APPEAL BY RES LTD

AGAINST THE DECISION OF RUSHCLIFFE COUNCIL TO REFUSE PLANNING PERMISSION FOR Installation of renewable energy generating solar farm comprising ground-mounted photovoltaic solar arrays, together with substation, inverter stations, security measures, site access, internal access tracks and other ancillary infrastructure, including landscaping and biodiversity enhancements.

AT LAND AT

Land East Of Hawksworth And Northwest Of Thoroton, Shelton Road Thoroton Nottinghamshire

APPENDICES TO PROOF OF EVIDENCE OF MR SAM FRANKLIN BSc (Hons) MSc MRICS FAAV FBIAC PIEMA MISoilSci.

On Behalf of the Rule 6(6) Party, the Hawksworth and Thoroton Action Group (HTAG)

PINS REF:	**APP/P3040/W/23/3330045**
LPA APPLICATION REF:	**22/02241/FUL**
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Landscope Land and Property
Village Farm
Thorncote Green
Sandy
Bedfordshire
SG19 1PU

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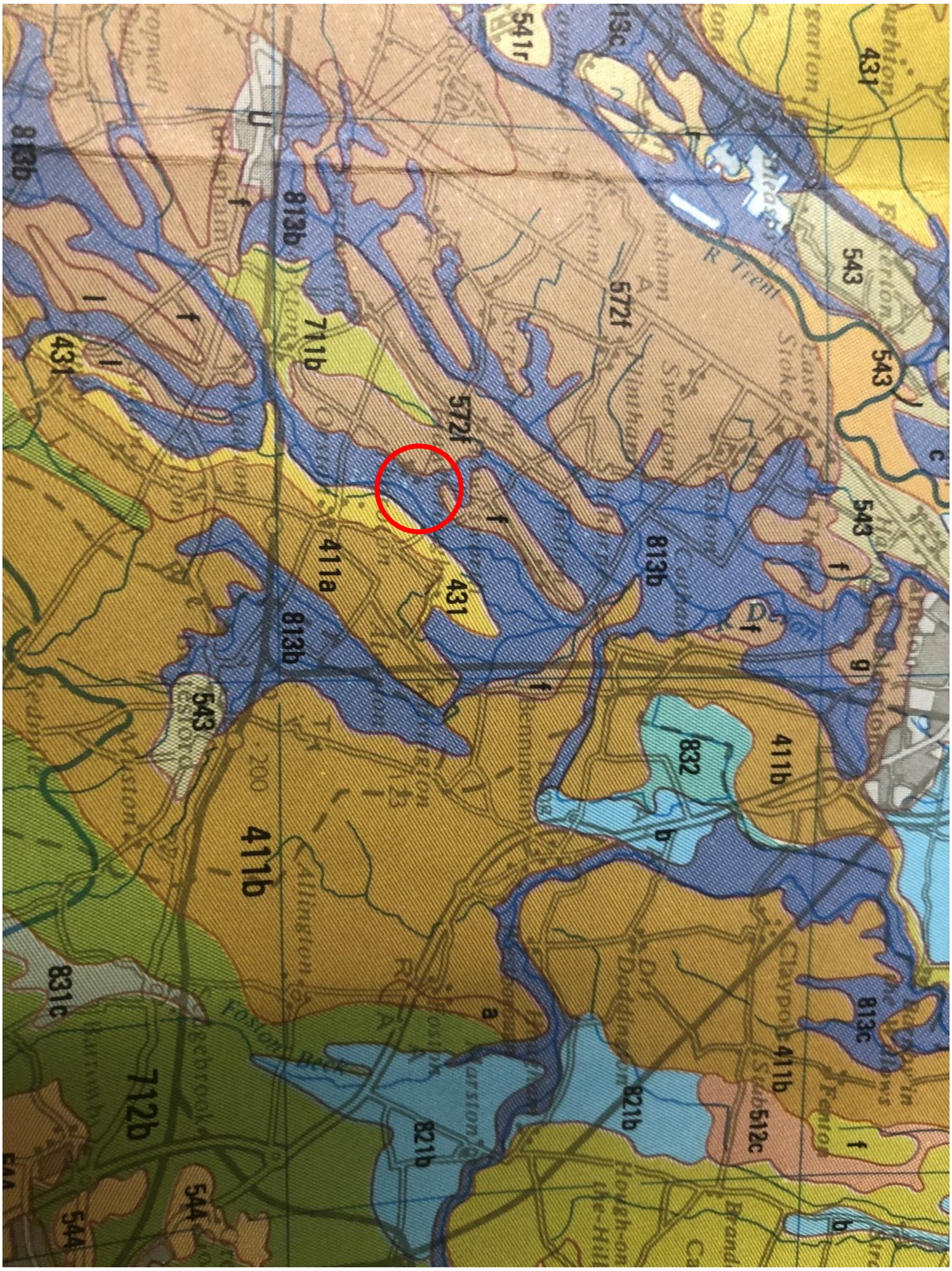
Soil Map of The Area



Appendix 2

0572f WHIMPLE 3 Detailed Description

This association of seasonally waterlogged reddish fine loamy or fine silty over clayey soils, developed in thin drift over Permo-Triassic and Carboniferous mudstone or clay shale, is widespread (1,543 km²) in the Midlands and South West England, mainly on moderate slopes. It also includes reddish clayey soils developed directly in the mudstone and wet soils on gently sloping ground. The soils occur mainly over Triassic mudstones, though in Devon they mostly overlie Permian beds. In parts of Staffordshire they are developed in mudstones of the Upper Coal Measures. Altitudes range from 10 to 230 m O.D. though most of the land lies between 50 and 150 m O.D. The dominant Whimple series, of the stagnogleyic argillic brown earths, has fine loamy or fine silty drift horizons overlying slowly permeable mudstone or clay shale and is found mainly on gentle or moderate slopes. Steeper drift-free slopes support the Worcester series which is reddish and clayey throughout and belongs to the typical argillic pelosols. Gently sloping land in receiving sites carries fine loamy or fine silty over clayey soils of the Brockhurst series, belonging to the typical stagnogley soils. Fine loamy soils of the where the drift is thick, fine loamy over clayey Flint soils are included. Clayey Spetchley soils are found on some flat receiving sites and occasional profiles of the Dunnington Heath series occur on slopes where thin coarse loamy drift overlies mudstone. Locally in narrow valleys there are thin strips of Compton series in alluvium too small to be shown separately on the map. The association is extensive (1,085 km²) throughout the Midlands, mainly in Hereford and Worcester, Staffordshire, Derbyshire and Warwickshire, but also in Nottinghamshire and Leicestershire. Whimple series is predominant everywhere with Worcester series the main associate. The soils are found widely around Bromsgrove and Worcester, and extend down the Severn as far as Tewkesbury. They also occur between Great Witley and Great Malvern. In these localities Brockhurst and Spetchley soils are important with Compton soils only along narrow valleys.

In central Staffordshire, the association is found on moderate slopes of the Trent, Blithe and Sow valleys where geological erosion has stripped most of the former cover of glacial drift. Here Brockhurst soils are confined to wet hollows and lower slopes. In some places, drift more than a metre thick gives Flint soils. Around Stoke-on-Trent, on reddish Carboniferous mudstones, clayey soils are much less common than on the Triassic beds further south and the main subsidiary soil is the Brockhurst series. In the Dove valley to the west of Derby and in parts of north-west Leicestershire, Whimple and Worcester soils are co-dominant with a few fine loamy Hodnet soils where sandstones and siltstones are interbedded with the clay and mudstone. South of Birmingham on the slopes of the Arrow and Avon valleys, Whimple and Worcester soils occur almost exclusively though around Henley-in-Arden interbedded sandstones and greenish grey marls give more loamy Hodnet soils than elsewhere. West of Leicester Brockhurst soils are common associates. In Nottinghamshire, Whimple soils occupy about two-thirds of the association which is mainly on gentle slopes flanking the river Trent east of Nottingham. Dunnington Heath soils are common locally but Worcester soils are mainly restricted to moderately sloping land or to steep river bluffs as near Kneeton. In this same area and further north near Wheatley, Walkeringham and on a hilltop near Oxton, well drained silty soils such as Barton and Wheatley series are included on bands of siltstone skerries.

The association is extensive (460 km²) in Devon, Somerset, Avon and Gloucestershire, over Triassic and Permian reddish mudstone. The thin loamy Head overling the mudstones is derived from various local rocks. Near Exeter topsoils contain large rounded stones from the Budleigh Salterton Pebble Beds. Further east in Devon and in adjoining parts of Somerset, the Head is from the Greensand and contains chert stones, but around the Quantock and Mendip Hills, stones from Palaeozoic rocks are found.

Soil Water Regime

Whimple and Worcester soils suffer slight seasonal waterlogging (Wetness Class III) in many districts but in the drier parts of the region, Whimple soils can have a better water regime (Wetness Class II). Brockhurst soils are usually waterlogged for long periods in winter (Wetness Class IV) though with drainage in districts where the annual average rainfall total is less than about 750 mm, the duration of waterlogging is shorter (Wetness Class III). Little excess winter rain is absorbed because all these soils have slowly permeable subsoils. All the soils can benefit from underdrainage which is most necessary for Brockhurst soils.

Cropping and Land Use

Almost all the land is in agricultural use though cropping varies considerably from one district to another. In Worcestershire and Nottinghamshire, arable farming predominates, the main crops being winter cereals sown in rotation with short-term grass and oilseed rape or occasional fodder crops such as kale. Sugar beet and potatoes are included in the rotation in Nottinghamshire. Cultivations are normally confined to slopes of less than 8 degrees and are mostly on Whimple rather than Worcester or Brockhurst soils. The period suitable for landwork is more than adequate in Worcestershire and Nottinghamshire, but in Lancashire there are fewer good machinery work days, particularly in spring, which results in a larger proportion of long-term grassland. Dairy cattle are widespread on long-term grassland in Staffordshire, Derbyshire and Warwickshire. Beef cattle are locally important but sheep are numerous only on higher ground. The topsoils of Worcester and Brockhurst series, and to a lesser extent those of the Whimple series, are water retentive which with their slowly permeable subsoils causes surface wetness and a strong risk of poaching. These soils are very susceptible to smearing and compaction when farm operations are mistimed. Opportunities for landwork in winter are negligible and often long delayed by wet weather in spring or autumn. Under continuous arable cropping deep subsoiling (60 cm) is necessary to break up plough pans. All component soils are very droughty for grass in the east and south-west of the region , with reserves of water barely adequate here for cereals. In south Derbyshire, Staffordshire and Warwickshire, there is a moderate drought risk for grass in normal years but this is only slight for cereal crops.

Cropping varies considerably from one district to another, in north-west Gloucestershire arable farming predominates, as in the Midlands, the main crops being winter cereals sown in rotation with short term grass and occasional fodder crops such as kale. The soils are generally not suitable for potatoes or horticultural crops. Opportunities for landwork are adequate in Gloucestershire, but further south-west there are fewer good machinery work days, particularly in spring, which results in a larger proportion of permanent grassland. These soils are also very susceptible to smearing and compaction when farm operations are mistimed. Opportunities for landwork in winter are negligible and often long delayed after wet weather in spring or autumn.

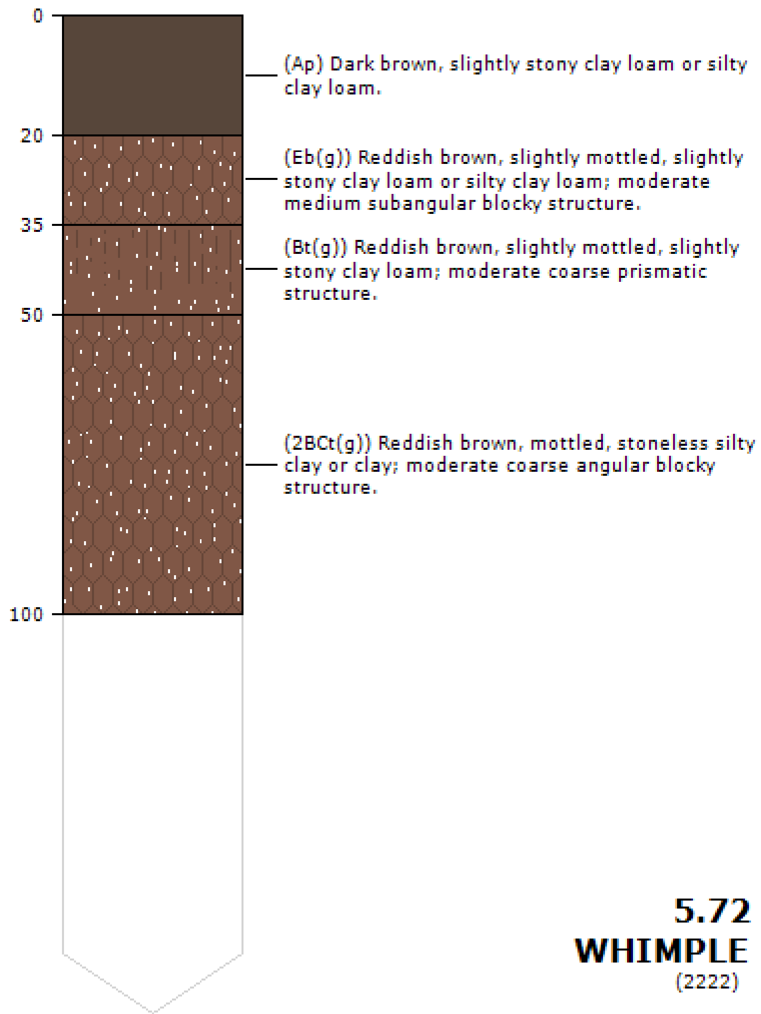
The climate of Avon, Devon and Somerset promotes good grass growth, though increased yields can be offset by wetter ground conditions in spring and autumn which lead to poaching damage. Because there are insufficient good machinery work days dairying is the main enterprise. In these wetter areas poaching risk is considerable, particularly on Worcester and Brockhurst soils. While summer droughtiness does not affect cereal cropping in the region, it limits grass production particularly in north-west Gloucestershire.

Nutrient reserves are naturally good, the underlying mudstone being rich in potassium, calcium and magnesium. Lime and nitrogen are necessary to maintain fertility though slow permeability ensures that leaching losses are minimal.

5.72 WHIMPLE Definition

Major soil group:	05 brown soils	With dominantly brownish or reddish subsoils and no prominent mottling or greyish colours (gleying) above 40 cm depth. They are developed mainly on permeable materials at elevations below about 300 m.0.D. Most are in agricultural use.
Soil Group:	7 argillic brown earths	Loamy or clayey with an ordinary clay-enriched subsoil.
Soil Subgroup:	2 stagnogleyic argillic brown earths	(faintly mottled with slowly permeable subsoil)
Soil Series:		medium loamy or medium silty drift over reddish clayey material passing to clay or soft mudstone

Brief Profile Description



813b FLADBURY 1 Detailed Description

The deep clayey alluvial soils of this association are widespread on flat valley floors in the Midlands and South West England and occur to a limited extent in Cambridgeshire, Buckinghamshire, Essex and South Glamorgan. They often flank rivers draining catchments of Jurassic rocks and hence occur mainly on or near the broad Jurassic outcrop from east Nottinghamshire to south Somerset. Fladbury soils, pelo-alluvial gley soils, are clayey throughout and prominently mottled directly below the topsoil. The presence and proportions of the subsidiary Wyre and Thames soils varies not only between river systems but also along the rivers themselves, reflecting changes in sedimentary regime, catchment lithology and influence of tributaries. Thames series, pelo-calcareous alluvial gley soils, are similar to Fladbury series but calcareous and are most common where limestones are extensive in the catchment. Wyre soils, pelogleyic calcareous alluvial soils, occur on levees, or on other slightly elevated floodplain sites, and on narrow tracts of alluvium. They have a brown subsoil without grey mottles above 40 cm depth.

This association covers just over 180 km² in Nottinghamshire, Leicestershire, Warwickshire and Worcestershire alongside the Devon, Soar, Welland, Avon and their tributaries. Extensive tracts are Fladbury series with Wyre or Thames series only locally significant, as in the lower reaches of the Avon. Small areas of Stixwould soils are present where the alluvium thins over loamy and sandy glaciofluvial deposits, particularly towards the margins of the floodplains and in certain valleys such as that of the Wreake. Midelney soils are encountered occasionally where peat underlies alluvium at shallow depth.

In Eastern England The association occurs along the middle and upper reaches of the Welland and Nene, on the Great Ouse near Huntingdon and to a limited extent in the valleys of the Stour, Chelmer, Blackwater, Roding and Holland Brook in Essex. Typically about half the land is of Fladbury series with less than a quarter each of Wyre and Thames series. Along some rivers, for example the Nene, there are more Thames soils, and elsewhere, as along the Welland, Thames soils are rare. On the Great Ouse it is common to find Fladbury soils above the weirs and Wyre soils below them. Wyre and Uffington soils become dominant in places as the floodplains narrow upstream. Midelney and Windrush soils are common beside the Stour but otherwise are rare.

These soils are mapped along the Bristol Avon and Nadder in Wiltshire, along the Stour in Dorset, and in Somerset where the rivers Yeo, Tone, Isle, Brue, Cary and Axe enter the Levels. They also occur along the Rivers Leadon, Frome, Laddon and Chelt in Gloucestershire, and the Otter, Yarty, Axe and Alphin Brook in Devon. Fladbury soils are the main soils on most of these river floodplains, with Wyre and Thames soils occupying small areas where the groundwater is lower or the alluvium calcareous. Wyre soils are most extensive on the floodplain of the Bristol Avon. Other soils of local significance include Uffington; Conway, and Compton series, for example on Tibberton Meadows, and loamy typical and gleyic brown alluvial soils in Devon. In the Somerset Moors some Fladbury clays overlie peat within 1 metre and pass into Midelney soils where the clay is thinner than 80 cm.
This association is found in South East England on the alluvium of the Great Ouse in Buckinghamshire and in the Cherwell, Evenlode, Thame, Cole and Ock valleys in Oxfordshire. In the last three valleys, Wyre soils are rare but Thames soils account for up to one-fifth of the area. Some reaches of the Evenlode floodplain are dominated by Wyre series and others have inclusions of Usher series on levees. Small outliers of low gravel terrace carry patches of Kelmscot soils.

Soil Water Regime

Fladbury, Wyre and Thames subsoils are usually slowly permeable. However, the primary source of waterlogging is groundwater which fluctuates seasonally with changes in the river level. The duration of waterlogging is often related to elevation. In winter months, a water-table is at shallow depth for long periods in many Thames and Fladbury soils (Wetness Class IV) and locally they suffer prolonged waterlogging (Wetness Class V). Thin peaty topsoils occur in some low-lying areas. On raised areas of the floodplain, where the waterlogging is less frequent, Wyre soils (Wetness Class II or III) are found. Flooding is a perennial problem, its frequency and distribution depending on rainfall, catchment configuration and flood control measures. Many areas suffer partial inundation two or three times annually although, except in backswamps, duration is short.

Cropping and Land Use

These soils are predominantly under permanent grassland or long leys and rushes infest the wettest sites. Because of a large retained water capacity, there is a serious risk of poaching and the risk of flooding further curtails winter grazing. Nevertheless, the soils support good summer fattening pasture and mowing grass, growth being maintained during all but the driest periods by the large amount of available water (170 mm) and perhaps some additional moisture in spring from the groundwater-table. The short field capacity period in east Nottinghamshire and parts of Leicestershire not only allows a long grazing season but also some arable use. Cereals are most often grown; they are sown in autumn where there is little flood risk, but elsewhere are spring-sown into ground cultivated the previous autumn. Roots are occasionally grown in the Devon valley but wetness causes harvesting difficulties. Thames soils are naturally calcareous but Fladbury and Wyre soils are neutral or slightly acid in reaction.

In the west, these soils are predominantly under permanent grassland or long leys and rushes infest the wettest sites. Because of a large retained water capacity, there is a serious risk of poaching. Flooding further curtails late autumn and spring grazing, although flood control measures in recent years have considerably reduced the risk. Nevertheless, the soils support good summer fattening pasture and mowing grass, and growth is maintained during all but the driest periods. There is some arable land in Northamptonshire but it is more common in the drier areas of Cambridgeshire and Essex where there is more opportunity for tillage and where summer grass yields are reduced by drought. Cereals are the main crop, spring sowing being preferred where there is risk of winter flooding. Frost-weathering of winter cultivations on this heavy land provides a good seed bed for spring sowings. Cereal crops are little affected by drought. Thames soils are naturally calcareous but Fladbury and Wyre soils are neutral or slightly acid in reaction. All three soils contain good reserves of potassium but are inherently poor in phosphorus, its level depending on recent fertilizer use. Manganese deficiencies are common in grass herbage and cereals.

In a few places, for example, on Ot Moor, the water-table is controlled by pump drainage and the land is used for winter cereals. The soils are difficult to manage, however, and as there are few opportunities in spring for landwork, timely autumn cultivation is essential. Arable cropping is also possible where Wyre and Usher soils are extensive.

8.13 FLADBURY Definition

Major soil group:	08 ground-water gley soils	Seasonally waterlogged soils affected by a shallow fluctuating groundwater-table. They are developed mainly within or over permeable material and have prominently mottled or greyish coloured horizons within 40 cm depth Most occupy low-lying or depressional sites.
Soil Group:	1 alluvial gley soils	With distinct topsoil, in loamy or clayey recent alluvium more than 30 cm thick.
Soil Subgroup:	3 pelo-alluvial gley soils	(clayey with non-calcareous subsoil)
Soil Series:		clayey river alluvium

Brief Profile Description

LandIS Land Information System Soil Series

Citation: To use information from this web resource in your work, please cite this as follows:

Cranfield University 2021. *The Soils Guide.* Available: www.landis.org.uk. Cranfield University, UK. Last accessed 02/07/2021

Appendix 3

Alternative Ways to Sequester Carbon Dioxide

A recent scientific study has demonstrated that the use of ground rock, spread on farmland can capture far more carbon dioxide through ‘farming’ than renewable energy. (https://www.thetimes.co.uk/article/microsoft-funds-uk-climate-experiment-to-spread-crushed-rock-on-fields-6sjq5cwzz)

Microsoft is backing a pioneering effort to remove CO_2 from the atmosphere by scattering thousands of tonnes of crushed rock onto British fields. The technique, is designed to tackle global warming, with advocates suggesting it could play a large role in stabilising the climate.

In a pilot project, Microsoft will pay a Scottish company called Undo to spread 25,000 tonnes of finely crushed basalt rock, a quarrying by-product, on agricultural land in Scotland and the north of England.

The rock dust approach, called enhanced rock weathering (ERW) follows a research programme of the Leverhulme Centre for Climate Change Mitigation which confirms that spreading rock dust on farmland could suck billions of tonnes of carbon dioxide from the air every year, according to the first detailed global analysis of the technique.

The chemical reactions that degrade the rock particles lock the greenhouse gas into carbonates within months, and some scientists say this approach may be the best near-term way of removing $CO_2$from the atmosphere.

Basalt is the best rock for capturing CO_2, and many mines already produce dust as a by-product, so stockpiles already exist. ERW also reduces soil acidity; Basalt is preferred for ERW as it contains the calcium and magnesium needed to capture CO_2, as well as silica and nutrients such as potassium and iron, which are often deficient in intensively farmed soils.

Causes of soil compaction and how to beat it with Controlled Traffic Farming (CTF)

Farmers Weekly 23 October 2015

Soil degradation is a huge cost for farming, which was estimated at up to £1.4bn a year in a recent parliamentary report *Securing UK Soil Health*. Of this, flooding resulting from increased compaction is estimated to cost £233m a year.

The two main problems are compaction and the loss of organic matter, which is vital for soil structure and gives it much of its fertility. Both of these account for 80% of the £1.4bn cost.

Soil facts

- There are more microorganisms in a handful of soil than there are people on earth
- It takes 500 years to produce an inch of topsoil
- It greatly reduces flood risk by storing up to 3,750t water/ha
- About 10% of the world's carbon dioxide emissions are stored in soil
- Soil consists of 45% minerals, 25% water, 25% air and 5% organic matter

Causes of compaction

Shane Ward, director of soil and water management centre at Harper Adams University College points to increased machinery size as a factor in soil compaction.

"Over the past 20 years, one key element that has led to declining soil health is the growing mechanisation of farming and bigger tractors.

"It has been a gradual process, with machinery becoming more sophisticated and larger – with bigger, wider tyres to take the extra weight. This has taken its toll, having a direct physical effect on soil."

In addition, tractor drivers sealed in modern cabs are removed from action on the ground and are, therefore, less aware of the impact of machinery on the soil, he says.

Compaction reduces the water-holding capacity of soil by decreasing the air spaces between particles and consequently, you get more run-off and standing water.

"Run-off is not good. It can lead to soil erosion and contaminate water courses," says Prof Ward.

In addition, a healthy soil will hold on to nutrients better, reducing losses to the environment and promoting good crop growth. "Poor soil health is a restriction on crop yields and can lead to more disease, especially those in waterlogged conditions."

Assessing soils

The first place to start is by digging a soil pit, says Prof Ward. Examine the structure for any signs of damage that may need some repair work, such as deep cultivations to break up a plough pan.

Getting a spade out is especially valuable for determining if there is a hidden problem deeper in the soil profile.

"A rule of thumb is that compaction occurs at half the tyre width below the soil surface. So with more massive machines and bigger, wider tyres, this can be well below the plough layer.

Tim Chamen of CTF Europe explains that compaction at depth is governed by axle loading. "You can reduce tyre pressure or use tracks, but if the wheel load is high enough, you still get compaction at depth."

This damage occurs even with low ground-pressure systems, but it can't be seen because it is happening deep in the profile.

Prof Ward says this could catch out some farmers who are rotationally ploughing and believing this is breaking compaction.

Dr Chamen believes this hidden compaction could be the reason for the plateauing of wheat yields in recent years. He points to one trial looking at the impact of compaction under controlled conditions, where even after eight years, there was still a 1-2% yield penalty in wheat.

For this deep damage, Prof Ward says farmers need to consider using a ripper (subsoiler) to break up the pan, but again it has to be given a chance to recover and be managed over time.

How you manage fields after subsoiling is just as critical," says Dr Chamen, as soil is more vulnerable.

"You don't want to go in with machinery and end up back at square one."

Cracking compaction

That's why Dr Chamen believes prevention is key, as well as managing soils so they become more resilient. "It requires a range of measures, such as ensuring soils have a good level of organic matter."

Adding compost, manure and chopping straw will raise organic matter levels, as will cover crops. Minimising the period there is no crop growing by maintaining cover is good for soil structure.

Also check drainage. "If there is poor drainage, even with the best will in the world, none of the preventative measures will be successful," says Dr Chamen.

But the key thing farmer need to do is to avoid compaction in the first place by minimising trafficking.

"Trafficking damages the soil. It squashes out the air, squeezing it together, sealing up the surface and making it cloddy (see illustration)," he explains.

Switching cultivation system can help. He points to data showing that in a typical no-till system, about 45% of the field is trafficked. With a min-till system, this rises to 60-65% and with a traditional plough system, it's 85% of the area.

Controlled traffic farming

However, to get below 40% of the area being trafficked, farmers will need to adopt controlled traffic farming (CTF).

This is a system that confines compaction to the least possible area by the use of permanent traffic lanes. A satellite guidance system is a valuable component in making it work, says Dr Chamen.

There are three different tiers, depending on how much the machinery matches up in width, resulting in the area tracked:

- Tier 1 – 30-40% area tracked
- Tier 2 – 20-30% area tracked
- Tier 3 – 10-20% area tracked

Many farmers will point to the high investment cost of replacing machinery, but he says it can be done at low cost when put in place incrementally, as machinery is naturally replaced.

He encourages farmers to try tier 1 with their existing machinery, as some will match up and then they can see the benefits for themselves. “Seeing the benefits to soil will then encourage them to move to tier 2.”

For some crops, a full system is not possible. For example, sugar beet harvesting is not on a compatible width, but if you use CTF in the rest of the rotation, you will see improvement and after five to six years, soils will be more resistant to damage come the next sugar beet harvest.

From his experience, reducing compaction with CTF will lead to about 15% more yield (average across 15 different crops) in non-trafficked areas and when it covers 80% of the field (tier 3), this is a substantial gain.

As soils recover their natural structure, there is a 15% better nitrogen recovery, with up to four times better rainfall infiltration and a 10% increase in top soil porosity.

It’s not just soil health, Dr Chamen points to cost savings as soil becomes healthier – needing fewer passes – and can go shallower, with a 35% decrease in fuel use for crop establishment.

Healthier soils reduce the time it takes to produce a good seed-bed. “If it takes longer to produce a good seed-bed with poorer soil, the delay means you are likely to end up drilling in poorer conditions and increasing the risk of damaging soil.”

Case study

Jeremy Durrant, EW Davies Farms, Thaxted, Essex

One farmer seeing the benefits of controlled farming is Jeremy Durrant, who manages 1,300ha of cropping including wheat, oilseed rape, beans plus winter and spring barley.

“Six years ago, we were running an all plough-based system on Hanslope clay and we were expanding the area we farmed. But it was becoming clear that it was taking more time and effort to produce a good seed-bed and doing this over a larger area was not viable.”

“So we moved to a min-till system, however, we were getting cloddy seed-beds.

He explains that producing good seed-beds required more intensive cultivations and he was having to do quite a lot of subsoiling.

“This was not only time-consuming, but also expensive. We looked at reducing costs and decided to go with controlled traffic farming.”

Now fully on CTF with 12m wheelings and 36m tramlines, he estimates that the move has cut fuel use by 30-40% and requires less labour. The business has also gone from six tractors to two, supplemented with hired-in tractors at harvest.

Soil structure has improved year on year. “When we take on new land, it takes two full seasons before we see any noticeable difference and it continues to get better over time.

The improved soil structure resulting from less trafficking means Mr Durrant has gone from two/three passes with a cultivator typically covering 30-40ha in a day when establishing wheat, to a single pass with a lighter, wider cultivator covering 120ha a day.

“This gives you more flexibility on timing and it gives us confidence to delay drilling for grassweed control and still get good establishment.”

The improved soil health has allowed Mr Durant to cut cultivations further, direct drilling oilseed rape and spring crops. “This year all our oilseed rape (200ha) was drilled in a single 24-hour period.”

Appendix 4

Direct drilling can boost profits and soil health

Better for light and heavy soils

A switch to direct drilling could help arable farmers improve soil health and business performance, suggests a study.

Average net profits rose by 15% under a direct drill system rather than full cultivation, according to the five-year study described as the UK's most comprehensive trial of crop establishment systems through a whole farm rotation.

Researchers also found that more ecological and environmental benefits were delivered by the direct drill system rather than the plough and drill.

Led by the Game & Wildlife Conservation Trust (GWCT) and Syngenta, the study was supported by NIAB monitoring and data analysis..

Arable rotation

It examined a full arable rotation on contrasting commercial farms at Loddington in Leicestershire and Lenham in Kent. Farms involved represented a spectrum of heavy to light land.

Belinda Bailey, of Syngenta UK, said the study provided rigorous scientific insight into the implications of adopting direct drill establishment. Researchers set out with no pre-conceived illusions as to which system would prove most effective, or a panacea for all situations, she added.

Seasonal challenges

"It has highlighted some of the potential pitfalls and the seasonal challenges across the different soil types and volatile market conditions. Overall, it has shown a no-till system can offer a more sustainable option for arable businesses in most situations."

Results found that yields of cereals, beans and oilseed rape yields were the same as with full cultivation establishment on the light land,. But yields were 7% lower on heavier soils in Leicestershire.

That said, the overall gross margin was better with the direct drill due to a 45% reduction in fuel use on both sites, combined with an 11% reduction in operating costs on heavy land and 7% lower on light land.

This gave a 14% and 16% improvement in net profit on the heavy soil and light land respectively over the five years. There was also a 50% improvement in work rate across both sites with direct drill establishment.

"That could give greater flexibility and resilience to increasing challenges of timely establishment in difficult weather conditions."

Work rates

"Improved work rate could also give some growers the opportunity to increase farmed area and spread costs further, or with the current high capital cost of machinery to explore opportunities to downsize their equipment and reduce soil impacts," explained Ms Bailey.

A reduction in fuel use and operational costs by adopting a direct drill system was a key driver in achieving a 9% reduction in carbon footprint.

This was through reduced cultivations on the light land soils, along with a 4% reduction on heavy land.

>>

Belinda Bailey demonstrates green cover for soil enhancement

Below: A Dale drill used in conservation agriculture establishment trials

> “ No-till can offer a more sustainable option

>> Soil scientists also assessed an 8% reduction in soil greenhouse gas emissions on the heavy land and a 5% reduction on light land, compared to crops established with full cultivations.

The study showed no increase in soil emissions of nitrous oxide (NO2) under direct drilling. This had been a concern because compacted soil conditions can give rise to elevated levels of what is a serious greenhouse gas.

Soil structure remained excellent throughout the direct drill establishment rotation, the study found.

There was a 10% improvement on the light land, compared to repeated cultivations and no significant impact on the heavy land over the course of the five years.

Grass weed control

"Elevated organic matter levels seen with direct drill establishment over a longer term trial at Loddington, or where rotational ploughing may be utilised for grass weed control within a direct drill system, could alleviate any potential for compaction on heavy land," said Ms Bailey.

The trial also identified 112% more earthworms on light land and 13% in the heavy soils under the direct drill system, she addded.

Soil nutrient sampling showed no significant differences between the establishment systems for nitrogen, phosphate and potash or magnesium levels on either site over the five years. But they did highlight some seasonal variability, particularly in nitrogen and potash.

Biodiversity

Bird sightings – a further indicator of farm biodiversity – were significantly higher across the direct drilled areas throughout the rotation.

Bird recordings were notably elevated for skylarks, meadow pipit and thrush species in the period of the study, primarily due to increased ground cover and available surface food sources. "Direct drill establishment offers significant advantages," said Ms Bailey.

"The results positively demonstrate that as more growers make a transition towards direct drill or light till establishment systems there are clear advantages for the economic and ecological sustainability of the farm finances and biodiversity."

Study 'underlines benefits' of regenerative agriculture

Direct drilling aligns well with the government's new Sustainable Farming Incentive (SFI), which rewards farmers who look after the environment while producing food. Joe Stanley *(right)* is head of partnerships at the Game and Wildlife Conservation Trust, which hosted one of the trials at its Loddington farm in Leicestershire. There were advantages in the direct drill system in terms of integrated farm management practices, he said.

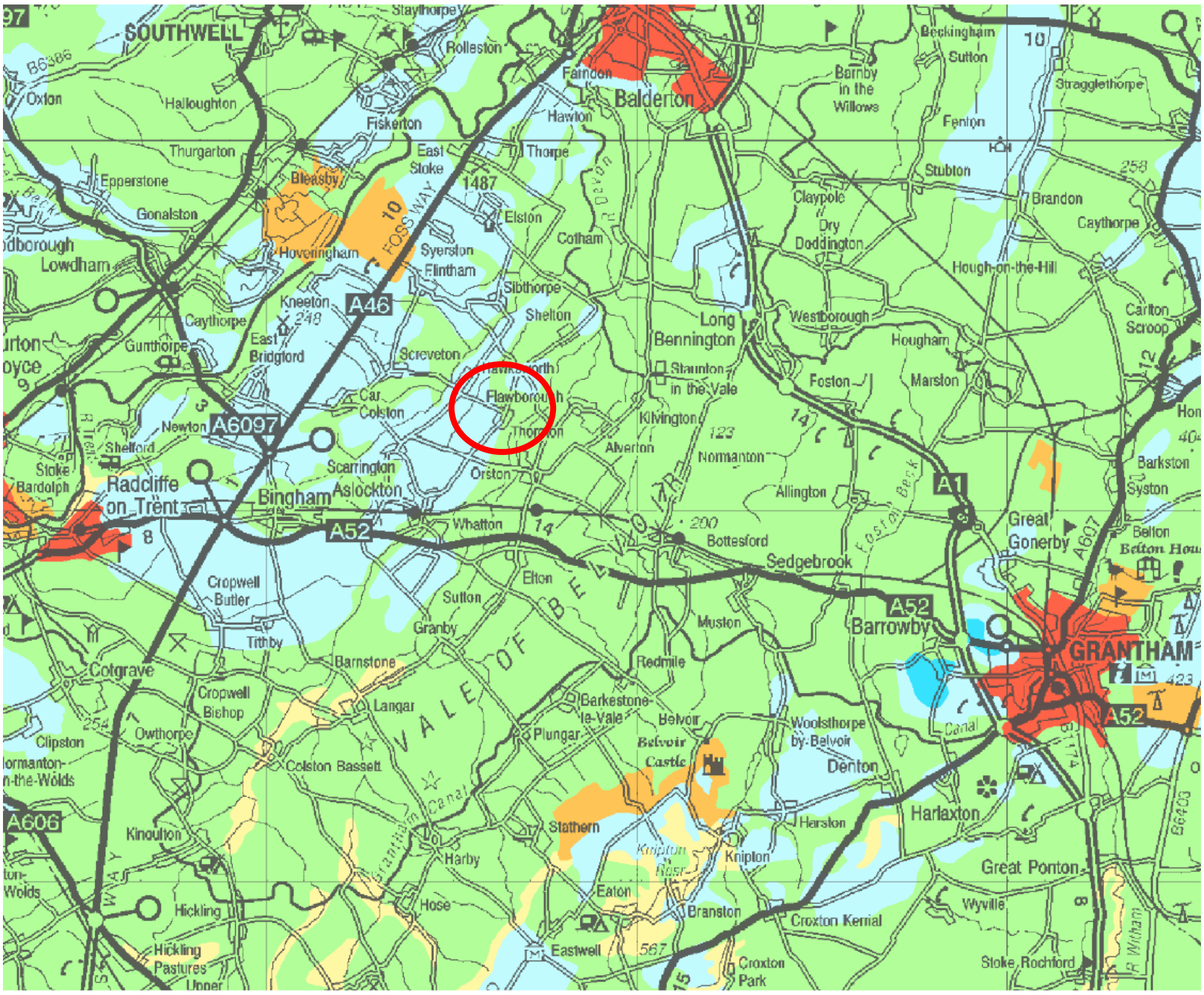
"We have been delighted to work alongside Syngenta on this long-term research project. These findings underscore the immense potential of Conservation Agriculture, and consequently Regenerative Agriculture.

"By making adaptations to establishment techniques, while keeping other inputs constant, we can achieve substantial cost savings in both time and money. Simultaneously, it can enhance profitability, contribute to environmental stewardship, and mitigate climate change.

"We are pleased to be continuing this work with Syngenta as we progress to a second, more 'regenerative' phase over the coming years, as we look to build on the solid data and foundations already built."

The Syngenta Conservation Agriculture & Sustainable Farming Systems project is a long-term pan-European research initiative.

Appendix 5

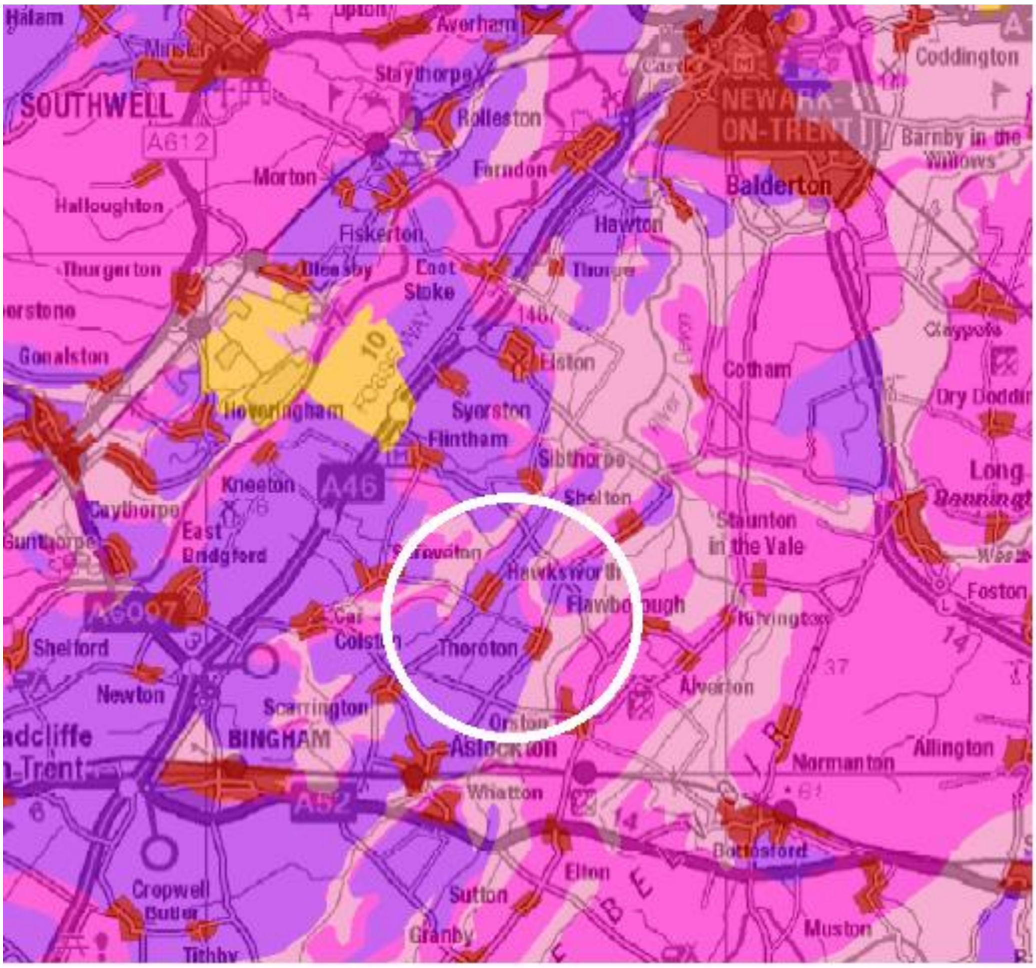


Grade		Description
1		Excellent
2		Very Good
3		Good to Moderate
4		Poor
5		Very Poor

Non-Agricultural Land

- Other land primarily in non-agricultural use
- Land predominantly in urban use

Appendix 6



0 5 10 Kilometres 20

Predictive BMV Land Assesment © Defra

- High likelihood of BMV land (>60% area bmv)
- Moderate likelihood of BMV land (20 - 60% area bmv)
- Low likelihood of BMV land (<= 20% area bmv)
- Non-agricultural use
- Urban / Industrial

Appendix 7

Damage During Construction and Operation

Soils

The soils locally are mainly clay or clay loams. Typically, these soils are slowly permeable, similar fine clay topsoils over clayey subsoils.

These soils can be badly affected by compaction, especially during the construction phase of the project. Experience from other solar sites built during poor conditions demonstrates the extent of damage that can be done. Contractors are often under severe time pressure to complete construction and will sacrifice soils in order to complete their works.

Compacted layers within the soil will affect drainage and it may cause areas of surface ponding across a field. Soil aggregate stability can be reduced by the construction, resulting in a degradation of soil physical quality. **Photo sheet 2 in Appendix 7** shows a timelapse series of photos of a solar farm during construction on similar soils. These deep soil compaction issues are difficult to remedy once the solar panels are installed.

As work progresses, so the soil conditions deteriorate. In more extreme circumstances due to the need to complete works within a deadline, serious soil damage can occur. Far from improving the status of land by taking it out of production, this soil damage can permanently harm the soils' productive capacity into the longer term, leading to a change in the soil-water regime.

Compaction caused during construction damages the soil structure and means that soil remains wet due to poor drainage. This in turn affects the fertility of the land, the type of grass and other plants that can grow and makes long term predictions about improved fertility due to taking land out of arable production, much less likely.

Damage During Management

The fine clay nature of these soils are slowly or moderately permeable in the topsoil, slowly permeable at depth in the growing season. Clay soils such as these do respond to drainage measures and where annual rainfall is less than 600 mm can be improved to Wetness Class II, but even with under drainage the soils remain vulnerable to damage.

As water washes off solar panels, it collects on the grassy areas between the panels, along with the incident rainfall falling. As such, the un-panelled areas receive most of the rainwater, whilst the areas under the panels remain much drier.

When machinery is used to cut the grass or clean the panels, damage to the soil can occur through excessive trafficking when wet. Again, contractual obligations and time pressure encourages operatives to work in less-than-ideal conditions and this can cause soil damage that persists.

Use of Machinery in Inappropriate Conditions on similar soils

Traditionally these soils would have been ploughed regularly and by using deeper cultivations such as subsoiling and mole draining, would help to improve drainage. However, once the solar farm is constructed it is not possible to remedy any damage under or close to the panels. Between the panels, deeper cultivations are limited due to the risk of damage to buried cables and the narrowness of layouts.

As such once layers of soil are compacted the compaction can persist for much of the life of the project and even beyond with only limited opportunity to remedy problems. Far from resting the land and improving its status, soil quality will suffer in such circumstances.

Conditions during construction

Photo Sheet 2

1


2


3


4


5


6


Conditions as construction proceeds

Commencement

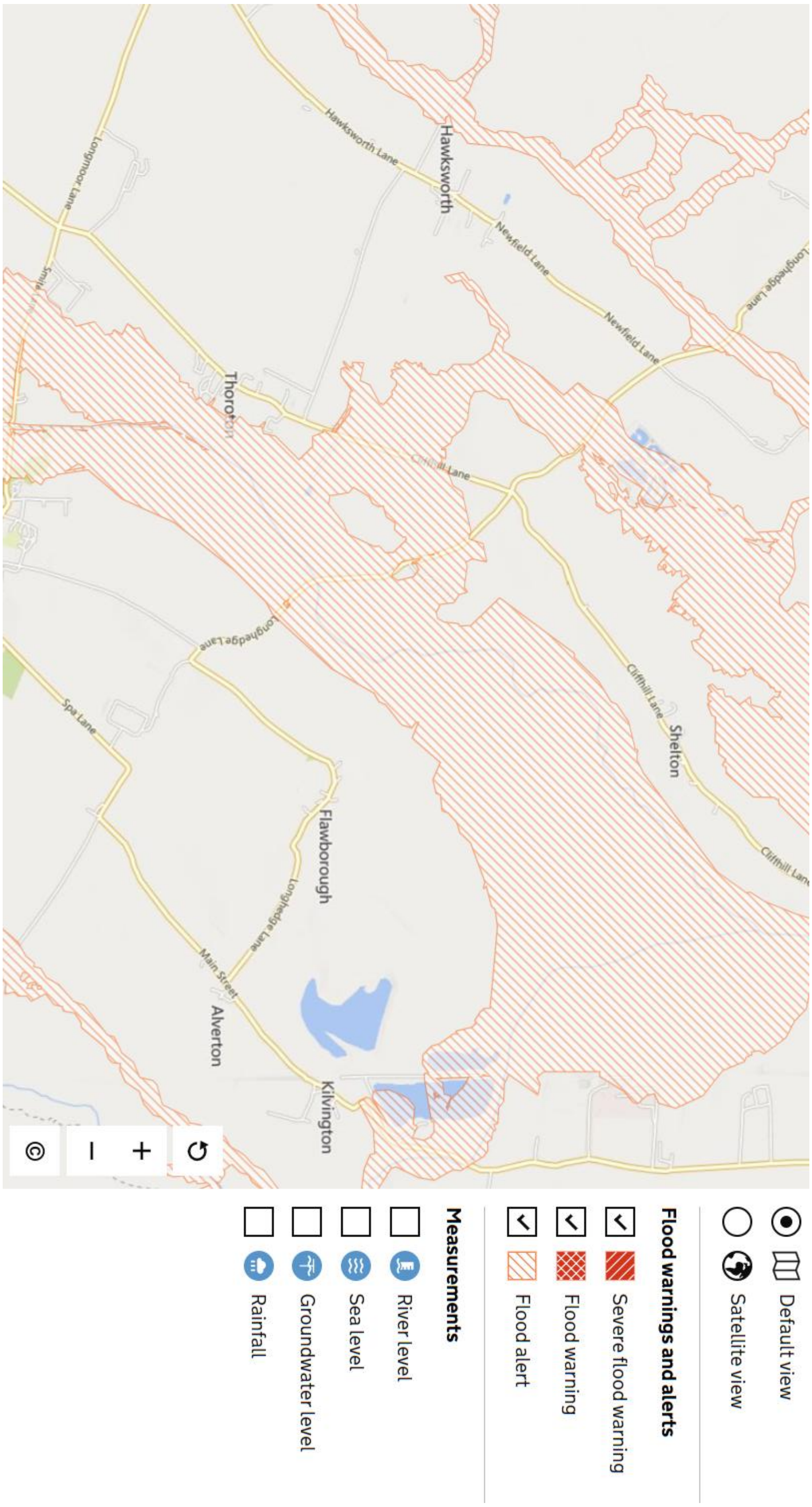
Mid construction

Near completion

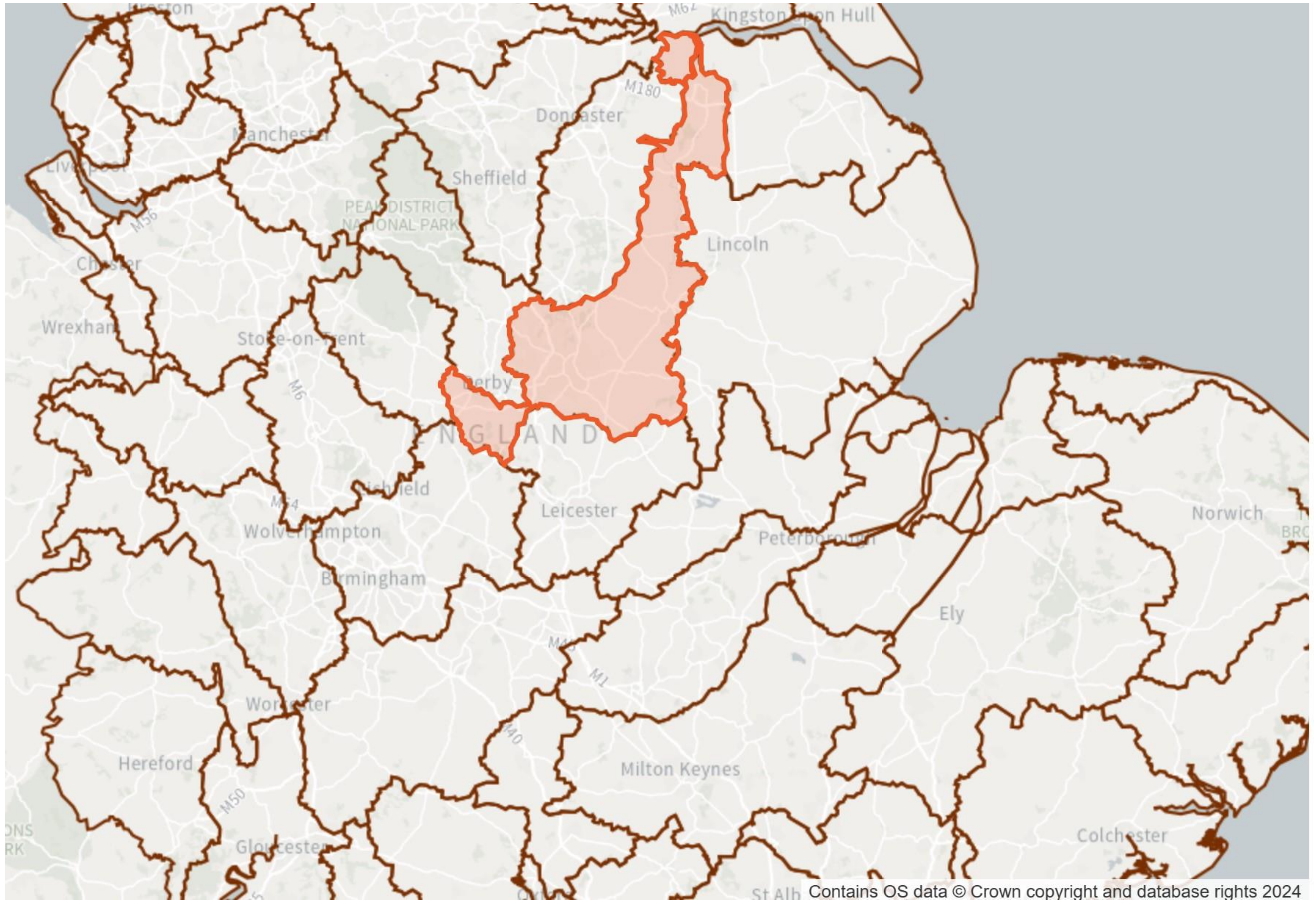
Examples of Localised Drainage Issues/ No Grass Under Panels

Appendix 8 Appeal Site Flooding

Flood Alert October 2023



Amended climate change allowances for the Humber Basin

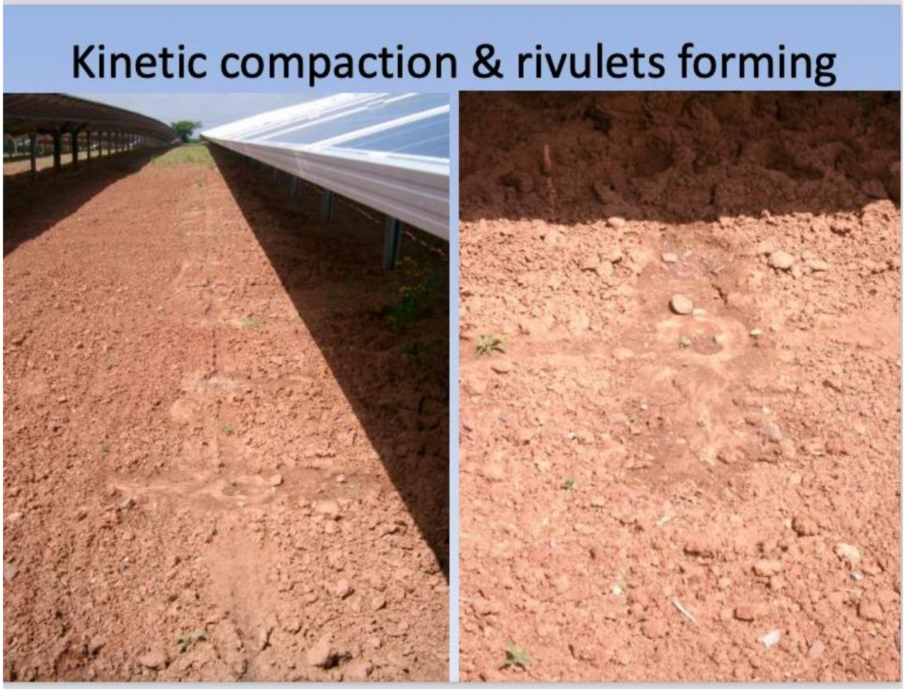


Lower Trent and Erewash Management Catchment peak river flow allowances

	Central	Higher	Upper
2020s	13%	18%	29%
2050s	17%	23%	38%
2080s	29%	39%	62%

This map contains information generated by UK Centre for Ecology and Hydrology using UK Climate projections.

Appendix 10



Appendix 11

Sheep Grazing Under Panels

Whilst it is perfectly possible to graze the areas under and between the panels, it is unlikely to be very cost effective for a grazier. The difficulties of rounding up sheep and handling them, together with finding sick or wounded animals amongst the panels, makes the graziers workload harder and more complex.

As such the economics of moving sheep to and from the site will be marginal. However, most examples of sheep farming quoted do not charge much or anything for the grazing and this may make it sufficiently attractive for a local farmer or shepherd with a ‘flying flock’.

Land in use for solar panels is generally ineligible for the normal agricultural subsidies, such as the Basic Payment Scheme (now being phased out) and the Environmental Land Management Scheme (ELMS). It does not prevent land from being managed in similar ways but there will be no payments available to farmers (eg graziers) for compliance and this could make farming less financially attractive going forward.

The site will probably have to be (re)seeded to grass, or species rich grassland, but this will probably occur after the panels have been sited on the land. In my experience grass does not grow well under the panels themselves. There are often areas that are dry and barren or that only host weeds species, due to heavy shading.

The reality often is that ‘nothing’ grows under the panels, or that only weeds grow and must be sprayed.

Appendix 12

NFU warns the clock is ticking for government to back British farming to feed a changing world

First published 21 February 2023

In the face of global turmoil, climate change, and rapidly rising world populations, the NFU is today warning that the clock is ticking for government to match warm words with actions to ensure British farmers and growers can continue to play their part in feeding and fuelling a changing and challenging world.

In the face of global turmoil, climate change, and rapidly rising world populations, the NFU is today warning that the clock is ticking for government to match warm words with actions to ensure British farmers and growers can continue to play their part in feeding and fuelling a changing and challenging world.

Delivering the opening address at NFU Conference, NFU President Minette Batters will lay out the three cornerstones needed to ensure a prosperous food and farming sector; one that delivers a secure, safe and affordable supply of British food, for both home markets and overseas, and recognises that farmers are the nation's working conservationists in protecting and enhancing the environment.

"There are three key lessons we can take from this extraordinary year," she will say. "As the global population continues to rise, and parts of the planet become less suited to producing the food we eat, we have an opportunity, and a duty, to get the best out of our maritime climate. Secondly, in the face of climate change, we should be unwavering in our commitment to achieving net zero and contributing to our energy security through on-farm renewables generation. And thirdly, we should never take our food security for granted.

"But the fact remains, volatility, uncertainty and instability are the greatest risks to farm businesses in England and Wales today. Critically, those consequences will be felt far beyond farming, they will be felt across the natural environment, and in struggling households across the country.

"Labour shortages and soaring energy prices are hitting the poultry industry, already reeling from avian influenza, as well as horticultural businesses and pig farms. Meanwhile, other sectors are facing an uncertain future as direct payments are phased out against a backdrop of huge cost inflation, with agricultural inputs having risen almost 50% since 2019. And the impact of this? UK egg production has fallen to its lowest level in nine years. In 2022, UK egg packers packed almost a billion fewer eggs than they did in 2019.

"This was also the year that the potential impact of climate change really hit home. The extraordinary temperatures we experienced in July topped the previous record by almost a degree and a half. While many parts of the country have experienced huge amounts of rainfall recently, impacting farming operations over autumn and winter, some counties still remain in official drought status.

“Despite all this, NFU members and the farmers and growers of Britain continued to bring in the harvest, to produce the nation’s food and to keep the country fed through tough times. We have seen progress; with the publication of the prospectus for the new Environmental Land Management Schemes; with increases to the Seasonal Agricultural Workers schemes; and in securing the establishment of the Trade and Agriculture Commission, leading to the Food and Drink Export Council and the placement of eight new agriculture attachés to sell British food overseas.

“More often than not – it has been incredibly hard getting government to back up its rhetoric with concrete actions. The time is nearly up for government to demonstrate its commitment to food and farming in our great country, not just by saying they support us, but by showing us they do. I won’t let the opposition off the hook either, I believe the rural vote will be crucial in the next election.

“There are three cornerstones on which a prosperous farming sector must be built and which any government should use to underpin its farming policy. They are boosting productivity, protecting the environment and managing volatility.

“But the clock is ticking. It’s ticking for those farmers and growers facing costs of production higher than the returns they get for their produce. It’s ticking for the country, as inflation remains stubbornly high, and the affordability and availability of food come under strain. It’s ticking for our planet, as climate change necessitates urgent, concerted action to reduce emissions and protect our environment. And it’s ticking for government – to start putting meaningful, tangible and effective meat on the bones of the commitments it has made. Commitments to promote domestic food production, to properly incentivise sustainable and climate friendly farming, to put farmers and growers at the heart of our trade policy, and to guarantee our food security. It really is time to back British farmers and back British food.”