Soil Wetness**

Soil wetness is a major determinant of land use, and environmental and ecosystem services in the UK. It is also a factor in the occurrence of significant compaction arising from handling soils with earth-moving machines and the practices used (Duncan & Bransden, 1986).

Relative soil wetness can range from the waterlogged to moist (mesic) or dry (xeric) depending on rainfall distribution and depth to a water-table and duration of waterlogging. In the UK, soil wetness is largely seasonal with higher evapo-transpiration rates potentially exceeding rainfall in the summer resulting in the soil profile becoming drier where there is vegetation. Whilst soil wetness is largely weather system and equinox (climate) driven, it varies with geographical and altitudinal locations, and importantly the physical characteristics of the soil profile, such as texture structure, porosity, and depth to the water-table and topography including flood risk (MAFF, 1988). The Soil Wetness Class is based on the expected average duration of waterlogging at different depths in the soil throughout the year (days per year), and can be determined by reference to soil characteristics and local climate (MAFF, 1988). The likely inherent wetness and resilience status of a soil should be indicated in the SRMP (see **Part 1, Table 2 & Supplementary Note 1**), reflecting potential risks for soil handling such as low permeability, permanently high groundwater, or a wet upland climate.

Wet soils can also be a result of other circumstances. For example, the interception of water courses, drainage ditches and field land drains. Where these occur, the provisions are to be made in the SRMP to protect the soils being handled and the operational area.

Soils, when in a wet condition generally have a lower strength and have less resistance to compression and smearing than when dry. Lower strength when soils are wet also affects the bearing capacity of soils and their ability to support the safe and efficient operation of machines than when in a dry state.

In terms of resilience and susceptibility to soil wetness, the clay content of the soil largely determines the change from a solid to a plastic state (the water content at which this occurs is called the 'plastic limit' (MAFF, 1982)). This is the point at which an increasing soil wetness has reduced the cohesion and strength of the soil and its resistance to compression and smearing.

Whilst coarse textured sandy soils are not inherently plastic when wet, they are still prone to compaction when in a wet condition. Hence, handling all soils when wet will have adverse effects on plant root growth and profile permeability, which may be of significance for the intended land use and the provision of services reliant on soil drainage and plant root growth. It may be less so in other circumstances where wet soil profiles, perched water tables and ponding are the reclamation objectives, though drainage control, for example to control flooding, may still be important in these contexts.

In cases of permanently wet soils, such as riverine sites, upland or deep organic soils where there is a persistent high water-table throughout the seasons within the depth of soil to be stripped and/or the soil profile remains too wet, a strategic decision has to be made to be able to proceed with the development of the mineral resource. This may mean alternative and less favourable soil handling practices have to be agreed with the planning authority.

**Predicting & Determination of Soil Wetness**
There are well established methods to predict and determine soil wetness of undisturbed and restored soil profiles (Reeve, 1994). The challenge has been the prediction of the best time for soil stripping. Models based on soil moisture deficits and field capacity dates for a range of soil textures can provide indicative regional summaries (**Table 4.1**) that can help with planning operations at broad scale but cannot be relied upon in practice for deciding operationally whether to proceed on the ground given the actual variation in weather events from year to year and within years.




| | Climatic Zones | | |
|---|---|---|---|
| **Soil Clay Content** | **1** | **2** | **3** |
| Soil Depth <30cm | | | |
| <10% | Mid Apr - Early Oct | Late Mar – Early Nov | Late Mar – Early Dec |
| 10 -27% | Late May - Early Oct | Early May – Early Nov | Early Apr – Early Dec |
| Soil Depth 30-60cm | | | |
| <10% | Late Apr - Early Oct | Mid Apr – Early Nov | Early Apr – Early Dec |
| 10-27% | Late May - Early Oct | Early May – Early Nov | Early Apr – Early Dec |
| >27% | Late June – Early Oct | Early June – Early Nov | Late May – Early Dec |
| Soil Depth >60cm | | | |
| <10% | Late Apr - Early Oct | Mid Apr – Early Nov | Early Apr – Early Dec |
| 10-18% | Late May - Early Oct | Early May – Early Nov | Early Apr – Early Dec |
| 18-27% | Late June – Early Oct | Early June – Early Nov | Late May – Early Dec |
| >27 | Mid July – Mid Sept | Early July – Mid Oct | Late June – Mid Oct |

**Table 4.1:** Indicative on-average months when vegetated mineral soils might be in a sufficiently dry condition according to geographic location, depth of soil and clay content

The timing of most soil handling operations takes place between April and September. Although in western (Zone 1) and central (Zone 2) areas it typically can be a later start in May with an earlier termination in August. Whilst the return to climatically 'excess rainfall' is later in the eastern counties (Zone 3) and can be as late as November/early December, there is a need to maintain transpiring vegetation to keep the soils being handled in a dry as possible condition and to establish new vegetation covers as soon as possible (on replaced soils and storage mounds). Hence, soil handling operations generally need to be completed no later than the end of September (Natural England, 2021), unless appropriate provisions can be assured.

Where data is available, more realistic local and real-time predictions can be made, however, because weather patterns and events differ between and within years, and soils can be vary locally in their condition. Experience has shown that the most practical approach for operations is to inspect the site and soils in question near to/ at the time when soil handling is to take place. Professional soil surveyors can advise on the best time for soil handling (stripping, storage & replacement) and carry out site assessments of soil wetness condition prior to the start of operations.

### A Practical Method for Determining Soil Wetness Limitation

During the soil handling season (see Table 4.1 above), prior to the start or recommencement of soil handling soils should be tested to confirm they are in suitably dry condition (**Table 4.2**). The 'testing' during operations can be done by suitably trained site staff and reviewed periodically by the professional soil surveyors.

The method is simply the ability to roll intact threads (3mm diameter) of soil indicating the soils are in a plastic and wet condition (MAFF, 1982; Natural England, 2021). Representative samples are to be taken through the soil profile and across the area to be stripped. It is the best available indicator of soils being too wet to be handled and operations should be delayed until a thread cannot be formed. For coarse textured soils which do not roll into threads, a professional's view as to soil wetness and the risk of compaction may have to be taken.

**Table 4.2**: Field Tests for Suitably Dry Soils

Soil tests are to be undertaken in the field. Samples shall be taken from at least five locations in the soil handling area and at each soil horizon to the full depth of the profile to be recovered/replaced. The tests shall include visual examination of the soil and physical assessment of the soil consistency.

**i) Examination**

- If the soil is wet, films of water are visible on the surface of soil particles or aggregates (e.g. clods or peds) and/or when a clod or ped is squeezed in the hand it readily deforms into a cohesive 'ball' means **no soil handling to take place.**
- If the samples is moist (i.e. there is a sligh dampness when squeezed in the hand) but it does not significantly change colour (darken) on further wetting, and clods break up/crumble readily when squeezed in the hand rather than forming into a ball means **soil handling can take place.**
- If the sample is dry, it looks dry and changes colour (darkens) if water is added, and it is brittle means **soil handling can take place.**

**ii) Consistency**

**First test**

Attempt to mould soil sample into a ball by hand:

- Impossible because soil is too dry and hard or too loose and dry means **soil handling can take place.**
- Impossible becuase the soil is too loose and wet means no soil handling to take place.
- Possible - Go to second text.

**Second test**

Attempt to roll ball into a 3mm diameter thread by hand:

- Impossible because soil crumbles or collapses means soil handling can take place.
- Possible means no soil handling can take place.

N.B.: It is possible to roll most coarse loamy and sandy soils into a thread even when they are wet. For these soils, the Examination Test alone is to be used.

**A Rainfall Protocol to Suspend & Restart Soil Handling Operations**

Local weather forecasts of possible rainfall events during operations and the occurrence of surface lying water have been used to advise on a day-to-day basis if operations should stop (Natural England, 2021). Single events such as >5mm/day in spring and autumn months, and >10mm/day in the summer have been suggested as more precise triggers for determining soil handling operations (Reeve, 1994). However, in practice the following generic guidelines are often used:

- In light drizzle soil handling may continue for up to four hours unless the soils are already at/near to their moisture limit.
- In light rain soil handling must cease after 15 minutes.
- In heavy rain and intense showers, handling shall cease immediately.

In all of the above it is assumed that soils were in a dry condition. These are only general rules, and it is at the local level decisions to proceed or stop should be based on the actual wetness state of the soils being handled. After the above rain event has ceased, the soil tests in **Table 4.2** above should be applied to determine whether handling may re-start, provided that the ground is free from ponding and ground conditions are safe to do so.There can be extreme instances where soil horizons have become very dry and are difficult to handle resulting in dust and windblown losses. In these conditions the operation should be suspended. The artificial wetting of extremely dry soils is not usually a practice recommended but has been successful in some cases.

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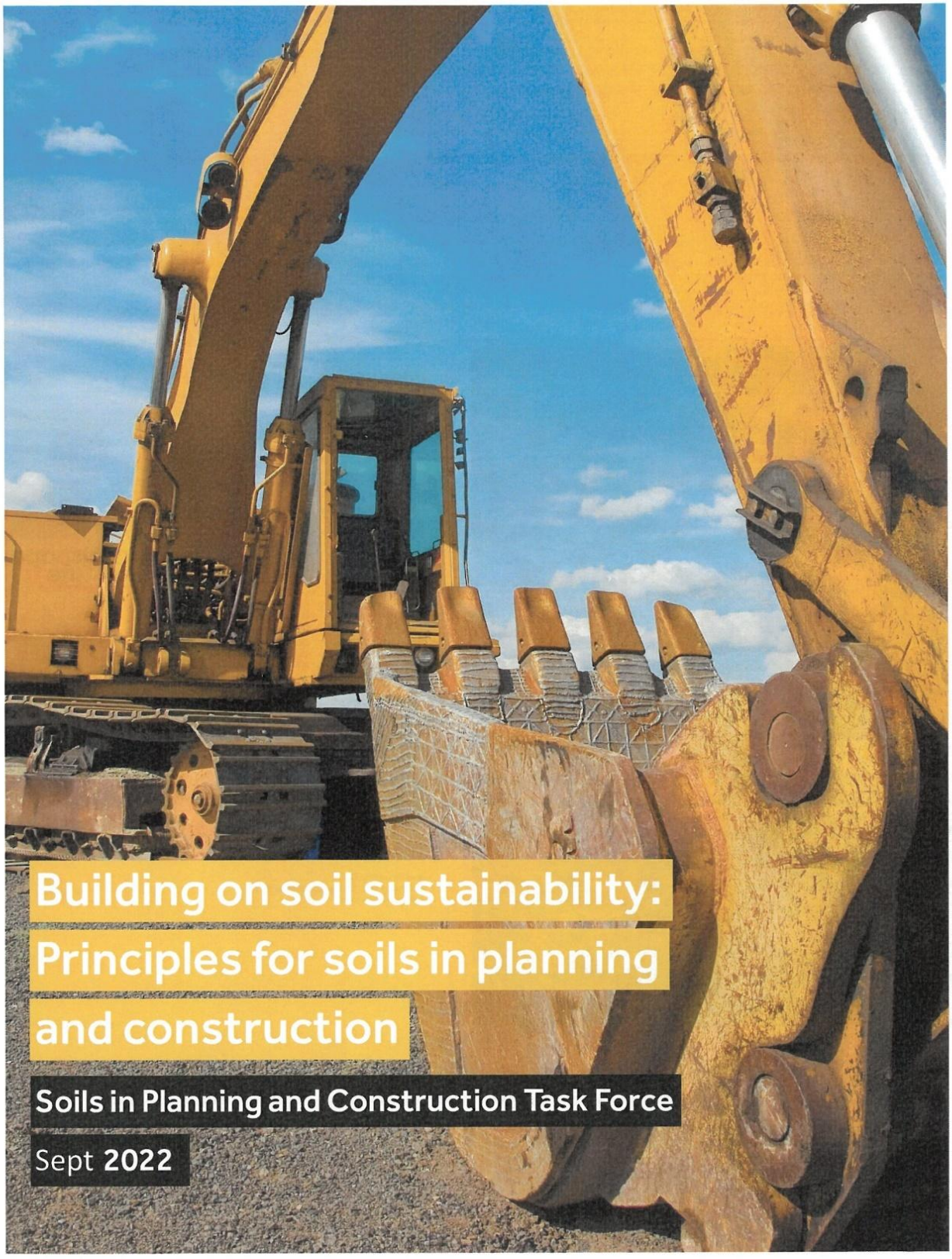
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**Appendix SMP5**

**Building on Soil Sustainability Cornwall Council and Others (September 2022)**



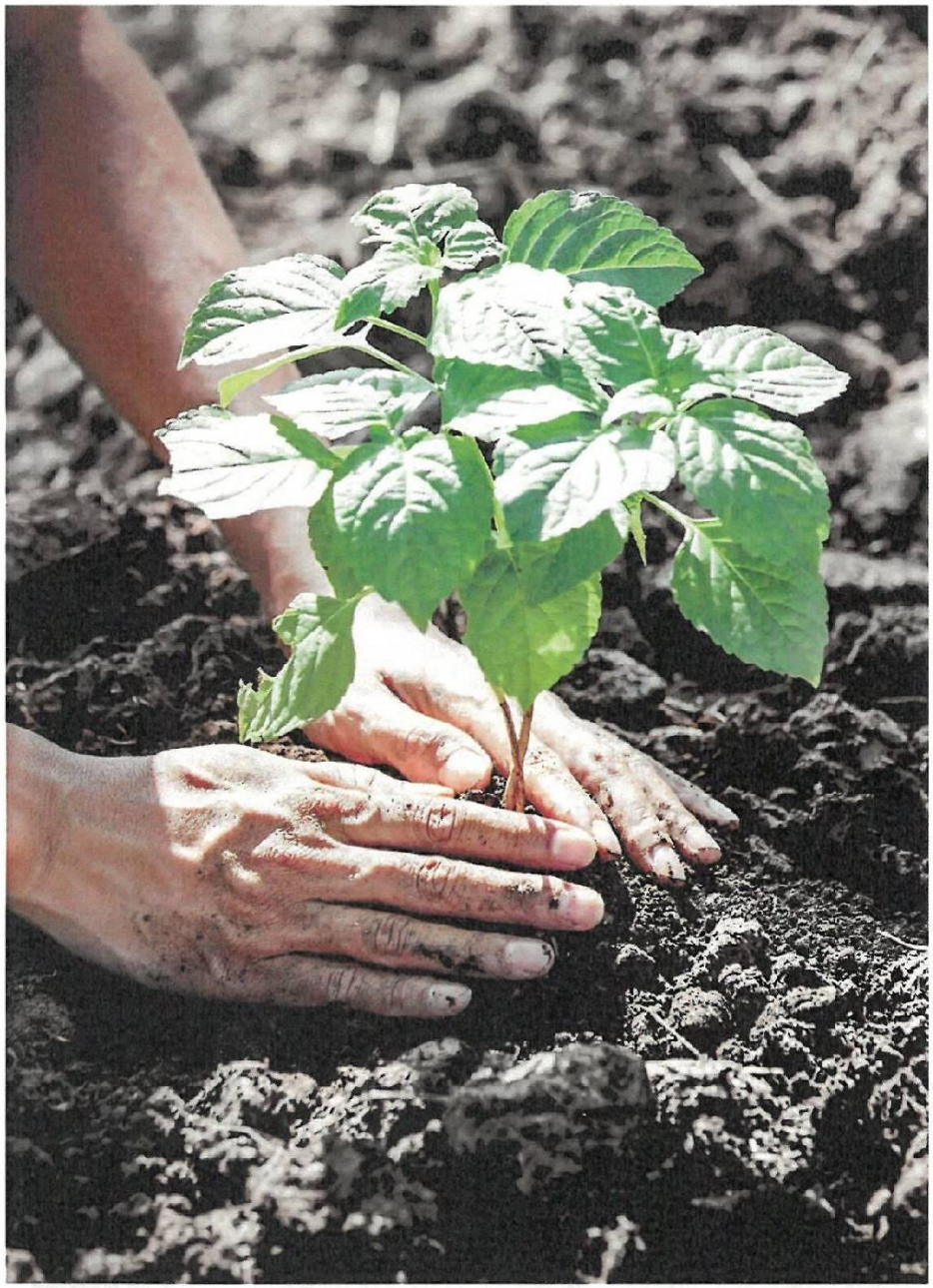

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# Foreword



Landscape Institute
Inspiring great places

This report is short, simple, important, revealing, and ultimately, just simple common sense. Soil is something we don't understand, see, or value. This must change.

I think we all know that soil is a source of nutrients for growing plants and crops. I think we know that healthy soil is important, and that with a bit of added compost it will deliver real benefits for our roses! But when it's on a construction site it simply becomes unwanted muck to be removed so building work can commence.

You'll be shocked by the horrifying truth of the level of ignorance there is toward soil. Every single teaspoon of soil contains around one billion bacteria; every cubic metre of healthy soil captures between 12kg and 35kg of carbon. In the construction sector we destroy and throw it into landfill at a rate of nearly 30 million tonnes each year, worth nearly £3 billion!

This report lays bare just how important soil is, and how much we undervalue the dirty brown stuff. It highlights the extent of soil waste in construction and the costs of failing to recognise soil as an asset worthy of preservation and use – including the huge carbon release and loss of biodiversity when we disturb or compact it.

The report starts by highlighting the multiple and complex benefits of soil, its health, and its capacity to harbour mycorrhizal activity essential for life on earth. It highlights how soil is abused in construction, setting out the guidance and legislation that we rarely follow, and concluding just how misunderstood soil is. Finally, it proposes guidance for the key sectors that need to collectively deliver realistic and achievable change.

This is a practical and timely report, which I invite you to read and disseminate. In highlighting the key issues that compromise responsible soil management and setting out how to address them, the report empowers the policies that do exist and provides the imperative for us to unite and advance cross-sector action.

Finally, I urge non-construction audiences to read this report – because we are all contributors. Paving over our garden areas and turning them into outdoor living rooms or car parking bays contributes significantly to both soil loss and associated localised flooding.

We can all do our bit to preserve and enhance soil at home, and this report provides the basis for the construction sector to reverse present practice and see soil for what it is: a fragile, fundamental, and valuable asset for the planet and for us all.

**Noel Farrer PPLI FLI**
Vice President of the Landscape Institute
(Image © Clare Elliott)

# Executive Summary

Soil provides a multitude of important functions and ecosystem services for society, including climate change mitigation and adaptation opportunities and supporting biodiversity. Yet, at present, soil is routinely undervalued, damaged and disposed of during construction and urban development. It is crucial that we not only stem the damage done to these vital ecosystems, but also actively consider how better planning and management of soil can result in environmentally and socially beneficial development. This report, collaboratively formed in consultation with a wide range of scientists, policy and industry representatives, aims to raise awareness of the importance of soil. It provices a set of guiding principles to help improve how soil is planned for and managed during construction and urban development.

## What can you do?

Use these guiding principles for soils in construction:

1. **Plan, design and construct for soil functions** – including soil carbon storage and reducing CO2 emissions, water infiltration and flood mitigation, soil biodiversity, and optimal support for above ground vegetation and trees
2. **Engage** local communities and stakeholders on soil issues and development during the consultation process
3. **Reuse or share soil** – maximise use of soil on site and share excess soil to ensure there is no loss to landfill
4. **Maximise permeability** – minimise soil sealed area and maximise permeable paving to allow water to infiltrate and soil to respire; manage draining on-site using SuDS rather than off-site
5. **Minimise compaction** – plan haul routes and materials storage and designate Soil Protection Zones (SPZs) where soil is protected from traffic, stripping and stockpiling
6. **Stockpile correctly** – minimise the duration of stockpiling and size of stockpiles, ensure this is undertaken according to soil texture, moisture and weather conditions, and ensure topsoil and subsoil are separated and do not become mixed or contaminated
7. **Minimise erosion** – prevent sediment loss by use of vegetation cover, seeding, mulching, silt fences or rolls, or geotextiles, particularly on slopes and stockpiles
8. **Learn through training** – engage with soil professionals to continually develop best practice

**Local Authorities** – use a standard planning clause for soil that includes consideration of soil functions, requirement of a soil survey and soil management plan, and a method statement for soil prior to commencement of works. Encourage the use of Soil Protection Zones (SPZs) to minimise vehicle compaction in areas for future green spaces and private gardens.

**Clients and Developers** – include the importance of soils in tender briefs. Bring in a soil specialist early and encourage their collaboration with other disciplines (ecology, landscape architecture, arboriculture and engineering). Undertake a soil survey as part of the EIA and use this to write a soil management plan, going beyond engineering or contamination surveys. Consider levels and earthworks early in the process to maximise cost benefits of reusing soils.

**Design Teams** – consider soil early on in a collaborative way and design based on soil functions and soil survey information. Maximise synergies across disciplines (landscape architecture, architecture, ecology, engineering) to create better schemes for soils, tree protection, habitats, biodiversity net gain, open spaces and private gardens.

**Contractors** – include soils in ECSR targets and raise with clients, undertake toolbox talks on good practice for soil management, and undertake soil handling according to methods in the latest Defra guidance: Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.







# Introduction

Soil provides a multitude of important functions and ecosystem services for society, including playing an important role in climate regulation and supporting biodiversity – two of the biggest existential threats to society. Yet, soil is routinely undervalued, damaged and disposed of during construction. The rising need for more homes and infrastructure to support growing populations and economies are putting increasing pressure on soils. It is vital that we better manage this non-renewable resource during construction so it can continue to provide its many crucial functions, and help us in our fight against climate change and biodiversity loss.

Currently in the United Kingdom, soils on construction sites fall within a gap in policy and legislation and large amounts of soil is being lost and damaged as a result. The key guidance document, the Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites is not often followed, and good practice is rarely seen. Whilst the total cost of the soil lost and damaged during construction to society is currently unknown, the initial evidence gathered together here indicates that in any terms the cost is large, and likewise, the scale of responsibility and opportunity for improving practice and delivering positive change is substantial.

This report aims to raise awareness of the importance of soil and why it needs to be better managed during construction. It has been developed by a cross-sector team of scientists and practitioners in consultation with a wide range of representatives from planning and construction industries. In developing and sharing this document, we hope to provide a valuable case for taking soils seriously in planning and construction, and a set of high-level useful principles for practice. The report is for anyone working in planning, development, design and construction, and focuses on the UK context. It provides a set of guiding principles to improve how soil is planned for and managed, and there are dedicated sections with specific actions for each industry to support project teams to manage soils more sustainably.





## Why is soil important?

Soil is a mixture of minerals, organic matter, living animals and micro-organisms, water and gas. It takes hundreds, thousands or even tens of thousands of years for soil to form – this means it **is a non renewable resource** and it is vital we look after it.

Soil provides many important functions and, as such, it is a valuable resource that we rely on for life on Earth. Soil provides nutrients for plants and crops to grow, it holds water and prevents flooding, it's an important store of carbon, is a cornerstone of biodiversity and habitats, and it filters pollution and contaminants from water.

Soil is a living system. **One teaspoon of topsoil contains around one billion bacteria**[1]. In urban parks, soil biodiversity can be very high. For example, in Central Park in New York, the breadth of soil microbes was similar to that found across the world in arctic, tropical and desert soils[2]. These soil micro organisms, along with soil insects and worms, decompose organic matter and recycle it into nutrients. In parks, gardens and new developments, these nutrients **support the growth of trees and green infrastructure**. Soil animals also burrow through the soil and help maintain the soil structure, creating pore spaces where oxygen is stored and water can infiltrate. Water movement and storage in the soil is key to mitigating flooding, so looking after soil helps to prevent waterlogging and reduce flood risk.

Soil also plays an important role in mitigating climate change. It is the largest store of carbon on land, storing nearly twice as much carbon as all the plants and atmosphere combined[3]. **When soil is disturbed, carbon is emitted to the atmosphere as CO2 – this means we need to manage soils carefully so that carbon remains stored in the soil.**

## Why does soil in planning and construction matter?

Whilst only a small fraction of our total global soil resource is built upon (around 1% of habitable land supports human settlements and infrastructure[4]) towns and cities are the fastest growing use of land and a major driver of soil change. Whilst this is only a small land area, the scale of soil degradation that currently occurs in this small fraction of land is astounding. We are only just beginning to learn about the scale and costs of soil degradation from construction, but from the initial insights presented in what follows, it is clear to see that the current approach to soils in planning and construction presents a major threat to national prosperity.

It is also important to note that these soils also matter because of their proximity to where the majority of people live and work. Soil's ability to function, for example by infiltrating water and reducing flood risk or supporting high quality green spaces, has direct effects on our daily lives. The opportunity is there to better plan and build for soil functioning and create positive benefits for communities and economies being developed.

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[4] https://ourworldindata.org/land-use







29.5 million tonnes of soil from construction sites was sent to landfill in 2018: ten times that lost due to soil erosion across the whole of England and Wales



Once compacted, soil structure is damaged and the soil can no longer function – the best approach is to prevent compaction in the first place

## Soil loss from construction sites

Topsoils can become mixed with subsoils, and both can be mixed with construction rubble or stones. If these soils no longer meet specifications following mixing or damage during construction, they will be disposed of to landfill. Soils need to be designated as a resource rather than a waste material and should be retained or reused on site as much as possible.

In 2018, **29.5 million tonnes** of soil from construction sites were disposed of in landfill in the UK[5]. Only 0.6 % of this was hazardous, which means a huge amount of this vital resource is being lost during construction. **This is 10 times greater than the 2.9 million tonnes of soil lost due to soil erosion each year in England and Wales**[6]. This soil has value and its loss constitutes a substantial material impact for schemes. The economic value at its most basic level is large. Topsoil has a sale value of between £80 – 100 a tonne bag, and even if only 10% of the soil lost to landfill was usable topsoil, this would equate to approximately £300m per year. However, when the broader functional value of this soil is considered, the cost of soil loss to landfill alone to the UK could be estimated to be in the order of £1.5bn per year.

In addition to soil lost to landfill, **soil erosion on construction sites can be 100 times greater than on agricultural soils** due to the removal of vegetation, disturbance of soil and alteration of topography through stockpiling[7,8].

**Take action:** Designate soil materials early through a soil survey, soil management plan and a materials management plan using the **CL:AIRE Definition of Waste Code of Practice** (DoW CoP)[9]. *The Routemap for Zero Avoidable Waste in Construction*[10] may also be useful. These actions, when combined with good erosion control, will help prevent the loss of valuable soil from construction sites. This will significantly enhance the sustainability credentials of projects and generate cost benefits if soil reuse can be maximised and earthworks minimised.

## Soil compaction

Soil compaction occurs due to trafficking of heavy vehicles, laydown of materials and poor soil stockpiling. This can occur in both topsoils and subsoils on construction sites. When soil is compacted the structure is damaged and the pore spaces are lost, meaning water and oxygen can no longer get into the soil, plants will not grow, and micro-organisms will not survive.

**Compaction can reduce water infiltration by 70-99%**, and heavily compacted soil starts to resemble the infiltration characteristics of an impervious surface[11]. This leads to poor drainage, waterlogged sites and issues with flooding. Compacted soils also cause problems for plant establishment and growth due to a restricted rooting area, particularly for woody plants and trees[12]. Restoration of soil structure is very difficult, takes many years, and is dependent on soil texture and the damage caused[13]. Remediation of compacted soil adds costs and time to a project and will not immediately return the soil to its former state. Recovery will only occur with time and a lack of disturbance.

**Take action:** The best approach is to prevent soil compaction in the first place rather than mitigate afterwards. Soils that are protected from vehicle traffic and are stockpiled appropriately will be less likely to suffer from compaction and will continue to function as healthy soils.

[5] Defra (2021) ENV23 - UK statistics on waste data

[6] Graves et al. (2015) The total costs of soil degradation in England and Wales. Ecological Economics, 119, 399-413.

[7] Hanif Ismail and Yee (2012) MUSLE Evaluation of Soil Loss on a Construction Site by Using Gauging Weirs. Advanced Materials Research, 446-449, 2718-2721.

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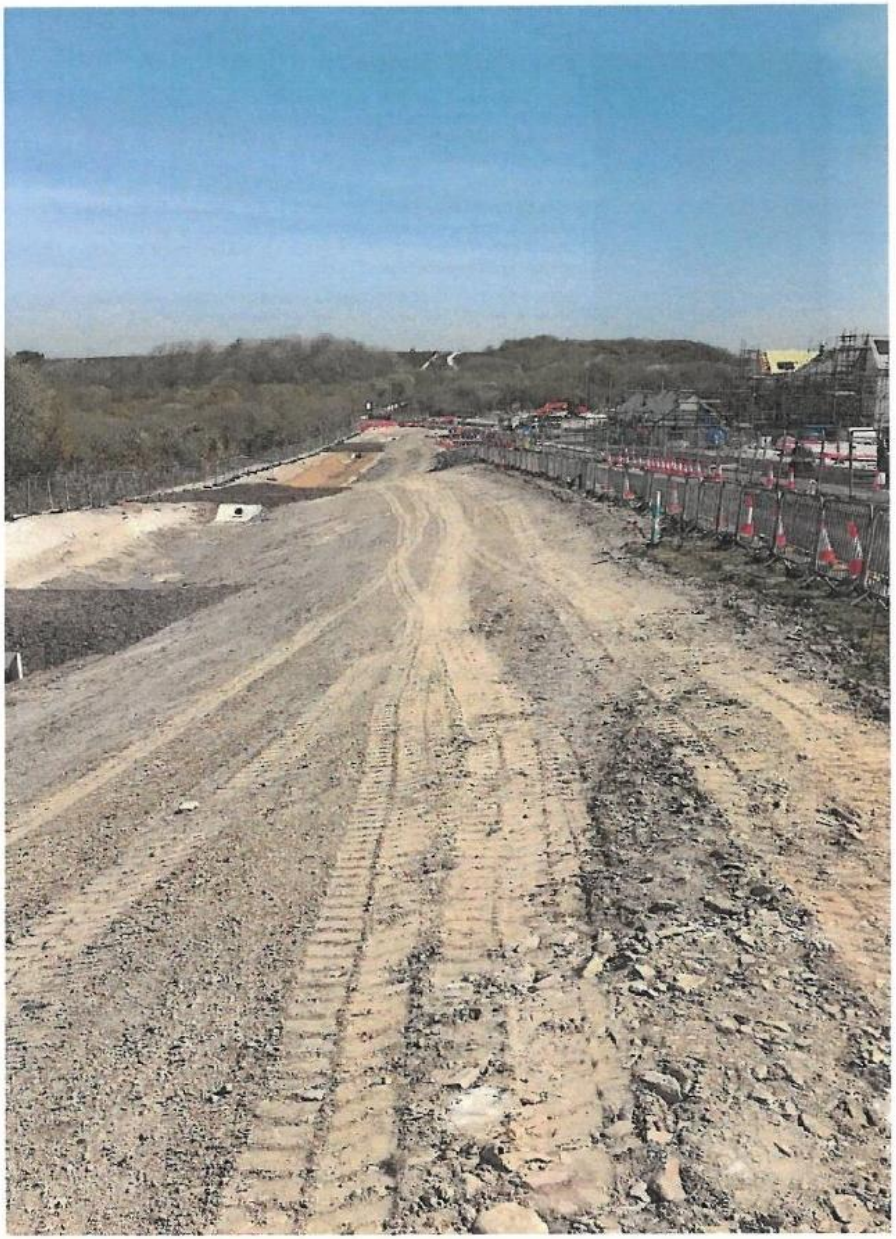
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Soil biodiversity is harmed by compaction from stockpiling or heavy vehicle traffic because it leads to a lack of oxygen

## Soil carbon storage

Typical construction soil management, where topsoil is stockpiled and then replaced onto compacted subsoil, leads to losses of carbon as CO2 emissions from the soil[14]. Earthworks disrupt soil aggregates, and the carbon stored in these aggregates and attached to soil minerals becomes more accessible to soil micro-organisms[14,15,16]. This makes the carbon more vulnerable to decomposition and it can then be lost as CO2.

Soil carbon stocks vary greatly depending on soil type, texture, climate, land use and management, and vegetation cover. In the UK, the top 1 metre of soil has been estimated to contain an average of 18 kg carbon per m2 soil (or 180 tonnes per hectare): in semi-natural habitats this is 32 kg per m2 soil, in woodlands it is 25 kg per m2 soil, and in arable land it is 12 kg m2 soil[17].

In 2013, **soil carbon losses due to development were estimated at 6.1 million tonnes of CO2**; this is greater than losses of greenhouse gases from other big emitting industries such as concrete production (6 million tonnes CO2 equivalent) and the chemical industry (5.2 million tonnes CO2 equivalent)[14].

**Take action:** To keep carbon in the soil there needs to be minimal disturbance, and ideally 'Soil Protection Zones' (SPZs) should be left completely undisturbed to maintain soil carbon storage. These SPZs could be combined with tree root protection areas and areas set aside for biodiversity net gain, where appropriate. Where movement and stockpiling is necessary, this should be done appropriately for the soil texture, water content and weather conditions.

## Soil biodiversity

Soil animals and micro-organisms are affected by soil stockpiling, compaction, damage to soil structure and contamination. Most harm to soil biodiversity occurs due to the creation of anaerobic conditions, where soil oxygen is depleted due to compaction during stockpiling or vehicle movement. Anaerobic conditions can develop soon after stockpiling and persist at depths below 1 metre in large stockpiles, though smaller stockpiles can also become anaerobic over time[18]. Anaerobic stockpiles can lead to a reduction in mycorrhizal fungi and earthworm populations[20], and a reduction in the diversity of mycorrhizal species[21]. Compaction can also alter the community structure of soil invertebrates[22].

**Take action:** To maintain healthy soil life and biodiversity, reduce disturbances to soil structure and chemistry (i.e. avoid physical disturbance and contamination), and ensure that soil is kept oxygenated and is not compacted. This will allow soil insects, worms, bacteria and fungi to continue their ecological processes, helping to recycle nutrients, support vegetation growth, and store carbon in the soil.

[14] Chen et al. (2013) Changes in soil carbon pools and microbial biomass from urban land development and subsequent post-development soil rehabilitation. Soil Biology and Biochemistry, 66, 38-44.

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## Soil sealing

Urban development seals the soil with impermeable surfaces such as road asphalt, paving and concrete. In England, an average of 15,800 hectares (158 square km) of undeveloped land was developed each year between 2013-2018[23]. This is a large increase from an average of 4,500 hectares per year in the 2000s[24], with a percentage increase of over 250 %. As soils are increasingly sealed over there is less water and gas exchange between the soil and atmosphere, and this prevents the soil providing its many functions[25].

Sealing also leads to increased surface run-off, risk of flooding, and pollution to surface water from roads. In urban areas, the proportion of front gardens in England that are paved over increased from 28% in 2001 to 48% in 2011[26], further exacerbating the problem of sealed surfaces in urban areas and putting pressure on urban drainage systems.

**Take action:** To reduce surface run-off and waterlogging on sites, green spaces and permeable paving should be maximised to enable water to infiltrate. SuDS and water management should be dealt with on-site.



Soil sealing increased from 4,500 hectares per year in the 2000s to 15,800 hectares per year between 2013-2018

## Soil contamination

Contamination in soil can occur during construction through the misuse and spillage of materials or chemicals on site. Notable examples of this are the pollution of soil with hydrocarbons during storage of fuel, and asbestos fibres through the demolition or reuse of rubble materials. Historically, waste materials and rubble were used as fill and there may be legacy contamination in some urban soils and construction sites. Once soil is contaminated or earthworks expose older contaminated soils, rainfall and groundwater can move the contaminated soils and sediments across the site and to adjacent areas spreading the problem further.

Soil that is considered to be lightly contaminated may be reused for some purposes if it does not pose a risk. However, the uncertainty of environmental risk related to soil reuse can lead to resistance, and often new materials are sought as a preference[27].

**Take action:** Ensure all risk assessments and method statements are adhered to for materials and chemicals on site to prevent spillage and contamination. Be aware of the location of materials laydown and rubble storage in relation to soil stockpiling, water courses and the future landscape design to minimise contamination to both soil and water. Undertake toolbox talks on the importance of soils, good soil management techniques and prevention of contamination.

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# Current state of UK policy and guidance or soils in construction

There are a number of relevant existing policies, reports and guidance documents that address soils in construction, as summarised in Table 1. These policies and documents contain a great deal of useful advice. However, the current state of soils in planning and construction is evidence that, to date, these have not gone far enough or have not been effectively implemented.

## Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites

The Defra Code of Practice (2009) sets out the importance of soil functions and the issues that arise through poor management of soils on construction sites. The key messages in the Code of Practice are the need for a **soil resource survey** which can feed into a materials management plan, and a **soil resource plan**, which sets out how soil will be stripped, hauled and stockpiled.

The guidance sets out methods for soil handling including topsoil and subsoil stripping, stockpiling, reinstatement, and remediation of compaction. **This guidance is due to be updated in 2022/2023 – the most up-to-date version of the guidance should be used when making soil management plans and construction method statements.**

## Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction – British Society of Soil Science (2022)

This BSSS (2022) guidance note sets out recommendations for **soil resource surveys** and **soil management plans**. It states that a soil resource survey should be conducted by a professional soil scientist with the appropriate competencies as set out in BSSS *Working with Soil Professional Competency in Soil Science* Documents. It also highlights some key recommendations around surface flooding, planting in relation to soil conditions, and soil biodiversity.

## British Standards

The following British Standards are relevant when working with soils in construction:

- **BS 3882:2015 Specification for topsoil** – this specifies requirements for natural or manufactured topsoil brought in to a site rather than topsoils remaining in situ.
- **BS 5837:2012 Trees in relation to design, demolition and construction** – provides recommendations relating to tree care and Root Protection Areas. It recommends that there should no excavation, no changes of soil level and no compaction within the root protection area.
- **BS 8683:2021 Process for designing and implementing Biodiversity Net Gain** – sets out a process for implementing biodiversity net gain to ensure that development and land management leaves biodiversity in a measurably better state than before.
- **PAS 100:2018 Specification for composted materials** – provides a compost quality standard for the organics recycling sector.





## National Planning Policy

The National Planning Policy Framework (NPPF) for England (DLUHC, 2021) recognises the need for local planning policies that relate to the protection and enhancement of soils. Through the NPPF, mitigation and remediation of despoiled, degraded, contaminated and unstable land, where appropriate, is recommended. In relation to green field sites, the NPPF advocates that the best agricultural land is preserved from development and poorer quality agricultural land be used preferentially.

## Soils in Environmental Impact Assessment

Depending on the type of development and statutory importance of the site, soils may be considered in Environmental Impact Assessment (EIA). The recent IEMA guidance: A New Perspective on Land and Soil in Environmental Impact Assessment (2022), provides a comprehensive methodology to assess the effects of developments on soil functions. Soil specialists in EIA teams should use it to assess the significance of development impacts on selected soil properties and the consequent changes in soil functions.

## Local Planning Guidance

Soil in local planning is routinely dealt with through Agricultural Land Classification (ALC), however ALC data alone is not sufficient for assessment of a development site, as confirmed by Natural England[28]. Specific soil policies in local plan documents are not common, though two examples of local soil guidance and policy follow.

Worcestershire County Council set out the importance of soil and the implications of poor management during development in a technical research paper[29]. West Lothian Council provide a more recent example of local policy and guidance adopted in 2021. They set out a policy requirement for developers to provide a soil sustainability plan and to use their planning guidance document: *Soil Management & After Use of Soils on Development Sites*[30], which will be applied when making planning decisions. The aim of the guidance is to reduce flooding, water logging and failed landscaping due to poor soil handling.





## Table 1 – UK Policy and Guidance

### Strategies, Plans & Legislation

| Document Type | Date | How is soil considered? |
|---|---|---|
| Safeguarding our Soils: A strategy for England (Defra) | 2009 | The vision of the strategy is that by 2030 all England's soils will be managed sustainably and degradation threats tackled successfully. This includes soils in urban areas being valued during development and construction practices that ensure that vital soil functions are maintained. |
| 25 Year Plan to Improve the Environment (Defra) | 2018 | The plan identifies actions to protect and improve soils with a focus on agricultural soils. The risks to soils from construction and subsequent loss of soil functions are not addressed in the plan. |
| The Environment Act (UK Parliament) | 2021 | The Act does not set specific soil targets. However, a Soil Health Action Plan for England (SHAPE) is expected to be produced which will provide soil targets. |
| The Scottish Soil Framework | 2009 | The aim of the Framework is to promote the sustainable management and protection of soils in relation to the economic, social and environmental needs of Scotland. It does this by identifying 13 soil outcomes. |
| EU Soil Strategy for 2030: Reaping the benefits of healthy soils for people, food, nature and climate (European Commission) | 2021 | The strategy provides a framework to protect and restore soils. It sets out a vision and objectives to achieve healthy soils by 2050, with actions by 2030; and announces a Soil Health Law to ensure a high level of protection. |

### National Planning Policy

| Document Type | Date | How is soil considered? |
|---|---|---|
| National Planning Policy Framework (NPPF) | Updated 2021 | The NPPF focuses on valued landscapes and sites of biodiversity, geological value or soils with a statutory status or identified quality. Soils are not valued or given statutory status unless they are peat soils or considered through Agricultural Land Classification (ALC). |

### National Planning Guidance

| Document Type | Date | How is soil considered? |
|---|---|---|
| Code of practice for the sustainable use of soils on construction sites (Defra) | 2009 – update in 2022 | This voluntary code sets out the importance of soil functions, gives guidance on best practice, and highlights issues that arise through poor management of soils on construction sites. Key messages are the need for a soil resource survey which can feed into a materials management plan, and a soil resource plan which sets out how soil will be stripped, hauled and stockpiled. |
| Planning Practice Guidance for the Natural Environment | 2019 | This guidance suggests planning can safeguard soils by referring to the Defra Code of practice. |
| Guide to assessing development proposals on agricultural land (Natural England) | Updated 2021 | This sets out how the NPPF and 25 Year Environment Plan aim to protect agricultural land and soils, with a focus on using ALC to inform planning decisions. |
| A New Perspective on Land and Soil in Environmental Impact Assessment (IEMA) | 2022 | This provides guidance for soils and land in Environmental Impact Assessment. It provides an approach to assess the impacts of a development proposal on soil properties and soil functions and sets out how soils should be considered more substantially in EIA. |
| SEPA Position Statement on Planning and Soils | / | Sets out SEPA's role in relation to land use planning and the Scottish Soil Framework. |



### Local Planning Guidance

| Document Type | Date | How is soil considered? |
|---|---|---|
| Technical research paper: Planning for Soils in Worcestershire (Worcestershire County Council) | 2011 | Highlights the importance of soil and the implications of not managing it well through development. |
| Planning Guidance: Soil Management & After Use of Soils on Development Sites (West Lothian Council) | 2021 | The local development plan sets out a policy requirement for developments to have a Soil Sustainability Plan and to use this planning guidance. The guidance aims to reduce flooding on development sites and failed landscaping due to unsuitable soil handling. |

### Other Resources

| Document Type | Date | How is soil considered? |
|---|---|---|
| The Definition of Waste: Development Industry Code of Practice (CL:AIRE) | 2011 | This voluntary code describes good practice for assessing whether excavated materials are classified as waste or not, and determine whether treated material can be re-used. |
| Policy Position Statement: Protecting and Enhancing Soils (CIWEM) | 2019 | Highlights the multi-functional and non-renewable nature of soils. It calls for actions to reflect this, including increased legislation to protect soils, implementation of the 25 Year Environment Plan, and improvements to the evidence base for policy decisions about soils. |
| Position Statement: Sustainable Urban Soils Health Initiative (SUSHI) (Sustainable Soils Alliance) | 2020 | The position statement sets out where policy and guidance is lacking, where current issues are arising, and makes the case for an update to the Defra Code of practice. |
| Guidance Note: Benefitting from soil management in development and construction (British Society of Soil Science) | 2022 | This note makes recommendations based on soil resource surveys and soil management plans. It also highlights key recommendations around surface flooding, planting in relation to soil conditions, and soil biodiversity. |
| Soils and Stones Report (Society for the Environment) | 2021 | This report recognises soil as a valuable resource and material, and aims to prevent it ending up in landfill by promoting its re-use in construction projects. |



# Three barriers to improving integration of soil sustainability into planning and construction

**Consultation with policy, industry and academic experts presented three major barriers to better treatment of soils in planning and construction.**

**1** Soil is not understood or valued – earthworks are seen as something to be completed to get to the 'real work', and soil is seen as 'muck' to be removed. Project teams (including clients, designers and contractors) are often unaware of the importance of soils and how to design with soils in mind. Soil specialists are often brought into a project too late, leaving little opportunity to make useful plans for soil management and prevent soil damage.

**2** Soil data availability – site-scale soil data is not always available and desk-based studies or ALC data is not sufficient to understand the soil resource, in particular for soil carbon storage. A full soil survey should always be done for EIA or during early stages of the project and the soil data shared throughout the design and construction stages.

**3** Time and space constraints – project timelines can mean that topsoil stripping and stockpiling go ahead even in poor weather. Once the soil is damaged in this way it cannot be restored easily. Space limitations can also lead to poor stockpiling, where topsoils and subsoils become mixed. This means soil will be replaced incorrectly and will cause damage to the soil ecosystem, biodiversity and soil structure.



# What would help?

**Think about soil early on** – this applies to all those involved in a project: developers, EIA consultants, masterplanners, designers and contractors.

**Understand the soil resource on site** – a soil survey (see appendix 1) will tell you what type of soil you have and help you understand the functions it provides. This must go beyond geotechnical or contamination properties and should include soil texture, water holding, nutrients and carbon storage capabilities.

**Design for soil retention and reuse – consider levels and construction methods from the outset** – aim to minimise cut and fill, locate road access on areas of lower soil quality, prioritise greater topsoil depth in gardens and open spaces, work with the existing soils and landscape.

**Write a soil management plan** (see appendix 2) – use the soil survey to plan how best to use the soil resource, including how and when to move, store, and respread the soil, and how to avoid contamination. Proper planning and management of the soil on site means it can be reused, reducing the need to buy in new topsoil and leading to cost savings. Functioning soil at project completion with minimum compaction or disposal should be the outcome.

**Soil Protection Zones (SPZs)** – fence off areas in a similar way to tree Root Protection Areas (as per BS 5837) to prevent disruption to soil in those areas – this will enable soil to continue to function and retain soil biodiversity, soil carbon storage and water storage capability in those areas.

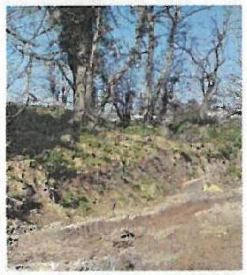
**Include soil in accreditation schemes** – soil, its biodiversity, and carbon storage properties should be taken account of in sustainability, nature and carbon accreditation schemes and targets.

**Education and training** – this would be useful for contractors moving and storing soil on site, planners making planning decisions, and landscape architects writing soil specifications.

**Integrate soil with existing regulations** – biodiversity net gain could provide an opportunity to protect soil through protection of older trees and habitats.

**Monitoring of soil at completion** – the aim is to have a functioning soil following project completion, with minimum compaction and good soil structure which will benefit water infiltration, soil biodiversity, plant growth and carbon sequestration. Monitoring the soil after it is respread or topsoil is brought in, and subsequent compaction is avoided, would ensure soil is able to provide these functions.









## Guiding Principles for Soils in Planning & Construction

1. Plan, design and construct for soil functions – including soil carbon storage and reducing CO2 emissions, water infiltration and flood mitigation, soil biodiversity, and optimal support for above ground vegetation and trees
2. Engage local communities and stakeholders on soil issues and development during the consultation process
3. Reuse or share soil – maximise use of soil on site and share excess soil to ensure there is no loss to landfill
4. Maximise permeability – minimise soil sealed area and maximise permeable paving to allow water to infiltrate and soil to respire; manage draining on-site using SuDS rather than off-site
5. Minimise compaction – plan haul routes and materials storage and designate Soil Protection Zones (SPZs) where soil is protected from traffic, stripping and stockpiling
6. Stockpile correctly – minimise the duration of stockpiling and size of stockpiles, ensure this is undertaken according to soil texture, moisture and weather conditions, and ensure topsoil and subsoil are separated and do not become mixed or contaminated
7. Minimise erosion – and prevent sediment loss by use of vegetation cover, seeding, mulching, silt fences or rolls, or geotextiles, particularly on slopes and stockpiles
8. Learn through training – engage with soil professionals to continually develop best practice



## What you can do

### Local Authorities

- Include a specific soil policy in new local development plan documents – highlight the importance of soil functions and ensure soil is valued and protected in construction.
- Use a standard planning condition for soil that includes – consideration of soil functions, requirement of a soil survey and soil management plan, and a method statement for soil prior to commencement of works. It should also require evidence of good practice for soil management in construction, and monitoring of the soil following project completion. See West Lothian Council planning guidance for an example (see resources below).
- The construction method statement should include soil as a resource – ensure the order of work and project timings take account of soil management and that measures will be taken to minimise damage. Methods should be informed by the latest Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites
- Use Soil Protection Zones (SPZs) to minimise vehicle compaction in areas for future green spaces and private gardens
- Ask for details on how a scheme has considered and optimised synergies for soils, trees and biodiversity
- Request sustainable drainage (SuDS) and that permeable paving is maximised to enable soil to function, allowing water to infiltrate and enable flood mitigation.

#### What to look for in a soil survey

- Ensure that site-based data is included that is based on soil sampling from the site and laboratory analysis.
- Look at the soil texture, water content, pH, carbon content and any contamination – this will tell you about the soil's permeability, biology and chemistry and will give an indication of its functioning (see Appendix 1: What should a soil survey contain?)
- Look for evidence of liaison with the project ecologist, landscape architect and arboricultural consultant to ensure the soil survey provides data they require to inform their work.

#### What to look for in the soil management plan

- The soil management plan should be based on information in the soil survey.
- It should set out plans for: soil protection, soil handling, soil use and any soil remediation needed (see Appendix 2: What should a soil management plan contain?)

#### Resources:

- Example of planning guidance for soils in construction – West Lothian Council – Planning Guidance: Soil Management & After Use of Soils on Development Sites (adopted 2021).
- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated



### Clients and Developers

- Include the importance of soil functions in tender briefs to consultants and contractors
- Bring a soil specialist in early before the scheme is set and ensure their liaison with the ecologist, arboricultural consultant and landscape architect at early project stages to achieve collaborative working and maximising synergies
- Consider levels and earthworks quantities early in the process and involve Quantity Surveyors to maximise cost benefits of retaining and re-using soils, feeding into the overall project viability analysis
- Undertake a soil survey for EIA and use the IEMA guidance for land and soil in EIA. Use the soil survey to write a soil management plan and construction method statement, going beyond engineering or contamination surveys (see Appendix 1: What should a soil survey contain? And Appendix 2: What should a soil management plan contain?).
- Use the latest Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites to inform the soil management plan and appropriate method for soil stockpiling.
- Make EIA soil data available to all consultants and contractors for all project stages
- Provide the design team with levels data from the outset and ask them to design to minimize cut and fill
- Write a materials management plan before work starts on site – retain the valuable soil resource and reuse it appropriately
- Plan for the use of excess soils across the site: share with another site if it can't be reused
- Consider carbon calculations for projects that take account of soil carbon, and use such data to feed into project viability and sustainability credentials. Monitoring of soils following project completion can provide evidence of good soil management and the maintenance of soil carbon stores.
- Plan for rubble management – ensure it is not disposed of in gardens and green space areas
- Promote the understanding and importance of soil to contractors e.g. through training, and demand careful management of soil from contractors on site.

#### Benefits to clients and developers

- Shows you are taking environmental and climate change issues seriously – this could reduce planning uncertainty
- High standard private gardens and green spaces are a selling point for future home owners
- Involving a soil specialist early will help you get it right first time – this leads to reduced project time
- Careful management of existing soil resources will lead to less landfill tax and smaller topsoil import costs
- Lower transport and fuel costs – less need to move soil to and from the site
- Fewer complaints and claims, for example, from home owners when private garden soils fail, are waterlogged, the structure is damaged, large amounts of rubble is found etc.
- Help with ECSR targets

#### Resources

- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated
- CL:AIRE – DoW CoP – The Definition of Waste: Development Industry Code of Practice (2011)
- IEMA guidance – A New Perspective on Land and Soil in Environmental Impact Assessment (2022)
- Green Construction Board & Construction Leadership Council – The Routemap for Zero Avoidable Waste in Construction (2021)
- British Society of Soil Science – Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction (2022)
- Farm Carbon Toolkit – Monitoring Soil Carbon: a Practical Field, Farm and Lab Guide (2021) – though this is based on agricultural soil it provides a useful resource to understand monitoring for soil carbon.

## Design Teams

- Consider soil early on in a collaborative way – design based on soil functions and soil survey information.
- Key disciplines to collaborate and advise on soil functions: soil specialist, ecology, arboriculture and landscape architecture.
- Key disciplines to design with soil in mind: landscape architects, architects and engineers. The lead designer must coordinate collaboration.
- Maximise synergies to create better schemes for soils, tree protection, habitats, biodiversity net gain, open spaces and private gardens
- Use these collaborations to inform the masterplan – plan to reuse the existing soil resource
- Design with levels in mind from the outset – explore options to minimise cut and fill, consider construction solutions, such as foundations, early to inform design solutions, ensure greater topsoil depths in private gardens and green spaces
- Maximise permeable paving in the design
- Soil specification – provide sufficient detail to allow soil to be stockpiled carefully, reused appropriately, and soil condition to be able to function to support the design.

### Benefits to Design Teams

- Better and more sustainable masterplans that take advantage of the existing soil resource
- Show greater value for money to clients
- Greater sustainability credentials of schemes
- ECSR benefits

### Resources

- Landscape Institute – Technical Information Note: Soils and Soil-forming Material (2017)
- Landscape Institute – Technical Information Note: Carbon and Landscapes (2018)
- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated
- British Society of Soil Science – Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction (2022)

## Contractors

- Include soils in ECSR targets and raise with clients
- Undertake toolbox talks on the importance of soils and good practice for soil management
- Work to the soil management plan, construction method statement and planning recommendations
- Refer to the latest Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites to inform methods for soil stockpiling
- Keep topsoil and subsoil stockpiles separate and label clearly
- Undertake stockpiling appropriately according to soil texture and weather conditions
- Consider soil compaction when planning haul routes and materials laydown – minimise subsoil compaction rather than remediating afterwards
- Stick to planned haul routes, and minimise soil compaction or damage in Root Protection Areas or Soil Protection Zones
- Work to rubble management plans – ensure it is not disposed of in private garden and green space areas.

### Benefits to contractors

- Good soil management from the start will enable better functioning soils at completion – less risk, and less cost for remediation or replacement afterwards
- Help with ECSR targets

### Resources

- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated
- CL:AIRE – DoW CoP – The Definition of Waste: Development Industry Code of Practice (2011)



# Soils in Planning and Construction Task Force

## Who we are

The Soils in Planning and Construction Task Force is made up of professionals from across soil science, local authorities, urban design and landscape architecture. The task force have come together to drive better management of soils through the planning and construction stages of development projects. Their aim is to protect and improve our vital soil resources, enabling soils in the built environment to function and provide crucial ecosystem services that support thriving places to live and work.

### Task Force members

- Professor John Quinton, Lancaster University
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**www.lancaster.ac.uk/soilstaskforce**

### Network of Experts

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- Jess Hrivnak – RIBA
- Jessica Lewis – St James Group / St William Homes, Berkeley Group
- Joanne Kwan – CIRIA
- Julia Thrift – TCPA and Green Infrastructure Partnership
- Luke Engleback – Studio Engleback
- Martin Ballard – Willmott Dixon, Soil & Stones Group at SocEnv
- Nicholas Invernizzi – St James Group / St William Homes, Berkeley Group
- Olivia Dear – Countryside Properties
- Rob Askew – Askew Land and Soil
- Robert MacDiarmid – Countryside Properties
- Robin Nicholson – Cullinan Studio, Chair of Cambridgeshire Quality Panel
- Sue James, Trees & Design Action Group

# Glossary

- **Orgenic matter** – is the organic material that comes from dead plant matter, including roots, leaves and stems, and dead organisms in the soil that all contribute organic compounds to the soil as they decompose.
- **Permeability** – is a measure of the ability of soil to allow water to infiltrate and pass through it.
- **Soil biology** – this encompasses all the insects, worms, fungi, bacteria and all micro-organisms that live in the soil and are important for key soil processes.
- **Soil carbon** – this is the carbon stored in soils globally. It includes soil organic matter and inorganic carbon as carbonate minerals.
- **Soil functions** – these are the important processes and services that soil provides, for example, the ability of the soil to hold water, provide nutrients to plants, and to enable food crops to grow.
- **Soil organic carbon** – this is the organic carbon that is stored in soils and originates from the ecological processes in soils, through plants, roots and organisms.
- **Soil processes** – this include all the biological, chemical and physical processes that occur in soil, for example, nutrient cycling, water cycling, organic matter storage and carbon sequestration.
- **Soil sealing** – this is the covering of soil with impermeable surfaces in urban areas, such as asphalt, concrete, stone or paving.
- **Soil structure** – the arrangement of pore spaces and solids within soil.

**Photography** courtesy of **Birgit Hontzsch** and **John Quinton**



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# Appendix 1:
# What should a soil survey contain?

A soil survey provides information about soil properties and functions beyond the information given in a geotechnical survey, contamination survey or agricultural land classification. It enables an understanding of how the soil functions, including the texture and structure, nutrient availability, water holding capacity, ability to store carbon and support vegetation growth.

## The soil survey should

- Be based on representative site sampling and laboratory analysis
- Include a description of the soil types on site, their thickness and properties including soil texture, pH, water content, nutrient content, carbon content / stock, and any heavy metal or contamination issues.
- Include a map displaying areas of different soil types
- Include a report that describes the different soils on site and their suitability for future uses in the designed scheme.

## What the soil survey data tells you

- **Soil texture and water content** – this will tell you about the soil's permeability, clay / sand content and ability for water to infiltrate and be stored in the soil.
- **Soil thickness** – gives an indication of the volume of soil resource available and will determine how earthworks will be undertaken.
- **pH** – this will tell you about the chemistry of the soil which controls nutrient availability, biological processes such as micro-organism and fungi activity, and the behaviour of contaminants or heavy metals.
- **Nutrient content** – provides information on how fertile the soil is. This should be used to determine the type of habitat and planting scheme that will be used in the design of the scheme.
- **Carbon content / carbon stock** – this gives an indication of the soil carbon storage of each type of soil at the time of the survey. It is often referred to as soil organic carbon (SOC). It should be used to consider which areas could be protected from soil handling and compaction to maintain the carbon in the soil and prevent its loss to the atmosphere. It could also be used to plan for planting and soil management to increase soil carbon storage.
- **Heavy metals and contamination** – this information will highlight risks from the soil which will need to remediated.

The British Society of Soil Science document *Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction* (BSSS, 2022) makes similar recommendations for soil surveys and soil management plans. It states that a survey should be conducted by a professional soil scientist with the appropriate competencies as set out in BSSS *Working with Soil Professional Competency in Soil Science* Documents. See the guidance note for more details.



# Appendix 2:
# What should a soil management plan contain?

A soil management plan sets out how the soil will be planned for, handled, and managed so that the soil is able to function on completion of the project. The soil management plan will use data from the soil survey to inform plans for the site. It should include plans for:

## Soil Protection

Plans for haul routes and laydown areas to minimise the extent of soil compaction across the site and ensure clear signage to prevent additional damage and compaction outside of these areas

The potential use of Soil Protection Zones (SPZs) where soil will be fenced off and protected from all disturbance or compaction from vehicle traffic. These will be clearly signposted.

## Soil handling

- The location, size and duration of stockpiles that are appropriate for soil texture, moisture and weather conditions
- Methods of stripping and stockpiling
- The separation of stockpiles for topsoil and subsoils and clear labelling
- The prevention of mixing of soils with rubble or waste materials
- Haul routes and materials laydown to minimise soil compaction

## Soil use

- How soil will be reused across the site, the volume that will be reused, and plans for any excess soil.
- Soil reinstatement that is appropriate in depth, nutrients and texture for future planting and green spaces, private gardens, and SuDs features.

## Soil remediation

- How any damaged or compacted soil will be remediated.
- The plan should also state who will be responsible for supervising soil management on site.

Soil management plans should always refer to the latest Defra *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*. This provides detailed soil handling guidance for soil stripping, stockpiling, reinstatement and remediation of compaction. See more in the Defra Code of Practice.



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**Appendix SMP6**

**Planning Aftercare and Advice (Natural England, 2022)**

GOV.UK



NATURAL ENGLAND

Guidance

# Planning and aftercare advice for reclaiming land to agricultural use

Updated 19 April 2022

**Applies to England**

Contents

1. Plan to reclaim land to agriculture
2. What to check for in planning applications
3. Record keeping
4. Aftercare plan and conditions
5. Annual report and annual meeting
6. Government policies to protect agricultural land and soil

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This publication is available at https://www.gov.uk/government/publications/reclaim-minerals-extraction-and-landfill-sites-to-agriculture/planning-and-aftercare-advice-for-reclaiming-land-to-agricultural-use

# 1. Plan to reclaim land to agriculture

Natural England is a statutory consultee (https://www.gov.uk/guidance/consultation-and-pre-decision-matters#Statutory-consultees) in the planning process. Planners should use this advice to make sure developers understand what's needed to reclaim sites to agriculture.

It applies to planning and aftercare of:

- mineral extraction sites
- landfill and land raising sites (landforms created by above ground waste) - referred to as 'landfilling' in this guide

It provides advice to planners on:

- what to check for in planning applications
- how to manage development proposals

Refer to sections 4 and 5 in the Guide to reclaiming mineral extraction and landfill sites to agriculture (https://www.gov.uk/government/publications/reclaim-minerals-extraction-and-landfill-sites-to-agriculture) to make sure the proposed afteruse is appropriate.

# 2. What to check for in planning applications

You should check that development proposals for mineral extraction and landfill include considerations to reclaim land to agricultural use, where it's appropriate. Read this section for more information.

## 2.1 Restoration plan

Development proposals should have a restoration plan and statement that includes:

- an assessment of agricultural land and soil resource of the site before work started, refer to section 5 in the Guide to assessing development proposals on agricultural land (https://www.gov.uk/government/publications/agricultural-land-assess-proposals-for-development)
- how a developer intends to restore the site to agricultural use after mineral extraction or landfilling has finished

- an aftercare programme (usually for 5 years) to reach a satisfactory standard of agricultural afteruse from activities such as, cultivating, reseeding, draining or irrigating, applying fertiliser, or cutting and grazing the site

Maps to show the intended:

- landform after restoration showing contours on the map at appropriate intervals
- surface features, such as ditches, field boundaries and tracks
- habitat and water features

## 2.2 Agricultural land classification (ALC) report

Read section 4 in the Guide to assessing development proposals on agricultural land (https://www.gov.uk/government/publications/agricultural-land-assess-proposals-for-development).

## 2.3 Soil resources report

A soil resources report can use the same soil data as an ALC survey. The report should show how to deal with each soil type during the works and through restoration. It should include:

- soil profile and depth (usually to 1.2m)
- soil texture and stoniness
- soil structure
- volumes of soil types and suitability for reuse
- soil drainage status (a measure of its wetness)
- available water capacity (a measure of how dry and arid it is - its 'droughtiness')
- nutrient status, organic matter content, and pH (the acidity or alkalinity of the soil)
- chemical characteristics, such as salinity or potential contaminants (if appropriate)

Include soil data in the restoration plan to show:

- the intended stripping depths and volumes of each soil type
- the intended standard of restoration you expect to achieve

- how to replace lost soil that was part of the extracted mineral, such as stony or sandy subsoils, clay or brick earth
- how to safeguard soil with ecological significance, such as peats or woodland soil containing a seed bank and low nutrient soils

An experienced soil specialist should prepare these reports, such as a member of the British Society of Soil Science.

The reports should show soil and land quality comparisons at the beginning and end of workings so you can be sure restoration and aftercare provision will meet the required standard for agricultural use.

## 2.4 Soil handling plan

A soil handling plan should show how the developer proposes to:

- replace soil (for example its intended location, depth, composition and contour)
- handle soil to avoid mixing and contamination
- move and store soil to avoid compaction
- avoid double handling (to minimise soil losses, mixing and structural damage)
- keep different types of soil separate from each other when moved
- avoid compacting unstripped and partly-stripped soil especially on large-scale phased developments and show haulages routes
- avoid compaction
- remedy compaction (for example by ploughing into the subsoil or loosening hard layers of soil using agricultural machinery)

The plan should:

- show the intended storage location
- specify the equipment and technique needed for each soil type to strip, store and replace it (such as loose tipping from a truck with soil spreading using a 360 degree excavator) - read the Institute of Quarrying Good Practice Guide for Handling Soils in Mineral Workings (https://www.quarrying.org/soils-guidance)

### Moving soil

Operators should use a soil specialist to advise on the methods for using and handling different soils and the best time to strip soil and move it to limit damage.

The proposals should include moving soil in the drier months from April to September. The drier season can be longer in the east and south of England.

### Test soil wetness

Soil tests should include a visual examination of the soil and a physical assessment of the soil consistency. Refer to the Institute of Quarrying Good Practice Guide for Handling Soils in Mineral Workings Part One Table 4.2 (https://www.quarrying.org/soils-guidance) (this document may not be accessible to assistive technologies).

A soil moisture meter can test the wetness of soil samples. 80% of samples must meet the lower plastic limit for each soil type - that is the point at which the soil changes from pliable to crumbly. The lower plastic limit should be known for each soil type before using the moisture meter.

### When not to move soil

Operators shouldn't move soil if:

- the soil wetness tests or moisture meter indicate the soil is too wet
- it's raining or just been raining
- there's heavy rain forecast
- there are puddles on the soil surface
- the ground is frozen or covered by snow
- from October to March, when it's wetter, unless you get permission from the mineral planning authority (MPA) - refer to section 1.2 in the Guide to reclaiming mineral extraction and landfill sites to agriculture (https://www.gov.uk/government/publications/reclaim-minerals-extraction-and-landfill-sites-to-agriculture) for a definition of MPA

Keep land vegetated for as long as possible before moving topsoil. Avoid soil erosion by planting quickly. This:

- allows natural drying through evaporation and transpiration
- develops the soil structure

## 2.5 Soil storage proposals

Store soil in mounds (known as 'bunds'). To store soil for more than 6 months (or over winter), you'll need to:

- seed it with grass
- treat it for weeds

- cut the grass at least twice a year

To keep soil aerated, reduce erosion, runoff and ponding, soil bunds should:

- be no more than 3m high for topsoil and 5m high for subsoil
- be located on dry level ground
- not disrupt natural surface drainage
- be stable structures with side slopes between 25 degrees and 45 degrees

Loosen soil under the bunds when you remove them.

Soil storage areas need to be large enough to store soils separately. To reduce mixing, soil bunds should be:

- of a single soil type including topsoils and other soil forming material
- located on similar material, for example remove topsoil to store subsoil and store topsoil on similar topsoil (like-on-like)

Single bunds should have different soils separated by another material, such as straw bales or a synthetic barrier (geotextile).

## 2.6 Drainage and landform

Restored land must drain properly. Proposals may need to include adding surface ditches and underground drainage systems to restore land to its previous quality, even if the land was free draining before.

Minerals such as sand, chalk and gravel act as natural drainage. You must take this into account if your development takes away any natural drainage.

You should:

- replace soil to a depth specified in your restoration plan, typically 30cm of topsoil and 90cm of subsoil
- fill all uneven surfaces with suitable soils
- remove stones (larger than 10cm across) from replaced soil to avoid danger to livestock and damage to machinery

For mineral sites that don't need filling with 'overburden' (the geological material above the mineral being extracted) or imported material, you should replace topsoil and subsoil directly onto a well prepared and loosened base layer.

For landfill sites, replace soil over a capping layer - this forms a barrier to the waste products below.

The final landform should:

- have an even gradient for drainage and lets farm machinery operate safely and efficiently (for best and most versatile agricultural (BMV) land the gradient must be 7 degrees or less) - see section 4 in the Guide to assessing development proposals on agricultural land (https://www.gov.uk/government/publications/agricultural-land-assess-proposals-for-development) for a definition of BMV land
- have open-ended valleys to avoid drainage problems
- avoid a lower level restoration which could lead to wet soils and drainage problems
- merge with adjoining land to avoid sudden changes in levels and potential 'ponding' of water

# 3. Record keeping

Operators should keep records for:

- each soil bund - you should label every one you create
- all restoration operations including dates, volumes and types of soil moved and where the soil came from
- weather conditions during stripping and moving
- any problems encountered to help with future decisions

Operators should check their records each year to make sure they match the restoration plan, as this can change when works start. You can ask for these records when:

- deciding on planning permission
- monitoring the site at a later stage

# 4. Aftercare plan and conditions

You should check that operators have an aftercare plan to reclaim land for agricultural use. You should attach planning conditions to planning permission that sets out an appropriate outline strategy for aftercare for the site see section 4.2

Fully reclaimed land (that's restored land and its associated aftercare) should have topsoil and subsoil replaced as described in the restoration plan see section 2.1.

It must be cultivated and treated appropriately for up to 5 years to restore its structure and stability for normal agricultural use - this is often longer (by agreement) for woodland, amenity, or wildlife conservation.

You should refer to the planning practice guidance on restoration and aftercare (https://www.gov.uk/guidance/minerals#Restoration-and-aftercare-of-minerals) for more detail.

## 4.1 Operators' responsibilities for aftercare

Operators must pay for the restoration and aftercare of the site. Operators must discuss any extensions to their aftercare agreement with you.

## 4.2 Outline strategy for aftercare

Operators must submit an outline strategy for aftercare with their planning application. For projects with a long lifespan you can create a condition.

As part of the outline strategy, operators should:

- map all areas in the aftercare plan and include any operations taking place in different phases
- state when, where and how they'll establish grass or crops
- describe the hedgerows, trees and surface features they'll establish
- outline drainage plans and water supply if appropriate
- explain their plans for agriculture, soil management, using fertiliser and controlling weeds and pests
- commit to an annual meeting with you and other interested parties

## 4.3 Phased restoration and aftercare

Operators should agree care and maintenance plans with you (as an interim stage). You should do this when restoration of small parts of a larger site is taking place in phases, such as a landfill operation. The aftercare period starts when the smaller parts have made up a large enough area to start aftercare management. Operators should agree this size with you.

# 5. Annual report and annual meeting

All agricultural reclamation sites should have an annual aftercare report and annual meeting.

Operators should submit the annual aftercare report to you before an annual meeting of all interested parties. All interested parties should have time to read the report before the meeting. The report should include:

- work carried out that year (include soils analysis results and fertiliser and pesticide applications)
- details of work for the coming year
- any changes to original proposals set out in the outline aftercare strategy see section 4.2

The operator needs to agree with you:

- any further remedial work, such as improving drainage or removing soil compaction
- any changes to the aftercare plan, such as changing a crop

You can issue a 'certificate of compliance' if the aftercare plan meets the aftercare obligations. This can be in the form of a simple letter. This doesn't mean the restoration standard is met.

# 6. Government policies to protect agricultural land and soil

Read the Guide to reclaiming mineral extraction and landfill sites to agriculture (https://www.gov.uk/government/publications/reclaim-minerals-extraction-and-landfill-sites-to-agriculture) to make sure development proposals are appropriate and sustainable.

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**Appendix SMP7**

**BRE Agricultural Good Practice Guide Extract**

bre

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# Agricultural Good Practice Guidance for Solar Farms



NFU

EUROPEAN UNION
Investing in Your Future

European Regional
Development Fund 2007-2013

BRE
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CENTRE

**Principal Author and Editor** Dr Jonathan Scurlock, National Farmers Union

This document should be cited as: BRE (2014) Agricultural Good Practice Guidance for Solar Farms. Ed J Scurlock

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**With thanks to NSC Founding Partners:**

## Context

This document describes experience and principles of good practice to date for the management of small livestock in solar farms established on agricultural land, derelict/marginal land and previously-developed land.

Proposed for publication as an appendix to existing best practice guidelines by the BRE National Solar Centre[1], it should be read in conjunction with BRE (2014) Biodiversity Guidance for Solar Developments (eds. G.E. Parker and L. Greene).

The guidance presented here has been developed with, and endorsed by, a number of leading UK solar farm developers and organisations concerned with agriculture and land management.

## Introduction

Field-scale arrays of ground-mounted PV modules, or "solar farms", are a relatively recent development, seen in Britain only since 2011, although they have been deployed in Germany and other European countries since around 2005. In accordance with the "10 Commitments" of good practice established by the Solar Trade Association[2], the majority of solar farm developers actively encourage multi-purpose land use, through continued agricultural activity or agri-environmental measures that support biodiversity, yielding both economic and ecological benefits.

It is commonly proposed in planning applications for solar farms that the land between and underneath the rows of PV modules should be available for grazing of small livestock. Larger farm animals such as horses and cattle are considered unsuitable since they have the weight and strength to dislodge standard mounting systems, while pigs or goats may cause damage to cabling, but sheep and free-ranging poultry have already been successfully employed to manage grassland in solar farms while demonstrating dual-purpose land use.

Opportunities for cutting hay or silage, or strip cropping of high-value vegetables or non-food crops such as lavender, are thought to be fairly limited and would need careful layout with regard to the proposed size of machinery and its required turning space. However, other productive options such as bee-keeping have already been demonstrated. In some cases, solar farms may actually enhance the agricultural value of land, where marginal or previously-developed land (e.g. an old airfield site) has been brought back into more productive grazing management. It is desirable that the terms of a solar farm agreement should include a grazing plan that ensures the continuation of access to the land by the farmer, ideally in a form that that enables the claiming of Basic Payment Scheme agricultural support (see page 2).





[1] BRE (2013) Planning guidance for the development of large scale ground mounted solar PV systems. www.bre.co.uk/nsc

[2] STA "Solar Farms: 10 Commitments" http://www.solar-trade.org.uk/solarFarms.cfm

## Conservation grazing for biodiversity

As suggested in the Biodiversity Guidance described above, low intensity grazing can provide a cost-effective way of managing grassland in solar farms while increasing its conservation value, as long as some structural diversity is maintained. A qualified ecologist could assist with the development of a conservation grazing regime that is suited to the site's characteristics and management objectives, for incorporation into the biodiversity management plan.

Avoiding grazing in either the spring or summer will favour early or late flowering species, respectively, allowing the development of nectar and seeds while benefiting invertebrates, ground nesting birds and small mammals. Hardy livestock breeds are better suited to such autumn and winter grazing, when the forage is less nutritious and the principal aim is to prevent vegetation from overshadowing the leading (lower) edges of the PV modules (typically about 800-900mm high). Other habitat enhancements may be confined to non-grazed field margins (if provision is made for electric or temporary fencing) as well as hedgerows and selected field corners.

## Agricultural grazing for maximum production

The developer, landowner and/or agricultural tenant/licensee may choose to graze livestock at higher stocking densities throughout the year over much of the solar farm, especially where the previous land use suggested higher yields or pasture quality. Between 4 and 8 sheep/hectare may be achievable (or 2-3 sheep/ha on newly-established pasture), similar to stocking rates on conventional grassland, i.e. between about March and November in the southwest and May to October in North-East England.

The most common practice is likely to be the use of solar farms as part of a grazing plan for fattening/finishing of young hill-bred 'store' lambs for sale to market. Store lambs are those newly-weaned animals that have not yet put on enough weight for slaughter, often sold by hill farmers in the Autumn for finishing in the lowlands. Some hardier breeds of sheep may be able to produce and rear lambs successfully under the shelter of solar farms, but there is little experience of this yet. Pasture management interventions such as 'topping' (mowing) may be required occasionally or in certain areas, in order to avoid grass getting into unsuitable condition for the sheep (e.g. too long, or starting to set seed).

Smaller solar parks can provide a light/shade environment for free-ranging poultry (this is now recognised by the RSPCA Freedom Foods certification scheme) – experience to date suggests there is little risk of roosting birds fouling the modules. Broiler (meat) chickens, laying hens and geese will all keep the grass down, and flocks may need to be rotated to allow recovery of vegetation. Stocking density of up to 2000 birds per hectare is allowed, so a 5 megawatt solar farm on 12 hectares would provide ranging for 24,000 birds.

## Solar farm design and layout

In most solar farms, the PV modules are mounted on metal frames anchored by driven or screw piles, causing minimal ground disturbance and occupying less than 1% of the land area. The rest of the infrastructure typically disturbs less than 5% of the ground, and some 25-40% of the ground surface is over-sailed by the modules or panel. Therefore 95% of a field utilised for solar farm development is still accessible for vegetation growth, and can support agricultural activity as well as wildlife, for a lifespan of typically 25 years.

As described above, the layout of rows of modules and the width of field margins should anticipate future maintenance costs, taking into account the size, reach and turning circle of machinery and equipment that might be used for 'topping' (mowing), collecting forage grass, spot-weeding (e.g. of 'injurious' weeds like ragwort and dock) and re-seeding. Again, in anticipation of reverting the field to its original use after 25 years, many agri-environmental measures may be better located around field margins and/or where specifically recommended by local ecologists. All European farmers are obliged to maintain land in "good agricultural and environmental condition" under the Common Agricultural Policy rules of 'cross compliance', so it is important to demonstrate sound stewardship of the land for the lifetime of a solar farm project, from initial design to eventual remediation.

The depth of buried cables, armouring of rising cables, and securing of loose wires on the backs of modules all need to be taken into consideration where agricultural machinery and livestock will be present. Cables need to be buried according to national regulations and local DNO requirements, deep enough to avoid the risk of being disturbed by farming practice – for example, disc harrowing and re-seeding may till the soil to a depth of typically 100-150 mm, or a maximum of 200 mm. British Standard BS 7671 ("Wiring Regulations") describes the principles of appropriate depth for buried cables, cable conduits and cable trench marking. Note also that stony land may present a risk of stone-throw where inappropriate grass management machinery is used (e.g. unguarded cylinder mowers).

## Eligibility for CAP support and greening measures

From 2015, under the Common Agricultural Policy, farmers will be applying for the new Basic Payment Scheme (BPS) of area-based farm support funding. It has been proposed that the presence of sheep grazing could be accepted as proof that the land is available for agriculture, and therefore eligible to receive BPS, but final details are still awaited from Defra at the time of writing. Farmers must have the land "at their disposal" in order to claim BPS, and solar farm agreements should be carefully drafted in order to demonstrate this (BPS cannot be claimed if the land is actually rented out). Ineligible land taken up by mountings and hard standing should be deducted from BPS claims, and in the year of construction larger areas may be temporarily ineligible if they are not available for agriculture.

Defra has not yet provided full details on BPS 'greening' measures, but some types of Ecological Focus Areas may be possibly located within solar farms, probably around the margins, including grazed buffer strips and ungrazed fallow land, both sown with wildflowers. Note that where the agreed biodiversity management plan excludes all forms of grazing, the land will become ineligible for BPS, and this may have further implications for the landowner, such as for inheritance tax.

## Long-term management, permanent grassland and SSSI designation

Since solar farms are likely to be in place typically for 25 years, the land could pass on to a succeeding generation of farmers or new owners, and the vegetation and habitat within the fenced area is expected to gradually change with time. According to Natural England, there is little additional risk that the flora and fauna would assume such quality and interest that the solar farm might be designated a SSSI (Site of Special Scientific Interest) compared with a similarly-managed open field. However, there could be a possible conflict with planning conditions to return the land to its original use at the end of the project, e.g. if this is specified as 'cropland' rather than more generically as 'for agricultural purposes'. If the pasture within a solar farm were considered to have become a permanent grassland, it may be subject to regulations requiring an Environmental Impact Assessment to restore the original land use, although restoration clauses in the original planning consent may take precedence here. It is proposed that temporary (arable) grassland should be established on the majority of the land area that lies between the rows of modules. This would be managed in 'improved' condition by periodic harrowing and re-seeding (e.g. every 5 years), typically using a combination disc harrow and seed drill.

Other measures to maintain the productivity of grassland, without the need for mechanised cultivations or total reseeding, could include: maintaining optimum soil fertility and pH to encourage productive grass species; seasonally variable stocking rates to prevent over/under-grazing with the aim of preventing grass from seeding and becoming unpalatable. Non-tillage techniques to optimise grass sward content might include the use of a sward/grass harrow and air-seeder to revive tired pastures. When applying soil conditioners (e.g. lime), fertilisers or other products, consideration should be taken to prevent damage to or soiling of the solar modules.

## Good practice in construction and neighbourliness

Consideration should also be given to best practice during construction and installation, and ensuring that the future agricultural management of the land (such as a change from arable cropping to lamb production) fits into the local rural economy. Site access should follow strictly the proposed traffic management plan, and careful attention to flood and mud management in accordance with the Flood Risk Assessment (e.g. controlling run-off by disrupting drainage along wheelings), will also ensure that the landowner remains on good terms with his/her neighbours.

Time of year should be taken into account for agricultural and biodiversity operations such as prior seeding of pasture grasses and wildflowers. Contractors should consider avoiding soil compaction and damage to land drains, e.g. by using low ground pressure tyres or tracked vehicles. Likewise, when excavating cable trenches, storing and replacing topsoil and subsoil separately and in the right order is important to avoid long-term unsightly impacts on soil and vegetation structure. Good practice at this stage will yield longer-term benefits in terms of productivity and optimal grazing conditions.

## Evidence base and suggested research needs

A number of preliminary studies on the quantity and quality of forage available in solar farms have suggested that overall production is very little different from open grassland under similar conditions. A more comprehensive and independent evidence base could be established through a programme of directed research, e.g. by consultants (such as ADAS) or interested university groups (e.g. Exeter University departments of geography and biosciences), perhaps in association with seed suppliers and other stakeholders. Productivity of grasses could be compared between partial shade beneath the solar modules and unshaded areas between the rows. Alternatively daily live weight gain could be compared between two groups of fattening lambs (both under the same husbandry regime) on similar blocks of land, with and without solar modules present.



Case Steiger Quadtrac used to deliver inverters and other heavy equipment to site under soft ground conditions (photo courtesy of British Solar Renewables)



Cable trenching, showing topsoil stripped and set to one side, with subsoil placed on the other side ready for reinstatement (photo courtesy of British Solar Renewables)

## Agricultural case studies

### Benbole Farm, Wadebridge, Cornwall

One of the first solar farms developed in Britain in 2011, this 1.74 megawatt installation on a four-hectare site is well screened by high hedges and grazed by a flock of more than 20 geese. A community scheme implemented by the solar farm developers enabled local residents to benefit from free domestic solar panels and other green energy projects.



### Higher Hill, Butleigh, Somerset

Angus Macdonald, a third-generation farmer, installed a five megawatt solar farm on his own land. Located near Glastonbury, the site has been grazed by sheep since its inception in 2011.



### Eastacombe Farm, Holsworthy, Devon

This farm has been in the Petherick family for four generations, but they were struggling to survive with a small dairy herd. In 2011/12, a solar developer helped them convert eight hectares of the lower-grade part of their land into a 3.6 megawatt solar farm with sheep grazing, which has diversified the business, guaranteeing its future for the next generation of farmers.



### Newlands Farm, Axminster, Devon

Devon sheep farmer Gilbert Churchill chose to supplement his agricultural enterprise by leasing 13 hectares of grazing land for a 4.2 megawatt solar PV development, which was completed in early 2013. According to Mr Churchill, the additional income stream is "a lifeline" that "will safeguard the farm's survival for the future".



## Trevemper Farm, Newquay, Cornwall

In 2011, the Trewithen Estate worked with a solar developer to build a 1.7 megawatt solar farm on 6 hectares of this south-facing block of land, which had good proximity to a grid connection. During the 25-year lease, the resident tenant farmer is still able to graze the land with sheep at his normal stocking density, and is also paid an annual fee to manage the pasture.



## Yeowood Solar Farm, North Somerset

Completed in 2012, this 1.3 megawatt installation on 4 hectares of land surrounds a poultry farm of 24,000 laying hens, which are free to roam the land between and underneath the rows of solar modules, as well as other fields. The Ford family, farm owners, also grow the energy crop miscanthus to heat their eco-friendly public swimming pool and office units.



## Wyld Meadow Farm, Bridport, Dorset

Farmers Clive and Jo Sage continue to graze their own-brand Poll Dorset sheep on this 4.8 megawatt solar farm, established on 11 hectares in 2012. The solar farm was designed to have very low visual impact locally, with an agreement to ensure livestock grazing throughout the project's lifetime.



## Wymeswold Solar Farm, Leicestershire

The author pictured in July 2014 at Britain's largest connected solar farm. At 33 megawatts, this development provides enough energy to power 8,500 homes. Built on a disused airfield in 2013, this extensive installation over 61 hectares (150 acres) received no objections during planning and is grazed by the landowner's sheep – just visible in the background.



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