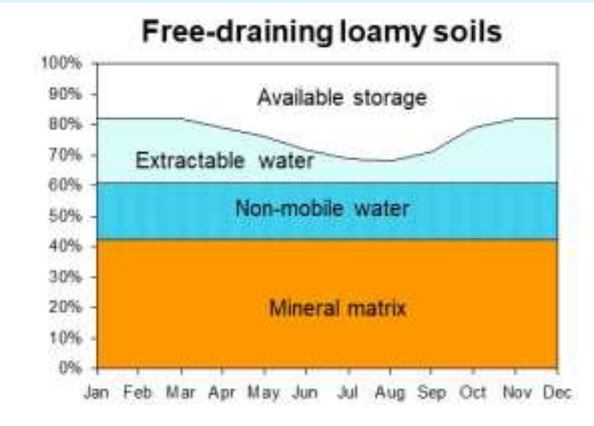
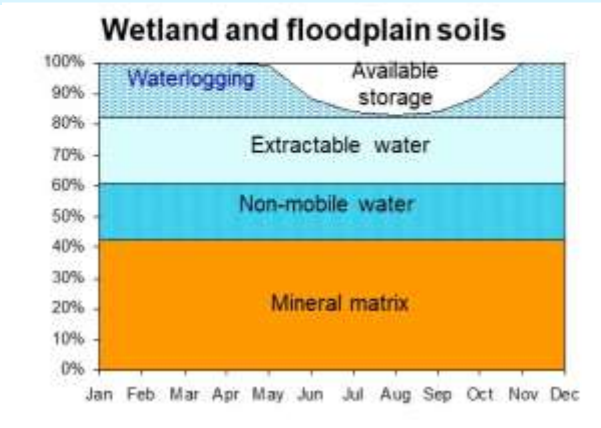
Compaction and drain maintenance in Soils with Seasonal Wetness resulting from rising groundwater

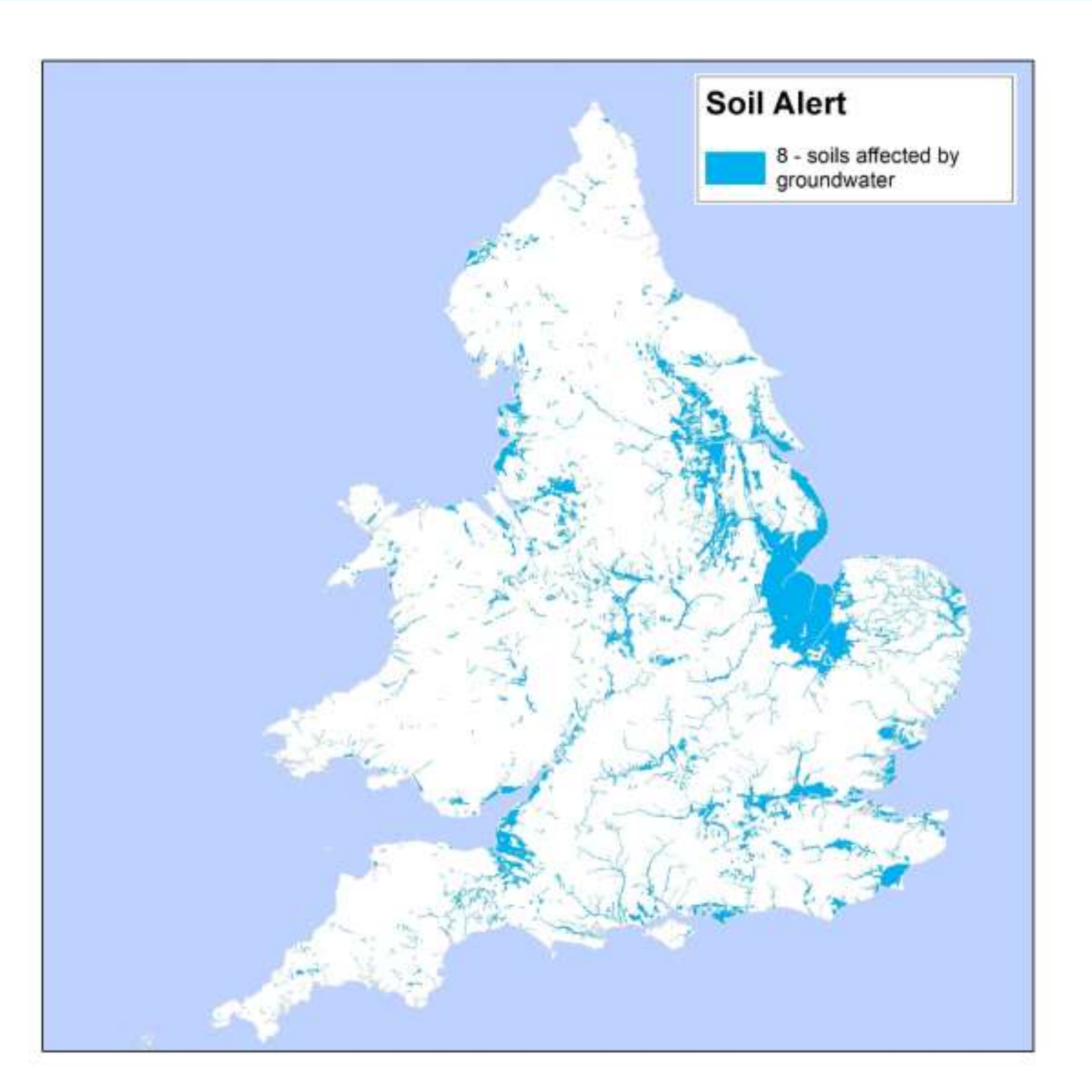
The ability of soils to support trafficking by farm machinery or stock without being significantly compacted depends to a great extent on how much water they hold at any one time. This amount varies seasonally. In all but the wettest parts of the country, vertical drainage of rainfall through the soil starts sometime during the autumn and ceases sometime during the spring. During this time of autumn, winter and spring, called the 'Field Capacity Period' (see below), topsoil is at its wettest and, in a free draining soil, the amount of moisture it can hold is governed largely by its clay and organic matter content – the greater the amount of these particles in the topsoil, the greater its amount of retained water.

However, in low lying land along rivers and streams as well as non-riparian wetlands, each autumn and winter groundwater can rise into and through the upper subsoil making the topsoil wet or even waterlogged for much of the field capacity period – a state that weather forecasts often refer to as 'saturated ground'. Also, in the absence of flood defence embankments, episodes of inundation from the river channel add surface floodwater.

Seasonal variation in soil water content in free-draining soils and those affected by groundwater







On the National Soil Map of England and Wales these types of soils are widespread in all Soil Associations starting with:

3.46; 3.72; 5.32; 5.43; 5.73; 8.11; 8.12; 8.13; 8.14; 8.15; 8.21; 8.31; 8.32; 8.41; 8.51; 8.61; 8.71; 8.72; 8.73; 10.21; 10.22; 10.24; 10.25

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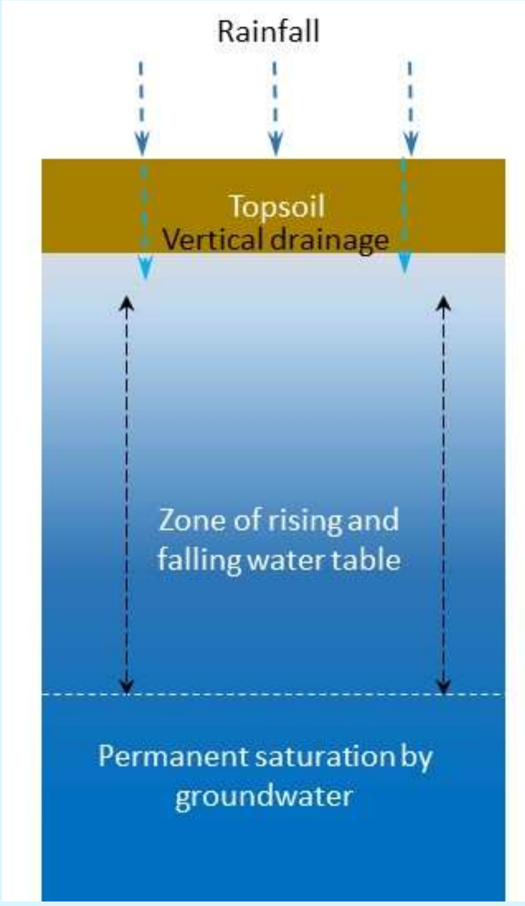
soils affected by groundwater

As can be seen below, such soils are easily recognised from their mainly greyish colours, associated with rusty ‘mottles’ that are concentrated around roots and subsoil pores.

Typical soil ‘profile’

Natural soil water regime



Up until the last half of the 19th Century, such wetland soils were usually under marsh or fen vegetation, woodland, or grassland, either as ‘water meadows’ or seasonal ‘Wash Lands’. Efforts to drain such areas have been made since Medieval times but, following the Second World War, with the need to increase agricultural production, the Government Ministry of Agriculture set up a Drainage Advisory Service with grant aided finance schemes to help farmers install effective field drainage systems. These were designed to ensure that the immediate topsoil drains well enough to safely support some trafficking, enabling the land to be brought into more intensive grassland management or arable production.

In larger areas affected by rising groundwater, such as the East Anglian Fens and Humberhead Levels, more comprehensive arterial drainage schemes have been implemented, with regional pumping schemes maintaining groundwater levels at significant depth from the surface. Here, the formerly seasonally waterlogged soils have effectively been changed to free-draining ones, enabling widespread productive arable farming, providing the pumping is maintained.

Soil associations in these areas are **3.46 Reach; 3.72 Willingham; 5.32a Blacktoft; 5.32b Romney; 8.11e Tanvats; 8.12b Wisbech; 8,12c Agney; 8.13f Wallasea 1; 8.13g Wallasea 2; 8.13h Dowels; 8.14b Newchurch 1; 8.14c Newchurch 2; 8.15 Normoor; 8.21a Everingham; 8.51a Downholland 1; 8.51b Downholland 2; 8.51c Downholland 3; 8.72 Peacock; 10.21 Turbary Moor; 10.22a Altcar 1; 10.22b Altcar 2; 10.24a Adventurers’ 1; 10.24b Adventurers’ 2.**

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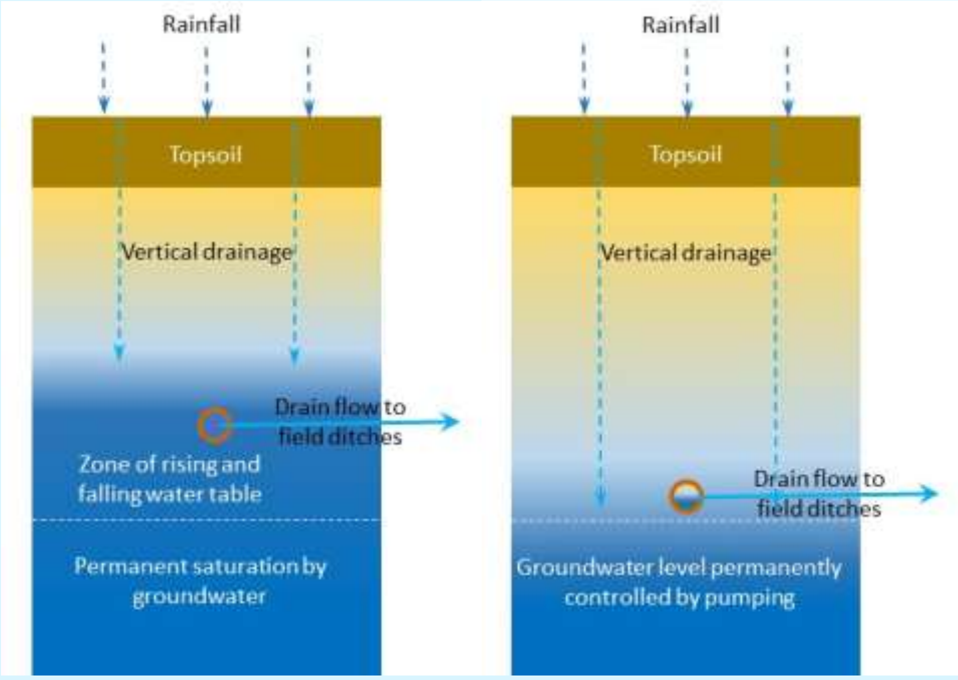
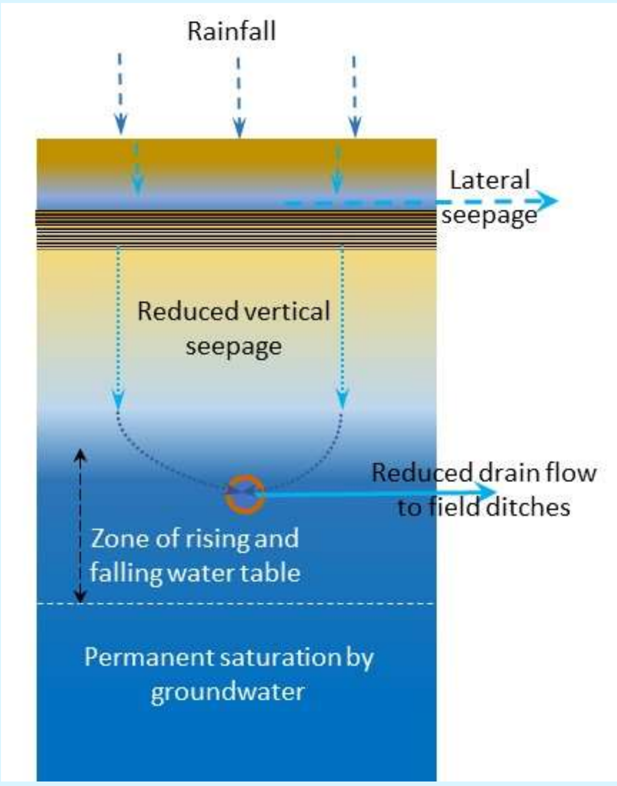
soils affected by groundwater

Soil water regime following field drainage | **Soil water regime following arterial drainage**



However, in those former wetland areas that do not have arterial drainage schemes, even if field drains have been installed, the immediate subsoil may still drain less effectively and land with medium or heavy loamy, silty or clayey subsoil can remain wet for long periods after rainfall, making it less stable and subject to compaction. Repeated over a few years, such compaction accumulates, further impeding downward percolation of water, increasing run-off and degrading the soil's inherent ability to store and effectively redistribute rainfall.

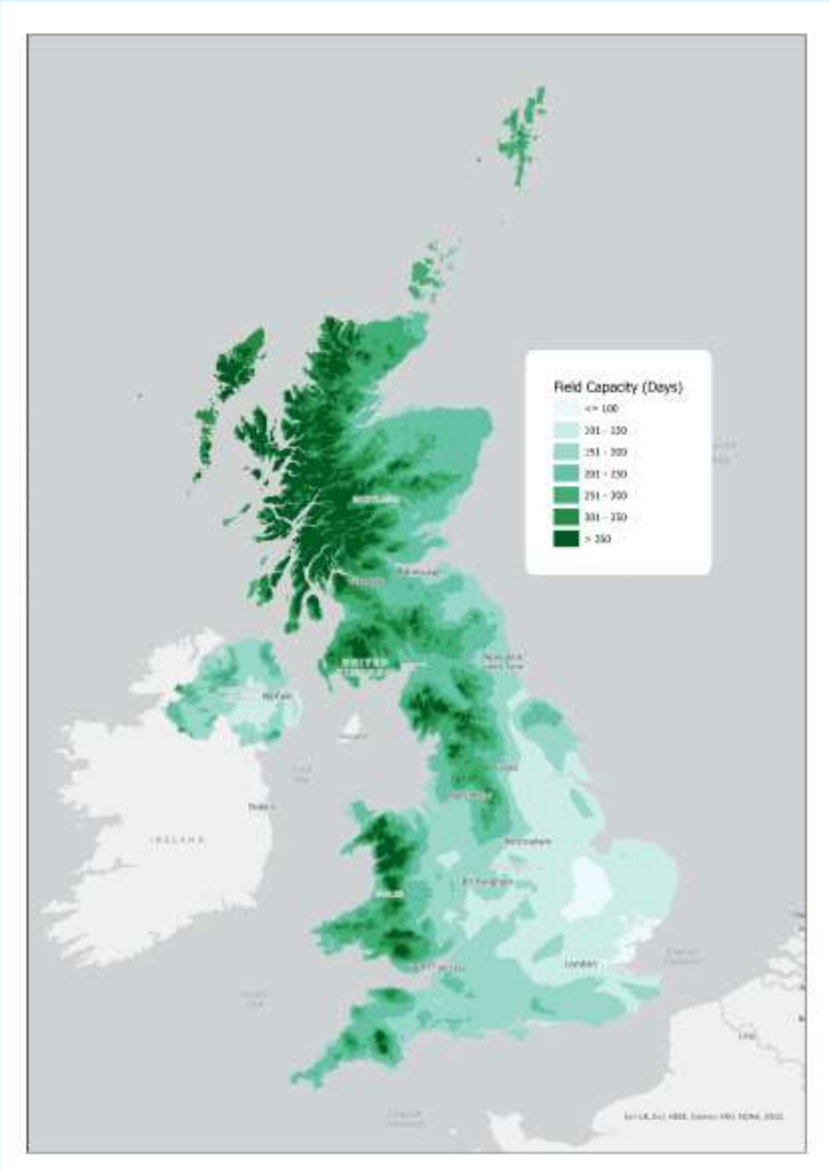
Impact of soil compaction



In grassland it can also result in de-nitrification, with yields depressed by poaching and increased wetness, soiled herbage being rejected by stock and weed invasion via broken swards at poach marks or in wheel ruts. A common symptom of such damage is the occurrence of fine rusty coloured areas along topsoil grass roots, often accompanied by a foul smell.

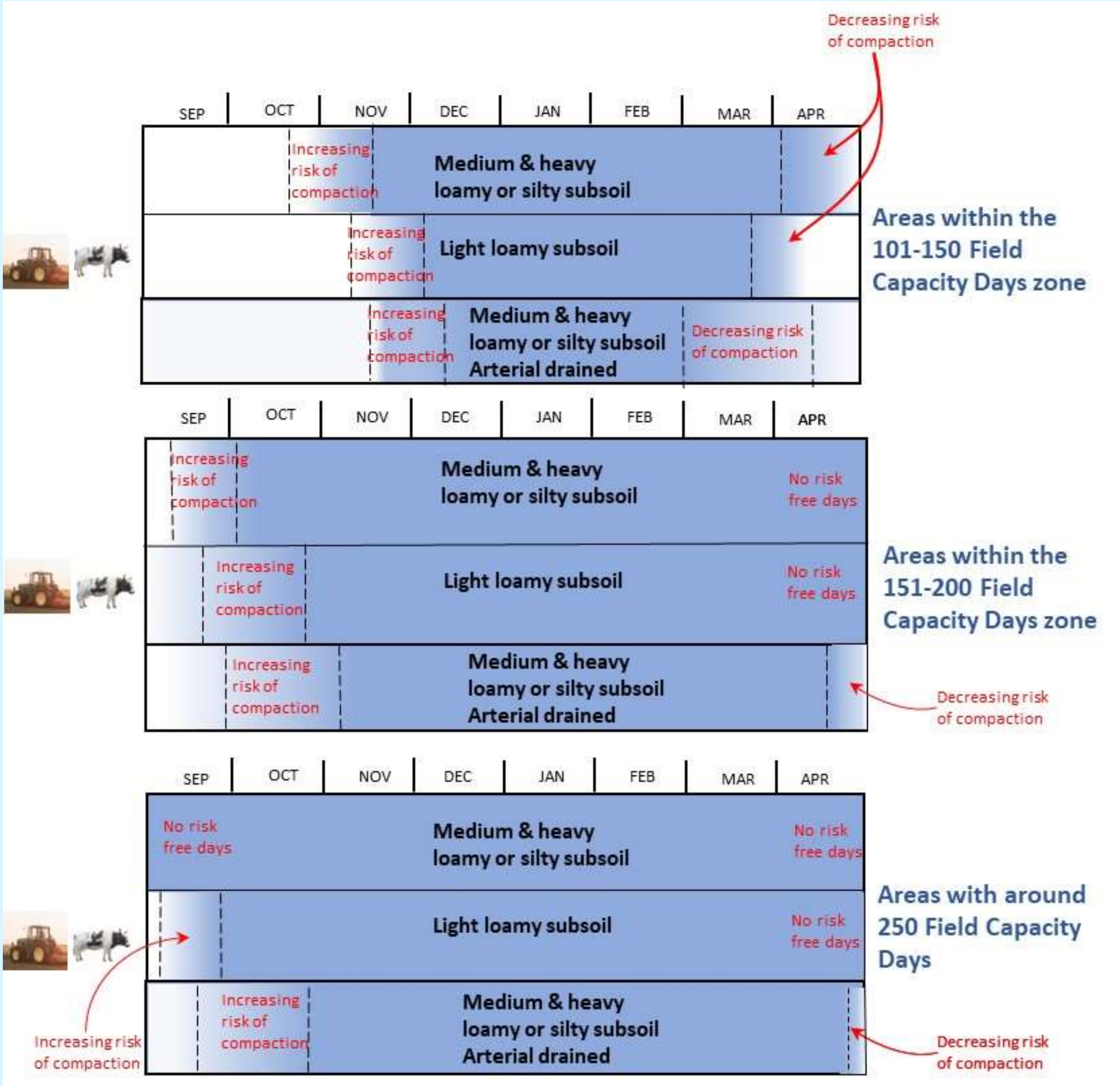
Where the start and end of the Field Capacity Period overlap with planned target dates for construction projects or crop-specific sowing and harvesting, turning out stock, or optimising silage production, there will be a significant compaction risk, particularly on land affected by groundwater but not included in arterial drainage schemes, and especially in 'wet' seasons. This risk increases from east to west of the country as, the Field Capacity Period starts increasingly earlier in autumn and ends increasingly later in spring (see the map below). Late-harvested crops such as sugar beet or maize, carry an especial risk. Compounding matters, most field drainage systems are now at least 40 to 50 years old and their efficiency has degraded, whilst many new farm owners or managers are unaware of the details of drain layouts. Even without compaction brought about by ill-timed stocking and cultivations, such degradation can result from neglect of outfalls or failure to repeat mole ploughing or subsoiling as appropriate.

Duration of the annual average Field Capacity Period (1971-2000) across the UK



The risks associated with access to land are illustrated below for three areas with increasingly longer Field Capacity periods. They show that, for large areas of Wales and western England the risk period for access to land can start before or in early September and extend well into May

Risk of compaction at the start and end of the Field Capacity period in three different Field Capacity zones, based on the climatic period 1971-2000.



Farming

Farmers can face an almost impossible balancing act between minimising these risks and their financial imperatives for crop establishment, yield maximisation and minimising winter feed costs. Furthermore, the increasing use of contracted-out farm operations which require access to land on fixed dates, almost irrespective of the weather conditions, reduce the opportunities for timeliness in going on the land, so essential for soils with restricted drainage.

Nevertheless, it is important that anyone planning field operations is aware of the risk of compaction when trafficking conditions are less than ideal. The Government already pays for actions to support the sustainable management of soils through the SFI arable and horticultural soils standard. To take advantage of this, recognition that their land contains these types of soils should be part of their soil assessment, whilst the soil management plan should include remedial actions such as subsoiling to adequate depth to break up compacted layers when subsoil conditions are suitable, usually during the summer when they are relatively dry and brittle, rather than plastic. This applies even to soils with light loamy or sandy subsoil layers.

Regular checking for subsoil pans should also be part of the farming schedule along with regular inspection and maintenance of field drains. In areas with arterial drainage schemes, there are also opportunities to take advantage of Defra's ELMS incentives to create wet grassland. Such an initiative is already underway in the Norfolk Broads where a number of farmers are working with the Broads Authority, Natural England and FWAG Norfolk on a Broads ELM test & trial. Environmental-Landscape-Management-ELM-scheme-Broads-Test-and-Trial-Summary-Action-Plan-October-2020

Where previously drained land is to be rewetted for nature conservation, it is important to take into consideration details of the drainage system and its current effectiveness to ensure successful future management. In addition, advice on rewetting soils likely to have a peaty surface layer (soil associations 8.51; 8.61; 8.71; 8.72; 8.73; 10.21; 10.22; 10.24; 10.25) can be found in the soil alert 'Lowland peats undergoing rewetting'.

Finally, the regular cropping of late-harvested forage maize on these soils in the western parts of the country should be avoided.

Construction

Seasonally wet soils resulting from rising groundwater that is not controlled by arterial drainage schemes and pumping are mainly confined to localized low lying areas. If these are crossed by the path of linear infrastructure or are subject to other construction projects, especial care needs to be taken in accessing the sites. Where they are to be stripped, stockpiled and eventually returned to farming or soft landscaping, particular care is needed to avoid long term structural damage. Stripping and restoration should be done outside the field capacity period or periods of significant rainfall when the soils will be wet and plastic, although tight project deadlines mean this may not always be possible. Stockpiles of heavy clay loams, silty clay loams or clays should be no more than 3 m high, and medium clay loams or silty clay loams no more than 4 m, with topsoils and subsoils kept separately. Soils that are handled in a wet and/or plastic condition should be reconditioned (such as by windrowing) either before or after stockpiling. Further guidelines can be found at: pb13298-code-of-practice-090910

Upon restoration of these soils for farming, an aftercare period of around five years will be necessary. This is particularly important because the conditions that cause seasonal waterlogging in these soils will still apply even after stripping and restoration. For subsoil, the stripping process will disrupt its slowly permeable nature and the restoration process will create artificial air pockets within the restored layer. Upon wetting up over the autumn and winter periods following restoration, these air pockets will fill with water, resulting in slumping that creates areas with horizontal layering. Attempting to remove air pockets by compacting the subsoil during restoration will only exacerbate this problem. It is therefore important to avoid trafficking restored areas on these soil types, giving their subsoils a number of years to naturally settle and restore their structure. Towards the end of this time, any compaction should be removed by subsoiling (when the soils are dry enough to shatter), whilst newly installed field drains should be checked and any subsidence corrected. On land intended for woodland or habitat creation any serious compaction will have to be removed before planting.

Sources of further information

More detailed soil association-specific information on the installation and maintenance of field drainage systems and the crop-specific assessment of land access risks, is given in Chapters 4 & 5 respectively of the Regional Bulletins on Soils and their Use in England and Wales.

More specific information on soil associations is also available in LandIS:
LandIS - Land Information System - Associations.