Compaction and drain maintenance in Slowly Permeable Soils with Seasonal Wetness

On land with naturally dense subsoil, downward percolation of rainfall is impeded and waterlogging occurs over the slowly permeable layers so that some or all of the topsoil remains wet or even waterlogged for much of the autumn, winter and spring months – a state that weather forecasts often refer to as ‘saturated ground’.

As can be seen below, such soils are easily recognised from their grey and rusty ‘mottled’ appearance.

Additional Warning

Although the presence of grey and rusty subsoil mottling is easily recognised in many soils, it is problematic in reddish coloured subsoil material (Munsell colour 5YR or redder) developed from heavy textured bedrock, often descibed as ‘Devonian’ or ‘Keuper Marl’, or drift derived from those rocks. Such reddish coloured material is particularly resistant to soil weathering processes that result in grey and rusty mottling, often showing little or very subdued colour changes on ped faces that are not easily recognised, particularly on a soil auger sample. A better and more easily recognised indication of waterlogging in these reddish materials is the presence of small black concentrations, rich in manganese. In such soils it is best to assume that the presence of a heavy textured reddish coloured subsoil present within 70cm of the surface is slowly permeable and will cause seasonal waterlogging. If there is any doubt as to the water regime of a reddish soil, a pit should be dug and the ped faces carefully examined for pale colours and other features of gleying.

Soil Alert 7

slowly permeable soils with seasonal wetness

Reddish soils with a slowly permeable subsoil but little evidence of grey and rusty mottling

Soil Alert 7

slowly permeable soils with seasonal wetness

Soil Alert 7

slowly permeable soils with seasonal wetness

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

4.11; 4.21; 4.31; 5.13; 5.42; 5.72; 5.82; 7.11; 7.12; 7.13; 7.14; 7.21

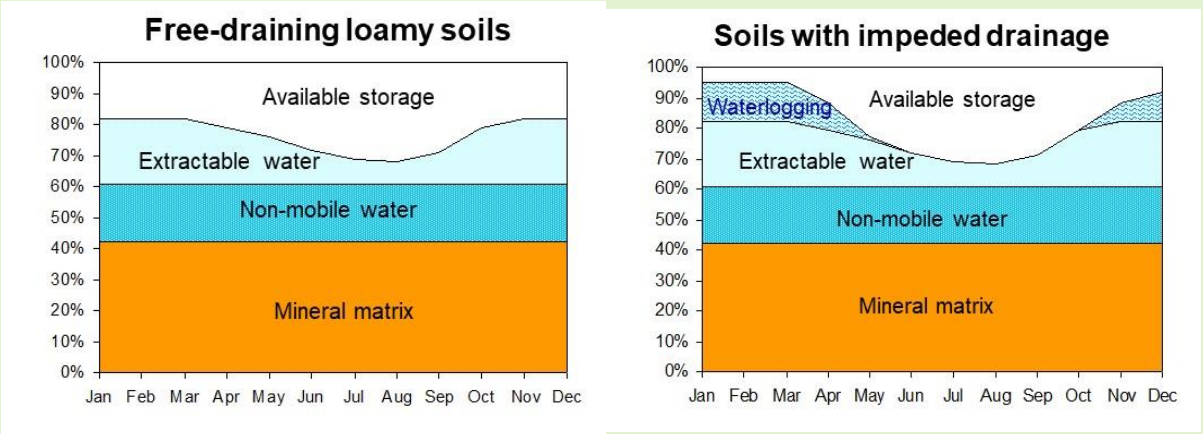
Soil Alert 7

slowly permeable soils with seasonal wetness

Soil Alert 7

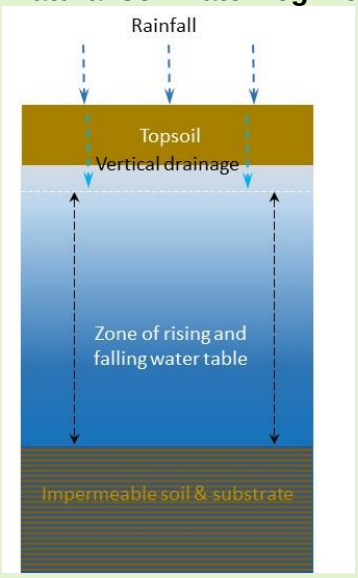
slowly permeable soils with seasonal wetness

Seasonal variation of soil water content in free-draining soils and those with impeded drainage

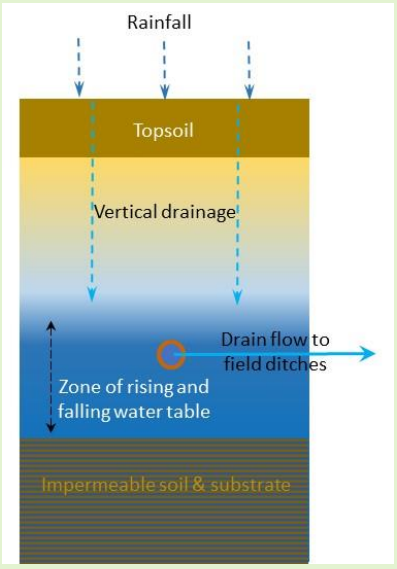


Up until the last half of the 19th Century, these type of soils were usually under woodland or grassland, either as 'water meadows' or seasonal 'Wetland'. However, following the Second World War, with the need to increase agricultural production, the Government's Ministry of Agriculture set up a Drainage 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, thus enabling such land to be brought into more intensive grassland management or arable production.

Natural soil water regime



Soil water regime after field drainage



Nevertheless, the immediate subsoil may still drain less effectively, particularly where it is a water-retentive medium or heavy loam, silt or clay. This land can remain wet for long periods after rainfall, making it less stable and subject to compaction if trafficked by farm machinery, livestock or construction equipment. 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. In grassland it can also cause problems such as de-nitrification, with yields depressed by poaching and increased wetness, soiled herbage being rejected by stock and weed invasion in poach mark sites. A common symptom of such damage is the occurrence of fine rusty coloured areas along topsoil grass roots, often accompanied by a foul smell.

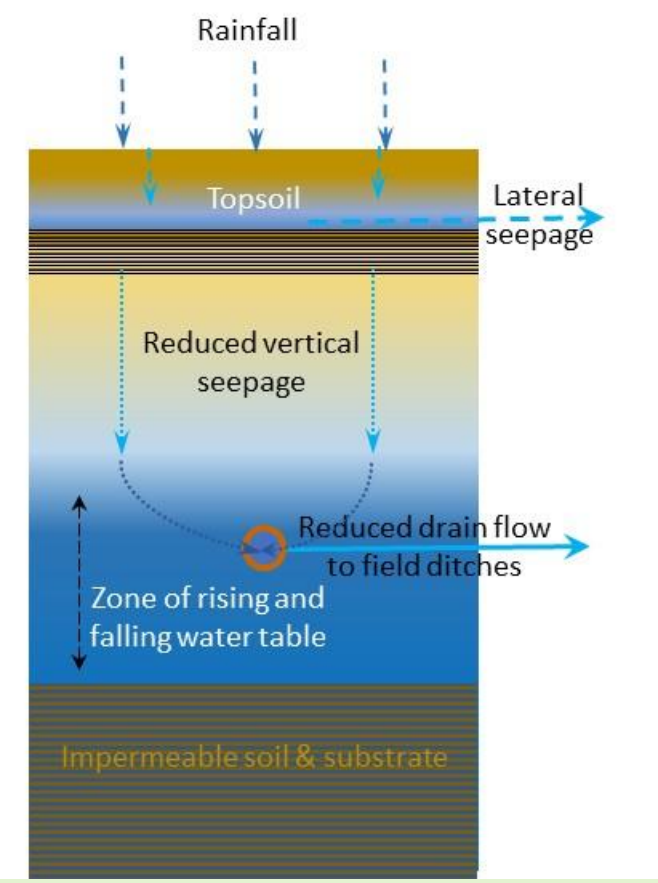
Soil Alert 7

slowly permeable soils with seasonal wetness

Soil Alert 7

slowly permeable soils with seasonal wetness

Impact of soil compaction



The time between when soils start to ‘moisten up’ during the autumn and dry out again during the spring is called the ‘Field Capacity Period’. Where its start and end overlap with planned target dates for construction projects or crop-specific sowing and harvesting, turning out stock, or optimising silage production, there will thus be a significant compaction risk, particularly on these slowly permeable soils, most especially in ‘wet’ seasons. This risk increases from east to west across the country as, going in this direction 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. This problem is compounded by the fact that most field drainage systems are now at least 40 to 50 years old and their efficiency has degraded over this period, whilst many new farm owners or managers are not aware of the details of installed systems. Even without compaction brought about by ill-timed stocking and traffic, such degradation can result from neglect of outfalls or failure to repeat mole ploughing or subsoiling as appropriate.

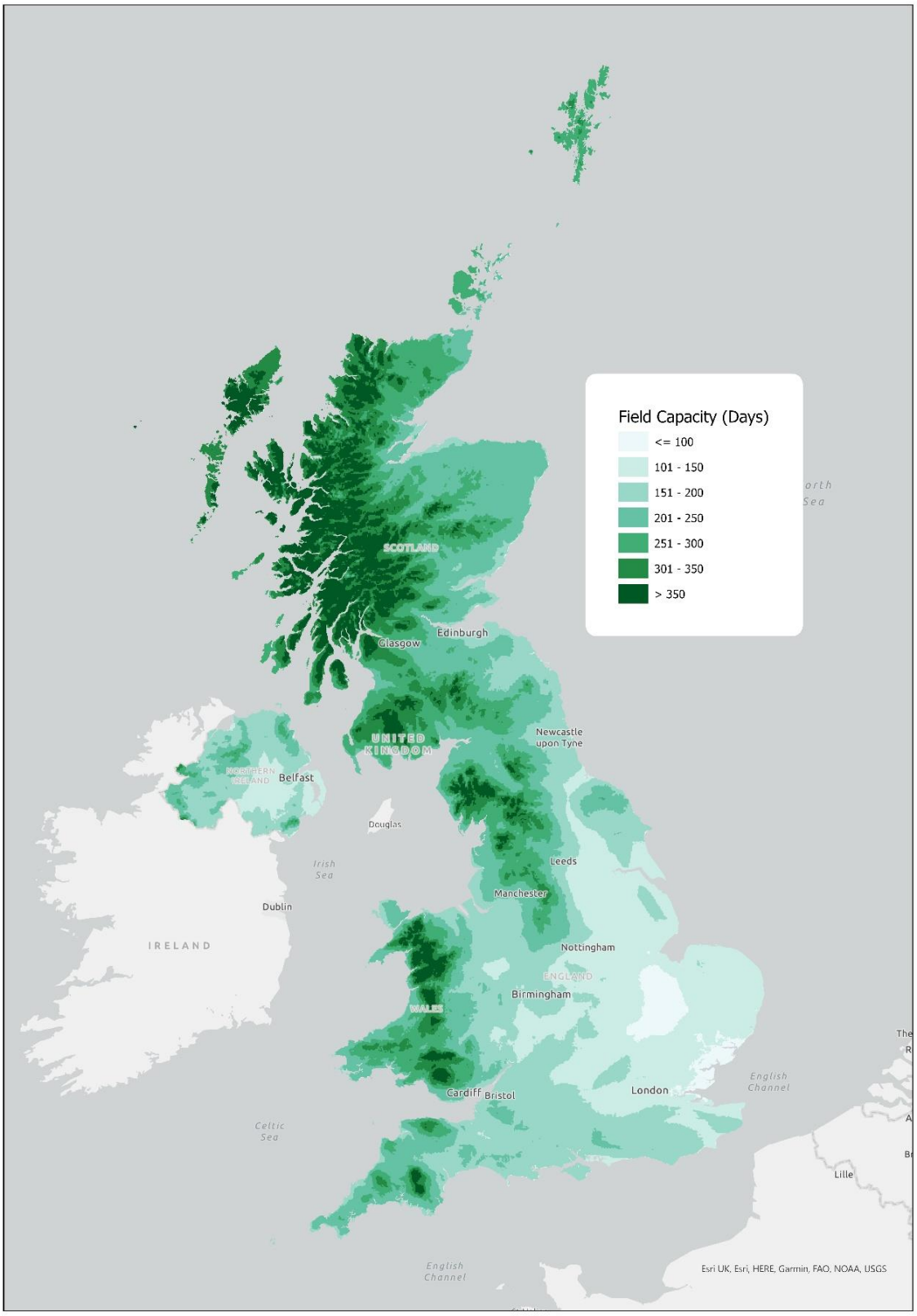
Soil Alert 7

slowly permeable soils with seasonal wetness

Soil Alert 7

slowly permeable soils with seasonal wetness

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

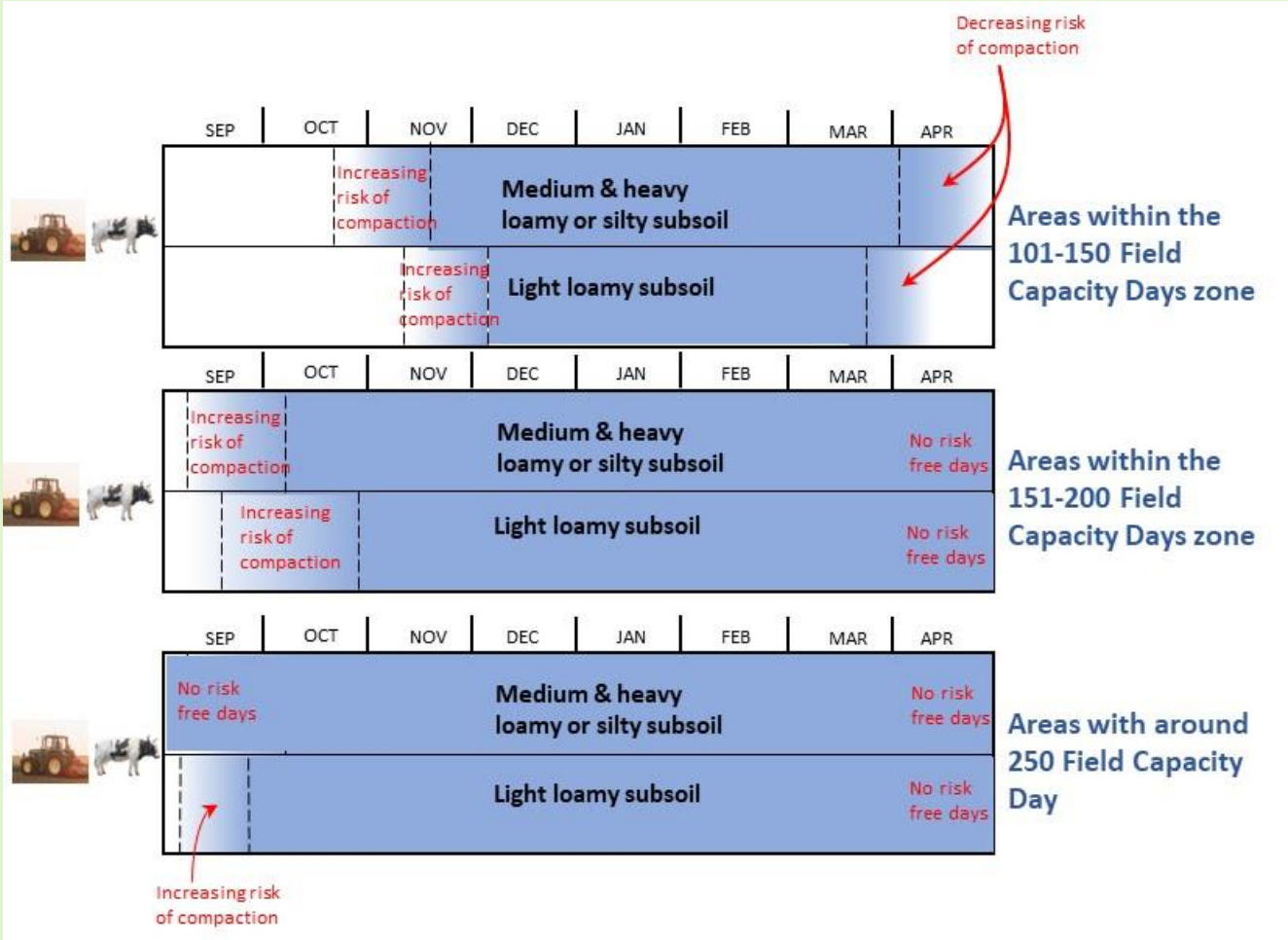


The risks associated with access to land are illustrated below for three areas with increasingly longer Field Capacity periods. They show that, for large areas of Wales and western England the risk period for access to land can start before or in early September and extend well into May

Soil Alert 7

slowly permeable soils with seasonal wetness

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.



It is also important to note that for, clayey soils (**soil associations** starting **4.11**, **4.12**, **4.13** and **7.12**) and soils with organic-rich topsoils (s**oil associations** starting **7.21**), the risk period is likely to start significantly sooner and end significantly later than those shown here.

Farming

Farmers can face an almost impossible balancing act between minimising these risks and their financial imperatives for crop establishment, yield maximisation and containing winter feed costs, together with the increasing use of contracted-out farm operations which require access to land on fixed dates, almost irrespective of weather conditions.

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 pay 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 type 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 plan along with regular inspection and maintenance of field drains and, on clayey soils in **soil associations** starting **4.11**, **4.12**, **4.13** and **7.12** the regular re-creation of mole drains. The frequency and opportunity for this varies with the clay type and climatic conditions. Some clays support the channels for several years, perhaps a decade, others may need redrawing every few years. On their wettest land, particularly on **soil associations** starting **7.21**, it may also be best to consider taking advantage of Government ELMS incentives to create wet grassland. Finally the regular cropping of late-harvested forage maize on soils with seasonal wetness, particularly in the western parts of the country should be avoided.

Harvesting on the same farm on a free-draining soil (left) and a heavy, slowly permeable, seasonally wet soil (right) on the same summer day near Yeoford, Devon (about 240 FC days).

Construction

Slowly permeable, seasonally wet soils are so widespread in England and Wales that they are often in the path of linear infrastructure and other construction projects. 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 are 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 3m high, and medium clay loams or silty clay loams no more than 4m, 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 obtained from Defra here:

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), 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.

Soil Alert 7
slowly permeable soils with seasonal wetness

Soil Alert 7

slowly permeable soils with seasonal wetness

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.

Soil Alert 7

slowly permeable soils with seasonal wetness