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P R. George

Salinity and Hydrology Research Branch, Western Australia

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Sub-surface drainage methods for

By P. R. George, Research Officer, Salinity and Hydrology Research Branch

Sub-surface drainage can control waterlogging and salinity of arable land by removing excess groundwater.

There are two broad types of sub-surface drainage: interception drainage and relief drainage.

The cost of drainage will depend on the specific design for the site. For relief drains the prime determinate of cost will be the required spacing. In general, clay soils of low permeability or seepage areas will need narrower spacings and will be harder and more expensive to reclaim than sands or areas only needing drainage of local water.

Interception drainage

When a seep or spring is fed by a distinct water source, interceptor drains are used to cut off this excess groundwater before it reaches the problem area. Figure 1 shows an example of an interceptor or 'foreign water' drain.

Interceptor drains, as shown in Figure 1, are usually a single tube or open drain placed between the water source and the problem area. Accurate location of the source of excess groundwater, together with proper placement of the drain, are critical to the success of this form of drainage. Thorough investigation of sub-soil conditions and groundwater flow are essential before drainage work starts. Even then the whole source of water flowing to the problem area may not be cut off.

The use of interceptor drains to reclaim saline areas has rarely been effective in Western Australia. One of the main reasons why interceptor drains are not effective is that the groundwater flows to saline areas through deeply weathered soils. Drains cannot be installed deep enough to completely cut off this flow (Figure 2).

Relief drainage

If an area is affected by excess water which results from a combination of shallow watertable, excess rainfall and runoff, rather than a specific source of groundwater flow, relief drainage will be required. Relief drainage is installed to a specific pattern which depends on a range of site and soil conditions.

Relief drainage can be carried out by drains or by pumping.

Drains

Relief drains can be open ditches or buried tube drains. Tube drains are perforated plastic pipes which collect groundwater which can then be drained off. The tubing is lightweight, flexible and is corrugated to give it enough strength to resist compression pressures when buried.
Salinity control

In undulating areas, relief drains can be installed on a random or herringbone pattern to drain depressions, but on flat, flood plain areas a parallel grid system is used. Figure 3 shows these main methods of drain lay-out. When a parallel system is used the necessary drain spacing and depth is determined by the required watertable depth, soil permeability, depth to and thickness of permeable layers, and the amount of excess water affecting the site. Figure 4 shows the effect that sub-surface drains have on depth to the watertable. Effects are similar for both open drains and tube drains. Open drains are cheaper to install than buried tube drains, and can be used to carry off excess surface water. However, they occupy arable land and impede access, and their silting causes severe maintenance problems.

Tube drains are more expensive initially than open drains, but are less expensive to maintain except in areas where high levels of iron in the groundwater cause blockages. They do not restrict access and can be cropped over.

Installation

In Western Australia, open drains two to three metres deep are installed using large excavators.

Tube drains can be installed using trenchers or by direct laying.

Experience indicates that the direct laying machines are more able to handle our hard subsoils. They are also more economical to operate. Careful grade control using correctly aligned laser guidance systems is, however, essential with this system.

Tube drains are often installed with clean gravel surrounding the pipe to improve water entry and to act as a filter. This can improve the effectiveness of the drains, and is essential in soils containing fine sand or silt which can block the pipes. The gravel surround, however, increases costs by between 50 and 100 per cent.

Specialised drain laying equipment used in northern Europe. The trench is dug and the piping laid in one operation.
Figure 4. A vertical section through a drained paddock showing the effect of subsurface drains on the watertable and groundwater flow. Tube drains and ditches are shown to indicate that effects are the same.

Figure 5. Drainage by relief of pressure in a semi-confined aquifer using wells.

Drainage by pumping

A pumped bore or well develops around it a circular pattern of draw-down which lowers the watertable. The radius of the draw-down or the zone of influence of a pumped bore depends on the amount of water pumped and soil conditions, primarily the hydraulic conductivity and the thickness of the water-bearing aquifer. Drainage bores are suited to:

- Flat areas where gravity disposal is a problem.
- Areas where surface soils are too impermeable for economical ditch or tube drainage, but where the existence of permeable aquifers allows the installation of high yielding bores.
- Areas with high artesian pressures in the groundwater where drains would have to be too deep and too closely spaced to effectively remove seepage water.

Single bores can be used. Where large areas must be drained, bores are laid out in a square or triangular pattern so that their zones of influence overlap. Figure 5 shows the method of controlling watertables with pumped bores. In areas of artesian pressure, bores may not need to be pumped. Free-flowing bores, known as relief wells, can be used to lower groundwater pressures. Relief wells sometimes discharge at the surface, but more often discharge into tube or open drains two or three metres below ground level. In some hillside areas syphoning may be possible.

Sometimes pumped drainage is not effective because the low permeability of the surface or ‘confining’ soils prevents a lowering of the watertable in response to the lowered pressure in the aquifer. In extreme cases artesian pressures can be lowered a kilometre or more from the bore with hardly any effect on the watertable in the confining layers within tens of metres of the pumped bore.