Drainage Explained

The GTC's approved learning materials offer excellent practical advice for young greenkeepers. This piece is generated from the Level 3 Learning Materials on drainage.

Improvement to drainage should be considered under two conditions; the need to remove surplus water out of the soil and to remove water from the surface.

- **Greatly reduced aeration of the soil**
- **Reduced root development**
- **Less resistance to wear**
- **Less resistance to drought**
- **Inefficient use of plant nutrients**
- **Late and slow growth in the spring**
- **Increased susceptibility to disease**

Table 1

Once a decision has been made that supplementary drainage needs to be used, the type of drainage required is the next consideration depending upon the problem identified. Several solutions are available:

- Pipe drainage
- Mole drains (rarely used)
- Open ditches
- Catchment drainage

Before any consideration is given to the location, spacing and installation pattern of any drainage, the outfall should be considered. The effectiveness of any system is determined by the outfall. Ideal drainage outfalls are considered to be positive outfalls, examples of positive outfalls would include:

- Ditches
- Streams
- Rivers
- Lakes
- Existing land or pipe drains
- Sump and pump

Soak away pits should not be used unless the underlying geological conditions are correct and it is possible for water to move into an underlying permeable layer.

Storm water drainage may provide an outfall, however this type of drainage is usually owned and managed by the local authority and permission must be sought before connection of other drainage into this system. Do not assume permission will be given.

Sump and pump systems are used to move water from a storage area, the sump, to an outfall via a pump. This type of system should only be considered when all other options have been exhausted. They can prove to be expensive and will require maintenance, further information can be found in MAFF leaflet, No 14 Pumped Field Drainage.

PIPE DRAINAGE

Flexible perforated plastic pipe is the commonly used drainage pipe now installed in the UK. Water enters the pipe through small perforations, although many people feel that the perforations will allow material in to the pipe and increase its susceptibility to blocking, tests have shown that this rarely happens. Three factors dictate the flow of water through a pipe; the fall, the pipe diameter and the pipe geometry.

The pipe geometry is the inside smoothness of the pipe. The flow rates for given pipe sizes can be found in the manufacturer's specifications.

Drainage pipe installation patterns usually fall into three categories depending upon:

- The surface grade of the land being drained.
- The size of the area being drained.
- The shape of the area.

These patterns are Herringbone, Grid and Random, (Figure 1)

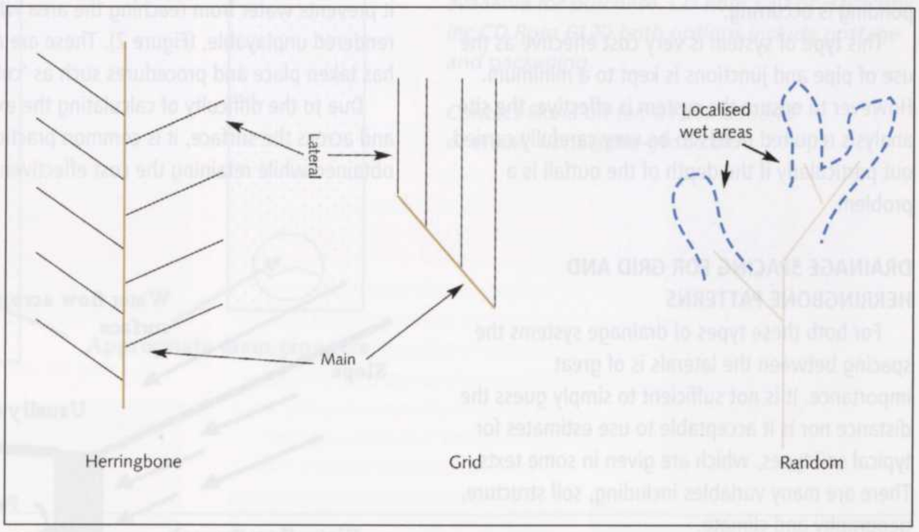

Figure 1

HERRINGBONE

Principal areas of use for this type of design pattern are large and/or irregular shaped areas. If the soil type does not have sufficient hydraulic conductivity and slit drains are also to be incorporated into the drainage scheme, then the herringbone pattern is not a practical solution.

If the ground slopes the main should be installed so that it runs down with that gradient and the laterals placed across the slope. The relatively short lateral length means that the depth of the main is not usually an issue. The longer the lateral at a given fall then the deeper the main needs to at the point of the junction. This pattern is often found in golf greens. Herringbone schemes can be complicated to install and unless accurate plans are kept, may be difficult to locate later.

GRID

A grid or grid iron pattern of drainage is often applied to areas which are relatively regular in shape. Winter games pitches and bowling greens are often designed with this type of drainage scheme. There are some advantages in this layout, fewer junctions are usually needed and the system is fairly easy to install.

If slit drainage is also being considered then the grid system allows for the slits to be installed at 900 to the laterals which can be, as previously mentioned, difficult to achieve with a herringbone system. Disadvantages of grid systems are that it can be prone to silting up at the junctions. For this reason laterals that enter the mains at 90° should be avoided. The use of long lateral lengths may also necessitate the use of very deep main drain runs.

RANDOM

A random pattern can be either designed or is derived over a number of years as an existing system is added to. A random system is used to enable only those areas that require drainage to be drained. Common examples of this are often found on golf course fairways, especially those that have undulations present. In this case water frequently collects in the low lying areas and a decision is made to drain those areas where surface water ponding is occurring.

This type of system is very cost effective as the use of pipe and junctions is kept to a minimum. However to ensure the system is effective, the site analysis required needs to be very carefully carried out particularly if the depth of the outfall is a problem.

DRAINAGE SPACING FOR GRID AND HERRINGBONE PATTERNS

For both these types of drainage systems the spacing between the laterals is of great importance. It is not sufficient to simply guess the distance nor is it acceptable to use estimates for typical soil types, which are given in some texts. There are many variables including, soil structure, geography and climate.

Before drain spacing can be calculated certain parameters need to be known.

- Rainfall: averages can be obtained from local weather data.
- The design rate: how fast is the rainfall to be removed? A system designed to remove 10mm over a 10 hour period would be less intensive than one designed to cope with 10mm per hour.
- The hydraulic conductivity of the soil: a measurement of the rate of moisture movement through a saturated soil.
- Depth of the pipe: the potential for water flow through the soil increases with depth.

The rainfall rate will be dependent upon the prevailing climatic conditions and geography of the area. The amount of rainfall that needs to be removed will depend on the sportsturf in question. Baker (1982), cited in Adams and Gibbs (1994), suggested that the maximum design rate, should reflect the greatest winter rainfall that is likely to occur in a 24 hour period once in every two years, however for top quality sports turf where revenue and playability are of major concern a 10 year period should be considered.

Rainfall data for the UK can be found at: www.met-office.gov.uk/climate/uk/averages/sites/ which gives the 30 year averages for all parts of the UK.

To calculate the spacing between the laterals the modified or simplified Hooghoudt equation is used, Gibbs and Adams, (1994), some assumptions are made with this namely that the depth of permeable top soil has a constant hydraulic conductivity and that the soil layer beneath the drains is impermeable. Therefore only the flow above the drains is considered. This produces the following equation:

$$S = \sqrt{\frac{h^2\,4k}{v}}$$

Where: s = drain spacing (mm)
k = hydraulic conductivity (mm/hr)
h = average depth of soil (average depth of the drains) (mm)
v = design rate (mm/hr)

OTHER DRAINAGE SYSTEMS

CUT OFF DRAINS:

This type of drainage is often called interceptor drainage. Pipework is installed in such it a way it prevents water from reaching the area which may otherwise be damaged or as a consequence rendered unplayable, (Figure 2). These are often found at the base of slopes where construction has taken place and procedures such as 'cut and fill' have occurred.

Due to the difficulty of calculating the exact amount of water that is moving through the soil and across the surface, it is common practice to install the largest pipe diameter that can be obtained while retaining the cost effectiveness of the solution.

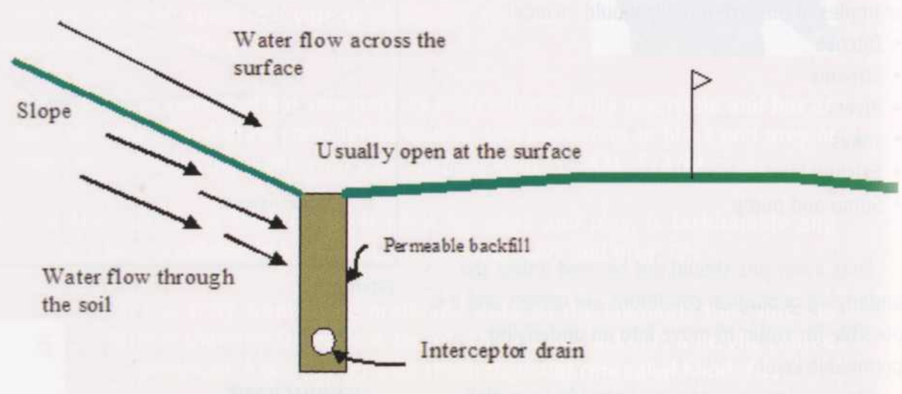

Figure 2

SAND SLITS AND SAND INJECTION

Sand slits, bands and grooves, are used to connect into existing pipe drainage laterals, usually at right angles and across any slopes that may be present. Slit material (sand/gravel), depth, width and length, can all be calculated. Further information on sand slits can be found in, Natural Turf for Sport and Amenity: Science and Practice, Adams and Gibbs, (1994), and Sports Turf: Science, Construction and Maintenance, Stewart, (1994).

OPEN DITCHES

Open ditches are frequently found on the perimeter of sports turf areas or, in the case of golf courses, through the area. Ditches are a useful way to move large quantities of water from the area. Ditches will have an effect on the water table of the soil, producing a draw down effect similar to piped drainage. The depth of water in the ditch and the fall of the ditch need to be considered both during the maintenance of the ditch, especially during work such as clearing out, and if large machinery is used to carry out this work, or if new ditches are being constructed.

Water, 0.75 - 1m deep in a ditch with a fall of 0.15 0.3m over 1km will have a velocity of approximately 1m/second. Higher velocities than this will cause undercutting and erosion of the bank.

DRAINAGE BACKFILL MATERIAL

Trenches for drainage as a rule of thumb need to be cut approximately 50 - 100mm larger than the pipe diameter. It is important that conditions for cutting the trenches are suitable; too much damage to the soil on the sides of the trench through smearing or damage to the structure will hinder the water flow into the trench.

A permeable backfill will need to be used over the pipe (Figure 3). This material should also be used under the pipe so that the pipe lies upon a layer of approximately 25mm of material.

This type of backfill will allow for the movement of water from the surface down to the pipe to be as rapid as possible; vertical movement. Lateral or sideways movement of water will also occur however; water will not flow from a small pore size - soil, to a large pore size - gravel, as the tension of the water in the small pores is too great.

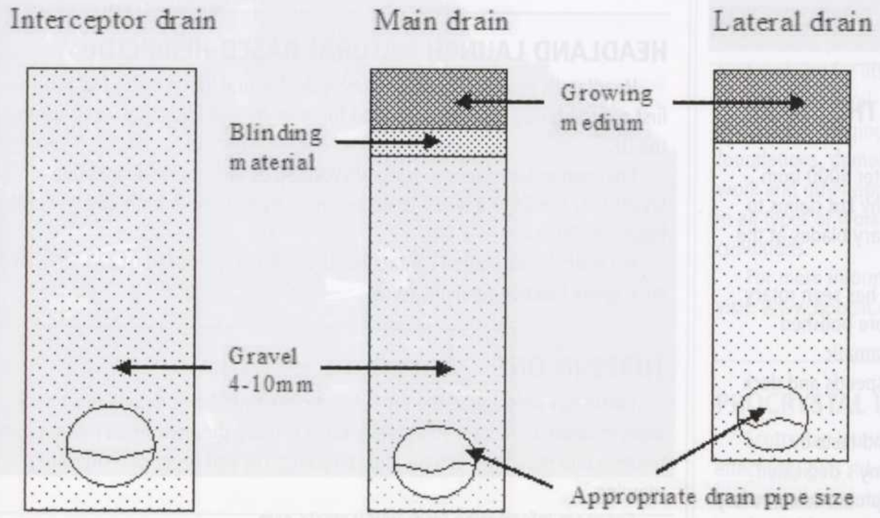

Figure 3

Gravel, material with a particle size of between 2 - 10mm, is commonly used as a drainage backfill material. A blinding layer of sand prevents particle migration from the final layer, either sand or soil into the gravel. Care must be taken in choosing/specifying the correct materials so that migration of one material into another does not occur.

RECORDS

It is important that accurate records are kept of all the drainage works carried out. "As built" plans, should be provided by drainage contractors as a matter of course. Work carried out by the greenkeeper or groundstaff will also need to be recorded onto a site plan.

The plan should show the location of all the drainage pipework along with notes on the installation date, pipe type and size. The location of any silt traps, inspection chambers or flushing points, along with outfall locations will also need to be recorded. Open ditches should be recorded together with their peak flow depths and grade. Any drains that outfall into the ditch will also need to be marked on the plan.

These learning materials are used by the GTC Approved Training Providers in Britain and are available for purchase. CD Rom £30 or Hardcopy inc CD Rom £120 both options include postage and packaging.

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