Pat Tuohy, Owen Fenton and James O' Loughlin, Teagasc

LAND DRAINAGE GUIDELINES

Approximately 49.5% (3.4 million hectares) of the total land area of Ireland is classified as 'marginal land', which is affected by natural limitations related to its soil, topography, relief and climate. The major limitation is its poor drainage status, and much is in need of artificial drainage if its productivity is to be improved. In wet years poorly drained soils may never dry out as persistent rainfall maintains high soil moisture content

Grass yields are limited due to the adverse effect of excess water and a lack of air at rooting depth, which limits plant respiration and growth. In cases of prolonged water-logging, plants will eventually die due to a lack of oxygen in the root zone. Furthermore, waterlogged soils are impassable to machinery and livestock traffic for long periods, due to high soil moisture content and reduced soil strength. This reduces the number of grazing days and hinders silage harvesting, thus introducing higher costs related to imported feedstuffs.

The purpose of land drainage is to remove excess water from the soil as quickly as possible. How best to achieve this will vary with soil type. There is a need, therefore, for a better understanding of the underlying causes of drainage problems and of the design and implementation of appropriate drainage systems to resolve these problems.

We must move away from the short-sighted approach that a broadly similar drainage system can be installed in every wet field, regardless of soil and site conditions.

CAUSES OF IMPEDED DRAINAGE

The difficulties of drainage problems are largely due to our complex geological and glacial history. Soil layers of varying texture and composition have the effect of irregularly distributing groundwater flow, with fine-textured soils acting as a barrier to movement, impeding drainage, and lenses of gravels and sands promoting water flow, transmitting groundwater over large areas with resulting seepages and springs on lower ground. In poorly drained soils the rate of water infiltration at the soil surface is regularly exceeded by the rainfall rate due to:

- Low permeability in the subsoil (or a layer of the subsoil);
- High water table due to low-lying position and poor/poorly-maintained outfall;
- Upward movement of water from seepage and springs.

OBJECTIVES OF LAND DRAINAGE

To achieve effective drainage, the works will have to solve one or more of these problems. The objective of any form of land drainage is to lower the water table, providing suitable conditions for grass growth and utilisation. A controlled water table promotes deeper rooting which improves productivity and improves load-bearing capacity of the soil.

The potential of the land to be drained needs to be first assessed to determine if the costs incurred will result in an economic return through additional yield and/or utilisation, and also to decide on the most appropriate part of the farm to drain. It is better to drain land which is nearer to the farmyard and work outwards; however, it may be more beneficial to target areas with high potential for improvement. This ensures a better return on the investment.

DRAINAGE INVESTIGATIONS

What exactly is the problem? How good is the existing drainage network (if any)? Is the whole profile made up of poor soils or is the problem caused by specific layers? Is there water movement at any depth?

Knowledge of previous drainage schemes in the area, and their effectiveness, will often provide an insight. A number (approximately one per hectare) of test pits (at least 2.5m deep) should be excavated within the area to be drained to investigate. These are dug in areas that are representative of the area as a whole; consider digging in wet and dry areas for comparison's sake.

As the test pits are dug, the faces of the pits are observed, soil type should be established and the rate and depth of water seepage into the test pit (if any) recorded. Visible cracking, and areas of looser soil and rooting depth, should be noted as these can convey important information regarding the drainage status of the different layers. The depth and type of the drain to be installed will depend on the interpretation of the characteristics revealed by the test pits.

Two principle types of drainage system are distinguished:

- Groundwater drainage system – a network of piped drains exploiting permeable layers; and
- Shallow drainage system – where movement of water is impeded at all depths.

GROUNDWATER DRAINAGE SYSTEM

Strong inflow of groundwater or seepage from the faces of test pit walls, indicate that layers of high permeability are present. Under these circumstances, the use of a piped drainage system (at the depth of inflow) is advised to capture and remove this water, thereby controlling the watertable.

Deep piped drains are usually installed at a depth of 1.5-2.5m and at spacings of 15-50m, depending on the slope of the land and the permeability and thickness of the drainage layer. Piped drains should always be installed across the slope to intercept as much groundwater as possible, with open drains and main piped drains running in the direction of maximum slope.

Where groundwater seepage and springs are identified, deep drains – 2-4m deep – can be used to intercept flow. Pipe drains are most effective in the layer transmitting groundwater flow, characterised by high water breakthrough. This issue is very site specific.

Clean aggregate, in the 10-40 mm grading band, should to be used to surround the drain pipe. The gravel should be filled to a minimum depth of 300mm from the bottom of the drain to cover the pipe. The stone should provide connectivity to a layer of high permeability and should not be filled to the ground surface. The purpose of a drain pipe is to facilitate a path of least resistance for water flow. In long drain lengths (greater than 30m) a drain pipe is vital to allow as high a flow-rate as possible from the drain, stone backfill alone is unlikely to have sufficient flow capacity to cater for the water volume collected.

SHALLOW DRAINAGE SYSTEMS

Where a test pit shows no inflow of groundwater at any depth, a shallow drainage system is required. These soils with very low permeability throughout are more difficult to drain. Shallow drainage systems aim to improve the capacity of the soil to transmit water by fracturing and cracking the soil. They rely on soil disruption techniques, namely: mole and gravel mole drainage and sub-soiling.

Mole drainage is suited to stone-free soils with a high clay content, which form stable channels. Mole drains are formed with a mole plough comprised of a torpedo-like cylindrical foot attached to a narrow leg, followed by a slightly larger diameter cylindrical expander. The foot and trailing expander form the mole channel while the leg creates a narrow slot that extends from the soil surface to the mole channel depth.

The mole plough creates both a zone of increased permeability adjacent to the mole leg (shallower depths) and a channel for water flow at moling depth. The effectiveness of mole drainage will depend on the extent of soil cracking during installation. As such, the ideal time for carrying out mole drainage is during dry summer

Figure 1: Test pit excavation.

Figure 2: Drainage trench excavation.

Figure 3: Mole plough showing cylindrical foot and expander.

conditions, to allow for maximum cracking in the upper soil layers and adequate traction to prevent wheel-spin on the surface.

Gravel-filled moles employ the same principles as ordinary mole drains but are required in soils which will not sustain an unlined channel. The gravel mole channel is filled with gravel from an attached hopper which supports the channel walls. Gravel moles require a very specific size range of gravel aggregate to ensure that they function properly. Washed aggregate within a 10-20mm size range should be used. Sub-soiling is used effectively where an iron pan or cemented layer impedes drainage. The effect is to break the layer and crack the soil. A stable channel will not be formed.

Collector drains, which are installed across the slope at 0.8–1.0m deep, are required for all shallow drainage systems. Depending on the topography and slope, the collector drains will be at a spacing of 10-40m. A larger spacing reduces costs but results in a much higher chance of failure. The disruption channels themselves are drawn at right angles to the collectors (up-slope) at spacings of 1.0-1.5m and a depth of approximately 0.4-0.5m. Stone backfill for collectors should be filled to within 250mm of the surface to ensure interconnection with the disruption channels when installed afterwards.

OUTFALLS/MAINTENANCE

Every drainage scheme is only as good as its outfall. Cleaning and upgrading of open drains acting as outfalls from land drains is an important step in any drainage scheme. Before commencing land drainage, the proposed outfall should be assessed and, where

Figure 4: Gravel mole plough showing hopper.

Figure 5: Single leg winged sub-soiler.

necessary, upgraded. Open drains, running in the direction of maximum slope, should be established at the greatest depth possible. Spoil from such works, where suitable, can be spread over the adjoining land-filling depressions and should not impede surface run-off to the watercourse. Unsuitable spoil should be buried and covered with topsoil or removed to waste ground.

When a drainage scheme has been completed, the layout should be drawn and noted on a farm map. This map can then be used as a guide when maintaining the works, as well as a record of the works. Land drain outlets should be regularly cleaned and maintained, especially if open drains are cleaned/upgraded, as this will result in blockages at the drain outlets. The use of a concrete or un-perforated plastic pipe over the end of the drain pipe, minimum 1m in length, will protect the outlet from damage and will make locating and maintaining it easier.