Water quality monitoring in acid sulfate soil areas

Introduction

This information sheet has been prepared to assist councils, industry, community groups and landowners develop effective water quality monitoring programs for small scale acid sulfate soil remediation projects.

The information sheet details some considerations that must be taken into account when designing a water quality monitoring program in acid sulfate soil areas.

As any water quality monitoring can incur high costs, considerable thought should be given to planning and designing an effective monitoring program. Clear aims and objectives should always be established prior to commencing any water quality monitoring program.

If the aim of water quality monitoring is to assess whether a change has occurred as a result of a remediation project, it is recommended that at least 20% of the total project budget be allocated to monitoring. This will ensure that the scope of the monitoring program is adequate to assess the project.

Reasons for monitoring

Every monitoring program is different, and the design will depend on what you need to know and what resources are available.

Some reasons for monitoring water quality in acid sulfate soil areas are:

- to assess where or how frequently acid is produced,
- to evaluate the effect that improved land management has on acid sulfate soil remediation projects.

Factors affecting monitoring

Water quality on coastal floodplains can vary greatly over a short timeframe, depending on rainfall, tidal range, time of day and season. Acid export is also dependent on ground water levels, soil characteristics, and types of flood-gates. Thus - where, when and how often samples are taken must be taken into consideration.

Fig 1. Automatic floodgate and water sampling unit at Shoalhaven. (Picture by Christina Collins, 2002)

Where to measure

Careful selection of sampling sites is essential, as the location of the sites depends on the aims and objectives of the water quality monitoring. For example, in a remediation project focused on floodgate management, sampling would concentrate in front of and behind the floodgate as well as within the drainage channel. Alternatively in a backswamp management project, sampling may concentrate in the backswamp itself, rather than at the floodgate.
Regular monitoring of sites is important, so that changes can be interpreted over time. It is also important to choose monitoring sites that can be accessed during all weather.

Equipment

Equipment must be regularly maintained to ensure accurate measurements. Water quality meters should be calibrated and probes serviced regularly. This is particularly important for Dissolved Oxygen probes, which can quickly become unreliable. Ensure that probes can tolerate and accurately measure the highly acidic conditions that may occur during monitoring.

What parameters to measure

The following tests are useful in acid sulfate soil areas, and are listed in descending order of priority. If you have a large monitoring budget, you may use all of them. However, every monitoring project should aim to use at least the first three tests.

1. **pH:** can be carried out in the field and indicates the degree of acidity or alkalinity of the water.
2. **Electrical Conductivity (EC):** can be carried out in the field and indicates the ability of the water to conduct electricity, which can be used to estimate salinity.
3. **Titratable Acidity:** a laboratory test that determines the quantity of acid the water can release.
4. **Dissolved Oxygen (DO) and Redox potential (Eh):** can be carried out in the field. The various reactions involved with the export and formation of acid and acid products can affect oxygen and redox levels. Iron monosulfide formation in drains is significantly governed by DO and Eh levels.
5. **Chloride:Sulfate Ratio:** a laboratory test that is used to assess whether elevated sulfate levels have derived from exposure of acid sulfate soils.
6. **Iron and Aluminium:** laboratory tests that measure dissolved iron and aluminium concentrations which are often released from acidic soils.

Depth

Water quality can vary with depth, particularly under low flow conditions. When monitoring pH, it is important to take this into account, as readings taken on the surface can vary widely from those taken deeper in the water column. During times of high flow, such as after heavy rain, this stratification can be less important, as the water column may be better mixed.

Floodgates

Leaky floodgates can influence water quality, especially if the drain water is relatively fresh compared to the river. As seawater is slightly alkaline, it may neutralise some acid, resulting in higher pH levels. Therefore, when monitoring in tidal areas, if possible collect samples on the outgoing tide to minimise the influence of saline water, and thus provide more accurate information on the quality of water discharging from the drainage system.

Fig 2. Floodgates on the lower Clarence. (Picture by Christina Collins, 2002)

Rainfall and weather

Recording local rainfall is essential for interpreting water quality results in acid sulfate soil areas. How much rain falls on a catchment will drive surface, and more importantly ground water flows, which primarily drive acid export into drains. Rainfall should be recorded at least daily.

Acid discharge is usually at its peak following heavy rainfall, especially after a dry period. If you are monitoring to determine whether there has been an improvement in water quality, it is important to ensure that adequate samples are taken during this time.

Monitoring should be conducted over a range of seasons as extreme dry or wet periods are not representative of the whole range of conditions an area might experience. Monitoring may therefore need to continue after a project has finished in order to fully appreciate how an area responds to different weather.

Groundwater

Ground water levels can be monitored through the installation of test wells. A transect of test wells should be installed perpendicular to drains along the suspected direction of ground water flow. It is important to space test wells closer together where large changes in ground water levels are expected (i.e. close to a large flood mitigation drain) and further apart where a more gradual change is expected (i.e. in the middle of a paddock). Drain water levels can be measured through the installation of level gauges or by an automatic logger, while ground water levels in the test wells are often measured with a dipstick.

Fig 3. Test well used to monitor ground water level. (Picture by Christina Collins, 2002)

Acid Export

Research into acid export has identified an important relationship between drain and ground water levels and soil structure and acidity. A high ground water level together with a low drain water level may increase the export of acid products into a drain. The soil composition alongside drains is a crucial factor, as the structure, type, acidity and permeability of the soil can also determine acid export rates.

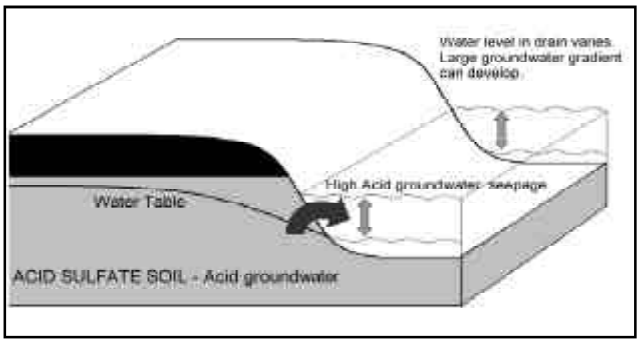

Fig 4. Low drain and high ground water increases discharge. (Diagram by Scott Johnston, 2002)

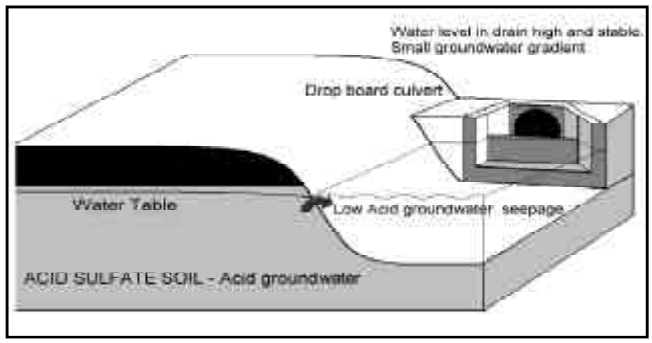

Fig 5. High drain water level decreases discharge. (Diagram by Scott Johnston, 2002)

Indicators

Acid sulfate soil indicators may assist in identifying acidic conditions. These include plant, water and soil indicators. Many plant species tolerate and even grow well in acidic conditions. These include tea-trees, smart-weed, couch grass, waterlilies, rushes and maundia.

Water indicators include; water that is crystal clear, yellow-brown, blue-green or milky-white in appearance. Iron flocs in the water or along drain banks are also a good indicator of acid sulfate conditions. Soil indicators include salt crusts, scalds and iron monosulfides. By recording your observations of these indicators, changes can be tracked over time.

Iron monosulfides can be an important indicator. These can form as a black oily sludge on the bottom of acidic drains in low oxygen environments. Measuring the distribution and depth of iron monosulfides throughout a system is useful when monitoring and interpreting acidic conditions.

Fig. 6. Plant indicators - rushes and waterlilies. (Picture by Alice Woodhead, 2000)

After monitoring

The information collected through an effective monitoring program is invaluable. It is important to communicate your results, findings and trends to interested people. This may include writing media articles, distributing regular reports and holding field days.

Further reading

This document has attempted to highlight some of the more important aspects of monitoring in acid sulfate soil landscapes. It is recommended that further reading be undertaken on more general aspects of water quality monitoring. Some documents that may assist are listed below.

NSW Acid Sulfate Soil Manual
A detailed technical reference manual which includes information on designing a water assessment program, laboratory tests, the relationship between ground water and acid sulfate soils, monitoring ground water and water quality and interpretation of results. $50, plus $5 postage. Contact Planning NSW (02) 93912222.

Acid Sulfate Soil: Keys to Success
An easy-to-read document that outlines how to identify and assess acid sulfate soils at a farm level. Contact NSW Agriculture (02) 6626 1200.

Acid Sulfate Soil Remediation Guidelines for the management of coastal floodplains in NSW
Available on CD. Contact DLWC (02) 6563 1212.

Australian Guidelines for Water Quality Monitoring and Reporting Summary
Comprehensive guidelines. Contact Australian Water Association (02) 9143 1288.

Field measurement of acid sulfate soil affected waters (1996) by J Sammut, I White and M Melville
Factors to consider in monitoring in acid sulfate soil landscapes, including instrument maintenance. $49.50. Contact NSW Agriculture (02) 6626 1347.

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