DEPARTMENT OF WATER RESOURCES

TILE DRAINAGE EFFLUENT SOURCES

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Tile drainage in the MIA has been successful in overcoming severe problems of waterlogging and salting. Horticultural plantings are protected. The volumes removed from the groundwater is a function of the following factors:

1. percolation as a result of rainfall, particularly in wet winters.
2. percolation as a result of irrigation.
3. the height of the watertable between drains.
4. the drain spacing
5. the hydraulic conductivity of the soil profile.
6. seepage from sources outside the farm.
7. seepage from the farm to other farms.

Factors 1 and 2 are the principal reason why tile drainage is installed. The original concept of tile drainage was to protect plantings against high winter rainfall, not irrigation. During wet periods the drain discharge is well above average. The drainage criteria to calculate drain spacing are dependent on the anticipated rates of percolation resulting from rainfall, and to a lesser extent. irrigation. In some cases an allowance is made for factors 6 and 7, if there is knowledge about them (e.g. elevation of the land).

Factor 3 controls the relative rate of flow to the tile drains. Just after the watertable is raised by factors 1 or 2 the flow is usually high, but after one or two days a linear relationship between factor 3 and the tile discharge establishes itself.

Factors 4 and 5 are interrelated. A higher hydraulic conductivity means the water moves more redily through the soil and the drain spacing may be widened to achieve the same rate of removal of groundwater, thereby lowering the watertable at the same (desirable) rate.

There are also seasonal affecting the rate of flow to tile drains. For instance during Spring the flows tend to be larger because the winter vegetation may have dried out the soil profile. The first irrigation is often quite heavy and the proportion of percolation to the watertable is higher than average. This is further increased by lower rates of evapotranspiration from the tree crops which have not yet developed their full foliage.

Factors 6 and 7 cause a possible deviation from the likely drain discharge predicted from rainfall and irrigation accessions on the farm itself. The assessment of the likely proportion of these flows in the total drainage flows from the farm is the subject of this technical note.

1. Potential External Sources of Tile Drainage Flow.

The following potential sources are recognised:

1. Channel Seepage
2. Seepage from neighbouring farm
3. Downslope seepage from upslope Farm.
4. Groundwater movement through a permeable layer (aquifer) to the farm.
5. Seepage from rice fields
6. Seepage from drains and toe drains on roads.
7. Upward leakage from deep seated aquifers.

Of course on many farms the reverse of seepage to the farm could be applicable. Removal of groundwater by seepage processes would lessen the flow to the tile drainage flow to the pump on the farm. This is not further considered in this report.

The various potential sources for seepage to the farm are discussed below.

2. Channel Seepage

Channel seepage may be a significant contributor to watertable conditions on the farm. In many situations extra lines have been installed to cope with this problem. No estimates are available for the proportion of total flow to the pumping sump for any installation, but in some situations it may be up to 50%. During early Spring, after the channel has been empty for some time, the rates of seepage may be above average.

The relative proportion of channel seepage of total drain discharge would depend on the permeability of the soils near the channel. The condition of the channel, which may be lined or unlined is an important factor, and also the lenght of channel in proportion to the area and physical layout of the farm are important. Finally irrigation practices are highly relevant, because if there is little percolation from irrigation the relative proportion of channel seepage will be higher.

In the past many farmers have blamed DWR channels for the watertable problems on their farms. However, investigations ususally revealed that the main factor causing the high watertable conditions were the irrigation practices on the farm. The channel seepage was recognised as a factor which merely aggravated an already existing undesirable situation.

The DWR (and predecessors) has never accepted the responsibility for any channel seepage that may occur. The DWR may have a duty to maintain channels in the best conditions feasible in the circumstances, however in the end it cannot be held responsible for the small amount of leakage that may escape.

3. Seepage from Neighbouring Farm

The seepage from a neighbouring farm depends on:

* the hydraulic conductivity of the soil
* the height of the watertable in the other farm relative to the farm.
* distances and gradients.

Generally the seepage from another farm will be very small to negligible unless there is a water conveying layer. This condition applies for most of the Yenda, Bilbul, Beelbangara and Hanwood areas. Several observations may be made:

1. Gradually almost all farms have now installed drainage. Obviously the seepage to the neighbouring property has never been sufficient to avoid high watertables on their own farm.
2. The MIA Tile drain committee has put a lot of effort over the years to get good tile drain designs. The drain spacing needs to be assessed carefully. If the assessed drain spacing is too large then under drainage may occur. Extra drains in between existing laterals have often been installed. This is an indication that the effect of drainage beyond a distance of an equivalent drain spacing cannot be very large.

A gradient of 1 in a 100 metres for seepage flow is possible when one farm has watered and the other has not been watered for some time. With a hydraulic conductivity of the soil profile to 2 metres ranging between 0.1 and 0.6 metres/day, as measured by thousands of tests in these areas, the seepage rate would be in the range of 0.4-2.4 metres^3/day over 400 metres length of common farm boundary. A typical sixteen hectare farm may discharge up to 800 m^3/day just after irrigation, declining to perhaps less than 100 m^3/day just before the next irrigation. It is shown that the seepage component would be very small.

The situation becomes different when a water bearing strata exists, conveying groundwater across the landscape. This applies to part of the south Hanwood area, and isolated parts around Yoogali and Bilbul, as well as the Wamoon and Stanbridge areas. This is discussed separately.

The situation may also be different when downslope seepage is involved, also discussed separately.

4. Downslope Seepage

Downslope seepage may be a factor at Corbie and Merungle Hills, Lake Wyangan, the Tharbogang slopes and the Beelbangara slopes. The rate of seepage is a function of the thickness of the waterbearing strata, the hydraulic conductivity, and the slope of the land.

The hydraulic conductivity usually becomes less towards the break of slope in the lower parts of the slopy land. However it is often still significant even in that situation, and interceptor drainage has usually been successfull. Sometimes gravelly or older, weathered soil layer provide high transmissive properties. Frequently there is substantial variation in hydraulic conductivity on the farm, which has caused difficulties in designing an appropriatre drain spacing, e.g. Corbie and Merungle Hills. The lower permeability is associated with sub-areas of clay soils or cemented conditions.

The thickness of the waterbearing layer often increases in a downslope direction, where the seepage comes to the surface the permeability is usually getting less.

In many cases the land originating the downslope seepage and the land receiving most of the downslope seepage is owned by the same person. This applies to the Tharbogang and Beelbangara slopes.

Where the land receiving the downslope seepage is owned by a different landholder the transfer in groundwater may be substantial. With a gradient of 1.5-2 metres in 100 metres (typical for Lake Wyangan), and a transmissivity (hydraulic conductivity times thickness of flow) of 2-40 m^2/day, typical seepage rates over a 400 metres long sectioin may vary from 12-240 m^3/day. This may be a significant proportion of the total average drainage discharged by the pump, up to 30% perhaps.

The highest figures are fairly rare however, but a 10-20 % proportion may occur reasonably frequently.

5. Aquifer Movement and Seepage

Where aquifers capable of transmitting seepage occur the watertable in the farm may be maintained at levels well above the tile drain level. When the farm is irrigated and the watertable in the farm is above the watertable in surrounding farms there would be groundwater movement away from the farm. However if the farm is not irrigated for some time then the drain discharge would represent mainly the incoming water. Observation during such periods may give an indication of how much is involved. Such measurements are valid after the farm has not been irrigated for about 20-30 days.

In many situations of this nature tile drainage has not been used and drainage tubewells have been installed, e.g. around Leeton, Wamoon and Stanbridge, quite successfully. Tile drains in these areas only exist where there is insufficient effect of the tubewells. When the tubewell still has a small positive effect on water conditions it is difficult to imagine that a seepage flow from other farms to the farm in question exists. This is an important discussion point, affecting many tile drained farms in the Wamoon, Leeton and Stanbridge areas.

At Hanwood it was found that a tubewell has an effect over about 50 hectares. Another tubewell nearby lowered the pressure levels in the sands but the effect on watertables was variable. At Yoogali a tubewell installed in a deeper aquifer had no effect. Where a tubewell has only a limited effect, and tile drains are the necessary alternative, it is not expected that there is a great deal of groundwater seepage from one farm to another, in fact it will be very small, unless there are land slopes that play a role. This applies for most of the Hanwood, Yoogali and Hanwood areas where there is a limited sand aquifer deposition.

In the Griffith West End Area one pump serving a couple of farms is located in a low area where some aquifer activity is also likely. This pump would receive water from an area larger than the tile drained area.

The proportion of external flows has not been estimated, but may be significant.

In general the volumes of flow into the farm through an aquifer depends on the following factors:

* size of the farm. With a larger size the relative proportion of external flow will be less
* the transmissivity of the aquifer, which may be in the range of 5-50 m^2/day, and more near tubewell drainage sites.
* the gradient towards the farm. This is higher if the farm is in a relative depressed location.

In a flat landscape where all farms are irrigated at about the same intensity the net flow to the farm would be about zero. The groundwater flow to the farm would be negative at times.

From calculation using analytical models the estimated contribution from external sources may be substantial. The actual proportion may only be calculated after assessment of the factors involved.

6. Seepage from Rice Fields

Seepage from rice fields is usually restricted by a buffer zone of 100 metres width. In this zone there may be a supply channel having a more dominant effect on seepage towards the farm (previous section), or there may be a drain intercepting some of the possible seepage (e.g. Main Drain 'J'). There also may be a road underneath which the soils may be somewhat more compacted, limiting seepage. However in the absence of such interferences it is possible that some seepage from a rice field to the horticultural farm occurs.

The factors affecting rice seepage to horticultural farms depends on the gradient, the hydraulic conductivity and the depth of soil contributing to the flow. Where no aquifer conditions occur the conditions are usually such that there is minimal impact. This would apply for 90 % or so of all buffer areas. In fact many buffers could be reduced without any effect on the watertables in the horticultural farm.

When measuring watertable gradients in the past it was frequently found that the watertable in the horticultural farm was much higher than in the buffer area, meaning that seepage ocurred from the horticultural farm to the rice farm.

In some instances in the past the buffer areas have been reduced, and the tile drain flow measured. In most cases the tile drain flow was not affected significantly. There are some exceptions.

In some cases horticultural farms have complained about watertables on their farms, blaming rice growing for it. Usually these farms were not yet tile drained and watertable conditions are caused by watering of tree crops or lawns. Then if a small amount of seepage from the rice field occurs there is an aggravation of the problem, which becomes more acute. The rice seepage is not the only cause, but it may contribute to it. This would of course particularly apply if there was an aquifer that conveyed groundwater from the rice farm to the horticultural farm.

Where an aquifer of significant transmissivity occurs the seepage may be trannsferred over more than 100 metres. Conceivably up to 1000 metres may be affected. Fortunately these conditions are rare, and restricted mostly to the areas where tubewell drainage is having a lowering effect on the watertables (Fivebridges, Wamoon, some farms in the anwood area).

Since the horticultural land is not usuallly depressed compared to the adjacent rice land, and aquifer activity between on the boundary between horticultural areas and rice land is usually absent (Yenda, Bilbul, Hanwood, Beelbangara), this factor is not believed to be of great significance, particularly since the buffer area policy is still apllicable.

7. Seepage from Drains and Toe Drains along Roads

The seepage from these sources may affect a narrrow strip of land within the horticultural farm. Road drainage improvements are a solution_where it applies. With drains the same principles apply as for supply channels, however the seepage is usually less as drains tend to located where the hydraulic conductivity is not extremely high. The gradients for groundwater flow from the drain into the horticultural farm is invariably a lot less than for supply channels.

8. Upward Leakage from Deep-seated Aquifers

This is mentioned because it is a hypothetical possibility. In the MIA however this movement is extremely small and generally downward, not upward.

9. Conclusions and Discussion

Of all the external sources of possible seepage to horticultural farms two seem to be significant, seepage from supply channels and downslope seepage from more upslope farms. There are isolated instances where aquifer conditions may cause seepage to occur from other horticultural farms or rice farms, increasing watertables and therefore drainage discharge from the farm. These instances, however, are fairly rare, particularly near existing tubewells, of which it is assumed that they will continue to be operated.

The vast majority of farms, say 70%, would not greatly be affected by seepage from outside sources.

The individual investigation of every tile drained farm to determine the ratio of internal and external sources of tile drainage flow is quite impractical. Ignoring the channel seepage issue it is possible however to classify farms in categories, perhaps as follows:

1. Farms where more than 90% of flow is derived from the farm itself.
2. Farms where downslope seepage is likely to be a significant factor.
3. Farms where aquifer conditions are such that a possible contribution from external sources exists.

Another category could be those where some doubt exists as to which condition applies.