WA Wheatbelt drainage – acidic groundwater, not just a salt issue

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Acid groundwater, that dissolves clays and minerals, has been encountered widely in drains built to counter salinity in the WA Wheatbelt. Acid groundwater has been debated as the main cause of off-site risk as it has the potential to release metals and elements harmful to flora and fauna that inhabit receiving areas.

A research project to assess the causes and risks and to identify management options has been developed as part of the Engineering Evaluation Initiative (EEI) and began in July 2004. This is part of the National Action Plan for Salinity and Water Quality (NAP). The project is led by CRC LEME and involves scientists from CRC LEME, the Department of Agriculture, the Department of Environment, and CSIRO.

Awareness of the presence of acid groundwater has grown over the last few years, and with it awareness of the potential for off-site damage resulting from building drains to remove saline water. It is important that we assess the risk and develop appropriate management strategies to minimise any potential hazards.

The first step in the project was to review historical groundwater records for salinity and pH information in the Agbores database of 2465 records held by the Department of Agriculture and the WIN database of 600 bores. This was undertaken in August-September 2004 to determine the geochemistry of groundwaters in the WA Wheatbelt and in particular the Avon Basin. These data were then analysed according to hydrogeology, geographical location and landform.

Photo: S Rogers

Drain sediments, red iron gels and black monosulfides, form in a matter of months

The review identified two distinct groups of groundwater, one which was clearly acid with pH about 3 to 4.5 (neutral is pH of 7) and a second around pH 6 to 8 (neutral to slightly alkaline). Combined with knowledge of groundwater chemistry from the WA Goldfields and elsewhere, this suggests that:

- Acid groundwaters are a natural regolith phenomenon and existed in agricultural areas well before any drains were installed.
- Groundwaters in the eastern Wheatbelt valleys and other areas with abundant salt lakes, such as north-east of Esperance, tend to be most acidic (affecting up to 70 per cent of bores in such areas).

Photo: S Rogers

Iron precipitates in drain base, source of acidity

Results from the groundwater review contrasted with a stream and lake sampling program in late 2004 which found that surface waters were generally neutral to alkaline (pH 8) especially in the western Wheatbelt. However, naturally acidic surface waters (pH less than 4.5) have been recorded as far back as 1974.

In late October 2004, more than 200 water samples were taken from more than 20 drains in an area between Dalwallinu in the north, Newdegate in the south-east and Williams in the west. Follow-up samples were taken at selected sites in January 2005. The drains were sampled for flow, salinity, pH, major metals, trace elements, rare earth elements and other elements such as uranium. In addition, over 200 soil and sediment samples were taken to determine what geochemical processes were taking place in the drains.

Results again indicated two broad groups of drain pH and salinity. The pH was lowest east of a line from Dalwallinu to Dumbleyung (pH less than 3.5) and highest (pH greater than 6) in the western and central Wheatbelt. Only a few sporadic high pH (alkaline) samples were taken from drains in the eastern areas. Most drains were typically very saline with conductivity in the range 6,000-10,000 mS/m. For comparison, seawater has a conductivity of 5,500 mS/m.

Data show that in most eastern drains with a low pH (less than 4.5), iron, aluminium, cobalt, copper, zinc, lead, uranium and a range of other trace elements and rare earth elements all elevated.

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In summary:

- Acidity is widespread, justifying the initiation of the project by EEI, with more than half of the drains sampled in October 2004 being strongly acid (average pH 3).
- Drain acidity increases during summer, probably due to iron oxidation in sediments.
- Formation of 'new' sediment profiles in drains characterised by iron sulfide minerals occurs over a period of months, and has the potential to generate some additional acid through sulfur oxidation if drain sediments dry out.
- In many cases, metal and trace element levels are 10-100 times higher than in regional surface waters.
- Drains sampled in eastern areas are typically acid and contain large amounts of iron, aluminium, salt, metals, and the rare earth elements, lanthanum and cerium.
- Drains sampled in western, southern and some areas to the north of the Avon Catchment are in general more typically neutral pH.

Drain flows often migrate to receiving areas that are alkaline such as salt lakes and saline seeps.

Transporting acid water to these areas offers the opportunity to 'neutralise' the acidic flow. However while this can occur, it is not true for all metals and trace elements. For example some elements are potentially more toxic under higher pH and an anoxic (oxygen free) sediment environment.

As a result of the data analysis during the first 12 months of this project, the following management and assessment guidelines are suggested:

- Soils, groundwater geochemistry and pilot excavations should be assessed before drain construction to determine the risk of acid groundwater and trace element issues.
- Subsoils that contain calcretes, silcretes and red-brown hardpans are at less risk of erosion, sedimentation, dissolution and related problems than clay-rich, sodic subsoils.

Sampling Elachbutting drain

Photo: S Rogers

Photos: S Rogers

Elachbutting drain terminus

- Drains need to be kept free of sediments to both sustain their hydraulic effect (water tables) and prevent additional acidification and geochemical reactions within them (making more acids).
- Organic material (such as dead vegetation) should be prevented from entering drains for the same reasons (hydraulic and geochemical impacts).
- Drain designs should prevent erosion and the transport of acids, and related organic and metal-rich deposits (plus sediment) to receiving environments especially during flood events
- An assessment of the impact of acid and trace element-rich drain discharges on receiving environments (lake/river systems, evaporation basins) is critical.

Assessment of discharges on receiving environments and on-ground evaluation of management options will be the major focus of the second year of this project, running from July 2005 until June 2006.

Engineering Evaluation Initiative Steering Committee Chairman, John Ruprecht from the Department of Environment said: "Whilst the project has identified that there is an issue with regard to acid drainage and the presence of metals, rare earth elements, and trace elements, the EEI seeks to evaluate drainage through careful assessment of risk, opportunities and the determination of effective management systems.

"In particular these approaches and regional partnerships will assist NRM regions and interested groups to develop a consistent approach to catchment and regional drainage."

This project is laying the foundation for drainage to be undertaken in a responsible and organised manner. While the issue of acid groundwater is under evaluation, we need to carefully think through managing existing acid drains and developing new drainage systems.

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