EFFLUENT MANAGEMENT – Handling salt in effluent

Intensive livestock production in the Condamine region creates a large volume of high strength effluent which needs to be reused in a sustainable way. Pork production (in conventional systems) and abattoirs particularly, produce relatively large volumes of effluent.

While there can be high levels of nutrients in effluent, there can also be substantial amounts of salt and other contaminants. This fact sheet looks at the amount of salt in effluent and how it can be managed to maintain soil health and crop production.

How does salt cause damage?

Salt is a general term for a number of ionic compounds. Some elements that can form salts include potassium, sulphate, nitrate, ammonium and phosphate. Clearly these are not all harmful. However, some salts can be damaging to soil structure and toxic to plants and animals. Particular elements (or ions) of concern are sodium and chloride. These elements are responsible for soil structural decline (sodium – sodicity) and plant toxicity. Other elements including magnesium and calcium salts can also prove harmful if concentrations are high.

How much salt is in effluent?

Effluent water can become contaminated with salt from two major sources, feed and water. Water used for drinking or cleaning may be slightly saline, particularly if sourced from a bore. There is also a certain amount of salt added to some animal feeds to increase consumption. These salts accumulate in the effluent produced by the facility.

One measure of the salt level in water is by the electrical conductivity (EC). EC (measured in dS/m) for irrigation water is usually considered high if it is above about 3 dS/m. Some effluent samples show much higher EC readings than this, but not all the salts that contribute to the high EC in effluent are harmful. A typical analysis for piggery effluent is shown in Table 1
Table 1, note the EC, sodium (Na), Potassium (K) and Chloride (Cl) levels.
Table 1 shows a wide range in the values. This is because concentration can vary over time, particularly where water is lost from effluent storage dams by evaporation leaving high levels of salt behind. Concentration can also vary with other management factors. The high EC level for piggery effluent can be partly explained by the presence of other ions in the water, particularly potassium. But there is also a high amount of sodium and chloride present that must be managed.

Table 1. Salts contained in piggery effluent

	Units	Concentration	Range
pH		8	
EC	dS/m	7.5	2-14
Potassium (K)	mg/L	616	97-1845
Sodium (Na)	mg/L	603	103-2870
Calcium (Ca)	mg/L	18	7-31
Chloride (Cl)	mg/L	810	269-1950

Source: APL 2006.

An indicator of the amount of sodium in effluent, relative to other ions is given by the Sodium Adsorption Ratio (SAR) which is a measure of the ratio of sodium to calcium and magnesium in water. This measure can be useful in working out if the effluent will lead to sodicity in the soil. Generally speaking, an SAR of more than 5 will not be suitable for heavy clay soils, but this can increase to about 20 for sand to sandy loam soils.

To estimate the risk of impacts from sodium and chloride in effluent, one way is to calculate the mass of these elements. This can be done as follows;
Sodium (Na) in the effluent (
Table 1) = approx. 600 mg/L.

To convert this into kg / ML of effluent applied, use the conversion; 1 **mg/L** = 1 **kg/ML**. This means that 600 mg/L = 600 kg/ML.

Therefore, in the example above, **600 kg** of sodium is present in 1 mega litre of effluent. If this effluent was applied regularly without any other management, the sodium could lead to soil sodicity in a short amount of time. The same calculations can be used to work out the amount of chloride or other elements found in effluent so that these can be managed also.

Management options for irrigating effluent

Land reuse of effluent is one of the best ways to make use of the water and nutrients in a productive way. However this will require management of potentially large salt loads. These management steps could include;

- Mixing (shandying) effluent with clean irrigation water prior to application to lower salt concentrations
- Applying clean irrigation water after effluent to wash salts through the soil profile
- Rotating fields from year to year to reduce the total salts being applied to each area
- Regular application of gypsum to soils showing high sodicity

The best option will depend on the system and the availability of resources (clean irrigation water or additional land). If these are not available then it may be necessary to plan for alternative methods of using effluent to lower the pressure on reuse land (see other fact sheets in this series on alternative effluent reuse).

In all cases, monitoring of soils will show up trends that may lead to a problem. Monitoring can be done by taking soil tests and observing soil and crop characteristics. For instance, increasing sodium levels can lead to sodicity, causing a breakdown in soil structure which will lead to hard setting and reduced infiltration. Chloride toxicity will be seen in reduced crop yields, and in extreme cases by burning and yellowing of plant leaves. Keeping crop yield records will allow comparison with previous years to help show these trends. Annual soil testing is part of EPA licence regulations and will identify any changes in soil conditions such as; increased sodium and exchangeable sodium levels, increased chloride levels and increased soil EC. The following points are a general guide to identifying salinity and sodicity problems from the soil analysis. They require some knowledge of soil clay percentage for interpretation; Electrical Conductivity[1] (EC)

- $EC_{1:5}$ of more than 0.15 in a sandy loam to loam soil (less than 20% clay) is given a medium salinity rating, if the $EC_{1:5}$ is higher than 0.34 this is considered a high salinity level
- $EC_{1:5}$ of more than 0.19 in a loam to sandy clay soil (less than 40% clay) is given a medium salinity rating, if the $EC_{1:5}$ is higher than 0.45 this is considered a high salinity level
- $EC_{1:5}$ of more than 0.24 in a sandy clay to medium clay soil (less than 60% clay) is given a medium salinity rating, if the $EC_{1:5}$ is higher than 0.56 this is considered a high salinity level

For soils with high EC levels, monitor crop production and consider planting crops with higher salt tolerance. Generally, soils are too saline for crop growth where $EC_{1:5}$ is >1.53 dS/m (in soils with 40-60% clay), or >0.93 dS/m (10-20% clay).

Exchangeable Sodium Percentage[1] (ESP) – indicates sodicity levels.

- ESP Less than 6% → non sodic
- ESP 6 – 14% → sodic
- ESP greater than 15% → strongly sodic

For sodic soils, apply gypsum to improve soil structure. Rates vary from 2.5 – 4t/ha.

High chloride levels – indicates chloride toxicity.

- 120mg/kg for sand – sandy loam
- 180mg/kg for loam to clay loam
- 300mg/kg for clay soils

Levels in excess of these listed may lead to reduced plant growth depending on plant tolerance and soil drainage. Chloride levels may decrease over time as chlorides are leached from the system. It is suggested that paddocks are spelled, chloride inputs are reduced and crops with higher chloride tolerance are sown.

References and further reading;

[1] Department of Natural Resources (DNR) 1997, Salinity management handbook, Scientific Publishing, Resource Sciences Centre #222, Department of Natural Resources, Queensland.
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Australian Pork Limited (APL) 2006, *National Environmental Guidelines for Piggeries*, Australian Pork Limited, Canberra, ACT.

Some other fact sheets in this series:
Effluent management – Sustainable land reuse
Effluent management – Co-composting for effluent reuse

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