



# ASSAY

A NEWSLETTER ABOUT ACID SULFATE SOILS

No 37. April 2004

## Floodplain Drainage Guidelines Launched

In February the culmination of seven years joint research by NSW Agriculture and NSW Fisheries was launched at Grafton on the north coast of NSW. A set of guidelines have been developed to outline strategies that will reduce the adverse impacts of coastal floodplain drainage systems on fisheries and estuarine water quality. At the same time they are designed to help land managers maintain agricultural production and prevent further degradation.

Floodplain drainage systems, established for flood mitigation have opened large areas of coastal NSW for agricultural and urban development, but many have also been a source of poor water quality to coastal estuaries. In many cases drainage systems have altered the hydrology of low lying swamps, resulting in oxidised acid sulfate soils, changed wetland vegetation and reduced fish habitat.

The guidelines have been written for people who actively manage coastal floodplain drainage systems, including local government authorities, landowners, drainage unions, industry groups and community groups. They include a simple decision making process for determining best management practice, through assessing site specific characteristics, including the hydrological conductivity of the surrounding soil (how quickly groundwater can travel through soil).

Soils with high hydrological conductivity have the potential to discharge very acidic groundwater into drainage systems for extended periods of time. Acid sulfate soils Hotspots in northern NSW such as the Tuckean Swamp, Shark Creek

and Partridge Creek were found to have soils with very high hydraulic conductivity

The guidelines describe how seepage of acid groundwater into the drainage system can be reduced by keeping drain water levels similar to or slightly higher than the watertable level in the field next to the drain.

The guidelines were launched by Senator Judith Troeth, Parliamentary Secretary to the Federal Minister for Agriculture, Fisheries and Forestry in front of an audience of local stakeholders. Senator Troeth spoke of the uniqueness of the research, being an integrated look at both land management and estuary health, and how the program would act as a model for other areas.

Copies of the guidelines can be accessed from <http://www.agric.nsw.gov.au/reader/floodgate-guidelines>



**Researchers Scott Johnston (far left) and Frederike Kroon (second from right) look over the finished guidelines with Sen Troeth and Local Federal MP Ian Causley.**

## Results of ASSAY survey are in

Hundreds of readers have taken the opportunity to comment on ASSAY through the survey distributed with the last edition. Readers from all corners of the country have completed and returned over 500 surveys.

For most readers, ASSAY plays an important role in maintaining their knowledge of acid sulfate soils, with 95% of respondents using the newsletter to generally stay up to date on the issue. 80% of readers are happy with the current format of ASSAY and 75% wished it to stay as a quarterly publication.

For the most part, readers were happy with the content and range of issues covered in ASSAY. Readers wanted to see more research findings and information on farm management included and readers from states other than NSW said they would like to see better coverage of national issues within ASSAY.

One change that will take place as a result of the survey is that many readers will now receive ASSAY electronically, after electing to have the newsletter sent to them through email.

Receiving ASSAY electronically will assist in keeping future production costs down.

The survey has provided wonderful ideas for future articles and gives the editorial team a better idea of what readers are looking for. Thank you to everyone who responded. If you haven't responded, surveys are still being collated and can be returned to the editor.

## Who Has the Oldest ASS?

The Queensland Acid Sulfate Soil Investigation Team (QASSIT) have thrown out a challenge to see who can find the earliest written reference to acid sulfate soil in Australia. Spurred into action by a recent student inquiry, the team has come across what they believe to be the earliest report, dated 1917.

Steve Appleyard from the Western Australian Department of Environment had a copy of the 1917 reference by HP Woodward. The reference appeared in a study titled "Investigation into the cause of the mineralisation of the 'Seven-Mile' swamp at Grassmere, near Albany, South-West Division", contained within an annual report from the Mines Department of Western Australia.

Woodward describes the results of an investigation into a tract of land near Albany, which had been previously drained by the government. He states very clearly that "... *the whole source of the trouble can be directly attributed to the decomposition of pyrite which is present in soil and subsoil of the swamp itself in considerable quantity ... Pyrites in its natural state is perfectly innocuous and remains so, so long as it is kept from coming in contact with the air or any oxidising substance ... The decomposition of pyrites is, however, brought about either, or more rapidly by both, of the following conditions: firstly, by the drainage of the land which permits the access of the air into the soil, and secondly, by cultivation, which opens up the soil thus exposing the pyrites to the atmosphere.*"

Internationally the earliest report QASSIT has found (thanks to David Dent) is dated 1735 by Linnaeus documenting acidity problems in The Netherlands due to reclamation of polders.

### Wayne Anderson

Excavator Owner/Operator

✪ *Specialising in drain maintenance*  
*Nth Coast NSW/SE Queensland* ✪



Featuring a 10ft long weed bucket as recommended for drain cleaning in the **ASS Manual** and NSW Sugar Cane Industry's **Best Management Practice Guidelines**

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So the challenge has been set, can anyone beat the Western Australians to hold the title of the oldest Australian reference to acid sulfate soils? Both the editor and QASSIT member Kristie Watling are keen to hear from anyone with an early reference to acid sulfate soils. Contact them on [christina.clay@agric.nsw.gov.au](mailto:christina.clay@agric.nsw.gov.au) or [kristie.watling@dnr.qld.gov.au](mailto:kristie.watling@dnr.qld.gov.au)

## NSW UPDATE

### 4 years on, what changed?

In 1998 the NSW Acid Sulfate Soil Management Committee (ASSMAC) funded a benchmarking study to monitor any changes to acid sulfate soils management across the state. Social benchmarking was identified as a method of not only measuring on-ground action but changes in attitudes, beliefs and knowledge. In terms of how effective different remediation programs had been, these social indicators were recognised as important as the level of best management practices implemented, e.g. how many floodgates opened or drains filled in.

A group of cane farmers, tea tree growers, graziers and dairy farmers were selected from seven catchments along the NSW coast and were initially surveyed in 1998 and then again

in 2002. The farmers were surveyed on their knowledge of management techniques, whether they had implemented any on their farms and their attitudes towards the management of acid sulfate soils.

Overall the results of the 2002 survey were a positive reflection on the programs that had been initiated since 1998. General awareness of acid sulfate soils was higher in 2002 across all industries and catchments. The grazing industry had the biggest increase in awareness since 1998 with the gap in knowledge between the cane industry and other ventures narrowing. The survey found that there is now less conflict and stronger networks between government, industry, landowners and the community. This is all leading to more drains being filled in or shallowed, floodgates being managed and in-drain weirs being installed.

Whilst the results were positive they did identify challenges for the future. The need for ongoing support and information was highlighted if landowners were not to believe that acid sulfate soils was 'just another government bandwagon'. To keep landowners 'on a roll' they need ongoing information and support about management options to prevent the recurrence of past drainage problems.

A summary report from the 2002 survey is available from NSW Agriculture on (02) 6626 1355 or [christina.clay@agric.nsw.gov.au](mailto:christina.clay@agric.nsw.gov.au)



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### Environmental Services Scheme - the acid test

The Environmental Services Scheme is a NSW Department of Infrastructure Planning and Natural Resources (DIPNR) funded pilot program comprising a series of projects across rural NSW. Each project is based on a competitive bid by the landowner to carry out specific on-ground remediation works to address natural resource degradation. The cost of these works is being measured against the value of the environmental services (e.g. reduced acid runoff, improved water quality, increased biodiversity) produced.

Three north coast landowners were selected to participate in the scheme, with their bids

addressing acid sulfate soils in the Clybucca, Shark Creek and Tuckean regions. Remediation options proposed for the three sites include modification of drains, fencing, re-introduction of longer wetting and drying cycles and revegetation of acid scalds as well as tree planting.

So how do we measure the environmental services we are getting for our investment?

Compared to other natural resource issues, there are no sophisticated models to effectively predict the environmental benefit of a landuse change in acid sulfate soil areas. Whilst the Environmental Services Scheme is not designed as a major research project, the opportunity exists to gather information that can assist in the development of a 'toolkit', which would increase our ability to predict outcomes from managing acid sulfate soils.

To assist with the monitoring component of the scheme DIPNR has entered into a partnership with Southern Cross University and with the assistance of an ARC Linkage Grant, a PhD student will be collating information on the three north coast sites. This will allow the accuracy of the acid sulfate soil 'toolkit' to be tested whilst monitoring the environmental benefits of the land use changes. The results of which may have much wider relevance to other remediation



**Fencing off drains from stock is a remediation option being implemented in the Clybucca and Tuckean Swamp as part of the Environmental Services Scheme.**

programs and their ability to measure on-ground change.

For further information on the Environmental Services Scheme contact Simon Proust at [simon.proust@dipnr.nsw.gov.au](mailto:simon.proust@dipnr.nsw.gov.au)

## **Natural Resource changes in NSW**

As part of the Carr Governments reforms to how natural resource management is delivered in NSW, further changes have occurred to state agencies.

As identified in the last edition of ASSAY, Catchment Management Boards are in the process of evolving into Catchment Management Authorities. Chairs have now been appointed to the Authorities and are amidst the process of selecting their fellow board members.

With the new focus of regional delivery, state wide committees such as ASSMAC ceased functioning. The newly formed Department of Infrastructure, Planning and Natural Resources (Dept Land & Water Conservation and Planning NSW) is being restructured to align more closely with the new role of the Catchment Management Authorities. To do so it is expected that DIPNR staff servicing the old Boards will have new roles working for the Authority.

The National Parks and Wildlife Service and the Environment Protection Agency have also merged to form the Department of Environment and Conservation, which will also work in more closely with the newly formed Catchment Management Authorities.

As from 1st July, NSW Agriculture, NSW Fisheries, State Forests and the Department of Mineral Resources will jointly combine to form the Department of Primary Industry. Recent announcements from Treasury indicate that further changes to Departments and budgets are still to come.

## **ASS Manual Update**

The disturbance of acid sulfate soils in NSW has been regulated through Local Environment Plans, which are administered through local government. A key component of this regula-

tion is the Acid Sulfate Soil Manual, which outlines how to assess any potential disturbance and mitigate any potential effects. The Acid Sulfate Soil Management Committee first published the Manual in 1998 with significant input from a number of stakeholders including the then Department of Urban Affairs and Planning.

As advancements in assessment techniques and management have occurred the need to review the Manual became apparent. The review period has been under way for some time, including updated information as it has come to light. Over the past twelve months this process has become significantly delayed due to the on-going changes to natural resource management in NSW. It is now unlikely that a new edition of the Manual will be published until there is certainty on where and how the underpinning process of planning and assessment will be delivered at a state level.

The disturbance of acid sulfate soils continues to be regulated under Local Environment Plans, through local government. The 1998 version of the Manual also remains the official document providing information on assessment and management of acid sulfate soils. The Department of Infrastructure, Planning and Natural Resources (DIPNR) is continuing the review process and any inquiries on specific aspects of planning, regulation and the Manual can be referred to [jane.gibbs@dipnr.nsw.gov.au](mailto:jane.gibbs@dipnr.nsw.gov.au) or your local DIPNR office.

## Hotspot Program - Stage 1 ends

Stage one of the Hotspot Program administered through the Department of Infrastructure, Planning and Natural Resources is in its final stages. The Program that was announced by Premier Bob Carr in November 2000 was planned to be a two staged approach to address large sub-catchment areas effected by acid sulfate soils along the NSW coast.

In late March when all on-ground works were due to be complete, the project moved into an assessment and review period. From the programs involvement with the seven identified Hotspots included in stage one, a series of milestones have been reached.

One of the more significant achievements of the Program has been the capacity building aspect that occurred when local councils took the responsibility of managing local remediation projects. Stakeholders and landowners have since recognised the effective role local government can play as local drivers for improved floodplain management.

Significant planning and assessment of best management practice occurred at all sites, with valuable information such as land elevation and soil surveying being completed as part of the program. On-ground works were negotiated with landowners and implemented at five of the seven Hotspots.

As with any remediation project, the decision to change landuse is influenced by many different factors. On-going communication and extension will continue with landowners in Hotspots yet to complete on-ground works. Another common aspect of remediation is the difficulty in quantifying any outcome from changed landuse. Project timeframes often fail to fall over a range of climatic events and detecting any improvement to water quality is reliant on significant rainfall events. Water quality monitoring systems installed as part of the program will continue beyond the completion of on-ground works to assist with measuring any improvement made.

Once reporting is complete the funding body, the Environmental Trust, will then evaluate the effectiveness of this model of remediation program in light of funding Stage 2 and any further programs addressing acid sulfate soils.

For further information please contact Andrew Ling (02) 4960 5056 or email [andrew.ling@dipnr.nsw.gov.au](mailto:andrew.ling@dipnr.nsw.gov.au)

## McLeods Creek update

McLeods Creek on the Tweed floodplain (far north coast of NSW) has been a hub of acid sulfate soil research for the past decade. Once a highly scalded area, McLeods Creek and other low lying areas of the Tweed floodplain are now supporting excellent crops of sugar cane, lablab, oats, soya beans and canola. Mound planting has been shown to provide better drainage

and allowing the soil biota a micro-environment to live in. Mounding can significantly contribute to the success of such crops being grown in severe acid sulfate soils.

Monitoring of the water quality leaving the site is continuing with the support of Tweed Shire Council and the University of NSW. Ongoing funding to permit such long term monitoring has enabled McLeods Creek to be one of a few sites where improvements from changed land management practices can be quantified. As a new component of the monitoring Dr Ben MacDonald will be tracking the influence of air pressure on water table movement, early results indicate that as the ambient air pressure drops the water table rises and vice versa.

In new research happening at McLeods Creek, two local cane growers are working with PhD student Richard Reilly from the Australian National University to develop soil practices that will increase soil health in acid sulfate soil areas. The research will look at retaining organic matter in an attempt to reduce application rates of artificial fertilisers.

## How healthy is that wetland?

Assessing and understanding the 'health' of a wetland can be a useful component to acid sulfate soils and floodplain management. Wetland Care Australia is currently working on such a program, which seeks to identify, assess and prioritise wetlands on the north coast of NSW. In partnership with the Department of Infrastructure, Planning and Natural Resources, the twelve month project will focus on wetlands in the Bungawalbyn, Cudgen, Coraki, Belongil, Tuckean and Newrybar areas.

Wetland systems will firstly be identified at a desktop level, using *Towards a conservation value assessment methodology for wetlands in the NSW north coast* (still in draft) by Stuart Blanch from Department of Environment and Conservation. Wetlands with high conservation value and those that are severely degraded will be mapped using geographic information systems (GIS) and will be targeting for further field assessments.

Field assessments will use the *Wetland assess-*

*ment technique for north coast paperbark and freshwater wetlands*, developed by Southern Cross University's Keith Bolton. The technique assesses a number of wetland characteristics such as, connectivity, wetland establishment, acid sulfate soils, human disturbance, water quality and vegetation. Data collected in the field will be input to a database to produce reports, wetland health maps and a wetland register based on health and condition.

The information and assessments made throughout the project will assist in determining future priorities for public and private funding. Landowners from any of the above mentioned areas are encouraged to contact project staff. Interested landowners will be given an assessment report of their wetland, with a view of identifying potential management options to improve or maintain its current state.

For further information on the project contact Cassie Burns on (02) 6627 0126 or [cassieburns@wetlandcare.com.au](mailto:cassieburns@wetlandcare.com.au)

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## QLD UPDATE

### How much does ASS cost local government?

The Queensland Fisheries Service (QFS) is interested in gauging the level of financial and other resources being expended by local councils to manage acid sulfate soils in coastal Queensland. The management of potential impacts on community assets such as fish stocks and health is of major interest to the QFS and the information will be used to update previous surveys completed in 2000.

The QFS is particularly interested in hearing from engineers, planners or other relevant council staff who deal with the management of infrastructure such as bridges, roads or development applications involving the disturbance of acid sulfate soils.

The short survey can be accessed on-line at <http://www.dpi.qld.gov.au/fishweb/14578.html>  
Closing date for responses is 21st May 2004

For further information please contact Dawn Couchman on (07) 3224 2249 or [dawn.couchman@dpi.qld.gov.au](mailto:dawn.couchman@dpi.qld.gov.au)

## WA UPDATE

### Mapping Reaches 4000 Ha

Mapping of acid sulfate soils in WA has started in the Peel Region, south of Perth, and identified over 4000 hectares with shallow (<3m) acid sulfate soils after covering over 100 000 hectares of coastal flats. Brad Degens, of the WA Department of Environment, is leading a field team of three to carry out the large task of identifying high acid sulfate soil risk in over 11 000 squares of the Swan Coastal Plain. Work is focusing on coastal acid sulfate soils with the intention of mapping inland acid sulfate soils associated with wetlands on the Swan Coastal plain in later years. This work is being undertaken as part of an initial \$680 000 program funded by the WA State Government to undertake mapping in areas under high pressure from development in response to the problems encountered in the Stirling area of Perth.

## Dredge Spoil Management

The Department of Environment has been working with the Department for Planning and Infrastructure, Shire of Murray and Manurah City Council to manage dredging of sediments in the Peel-Harvey Estuary and adjoining canal estates. Practices in the past have involved disposal of dredged materials on land around the estuary and onto artificial islands. This has resulted in creation of at least one site (>1000 cubic metres of material) where acidic runoff is entering the estuary. The plan is to first identify where dredged spoils have been deposited and which sites have acid sulfate soil problems, what actions should be taken to deal with these and how to manage on-going disposal of dredge materials.

## Groundwater Guidelines

Dr Steve Appleyard has prepared a set of draft guidelines on managing groundwater in acid sulfate soil risk areas for WA. The guidelines will address immediate concerns on the common practice of de-watering soils as part of construction and development activities on the Swan Coastal Plain. Concerns about excessive draw downs from de-watering spears have in some instances affected the water quality of the domestic bore users and threatening long term acidification. The report can be located at [http://www.environ.wa.gov.au/downloads/2561\\_ASS\\_GroundwaterControl\\_0312.pdf](http://www.environ.wa.gov.au/downloads/2561_ASS_GroundwaterControl_0312.pdf)



Field testing at South Yunderup as part of the Western Australian mapping program.

## TAS UPDATE

### NatCASS visit sparks interest in Tasmania

A recent visit to Tasmania by the National Committee on Acid Sulfate Soils (NatCASS) has prompted new interest and enthusiasm in the issue at a state level. While some early soil surveyors acknowledged the presence of sulfidic material in both coastal and inland situations across Tasmania, it was not until relatively recently that specific impacts of acid sulfate soils have been recorded.

Tasmania has not been subject to the infrastructure development pressures that have occurred in other parts of eastern Australia and there has consequently been little risk of disturbing potentially sulfidic sediments. Indeed, the issue has only now arisen in some parts of the State following an unusual series of low rainfall summers that have led to lower groundwater levels and oxidation of sulfidic sediments in the soil profile. In the one recorded incident it was subsequent irrigation of pasture on a dairy property that led to the leaching of acid into drainage lines and streams, causing some fish kills and contaminating stock drinking water. Subsequent soil investigations by the Department Primary Industry, Water and Environment identified the presence of sulfidic sediments within drained swamps and marshes in the area.

Reconnaissance soil mapping undertaken by Mineral Resources Tasmania in 2001 has indicated that there might be up to 200km of coastline that could be affected by acid sulfate soils. Potential sites typically occur along the Tasmanian north coast and on King and Flinders Islands, as well as in coastal, estuarine and backswamp areas often exceeding elevations of 20m AHD. Investigations undertaken during a field trip by NatCASS members confirmed the presence of acid sulfate soils at a number of locations across the north of Tasmania.

Parts of Tasmania are now under going a significant land use change such as high value viticultural developments replacing traditional pastoral activities in areas where soil drainage is

considered a major issue. Soil investigations have indicated the presence of acid sulfate soils in some of these areas. With increasing development and risk of disturbing sulfidic sediments there is a clear need to further investigate the distribution of potentially affected land in Tasmania.

For further information contact Chris Grose at [chris.grose@dpiwe.tas.gov.au](mailto:chris.grose@dpiwe.tas.gov.au)

## RESEARCH UPDATE

### Understanding 'backwater' events

Johnston, S.G., Slavich, P.G., Sullivan, L.A., Hirst, P. (2003) Artificial drainage of floodwaters from sulfidic backswamps: effect on deoxygenation in an Australian estuary. *Marine and Freshwater Research* 54, 781-795

A recent paper published in the *Journal of Marine and Freshwater Research* examines the quality of surface water draining from two low lying floodplain swamps after a flood event in the Clarence River (north coast of NSW) during 2001. After flooding the estuary experienced extensive periods of poor water quality and fish kills which closed the important fishery for months afterwards. Water discharging from the backswamps was severely deoxygenated, with high chemical oxygen demand and elevated iron levels for weeks following the flood. The quality of the surface water was found to be influenced by the decomposition of swamp vegetation, iron and sulfur concentrations in surface sediments and the drainage of acidic groundwater. Research suggested that in the absence of artificial drainage, the worst of the floodwaters which contain high levels of deoxygenating compounds, would have been retained within the swamp behind natural river levees. For copies of the paper contact the editor [christina.clay@agric.nsw.gov.au](mailto:christina.clay@agric.nsw.gov.au)

### Melaleuca encroachment in backswamps

Johnston, S.G., Slavich, P.G., Hirst, P. (2003) Alteration of groundwater and sediment geochemistry in a sulfidic backswamp due to *Melaleuca quinquenervia* encroachment. *Australian Journal of Soil Research*, 41, 1343-1367

ASSAY reported in April 2003 about the effects

of encroaching paper bark forests *Melaleuca quinquenervia* into low lying open swamps. The detailed findings are now available in a paper published in the Australian Journal of Soil Research. The paper describes how large areas of open swamp have been invaded by *Melaleucas* as a result of changes in surface hydrology after construction of drainage systems. Shallow groundwater and surface sediments beneath encroaching forests were much more acidic when compared to adjacent open swamp country. For a copy of the paper contact the editor christina.clay@agric.nsw.gov.au

## Habitat requirements for mosquito species

Strategies designed to rehabilitate acid sulfate soil wetlands, through the retention of surface water, have the potential to create mosquito breeding habitats. Apart from the potential to cause nuisance biting impacts, the increased risk of people contracting mosquito-borne viruses (eg. Ross River virus and Barmah Forest virus) is a growing national health concern.

Understanding the habitat requirements of different mosquito species will help determine what type is likely to inhabit an area. This information is probably the first step in identifying any possible increased risk of coming into contact with disease carrying mosquitoes.

*Ochlerotatus vigilax*: closely associated with saltmarsh habitats and can generate exceptional-



*Ochlerotatus vigilax* can travel as far as 10km from breeding sites and are mainly associated with flooded saltmarsh environments.

ly large populations and disperse great distances (>10km) from breeding sites. *Verrallina funerea*: usually associated with temporarily flooded *Melaleuca* and *Casuarina* forests and does not disperse far from breeding habitats but, as developments move closer to wetland areas, people are increasingly exposed to this species. *Culex annulirostris* and *Coquillettidia linealis*: associated with freshwater habitats and the creation and/or enhancement of freshwater wetlands may increase populations of these species.

Habitat salinity, the frequency and duration of inundation and vegetation composition will all influence mosquito populations. Fluctuating water levels will promote *Ochlerotatus* spp. and *Verrallina* spp. breeding at the wetland margins and, if the wetland is allowed to completely dry out, populations of mosquito predators (fish and macroinvertebrates) will decline. While permanent inundation of habitats will favour mosquito predators, when dense vegetation occurs in freshwater habitats, the reproduction of *Coquillettidia linealis* and *Culex annulirostris* may increase.

The contribution of a wetland to the local pest mosquito populations will be dependent on the extant mosquito fauna and the quantity and suitability of nearby habitats. Mosquito sampling (including adult and larval populations) is the only reliable method to determine changes following rehabilitation projects while also providing important information that may help develop mosquito management strategies or disassociate mosquito impacts from the rehabilitated wetland.

For more information contact Cameron Webb, Department of Medical Entomology, ICPMR, (02) 9845 7548 or cameronw@icpmr.wsahs.nsw.gov.au

## WEBSITES/FORUMS

### West gets own website

Western Australian readers can now access a range of information specific to their own state at <http://www.environ.wa.gov.au> (under the Land Use link). The website pulls together guidelines, local reports as well as useful links to sites in the eastern states.

## NSW Agriculture research

Copies of the floodplain drainage guidelines "Restoring the Balance" mentioned on page one can be downloaded from NSW Agriculture's website [www.agric.nsw.gov.au/reader/floodgate-guidelines](http://www.agric.nsw.gov.au/reader/floodgate-guidelines). Other resources available on-line include instructions on how to determine soil hydraulic conductivity and vision of acidic groundwater rapidly discharging through a macropore.

## PUBLICATIONS

### Who cares about the environment?

The NSW Department of Environment and Conservation's survey of people's attitudes to and knowledge of, the environment shows that in 2003 the environment was sixth in people's priority, after issues such as health and education. Environmental issues of concern are water conservation, public transport, roads and traffic, and urban development. The full report, summary and previous reports are available at <http://www.environment.nsw.gov.au/whocares/index.htm>.

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## CONFERENCES

### 20-25 June 2004

#### *Response of tropical, temperate and polar estuaries to natural and anthropogenic changes - Ballina NSW*

The aim of the conference is to bring together scientists and managers with an interest in estuaries and change. Conference registrations are now open, for further information log on to [www.scu.edu.au/ecsa37erf2004conference](http://www.scu.edu.au/ecsa37erf2004conference)

### 4-9 July 2004

#### *Conserving Soil and Water for Society: Sharing Solutions - Brisbane Qld*

Organised by the Australian Society of Soil Science Inc and the Australian Chapter of the International Erosion Control  
<http://www.isco2004.org/>

### 31 August -3 September 2004

#### *Riversymposium - Threats to Sustainable River Systems - beating the odds - Brisbane Qld*

Covers the ecological and social value of rivers by examining world's best practice in river and watershed management. <http://www.riverfestival.com.au>

## Electronic version available

To receive ASSAY electronically please contact the editor at [christina.clay@agric.nsw.gov.au](mailto:christina.clay@agric.nsw.gov.au)

## ASSAY

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*Typeset by Sharon Bailey*