Utilise rainfall to limit the risk of local seeps

Key facts

- Seeps result when unused water moves through the dune–swale landscape to a low-lying discharge site.
- Maximising crop water use efficiency (WUE) is the key to preventing and managing seeps.
- Establishing perennial pastures on sandy crests will optimise year-round rainfall utilisation, preventing water loss through the soil profile.

Farming systems and management practices that maximise plant water use will limit seeps from developing. Localised seeps and salinity can occur within a matter of seasons and render low-lying productive areas within a paddock unable to support any plant growth.

Growers in the Southern Mallee region of South Australia first noticed seeps developing during the early 2000s. Areas that were historically the best-performing zones of a paddock were slowly becoming waterlogged and salt levels were increasing. Eventually trafficability was affected and crops could no longer be established in these zones.

What are seeps?

Seeps occur when unused rainfall drains through a vulnerable landscape, meets an impermeable subsoil layer and discharges at the sand–clay interface (see Figure 13).

Seeps are typically seen in dune–swale landscapes under annual cropping systems, where the catchment area is a coarse sandy soil, often with poor water-holding capacity.

Rainfall penetrates the soil surface rapidly, collecting salts and nutrients as it moves through the profile.

At depth these soils have a non-continuous, impenetrable clay layer. Water pools at this sand–clay interface, and moves laterally across the clay. Over time, and with subsequent rainfall events, this water eventually discharges at the base of the catchment site.

Water recharge is greatest during a summer fallow, which aims to conserve summer rainfall for the following winter crop.

During the growing season annual crops and pastures intercept and use a proportion of the rainfall. However, due to the rapid movement of water through the sandy soils, recharge still occurs, albeit at a lower rate than during a fallow.

When the accumulated recharge evaporates, salts remain, leaving a semi-permanent to permanent scald area at the discharge site.

Farming system influences

Modern farming systems and practices have, in part, contributed to the occurrence of localised seeps. A shift to continuous annual cropping, a reduction in perennial species and effective summer weed control are likely to be contributing factors.

PREVIOUS PAGE: Continuous annual cropping, a reduction in perennial species and effective summer weed control are likely to be contributing to the development of seeps.

ABOVE: Seeps occur when unused rainfall drains through the landscape and discharges at the sand-clay interface.

Photos: Lou Flohr, Agrilink Agricultural Consultants

The effective control of summer weeds across landscapes dominated by large areas of sandy dunes, relative to swales, with underlying low permeability are potential situations that cause localised seeps to occur.

Water-repellent sands with low inherent fertility also both directly and indirectly contribute to the development of a seep.

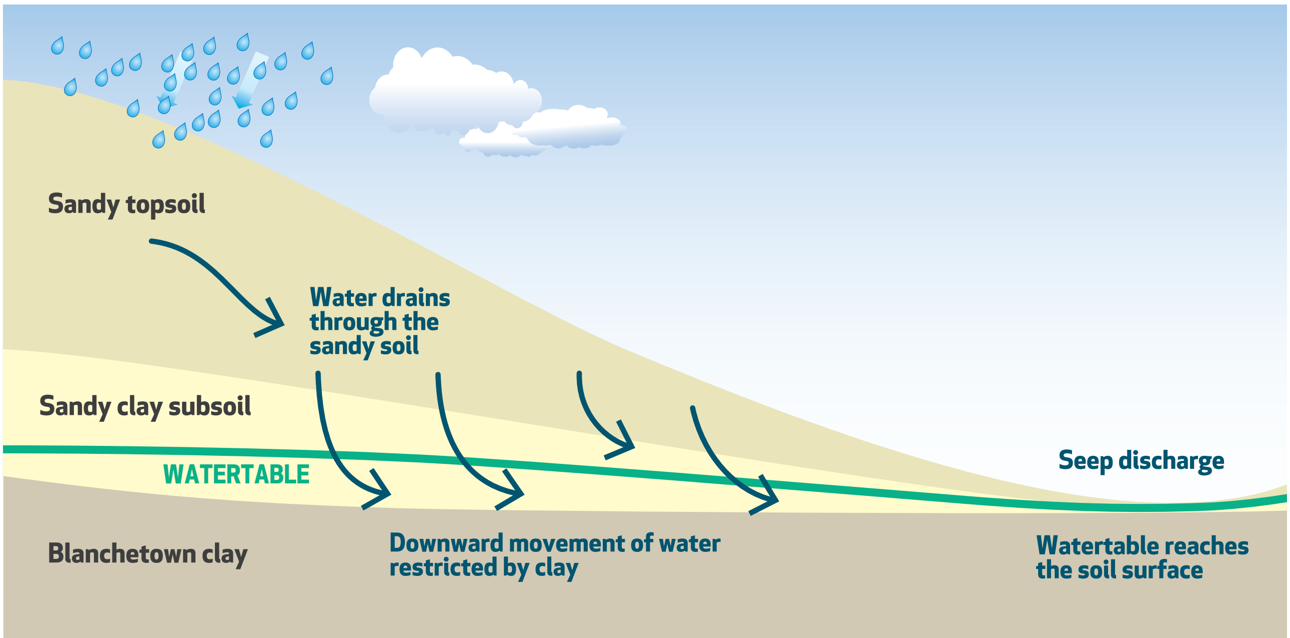
Seeps versus widespread salinity

It is important to distinguish the difference between the development of isolated, local seeps and salinity associated with a rise in groundwater levels across the region or catchment.

Seeps involve a local water system, which occurs close to the surface, they are not associated with the deeper groundwater basin, which in most cases is 40–60m deep.

It is the horizontal movement of water through the landscape, rather than a rising and falling water table that characterises a localised seep.

Figure 13. How seeps develop in a dune-swale landscape



Water drains through a sandy topsoil and sandy-clay subsoil before further downward movement of water is restricted by a Blanchetown clay layer, resulting in a perched watertable. In the lower-lying swale area, the perched watertable reaches the surface, resulting in the formation of a seep discharge area.

ABOVE: Sowing salt tolerant perennial species, such as messina (top), lucerne (above left) and tall wheatgrass (above right) will ensure water is used throughout the year. Photos: FFICRC and Catriona Nicholls

Farming system impacts

The major challenges surrounding seeps are the impacts at the discharge sites, including:

- persistent waterlogging, which can reduce trafficability for sowing and crop or pasture management activities, and limits crop and pasture options and production
- elevated soil salinity levels, which further limit crop and pasture and productivity
- poor plant growth and therefore the subsequent lack of ground cover, and evaporation, which causes salt to accumulate at the soil surface
- a bare soil surface, which is then exposed to wind or water erosion.

If the discharge or scald area is eroded, the loss of topsoil can result in a more-or-less permanent blow out, which creates an areas of permanently unproductive land.

Management strategies

The key to managing seeps is to act quickly. The faster a seep is identified and managed, the easier rehabilitation will be. Long-term degraded sites take considerably more effort (and money) to restore.

Appropriate strategies will depend on the current and potential enterprise mix and resources available. A summary of possible approaches is listed above in Table 4.

Table 4. Management options for seeps

Stage of detection	Possible symptoms	Hydraulic processes	Suitable management options
Early detection	High productivity at base or mid-slope of sandy catchment area. Small bare patches starting to appear. Trafficability not compromised.	Fresh water being discharged into the site, but site not rising to the soil surface.	Stop recharge from occurring. Take catchment area out of annual cropping and sow a perennial species, such as lucerne. After water has been used by the perennial species, the area can be re-sown to annual crops. This process may need to be repeated, as its likely to recur.
Intermediate detection	Small bare patches in discharge area from prolonged waterlogging. Some salt crusting around bare patches. Strong growth around bare patch. Boggy to drive through.	Water accumulation at the soil–clay interface has reached maximum potential, water starts to seep out of mid-slope or swale.	Stop recharge from occurring. Cover discharge site to stop evaporation — possibly with straw and consider sowing salt-tolerant perennial species, such as Puccinella and tall wheat grass. Take catchment area out of annual cropping, and sow a perennial species, such as lucerne. Consider planting shrubs and/or trees above the discharge site in conjunction with perennial species.
Late detection	Large bare patches, waterlogged, salt crusted, and can no longer drive on the affected area.	The recharge has been feeding into the discharge site for some time, expanding the area. Evaporation has occurred, increasing the salt content of the soil. It is likely to take 10 or more years before regaining productivity.	Stop recharge from occurring. Cover discharge site to stop evaporation — possibly with straw and consider with salt-tolerant perennial species, such as Puccinella and tall wheat grass. Take catchment area out of annual cropping, and sow a perennial species, such as lucerne. Plant shrubs and/or trees above the discharge site in conjunction with perennial pasture species. Damage may not be reversible.

Spading chicken manure — a novel idea for managing seeps

The ultimate goal when managing seeps is to use the water where it falls. During 2015, local agronomic consultant Chris McDonough suggested ameliorating water-repellent sandy soils, with low water-holding capacity, a bleached A2 horizon and poor nutrient status at Wynarka, SA with chicken manure sourced from local sheds.

At the Wynarka site, a large proof-of-concept demonstration was set up during 2015 on a site with a severe seep in the swale zone. Chicken manure was spaded into the soil profile to a depth of about 40cm. Three rates of chicken manure were used: 0, 6 and 9t/ha (Table 5).

The addition of chicken manure reduced water repellence and improved the fertility of the bleached A2 horizon and water-holding capacity of the topsoil.

The spading treatment without chicken manure incorporated, produced a 28% yield increase in barley. This would suggest the mixing process involved with spading reduced water repellence, increased nutrient availability through re-distributed nutrients within the horizons and stimulated mineralisation. It may also indicate the spading reduced the effects of subsoil compaction.

Replicated trials conducted by Sam Trengove, Trengove Consulting, at Bute, SA during 2015 investigated the effects of deep ripping, the deep placement of chicken manure or equivalent fertiliser (40–50cm applied with deep ripper) and surface applications of chicken manure or equivalent nutrients in fertilisers.

The deep ripping treatment without additional fertiliser or manure produced a 55% increase in yield, suggesting a possible hard pan at this site, or nutrient response from increased mineralisation from the soil disturbance.

The yields produced when chicken manure was placed at depth with a deep ripping machine can be seen in Table 6.

Results from both the proof-of-concept demonstration at Wynarka and replicated trial at Bute indicate crop yields drop above a certain quantity of applied manure. This is likely to be due to high levels of nitrogen (N) in the profile, resulting in strong early-season, using available soil water, but 'haying off' later in the season, due to low residual plant-available water. On-going trial work will clarify the optimal levels of manure to support maximum crop yields.

The above data suggests that improving the nutrient levels and water-holding capacity of a poor soil will improve crop growth through better water capture and water use efficiency (WUE). This is important information for the ongoing management of seeps. With improved water use, comes reduced loss of water deep into the profile hence less recharge entering the seep discharge point.

Table 6. Yield data from manure and deep ripping trial at Bute, SA, 2015

Treatment	Yield (t/ha)
Control	1.79
0t/ha manure, deep ripping	2.78
5t/ha manure, deep ripping	2.92
20t/ha manure, deep ripping	2.28

F pr 0.006, LSD (0.05) 0.65t

The least significant difference (LSD) gives an indication of the treatment difference that could occur by chance. The size of the LSD can be used to compare treatment results and values must differ by more than this value for the difference to be significantly different.

Table 5. Result from chicken manure demonstration at Wynarka, SA, 2015

Modification	Unmodified	Spading — no manure	Spading + 6t/ha chicken manure	Spading + 9t/ha chicken manure
Average grain yield (t/ha)	1.55	2.17	3.29	3.30
Gross income @ $220/t wheat ($/ha)	$342	$478	$725	$726
Additional income above the control ($/ha)	—	$136	$383	$384
Cost of modification ($/ha)	—	$100	$310	$415
Net return after first year ($/ha)	—	$36	$73	-$31

Further information

- *Mallee seeps*, NRM Fact Sheet http://www.naturalresources.sa.gov.au/samurraydarlingbasin/publications/mallee-seeps
- *Soak management: 2015 GRDC Updates*, Adelaide Proceedings https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02/Dune-discharge-seepage-areas-in-the-South-Australian-landscape