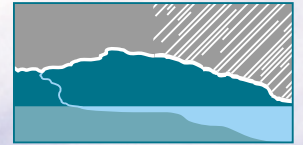




COOPERATIVE RESEARCH CENTRE FOR



CATCHMENT HYDROLOGY

Cooperative Research Centre for

# Catchment Hydrology Annual Report 2003-2004



Established and supported under the  
Australian Government's Cooperative  
Research Centres Programme

# Mission

The Cooperative Research Centre for Catchment Hydrology will deliver to resource managers the capability to assess the hydrologic impact of land-use and water management decisions at whole-of-catchment scale. Catchment hydrology is the study of water flows and material budgets in the landscape. It takes into account the many and varied factors impacting upon water resources, such as climate, land use, water allocation, river management, environmental values and hydrologic risk.

# Objectives

To achieve its mission, this CRC will:

- Mount a quality research program, targeted to meet national objectives in catchment hydrology, by focussing on achieving predictive capability at whole-of-catchment scale;
- Maximise the synergies of collaboration among its Parties and with related organisations;
- Involve end-users in the identification, formulation, conduct, and utilisation of its research activities;
- Provide training to increase awareness of, and the national skill base available in, catchment hydrology;
- Train and equip postgraduate students as future leaders in land and water management; and
- Seek to sustain continuity of research effort in catchment hydrology consistent with the widespread and persistent nature of land and water problems.

### Predictive capability – the Catchment Modelling Toolkit

- One of the main deliverables expected from this CRC between 2003 and 2006 is the application of sustainable water resource management by catchment managers through the provision of modelling capability designed to support the prediction of catchment behaviour. The Centre's Catchment Modelling Toolkit is a key to this capability.

### Portfolio of research projects

Developing a 'culture of integration' across research projects is an important part of this CRC's activities.

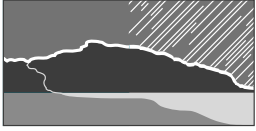
The Centre's current portfolio comprises:

- Six multi-disciplinary research programs comprising fifteen linked research projects to produce an integrated catchment modelling capability;
- Support programs to aid and sustain adoption of the modelling capability by the land and water industry; and
- Five development projects to build modelling capacity within the land and water industries.

The development projects involve five focus catchments, namely the Yarra, Goulburn/Broken, Murrumbidgee, Brisbane and Fitzroy river catchments. The two support programs focus on communications and adoption, and education and training.

A key consideration in developing this new portfolio of programs research was to address the following aims in this CRC's business plan:

- To develop a capacity to predict the consequences of land-use change, climate variability and river management at whole-of-catchment scale;
- To ensure this predictive capacity is 'integrated' such that a holistic analysis of catchment response and management trade-offs is possible; and
- To deliver that capacity to resource managers.



# Cooperative Research Centre for Catchment Hydrology

## Annual Report 2003 – 2004

### A cooperative venture between:

- Brisbane City Council
- Bureau of Meteorology
- CSIRO Land and Water
- Department of Infrastructure, Planning and Natural Resources, NSW
- Department of Sustainability and Environment, Vic
- Goulburn-Murray Water
- Grampians Wimmera Mallee Water Authority
- Griffith University
- Melbourne Water
- Monash University
- Murray-Darling Basin Commission
- Natural Resources and Mines, Qld
- Southern Rural Water
- The University of Melbourne

### Associate:

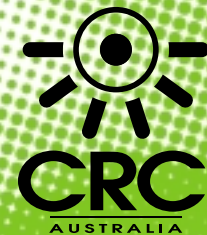
- Water Corporation of Western Australia

### Industry Affiliates:

- Earth Tech
- Sinclair Knight Merz
- WBM

### Research Affiliates:

- Australian National University
- National Institute of Water and Atmospheric Research, New Zealand
- Sustainable Water Resources Research Centre, Korea
- University of New South Wales



Established and supported under the  
Australian Government's Cooperative  
Research Centres Programme

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Courtesy Goulburn-Murray Water.  
Back Cover Spillway, Eildon Dam, Vic.  
Courtesy Goulburn-Murray Water.*

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# Chairman's Foreword

As the CRC is on the verge of challenging change, I have the opportunity to reflect on my many years of association with this organisation. In 1991, I co-wrote a bid to establish this CRC; however, on that occasion we were unsuccessful. Fortunately the following year, we received the imprimatur to set up the CRC, which I believe has gone on to make a most valuable contribution to water management in Australia.

To see the CRC develop a high national and international reputation has been very rewarding. The CRC's reputation has been confirmed in the very good independent reviews that have been undertaken to ensure that the CRC's research work is effectively achieving its objectives and milestones.

As Chairman since 1992, I have observed essentially two generations of researchers and I have seen the CRC grow from strength to strength. A major change I have witnessed has been the move from a focus on individual processes to the current focus on a whole-of-catchment scale and the integration of the various aspects of water management. This is exemplified by the Catchment Modelling Toolkit that brings together many different modelling tools for use by industry, government and consultants. The outstanding model so far is MUSIC, which is being widely applied in urban development in both Brisbane and Melbourne.



Prof John Langford Chairman

### Fifth Year Highlights

This year has been one of considerable achievement for the CRC for Catchment Hydrology. It has seen the culmination of much of our research work to-date. Going 'live' with the Catchment Modelling Toolkit through the website, and the Catchment Modelling School 04, held in Melbourne for two weeks in February, were particular highlights.

The Toolkit and the School 04 show our vision in action - to deliver to resource managers the ability to assess the hydrological impact of land-use and water management decisions at the whole-of-catchment-scale. I am confident and proud that the CRC is making a difference through its outstanding research focused on real-world issues.

### The CRC's young people

The CRC's young people are a major, if not the major output, of the CRC. They have great potential as both researchers and future water industry leaders. Through the CRC, they have access to research projects that are jointly developed between industry and the research groups, so they get wonderful industry experience as well as the academic discipline. Because the water industry has reduced its development programs, the CRC plays a critical role by filling that education gap and giving vital experience to young people. The CRC helps to nurture future leaders, which I believe is fundamentally important. This has been one of the main reasons I've been involved with CRCs.

### eWater CRC

The CRC has done a great job for 14 years, but there are times when change is needed. The Commonwealth Guidelines for new CRCs are quite restrictive on public good research. We have made the difficult, but I believe correct decision, to finish the CRC for Catchment Hydrology and to create a new CRC in collaboration with the CRC for Freshwater Ecology.

The bid for the eWater CRC is in full swing and the outcome is expected before the end of 2004.

The CRC has achieved a lot and built linkages that will last well beyond the organisation itself. In a way it is a healthy process because change is very stimulating and creative. So while we might be sad on the one hand, we can celebrate on the other, and recognise our great achievements and look to the opportunities that the future holds.

The interim CEO of the eWater CRC is Professor Gary Jones, the current Director of the CRC for Freshwater Ecology. We are fortunate that Don Blackmore, former CEO of the Murray-Darling Basin Commission, has agreed to be the interim Chair of the proposed CRC. The bid for eWater therefore has real strength of leadership and strong resolve behind it. The new CRC will ensure that hydrologists and ecologists work together to solve our substantial environmental problems in Australia's waterways and catchments.

### Thank you and best wishes for the future

I would like to thank the Board members and the CRC staff for their support during the year. It has been a challenging, but highly successful year and we have much to be proud about.

I would like to congratulate Rob Vertessy on the great job he has done as Director of the CRC for the last two years. His strong leadership and vision is evidenced by his appointment as the new Chief of CSIRO Land & Water. We wish him every success and we should see the parallel with the CRC – both are moving on to bigger and better things.

I'd like to wish Rodger Grayson well as the new Director. Appointed on short notice, he is already rising to the task of leading the CRC as it continues to build on its achievements and positions itself for the future. The CRC is in good hands and I feel confident that he will successfully continue the task of delivering the vision of the CRC.

I am continuing on as the Chairman of the CRC Catchment Hydrology as we progress with fulfilling our goals. However, I will not be involved on the Board of the eWater CRC as I was recently appointed as a Professor with The University of Melbourne's Water Research Centre. I'll be involved with one of the Parties of the new eWater CRC and therefore can no longer be an independent Chairman. Also, I believe it is important for the new CRC to have a change of chairperson and for someone with new energy and focus to oversee the organisation. I sincerely wish eWater and CRC staff every possible success for the future.

**John Langford**  
Chairman

After twelve years with the CRC for Catchment Hydrology, first as a Project and Program Leader and the last two years as Director, it is with a great sense of sadness that I am moving on. My time with the CRC has been professionally fulfilling and personally rewarding. I have enjoyed the comradeship of the talented staff and students and received great support from Board members. It has been an honour to be part of such a dynamic research organisation and its contribution to meeting the challenges facing land and water management in Australia.

#### **Fifth Year Achievements – The Catchment Modelling Toolkit and School 04**

I am particularly proud to report on our fifth year achievements, because they have made such a major contribution to meeting our vision of delivering improved capability to resource managers. This year has seen the maturation of the Catchment Modelling Toolkit – the cornerstone for delivery of our mission. The Toolkit now offers seven products to over 1500 registered users. The up-take of our modelling tools continues to increase, and support is expanding rapidly.

In particular, the Model for Urban Stormwater Conceptualisation (MUSIC), is now the leading edge tool for analysing urban stormwater management. It is widely used by CRC Parties and consulting engineers throughout Australia, especially in the design of new housing estates in Melbourne and Brisbane. Version 2 was released this year.

The Catchment Modelling School in February 2004 was a huge success. Participation rates were excellent, as was the representation from all the key end-user groups. The School, held over two weeks at The University of Melbourne, offered 29 separate workshops attended by over 300 people. More than 500 workshop seats were allocated. Representatives from research organisations comprised 20 per cent of participants, State government agency staff 23 per cent, and consultants 30 per cent.





Dr Rob Vertessy Director (to March 2004)

### New Industry Affiliates

This year we had the pleasure of welcoming three new Industry Affiliates to the CRC. We now have four Industry Affiliates: Earth Tech, Ecological Engineering, Sinclair Knight Merz and WBM Oceanics, who are helping us to evaluate and promote the use of our modelling tools.

These firms are also working with the CRC on joint consulting projects and training activities. Having them on board will really help to spread the word about the CRC's modelling tools and it is vitally important for developing meaningful links to the land and water management industry.

### International collaboration

In July 2003 I spent a month in Korea, thanks to the support of the Korean Federation of Scientific and Technological Societies and the Sustainable Water Resources Research Center (SWRRC). The visit was an excellent opportunity to understand and compare the environmental issues facing Korea with those in Australia. The SWRRC is a cooperative venture, set up by the Korean Federal Government, and like our CRC, it has a structured plan for getting research results applied in industry.

Through my stay in Korea, and the visit of a Korean delegation to Melbourne in February 2004, the CRC has been able to develop a purposeful partnership with an international agency, whose work complements ours. The SWRRC is doing excellent work in hydrologic data warehousing and spatial analysis and I firmly believe there is much to be gained by our collaboration.

### Annual Workshop

The 2004 Annual Workshop, held this year in Victoria's Yarra Valley, was a great success. This annual event is a major opportunity for members of the CRC to get together and reflect on what we have achieved in the preceding twelve months. It is also an excellent opportunity to plan our future activities and decide on ways to tackle the milestones we have set ourselves.

For young researchers and postgraduate students it is a wonderful chance to interact with peers, experienced academics and industry practitioners. This year over 100 participants attended the workshop, including the CRC Visitor and five Board colleagues.

As part of the workshop, Prof Gary Jones from the CRC for Freshwater Ecology and I described the new CRC – the eWater CRC (see below). This was the first opportunity for many staff to hear about the details of this proposal.

### Key staff changes

The success of this CRC owes much to the energy and dedication of its staff. This year we saw some key staff members move on and I thank them for their contribution to the CRC.

Peter Hairsine, Leader of Program 2: Land-use Impacts on Rivers, spent over ten years with the CRC before moving on within CSIRO as Research Director of the Integrated Catchment Management Research Directorate. Leadership of the Program has been taken on by Peter Wallbrink, who is also now a Deputy Director.

David Perry, Communication and Adoption Program Leader, has taken on the additional role of Leader of Program 8, Education and Training, since Tim Smith has left the CRC. Tim has taken up a position with the new Resource Governance Group of CSIRO Sustainable Ecosystems.

John Coleman has been appointed as Project Leader for Project 4.08 (4A) taking over from Tony Wong. Scott Wilkinson has succeeded Ian Prosser as Project Leader of Project 2.20 (2B).

### The future – the decision on the eWater bid

In late 2003, I had the task of preparing the re-bid for the upcoming CRC selection round. After consideration of the Commonwealth Guidelines and analysis of the CRC's role and position, the Board subsequently endorsed a recommendation to work closely with the CRC for Freshwater Ecology to jointly develop a bid for a new CRC. This new venture, called the eWater CRC, includes all the Parties from the two current CRCs as well as some new participants. The 'e' in this name stands for 'enterprise, environment and education', which will be the main foci of the proposed CRC.

I know that I am leaving the management of the bid for the eWater CRC in great hands, with Don Blackmore as Chair of the Interim Parties Committee and Professor Gary Jones as the interim Chief Executive. I would also like to acknowledge the goodwill and support of both CRCs' Industry Parties, and research and development providers, who were consulted during the preparation of the bid.

If the research of the CRC for Catchment Hydrology and the CRC for Freshwater Ecology is to continue to have an influence, then I believe the new joint CRC is the only way to go. I sincerely wish the eWater CRC all the best for the future. The new organisation will play a very important role in shaping the future of land and water management in Australia.

#### **Farewell**

To the many people I have known and worked with during my time at the CRC, I give you my sincere thanks and wish you well in both your research and your personal lives.

It is not possible to thank everybody, but I must pay a particular thank you to our Board Chairman John Langford who has been a terrific mentor to me. My gratitude also goes to John Molloy, a great CRC business manager. Whilst I am saying farewell, I do expect to remain close to the CRC through my new role as Chief of CSIRO Land and Water. I will certainly remain an enthusiastic supporter of this great CRC.

#### **Rob Vertessy**

#### **Taking over the reins**

It is a great honour to be the new Director of the CRC for Catchment Hydrology and to follow in the stellar footsteps of Emmett O'Loughlin, Russell Mein, and Rob Vertessy.

On behalf of all CRC staff and associated organisations, I wholeheartedly thank Rob for his outstanding leadership over the past couple of years. We wish him well in his new position and look forward to his continuing interest and involvement in our CRC.

I have been involved in the CRC since 1992, but always as part of my broader role as a researcher/academic at The University of Melbourne. I am an agricultural engineer by training, with PhD studies in hydrological and water quality modelling. Much of my work for the last 20 years has revolved around collaboration and this is what attracted me to the Director's position. This CRC is one of the best examples of collaboration in the natural resource management industry.

The CRC for Catchment Hydrology is responsible for fabulous successes to date. We are now embarking on the exciting final phase of the CRC as an entity and I look forward to leading the organisation to deliver on its mission.

#### **Progress towards the establishment of eWater**

The final business case for the new eWater CRC was submitted in early July 2004 and it is hoped that by the end of 2004, we will know whether the bid is successful. Should the eWater CRC become a reality, the CRC for Catchment Hydrology, together with the CRC for Freshwater Ecology, will both cease operating on 30 June 2005. Plans are now in place to ensure that should this occur, the CRC for Catchment Hydrology will still deliver on its core mission and will carry solid products into the eWater CRC.

#### **Integration – E2**

Looking ahead over the next twelve months, a major focus will be on integration. E2 is the name we have given to the software platform for delivering integrated modelling capability. E2 will enable users to build 'tailored' whole-of-catchment models to suit their particular modelling objectives. Currently there is no integrated modelling capability of this sort available on the market.

E2 will enable the prediction of the flow and load of sediment, nutrients, and salt at any point in a river network over time, operating at daily time steps and reporting on monthly to decadal scales. Ecologic consequences, such as changed habitat and riverine ecologic health, will also be available. E2 is designed to optimise the use of modules and models developed by our research projects. These include, EMSS, the Rainfall Runoff Library, the Stochastic Climate Library, MUSIC, SedNet, and the River Analysis Package. E2 will allow these modules to be flexibly combined to provide a range of model scales and complexities for predicting behaviour at the whole-of-catchment-scale. Providing the capability to model a range of components simultaneously, will assist resource managers to make more informed decisions.



Prof Rodger Grayson Director (from April 2004)

### Development Projects

The flagship of our delivery activities is the group of five Development Projects within our Focus Catchments. Development Projects are collaboration and application of research at the coalface. These projects provide the real litmus test for our work and so far, there have been some really outstanding results.

The Development Projects are important because they build capacity within our Industry Parties. The Parties apply the CRC's modelling tools, demonstrate the utility of the tools by applying them to a range of problems at the whole-of-catchment-scale, and provide our researchers with feedback from end-users on the suitability of the models for operational use.

Most of the projects are now at a stage where Environmental Management Support System (EMSS) models are up and running and scenario runs are underway.

These projects are not only building substantial capacity within CRC Parties, but they are also reaching beyond to the various steering, reference and stakeholder groups who are involved with the projects. This 'flow on' of delivery beyond our immediate Parties is another contribution to the uptake of our products, giving important data to decision-makers beyond our CRC family.

There is a huge commitment by Industry Parties underpinning the CRC's Development Projects and I would like to thank and congratulate all those involved.

### The final push

With potentially only twelve months to go for our CRC, we are entering an exciting final phase, where the three main objectives can be summarised as delivery, delivery and delivery! Delivery of the best research in a way that is usable and leads to improvement in Australia's land and water management.

Our plans for the 'final push' are based on the premise that the CRC must deliver on its core mission, even if the eWater CRC bid is successful and we have to wrap up in June 2005. If the eWater CRC is not successful, the extra time will be used to finish those tasks that were not so central to our core mission. We will also push harder on communication and adoption activities so that the CRC for Catchment Hydrology finishes with a bang.

We will continue to develop and improve our models and product support, ironing out any bugs, and continually working to deliver top-class tools. MUSIC v3 should be available by the end of 2004 and we will release other updates of models as they are finalised.

We will continue to add value to the Catchment Modelling Toolkit through associated features including training, user e-groups, and documentation. We are planning a Catchment Modelling School 05 to build on this year's successful School.

To conclude, I'd like to thank the Board for showing confidence in me and for helping me during the changeover period. To the CRC Office at Monash University, your assistance is invaluable – thank you.

Something that has been reinforced for me time and again is the enthusiasm, excellence and sheer hard work of all Project teams and Program Leaders. Indeed, as the Global Review Panel noted earlier this year:

*"The CRC for Catchment Hydrology has obviously attracted a highly skilled, innovative and dedicated team of researchers and project staff committed to delivering on the CRC's main objective - to produce an integrated, whole-of-catchment modelling capability for land and water managers and deliver this to them via the Catchment Modelling Toolkit."*

The 'final push' is on, and there is no doubt that we have an exceptional team to complete the transformation from vision to reality!

Land and water issues continue to be prominent on the public agenda and the CRC has a real opportunity to both influence and impact positively on managing our natural resources. I'm very proud to be leading this dynamic organisation.

**Rodger Grayson**

# Program Highlights



## Program 1 Predicting Catchment Behaviour

- The Catchment Modelling Toolkit now contains seven publicly released products:
  - The Rainfall Runoff modelling Library (RRL);
  - Chute – a rock chute design application;
  - MUSIC – the Model for Urban Stormwater Improvement Conceptualisation;
  - the Sediment Network model (SedNet);
  - The Stochastic Climate Library (SCL);
  - TREND – a suite of statistical tests for trend in data; and
  - the River Analysis Package (RAP).
- The functionality of The Invisible Modelling Environment (TIME) has been improved and expanded. Industry Parties, other CRCs and software developers have shown strong interest in TIME. In particular, the Department of Infrastructure, Planning and Natural Resources, NSW, has adopted TIME and two European Union (EU) environmental modelling groups have expressed interest.
- The Program team continues to develop and test protocols and procedures to produce high quality software products.
- The CRC's concept for a whole-of-catchment modelling capability was expanded into a multi-scale modelling system known as E2.

## Program 2 Land-use Impacts on Rivers

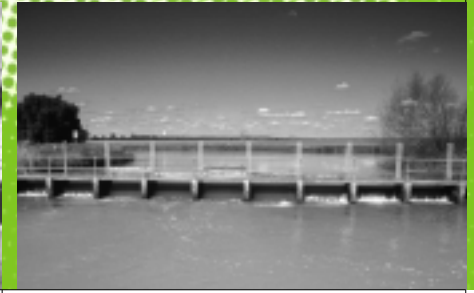
- The Catchment Modelling Toolkit now contains SedNet – a model for constructing sediment budgets. The Program team has documented how to use SedNet and conducted initial training in all focus catchments.
- Program 2 projects are providing key understandings and modules for developing the CRC's whole-of-catchment integrated model, called E2. Ultimately this will allow point-based assessments of sediment and nutrient generation rates and loads, salt load and concentration values. It will also allow users to spatially quantify riparian denitrification and determine the quality of irrigation return flows.
- Good progress has been made in developing a riparian denitrification model for Australian catchments. The model is coded in TIME for inclusion into the Toolkit.
- The design specifications for a new salt model were completed. The model's specifications describe the linkages between existing and proposed activities across project partners and the mathematical functions at each level.
- The flow duration curve model can now predict changes to the seasonal patterns of stream flow associated with major changes to land-use, such as new plantations. This model is being prepared for the Catchment Modelling Toolkit and coded into IQQM.

## Program 3 Sustainable Water Allocation

- An experimental water market environment, Mwater, has been developed, allowing policy makers to explore alternative instruments under controlled conditions.
- The Water Re-Allocation Model (WRAM) is complete. WRAM combines an economic model with the hydrological data underpinning IQQM.
- Published reports include a comprehensive review of water reform in Australia, water accounting and models exploring the redistribution of surplus water in catchments.

## Program 4 Urban Stormwater Quality

- MUSIC has consolidated its position as a leading edge tool for analysis of urban stormwater management improvement strategies and is now in widespread use within CRC Parties and by consulting engineers throughout Australia.
- The Program collected valuable data on wetland performance on predicting the inter-event water quality behaviour at two wetland sites: Bridgewater Creek in Brisbane and Hampton Park in Melbourne.
- Laboratory-scale wetlands and bio-retention systems were constructed and they are being used to test nutrient removal processes.
- Several key publications were completed on ecosystem responses to urbanisation and the potential for retrofitting existing suburbs to achieve significant improvements in ecosystem health indicators.



### Program 5 Climate Variability

- Two model products were produced for the Catchment Modelling Toolkit. The SCL (Stochastic Climate Library) contains stochastic models for generating rainfall and climate data, and TREND consists of statistical tests for detecting trend/change and randomness in time series hydrological data.
- A data product containing spatial vegetation, land-use and soil properties information for Australia was completed for adding to the Catchment Modelling Toolkit.
- Data sets for the Murrumbidgee River Basin were compiled for catchment-scale and land-surface hydrological modelling. The Murrumbidgee data monitoring program and land-surface modelling study are key parts of the Murray-Darling Basin Continental Scale Experiment in the Global Energy and Water Cycle Experiment (GEWEX). There is now more than two years of unique data available to run hydrological models and to test model simulations against runoff and soil moisture.

### Program 6 River Restoration

- In conjunction with the CRC for Freshwater Ecology, the Program 6 team completed the River Analysis Package (RAP) and it is now available as a Catchment Modelling Toolkit product. RAP workshops were run throughout the year at various locations across Australia.
  - Other software products for the Toolkit were completed, including CHUTE, which is now in the Toolkit. RIPRAP and MELS have been prepared for adding to the Toolkit website in 2004-2005, together with supporting documentation.
  - A substantial database of channel surveys was collated using GIS and other regional data sets. Derived catchment characteristics for these survey sites were determined.
  - A unique data set has been collated for over 80 river reaches across Victoria including: channel surveys, bed and bank particle sizes and catchment characteristics derived from GIS data bases.
- ### Program 7 Communication and Adoption
- By the end of June 2004, registered users could download seven products from the Catchment Modelling Toolkit website and a robust process to guide software development and delivery was established.
  - The five CRC Development Projects are successfully giving resource managers and Industry Partners the opportunity to apply and test the CRC's modelling tools in real life situations. Development of whole-of-catchment models in each Focus Catchment is underway.
  - Two special editions of the CRC's monthly newsletter *Catchword* were produced. One edition featured a summary of research outcomes of all Research Programs and another edition featured an update of the impressive work being done in each of the five Development Projects.

### Program 8 Education and Training

- A major highlight was the Catchment Modelling School held in Melbourne in February 2004. A total of 308 participants attended 31 catchment-modelling and related workshops. Altogether, there were 517 workshop places.
- The Respect, Reflect, React symposia series was held in Melbourne, Canberra, Brisbane and Emerald (Qld). These symposia featured presentations on a range of issues associated with change for healthy environments in Australia and were presented by a variety of speakers.
- CRC postgraduates attended a special workshop on 'People Skills' which was held prior to the CRC's Annual workshop in Yarra Glen in March 2004. Sessions included topics such as personality types, negotiation and conflict resolution skills and professional relationship dynamics.
- A revised student induction kit was developed for postgraduates and an email list group was established for final year postgraduates entering the Young Water Scientist of the Year Award.

# Structure and Management

*This Page Left* Governing Board participants at May 2004 meeting in Canberra. *Right* Presentation at Annual Workshop to Director Dr Rob Vertessy by Chairman Prof John Langford to mark Dr Vertessy's outstanding service to the CRC including his contribution as CRC Director to March 2004

*Opposite Page Left* Industry and research participants at Re-bid themes workshop, August 2004 at Indooroopilly. *Centre* Strategic issues discussion at Re-bid planning workshop, October 2003, Melbourne Airport. *Right* Internal Review by CRC Director and Program Leaders, April 2004



## Centre Structure

The CRC is a cooperative, unincorporated joint venture between the following industry and research participants in land and water issues:

### Land and Water Management Authorities

- Department of Infrastructure, Planning and Natural Resources, NSW
  - Department of Sustainability and Environment, Vic
  - Goulburn-Murray Water
  - Grampians Wimmera Mallee Water Authority (formerly Wimmera Mallee Water)
  - Murray-Darling Basin Commission
  - Natural Resources and Mines, Qld (formerly Natural Resources, Mines and Energy, Qld)
  - Southern Rural Water
- ### Urban Water Authorities
- Brisbane City Council
  - Melbourne Water

### CSIRO

- CSIRO Land and Water

### Universities

- Griffith University
- Monash University
- The University of Melbourne

### National Meteorological Body

- Bureau of Meteorology

## Governing Board

The role of the Board is to provide long-term strategic and policy planning with supervision of the management of the Centre and support of its operations.

Board membership as at 30 June 2004 was:

**Prof John Langford** (Independent Chairman), The University of Melbourne, formerly Executive Director, Water Services Association of Australia

**Mr Barry Ball**, Manager Water Resources, Urban Management Division, Brisbane City Council

**Mr Geoff Earl**, Manager, Water Systems and Environment, Goulburn-Murray Water

**Ms Christine Forster** (Independent Board Member), Chair, Victorian Catchment Management Council

**Prof Rodger Grayson**, The University of Melbourne, CRC Director, succeeding Dr Rob Vertessy, CSIRO Land and Water

**Mr Graham Hawke**, Deputy Chief Executive, Southern Rural Water (non-voting participant)

**Prof Jane Hughes**, Faculty of Environmental Sciences, Griffith University

**Mr Denis Hussey** (Independent Board Member)

**Mr Peter Jackson**, Manager of Technical Services, Grampians Wimmera Mallee Water Authority (non-voting participant)

**Prof Graham Hutchinson**, Faculty of Engineering, The University of Melbourne

**Mr Warwick McDonald**, Director ICM Unit, Murray-Darling Basin Commission (Mr McDonald transferred to CSIRO in June 2004 and was succeeded in the interim by Ms Louise Rose)

**Dr Wayne Meyer**, Business Director, CSIRO Land and Water (succeeded by Dr Rob Vertessy in August 2004)

**Dr Stuart Minchin**, Principal Scientist, Department of Sustainability and Environment, Vic (succeeding Ms Rae Moran).

**Mr Chris Robson**, Executive Director, Natural Resources and Sciences, Natural Resources and Mines, Qld

**Mr Bruce Stewart**, Assistant Director, National Operations, Bureau of Meteorology (Alternate Mr Jim Elliott)

**Mr Ross Williams**, General Manager, Centre for Natural Resources, Department of Infrastructure, Planning and Natural Resources, NSW

**Mr Graham Rooney**, Waterways and Wetlands Research, Melbourne Water

**Prof William Young**, Head of Department of Civil Engineering, Monash University

The Governing Board met on the following dates:

- 29 August 2003
- November 2003 (convened by post and email)
- 27 February 2004
- 11 June 2004



### Centre Management

Dr Rob Vertessy, the Centre's Director until 26 March 2004, was based at CSIRO Land and Water, Canberra. The incoming Director, Prof Rodger Grayson, from The University of Melbourne, is based at the Centre Office, Monash University, Clayton, Victoria.

There are four main research facilities, located at: Monash University, Clayton Vic; CSIRO Land and Water, Canberra; Griffith University, Brisbane; and The University of Melbourne, Parkville. Research is also conducted in various other Party Locations including Bureau of Meteorology, Melbourne; Natural Resources and Mines, Indooroopilly, Qld; Department of Sustainability and Environment, Heidelberg, Tatura and Rutherglen, Vic.

Deputy Directors oversee the operations at the three University sites — Mr Erwin Weinmann at Monash University, (succeeded by Dr Ana Deletic from July 2004), Prof Tom McMahon at The University of Melbourne and Dr John Tisdell at Griffith University.

### Strategic Directions

The Centre's strategic direction and operations are guided through the Centre's Business Plan, which was developed as part of the CRC's bid.

Future strategic themes and priorities for the period beyond 2005 were reviewed in August 2003. Further workshops were held in October 2003 and December 2003 as part of the planning for a possible CRC re-bid.

### Program Structure

Research and Supporting Programs

The Centre supports 15 second-round projects within the following six research programs:

**Program 1** Predicting Catchment Behaviour

**Program 2** Land-use Impacts on Rivers

**Program 3** Sustainable Water Allocation

**Program 4** Urban Stormwater Quality

**Program 5** Climate Variability

**Program 6** River Restoration

Program and Project Leaders manage these research programs and projects on behalf of the Centre. They meet regularly with the Centre Executive. There are five Focus Catchment Coordinators who provide ongoing feedback to the Board and CRC Executive about the progress and issues within each catchment.

The research programs are supported and complemented by further activities in the following programs:

**Program 7** Communication and Adoption

**Program 8** Education and Training

Five Development Projects, led or assisted by Focus Catchment Coordinators, are linked to each of the CRC's five focus catchments. They are key vehicles for further adoption and application of CRC research. The Development projects also contribute to capacity building within their communities and increasingly have the involvement and support of key stakeholders.

### Internal Review

During 28 and 29 April 2004, the CRC Director and Program Leaders held an internal program review. This review was a chance to summarise progress on final round projects and reassess priorities for the remaining time, especially to June 2005 – the termination date for the CRC for Catchment Hydrology – which would apply with a successful eWater CRC bid.

A key outcome of the review was an agreed set of priorities for the final phase of project activity to take to the Adjunct Global Review and to the Board. This included what will be completed within our CRC, what will not, and what could be carried forward into the eWater CRC. Part of the review included a "self assessment" report by each of the Development projects.

The management team concluded that the review was an important step in forward planning for the CRC for Catchment Hydrology and the development of the eWater CRC re-bid. It also helped the team to consolidate a shared vision of Program and Project directions over the final phase of this CRC.

### Global Review 2003-2004

A two-part independent global review of the CRC was undertaken in 2003-2004 using expert panels of invited science specialists. The initial review was held in August 2003 and the second, an adjunct global review, was held in May 2004.

Further details of the Global Review are set out in the section on 'Assessment of Track Record'.

# Structure and Management



*Above Annual Workshop participants from CRC Parties, Yarra Valley, March 2004. Right Centre Visitor, the Hon David Wotton*

## Annual Workshop

This year's annual workshop was held at the Yarra Valley Conference Centre at Dixon's Creek, near Yarra Glen, in Victoria's Yarra Valley. The Yarra Valley is in the upper reaches of the Yarra Catchment, so it was a chance for interstate participants to see some typical landscapes of one of the Centre's focus catchments.

More than 100 people attended the workshop over its three days (16-18 March 2004). Beyond its usual opportunity to reflect on past achievements and share information about the progress of individual programs and projects, it was also a chance for participants to hear first-hand about the decision to join with the CRC Freshwater Ecology to prepare a joint bid for a merged CRC.

The Director, Dr Rob Vertessy, and Prof Gary Jones, Chief Executive of the CRC Freshwater Ecology, gave a joint presentation describing the compelling reasons for the merger of the two Centres and detailing the vision for the proposed eWater CRC. They also gave an overview of the process of the preparation for the bid for the eWater CRC and the timetable for the selection round.

These annual workshops underpin the philosophy of this Centre and help to reinforce and demonstrate how each project is contributing to the fulfilment of the Centre's mission. The event is also about sharing ideas and meeting new members of the CRC family. At the Yarra Valley workshop, postgraduates presented short updates on their projects following outlines by Program Leaders of the respective Programs. Their presentations were a clear reminder of the CRC's critical role in training and developing future leaders of the water industry.

Six Board members attended the workshop during its three days. After lunch on the second day, Chairman John Langford and fellow Board Members, Graham Hawke from Southern Rural Water and Ross Williams from the NSW Department of Infrastructure, Planning and Natural Resources gave their Board perspectives of the role and future operations of the Centre. The workshop was also an opportunity to farewell Centre Director, Rob Vertessy, on the eve of his departure to take up the prestigious role as head of CSIRO Land & Water. Rob has led the Centre since July 2002 and was a Program Leader at the time of its establishment in 1992.

## Participation Arrangements

Organisations can participate in the CRC via one of the following arrangements:

### CRC Party

Direct involvement in setting priorities and sharing outcomes in research and technology adoption.

### CRC Associate

Direct involvement with a selected project activity and sharing of outcomes; alternatively a broader-based access to research findings.

### CRC Research Affiliate

An opportunity for major research collaboration with organisations outside the CRC.

### CRC Industry Affiliate

An opportunity for collaboration with commercial organisations within the industry but outside the CRC.



## Centre Visitor

The CRC Visitor scheme was established in 1993 to assist CRC Committees in the following ways:

- providing an independent link between the Commonwealth and individual CRCs; and
- as an independent, experienced and objective advisor.

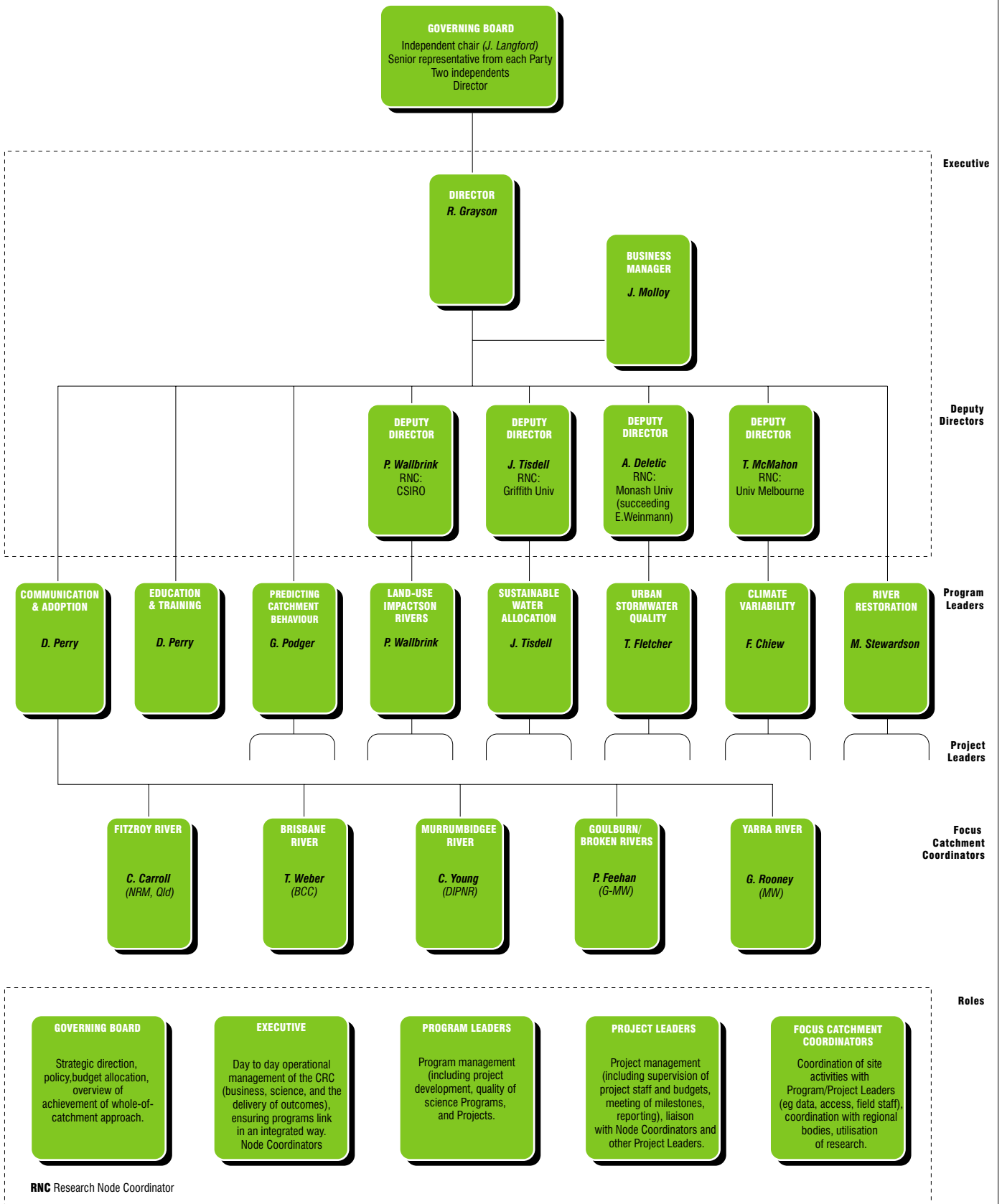
In March 2003, the Hon. David Wotton was appointed by the Commonwealth as the new CRC Visitor following nomination and endorsement by the Governing Board of the CRC.

The Hon. David Wotton has had a distinguished career with strong links to water resources issues. From 1993-1997, he was lead Minister for the Murray-Darling Basin Ministerial Council, a position he held while Minister for Environment and Natural Resources for South Australia. David is the current Chairman of the River Murray Catchment Water Management Board.

The CRC was fortunate to have its Visitor, David Wotton, at its Annual Workshop in March 2004, where he gave his views on how the CRC was travelling.



## Centre Structure and Links Between Programs



# Assessment of Track Record

*This Page* Initial Global Review Panel, (l to r) Dr Rory Nathan, Prof Wolfgang Geiger, Dr Chris Gippel, Dr Douglas Boyle, Prof Barry Hart, Mr Steve Markstrom, and Emeritus Prof Tom Chapman (Dr Alistair Watson not included)

*Opposite Page* Left Adjunct Global Review Panel, (l to r) Emeritus Prof Tom Chapman, Dr Alistair Watson, Dr Chris Gippel, Dr Rory Nathan, and Prof Barry Hart. Right Adjunct Global Review in session, May 2004



As the CRC for Catchment Hydrology is a part of the 2004 bid for the eWater CRC, formed from the existing CRCs for Catchment Hydrology and Freshwater Ecology, this section on the 'Assessment of Track Record' has been included to provide details of the reviews of the CRC for Catchment Hydrology's performance.

The CRC for Catchment Hydrology has undergone two major assessments of its track record: a Second Year Review held in 2001-2002, and a Global Review held in 2003-2004.

## Second Year Review

As required by the Commonwealth, a Second Year Review was held for the Centre, with the Review being conducted in two stages.

Stage 1 of the Second Year Review of the CRC for Catchment Hydrology was a scientific and technical review of the Centre conducted on 24, 25 and 26 July 2001 at Melbourne.

The Panel comprised:

- Prof David Maidment, University of Texas (Panel Chair)
- Prof Lawrence Band, University of North Carolina
- Prof John Lovering, The University of Melbourne
- Mr Jim Miller, CRC Visitor

Stage 2, which addressed strategic directions and the management of the Centre, was undertaken on 1 and 2 November 2001 by the following Panel:

- Mr Graeme Kelleher (Panel Chair)
- Dr Graham Allison (Panel Independent Member)
- Mr Jim Miller (CRC Visitor)
- Ms Caryl Treloar (CRC Programme)
- Mr Adrian Linehan (CRC Programme)

Stage 1 considered the quality and relevance of the research program, its progress, and achievability over the CRC's life.

In forming the Panel, the CRC placed particular emphasis on catchment-scale prediction. Panellists Professors David Maidment and Larry Band came as world leaders in this field. Professor John Lovering, former Chair of the Murray-Darling Basin Commission, provided specialist skills related to the practical application and usefulness of the research outputs. The Centre Visitor, Mr Jim Miller, brought highly relevant experience to the Panel as a former Director General of the Department of Primary Industries, Qld.

The CRC Board noted at the time that it was very pleased with the Panel's assessment, in what was a very thorough review. In their report,



the Panel made mention of the CRC's 'strong emphasis on the relevance of its research program, and on its adoption by stakeholders'. Examples where this was happening were mentioned.

Overall, the Stage 1 Panel found 'the research plan is being executed as planned, and good progress is being made in all programs'. A comment from the two overseas Panel members that they had seen nothing like the synergy achieved by the CRC between research and the user communities was particularly noteworthy.

Both Reviews praised the CRC's efforts – the second labelling the CRC for Catchment Hydrology as a model CRC – and delivered positive and constructive comments to improve future operational aspects. Particular note was made of the degree of stakeholder involvement and the close relationship of knowledge generated by the CRC and its application by stakeholders.

The CRC Board accepted and responded to the recommendations made by both Review Panels.

#### Global Review 2003-2004 – A further assessment of the CRC's 'Track Record'

A two-part independent global review of the CRC was undertaken in 2003-2004 using expert panels of invited science specialists. The initial review was held in August 2003 and the second, an adjunct global review, was held in May 2004.

##### Initial Global Review

The initial global review of the CRC was conducted over a four-day period (11 to 14 August, 2003).

The purpose of this review was to:

- Provide the CRC for Catchment Hydrology Board with an independent assessment of the quality and direction of the work;
- Point out any weaknesses in the program and indicate where improvements might be made; and
- Make recommendations related to the CRC's Fifth year review in 2004.

The Review Panel consisted of overseas and Australian specialists:

- Prof Barry Hart (Chair), Monash University, Melbourne, Australia
- Dr Douglas Boyle, Desert Research Institute, Nevada, USA
- Emeritus Prof Tom Chapman, University of New South Wales, Sydney, Australia
- Prof Wolfgang Geiger, University of Essen, Germany
- Dr Chris Gippel, Fluvial Systems, Newcastle, Australia
- Mr Steve Markstrom, United States Geological Survey, Denver, USA
- Dr Rory Nathan, Sinclair Knight Merz, Melbourne, Australia
- Dr Alistair Watson, Consultant, Melbourne, Australia.

The CRC Visitor, the Hon David Wotton, attended throughout the review.

In its Summary, the Panel noted:

*'The overwhelming view of the Panel was that the CRC for Catchment Hydrology is undertaking high quality work that serves well the immediate needs of industry stakeholders in three eastern States. The Panel is confident that the web-based modelling Toolkit that will be produced by the end of this CRC for Catchment Hydrology will be of great value to the natural resource management industry in Australia (even if all the components presently envisaged are not available at that time). The extent of effective collaboration and involvement across different agencies, institutions, and disciplines is a particularly striking feature of the CRC for Catchment Hydrology. The Panel was most impressed with the highly effective communications and adoption program the CRC has in place.'*

##### Adjunct Global Review

An independent Adjunct Global Review of the CRC for Catchment Hydrology was conducted over a two-day period (13, 14 May 2004).

The purpose of this review was to assess:

- the adequacy of response of each Program to the recommendations made in the previous review,
- progress to date, and the proposed program to June 2005, in relation to the target modelling capability required for the CRC to meet its mission.

The Review Panel comprised the Australian members of the August 2003 review:

Prof Barry Hart (Chair), Emeritus Prof Tom Chapman, Dr Chris Gippel, Dr Rory Nathan, and Dr Alistair Watson

The panel for the Adjunct Global Review noted: *'The Review Panel is confident that the CRC for Catchment Hydrology is well placed to achieve the outcomes required to satisfy their central mission by June 2005. This conclusion is based on the rate of progress and achievements over the past 9 months (which is impressive), and our current understanding of the benefits to be had by capitalising on early Toolkit building blocks. The Toolkit now boasts a number of products that demonstrate that the flagship promises of the CRC for Catchment Hydrology are fast becoming a reality.'*

*'The extent of effective collaboration and involvement across different agencies, institutions and disciplines continues to be impressive. There is increasing evidence that the CRC for Catchment Hydrology through its communication and adoption activities will meet its objective of having a profound effect in improving understanding and changing industry practice in Australia.'*

The CRC Board endorsed the conduct and findings of the Global Review Panels.

# Collaboration – Cooperative Linkages

*This Page Left* Collaboration with CRC for Freshwater Ecology: Prof Gary Jones, Dr Rob Vertessy with CRC Visitor David Wolton at Annual Workshop. *Right* Joint meeting of CRC for Freshwater Ecology and CRC for Catchment Hydrology Parties in planning new bid, Canberra, October 2003.

*Opposite Page Left* Signing of MOU for Sustainable Water Resources Research Centre Research, Korea as Research Affiliate of the CRC. (l to r) Dr Sanghyun Kim, Dr Rob Vertessy, Dr Kim Sung. *Centre Delegates* from Korea's Sustainable Water Resources Research Centre – participants in the CRC Catchment Modelling School. *Right* Dr Sanghyun Kim, collaborating researcher from Pusan National University, Korea.



## New Industry Affiliates

Early in the financial year, three new Industry Affiliates joined the CRC. Earth Tech, Ecological Engineering, and Sinclair Knight Merz have agreed to work with the CRC to evaluate and promote the use of the CRC's modelling tools and to participate in joint consulting and training activities. This brings the number of Industry Affiliates to four, as WBM Oceanics joined the CRC last year.

Having this Industry Affiliate arrangement provides the CRC the opportunity to work collaboratively with industry stakeholders. It encourages strategic relationships with some of Australia's leading environmental consulting engineers. Industry Affiliates benefit from the CRC's knowledge and tools, which help them do their business more efficiently and effectively. Following on from this, are significant benefits to Australia's land and water management industry.

The four organisations have made a valuable contribution to the CRC. The Industry Affiliates were actively involved in the CRC's Catchment Modelling School held in February 2004. Forty-seven of their staff participated in workshops and their specialists presented workshops including: 'An introduction to the Environmental Management Support System (EMSS)' by Tony McAlister, WBM Oceanics; 'Advanced MUSIC Modelling' by Assoc Prof Tony Wong, Monash University, also with Ecological Engineering; and 'Design of Rock Chutes' by Ross Hardy, Earth Tech.

Dr John Tilleard and Ross Hardy of Earth Tech were also presenters at a CRC one-day course on the 'Design of Rock Chutes for Stream Bed Stabilisation' given in August 2003.

WBM Oceanics furthered its collaboration with the CRC in a series of rainfall simulator experiments conducted in spring 2003. The experiments, on three suburban roads in Brisbane, were part of a larger project examining the pollutant loads from paved roads in the South East Queensland region. The opportunity was taken to extend the simulations at varying rainfall intensities to support studies being undertaken in the CRC's Urban Stormwater Quality Program. This collaboration will extend into the data analysis phases and is an excellent example of the mutual benefits that can be derived through the Industry Affiliates cooperation.

## Links between Parties

The CRC has continued its strong collaborative and cooperative links with Industry and Research Parties through the following:

- The Development Projects, which are building the knowledge and capacity of the Parties involved;
- CRC projects and their involvement of at least two Parties;
- Joint formulation of CRC research projects by research and industry representatives;
- Projects reviews;
- The Focus Catchments, which are a major opportunity to bring industry, researchers and regional representatives together;
- CRC staff being seconded from industry to research sites and vice versa;
- Postgraduate supervisory panels which include non-university members;
- CRC Parties participating in the Centre's Annual Workshop; and
- Regular communication via the CRC's monthly newsletter, *Catchword*, and the fortnightly internal news bulletin, *CatchUp*, both of which report on Parties' involvement in the CRC.

## Working with other research groups and agencies

This CRC works closely with some of the country's leading land and water research groups and management authorities, as well as collaborating with international research organisations.

The CRC, through its Program 1: Predicting Catchment Behaviour, is helping researchers at Korea's Pusan National University to apply the CRC's Rainfall-Runoff modelling library to a set of catchments in Korea.

The NSW Department of Infrastructure, Planning and Natural Resources worked closely with the CRC Program 1 team to adopt the TIME modelling environment for development of some of its own models.

Researchers in Program 5: Climate variability, have established significant collaboration with scientists from: the UK Met Office; Massey University, New Zealand; University of California, Berkeley; University of Newcastle; University of Natal, South Africa; and the University of New South Wales.

The CRC is working with the CRC for Coastal Zone, Estuary and Waterway Management on projects linked to Project 2.20 (2D)

Land and Water Australia funds CRC research in Programs 1 and 6. The CRC is working with Land and Water Australia and the MDBC to look at ways to incorporate riparian zone processes into Catchment Contaminant Cycle models.

The Brisbane City Council, Melbourne Water, Victorian EPA and NSW EPA provide funding and on-ground support for Program 4's research.



Collaboration with the CRC for Freshwater Ecology was furthered with the CRC Program 4 team collaborating to produce valuable models of ecosystem responses to urbanisation. Program 6 researchers worked with the CRC for Freshwater Ecology to complete the development of the River Analysis Package (RAP) as a Catchment Modelling Toolkit product.

The Victorian Department of Primary Industries, in conjunction with the Department of Sustainability and Environment, is involved with work on water markets and trade for salinity in Program 3: Sustainable water allocation.

The Department of Sustainability and Environment, MDBC and Sinclair Knight Merz are involved with the CRC in work on the impacts of the 2003 bushfires on water quality and quantity.

#### Location of staff with other Parties

Industry and research participating organisations assisted further collaborative activity between Parties with the location of staff at other Parties' centres. The staff included Geoff Podger (DIPNR) and Dr Mark Littleboy (DIPNR) who both spent several periods at CSIRO; Hugh Duncan (Melbourne Water) full time, and Matt Francey (Melbourne Water) part time, co-located at Monash University; Dr Tim Fletcher (Monash University) who worked during August 2003 at Brisbane City Council, and Prof Rodger Grayson (University of Melbourne) who has been based at Monash University since taking up his appointment as CRC Director in April 2004.

#### International Collaboration New Research Affiliate

World-class research requires involvement and collaboration with international agencies. This Centre continues to work with leading international institutions in pursuit of state-of-the-art catchment modelling science.

This year has seen an important collaboration developed between the CRC and the Korean Sustainable Water Resources Research Centre (SWRRC). The SWRRC became a Research Affiliate of the CRC with the signing of a Memorandum of Understanding in August 2003.

The SWRRC was established by the Korean Federal Government in 2001 for a ten-year period to undertake research aimed at alleviating Korea's prime water resources problems. The Centre is a cooperative venture involving several research institutes and so is similar in nature to the CRC for Catchment Hydrology. Currently, the SWRRC funds 21 projects and more than 1000 scientists and over 600 students are involved in its research and development program.

As part of the collaboration, a First Joint Symposium between SWRRC and the CRC for Catchment Hydrology was held in Melbourne on 14 – 15 February 2004 to discuss their latest research findings in the field of watershed management. Held in conjunction with the CRC's Catchment Modelling School, seventeen researchers from the Korean Centre participated in the Symposium with a similar group from the CRC.

*'Working together with the CRC for Catchment Hydrology will assist our two countries as we tackle major water issues. We look forward to extending our collaboration.'*

**Dr Kim Sung**, Director, Sustainable Water Resources Research Centre, Korea

The relationship between the Sustainable Water Resources Research Center (SWRRC) and the CRC for Catchment Hydrology has been established to foster collaborative research between the two organisations.

The First Joint Symposium between the SWRRC and the CRC was held on 14-15 February, 2004. Ideas and experiences in the field of watershed or catchment management were exchanged at the Symposium.

Further collaborative activities planned are:

1. SWRRC looks forward to the introduction to the CRC for Catchment Hydrology of one of its CDMA wireless internet research products as used in the design of the SWRRC Water Resources Observation Network (WRON). A sensor web has been installed at Hampton Park, Melbourne, Australia, to show the potential of this technology (<http://www.hydrology.co.kr/aus>).
2. SWRRC plans to promote collaborative research involving the integrated simulation environment, TIME. Discussions on blending the simulation tool with wireless sensor web technology are currently underway.
3. A delegation from Australian water industry and research organisations will visit Korea in October 2004. The SWRRC will be very pleased to welcome Australian delegates who will be visiting Korea to promote mutual collaboration between our two institutions. More than ten experts from CSIRO, the CRC for Catchment Hydrology, Australian industry and major academic institutions are expected to join this visit.

*continued overleaf*

# Collaboration – Cooperative Linkages

*This Page Left Dr Mohamed Wahba, visiting researcher from Drainage Research Institute, Egypt. Right Visiting researcher Assoc Prof Xiang Zhang, Wuhan University, China – catchment modelling research with the CRC*



Working together with the CRC for Catchment Hydrology looks promising as the Centres together explore and find solutions to water problems common to both countries.

**Dr Kim Sung, Director, Sustainable Water Resources Research Centre, Korea**

Other significant collaborations included:

- Dr Ana Deletic discussed collaboration between the CRC and several prominent international research groups involved in research related to the CRC's Urban Stormwater Quality Program. The researchers included Prof Richard Ashley from Bradford University (head of Pennine Water Research Group in the UK); Jiri Marsalek, National Water Research Institute, Ontario Canada; and Jean-Luc Bertrand Krajewski from URGC Hydrologie Urbaine, France.
- Cooperation with the University of California, Berkeley was maintained with a further visit from Prof John Dracup. Prof Dracup spent two weeks over May and June 2004 at The University of Melbourne working with Dr Francis Chiew on hydroclimate variability and Melbourne's water resources.
- Dr Tim Fletcher and Dr Ana Deletic (Program 4) have been asked to chair the UNESCO International Hydrology Program, IHP-VI 'Data requirements for urban water management' project. Dr Fletcher attended the first project workshop in Paris, 26-28 November 2003.
- Dr Tim McVicar, Project Leader for CRC Associated/Additional Project 2.24, collaborated with scientists from the Chinese Academy of Sciences, Institute of Soils and Water Conservation. Two researchers visited Australia during the year to work at CSIRO Land and Water Canberra. The visitors were:
  - Dr Qinke Yang (a GIS specialist), 17 March – 11 June 2004
  - Ms Xiaoping Zhang (a land-use specialist), 14 April – 27 May 2004

## International visitors

This year, the CRC hosted the following international visitors or visiting groups:

- Seventeen members of Korea's Sustainable Water Resources Research Centre (SWRRC) attended the Catchment Modelling School 04. The delegation included the Centre Director, Dr Kim Sung, who also visited a number of CRC research groups, including those at The University of Melbourne, Monash University, and CSIRO Land and Water, Canberra.
- Dr Sanghyun Kim from the Pusan National University in Korea commenced, in late January 2004, an eight month stay with the CRC, located at CSIRO Land and Water Canberra. Dr Kim has been involved in research related to CRC Programs in predicting catchment behaviour and land-use impacts on rivers.
- Dr Mohamed Wahba, from the National Water Centre, Drainage Research Institute, Egypt, Visiting Scientist with CSIRO, has been working with Dr Evan Christen at CSIRO Griffith on aspects of irrigation research, particularly drainage issues.
- Associate Professor Xiang Zhang, Wuhan University, China, visited Dr Francis Chiew (Program 5) at The University of Melbourne from July 2003 to February 2004 to work on catchment modelling for different scales and land-use types.
- Dr Alessandro Simoni, University of Bologna, Italy, visited Dr Andrew Western (Program 5) at The University of Melbourne from September to December 2003 to work on hydrological and soil moisture modelling.
- Mike Dunbar from the Centre for Environmental Hydrology, United Kingdom, visited The University of Melbourne, 1-4 July 2003.

- Dr Tim Fletcher hosted Stefan Ahlman, a PhD student from Chalmers University of Technology, Gothenburg, Sweden, for two months. Stefan worked on stormwater quality modelling, using Brisbane City Council's database. This work will link with the European Union's DayWater programme.
- Prof Jeff McDonnell, Oregon State University, USA, visited The University of Melbourne (Program 5 researchers) during 11 and 12 Sept 2003 and held discussions on catchment hydrological processes and interpretation of spatial patterns. Prof McDonnell also gave a seminar entitled "Where does water go when it rains? – Towards a new dialogue between experimentalist and modeller in catchment hydrology"
- Assoc Prof Takamitsu Kajisa, Mie University, Japan, visited CSIRO at Griffith NSW in March 2004 for discussions with Dr Evan Christen and colleagues on irrigation and catchment drainage issues and areas of potential collaboration.
- Prof Geoff Pegram, University of Natal, Durban, South Africa, worked with Assoc Prof Francis Chiew and colleagues at The University of Melbourne during 12 January to 20 February 2004 on stochastic hydrology and analyses of cycles in rainfall and streamflow data.
- As noted, Prof John Dracup, University of California, Berkeley, USA, collaborated with researchers at The University of Melbourne including Assoc Prof Francis Chiew during his stay in Melbourne during 24 May to 4 June 2004. Prof Dracup worked on interdecadal hydroclimate variability and its impact on Melbourne's and California's water supply.
- Pascal Horton, a visiting scholar from the Swiss Federal Institute of Technology, Lausanne, spent three months at Monash University working with Dr Tony Ladson on improving stream health.

## Cooperative Linkages



# Collaboration – Cooperative Linkages

*This Page* **Left** Visiting researcher Prof Geoff Pegram, Univ of Natal, South Africa (at left) – collaborating in CRC Program 5. **Right** Prof John Dracup, University of California, Berkeley, and Assoc Prof Francis Chiew – collaboration in climate variability

*Opposite Page* **Left** Pascal Horton, visiting scholar from EPFL (Swiss Federal Institute of Technology, Lausanne), researching improvement of stream health. **Centre & Right** Interaction with other research and industry groups – CRC Catchment Modelling School, February 2004.



## International visits

CRC staff made the following international visits:

- Dr Rob Vertessy spent a month in Korea, supported by the Korean Federation of Scientific and Technological Societies and the Sustainable Water Resources Research Centre (SWRRC), which is based at the Korean Institute of Construction Technology in Seoul. The purpose of the visit was to showcase the CRC, to learn more about the water resources research and development efforts of the SWRRC, and to stimulate research collaboration between the CRC and the SWRRC. The SWRRC is doing some excellent work in hydrological data warehousing and spatial analysis that very strongly complements the CRC's Catchment Modelling Toolkit.
- Dr Alan Seed, Project Leader in Program 5: Climate Variability, visited the:
  - National Weather Service (NWS) Hydrologic Development Laboratory, USA, 4-5 August 2003 to discuss the NWS plans to develop probabilistic rainfall forecast products in the USA and to explore cooperative linkages in this field;
  - Met Office Joint Centre for Hydro Meteorological Research, Wallingford, UK 15-19 September 2003 to evaluate the results of the UK trials of STEPS and to finalise the model, and the Met Office on 3-4 June 2004 for collaborative work and discussion on rainfall nowcasting;
  - WMO Nowcasting Workshop for Latin America, 3-14 November 2003, in Brasilia, Brazil and presented lectures;
  - Ha Noi Hydrometeorological College, Socialist Republic of Vietnam, 1-5 December 2003 and gave lectures on radar rainfall estimation and nowcasting; and
  - Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada, from 24 March to 1 June 2004, to work on rainfall nowcasting.

- Dr Ana Deletic discussed CRC research in Program 4: Urban stormwater quality, at a meeting of the Committee of the Sewer Systems and Processes Working Group, (working group of the joint IAHR/IWA Urban Drainage Committee) held in Thessaloniki, Greece, in August 2003.
- Dr Robert Argent visited the International Water Management Institute, Sri Lanka, and held meetings with key staff on the opportunities offered by investigation and adoption of the CRC's Catchment Modelling Toolkit.
- Assoc Prof Francis Chiew (Program 5) participated in the WMO/UNESCO (WCP-Water) Expert Meeting on 'Hydrological Sensitivity to Climate Conditions' in Wallingford, UK, during 2-4 December 2003.
- Dr Andrew Western (Program 5) visited the European Centre for Medium Range Weather Forecasting, Reading, UK, on 14 April 2004.
- Dr Tim Fletcher (Program 4) worked at INSA (Institute Nationale Scientifique Application) in Lyon, France, from 14 June to 14 July 2004.
- Dr Sri Srikanthan (Program 5) visited Prof Don Burn and Dr Mohamad Sherrif of the University of Waterloo, Canada, on 23 June 2004 to discuss work on the generation of climate data using non-parametric methods. Dr Srikanthan also visited Prof Slobodan Simonovic and Dr Juraj Cunderlik of the University of Western Ontario, London, Canada on 28 June 2004 to discuss research studies on the impact of climate change on flood risk.

## Other Interactions

Highlights of the CRC's interactions with other research and industry groups during 2003-2004 included:

- Dr Robert Argent (Program 1), Assoc Prof Francis Chiew (Program 5) and Dr Christy Fellows (Program 2), participated in a meeting in Canberra on 17 November 2003 to develop an ARC network proposal led by Prof Tony Jakeman of ANU, for Sustainable Terrestrial, Aquifer, and River Systems (STARS). Prof Rodger Grayson was also involved in the development and submission of the STARS proposal.
- Dr Argent (Program 1) conducted a workshop on integrated catchment modelling on 4 February 2004 as part of the CSIRO Water for a Healthy Country, Urban Waterscapes (WHC-UW) project. This workshop was followed with meetings between WHC-UW staff and Program 1 staff on the use of the TIME modelling environment to support WHC-UW modelling.
- Dr Argent continues to sit on the International Panel of Experts for the European Open Modelling Interface and Environment (OpenMI). He attended the Panel meeting in Singapore on 21 June, 2004.
- Prof Rodger Grayson and Dr Robert Argent (Program 1) continued work as specialist consultants on the development of the Water Quality Management Strategy for Gippsland, Victoria.





- Prof Stuart Bunn (Program 6, and also CRC for Freshwater Ecology) continued as Deputy Chair, and Dr Heather Hunter (Program 2) continued as a member, of the Scientific Expert Panel for the Moreton Bay Waterways and Catchments Partnership.
- Dr Tim Fletcher (Program 4), with Prof Russell Mein and Dr Earl Shaver (Auckland Regional Council), conducted an external review of the Water Sensitive Urban Design (WSUD) Technical Manual project for Melbourne Water.
- Dr Tim Fletcher and Dr Tony Ladson (Program 4) met with NSW EPA regarding an associate project with CRC Freshwater Ecology Project Leader, Dr Chris Walsh.
- Dr John Tisdell (Program 3) collaborated with industry and research groups on Sustainable Water Allocation with presentations to:
  - DIPNR staff, Coleambally Irrigation and Murrumbidgee Irrigation representatives and others on development of Murrumbidgee experiments, in Sydney on 29 January 2004.
  - Academic and industry representatives and others on 'Application of Experimental Methods to Resource Markets' at The University of Melbourne on 10 February 2004, and to the South East Queensland catchment group at the Moreton Bay Waterways and Catchments Partnership, Brisbane, on 5 March 2004.

- André Taylor (Program 4) undertook a consultancy on urban stormwater quality for the Department of Environment in WA, writing guidelines for non-structural best management practices (BMPs), building on CRC research.
- Dr Alan Betts, a leading land-surface modelling expert, in particular the VB95 model used in CRC Project 5.05 (5A), visited the Bureau of Meteorology Research Centre, 1-3 October 2003. Several CRC Program 5 staff (Assoc Prof Francis Chiew, Dr Harald Richter and Dr Andrew Western) engaged in fruitful discussions with Dr Betts regarding VB95 and research directions for Project 5.05 (5A).
- Assoc Prof Francis Chiew (Program 5) completed a consultancy on climate change impact on runoff in the ACTEW water supply catchments.
- Prof Rodger Grayson was appointed to the Board of the East Gippsland Catchment Management Authority in July 2003 and participated in the governance and strategic management of the Authority throughout the year. Prof Grayson was also involved with the Authority and other natural resources management agencies in a series of meetings in January to March 2004 related to the final preparation of the Regional Catchment Strategy.
- Dr Mike Stewardson (Program 6) continued as a member of the Scientific Reference Panel for the Snowy River Rehabilitation Trial.
- Dr Mike Stewardson and Assoc Prof Ian Rutherford (Program 6) were members of the Scientific Panel for the Goulburn River Environmental Flow Panel which provided environmental flow recommendations to the Department of Sustainability and Environment, Vic.

# Program 1 Predicting Catchment Behaviour

*This Page* Geoff Podger,  
Program Leader, Predicting  
Catchment Behaviour

*Opposite Page* Program group,  
Program 1, Predicting Catchment  
Behaviour



Aim To provide land and water managers with the tools and skills to make better-informed decisions at a whole-of-catchment level.

**Program Leader**

Geoff Podger, Department of Infrastructure Planning and Natural Resources, New South Wales.

**Program Output**

This Program builds on two earlier projects and comprises two second-round research projects designed to help fulfil the CRC's core requirement of building a Catchment Modelling Toolkit.

The Catchment Modelling Toolkit is an integrated software solution comprising modelling tools and modules capable of predicting catchment behaviour.



### Outcomes and benefits

In this CRC's current portfolio of projects there is a major emphasis on integration of modelling tools. A culture of integration has been developed across research projects and industry Parties to ensure outputs comply with integration needs.

New generation catchment models and modelling support tools produced within a new model development environment called TIME (The Invisible Modelling Environment) are consistent with this culture. The software products developed by this CRC are being delivered via a web interface and form the basis of the Catchment Modelling Toolkit.

The Toolkit has already improved the standard and efficiency of catchment modelling and future developments will provide much needed enhancements in predictive capability for land and water managers. This system of software will enable them to fully evaluate and better predict the short and long-term outcomes of land and water policy decisions at regional scales.

The Catchment Modelling Toolkit is providing:

- demonstrated ability to plan for changes in catchments, and manage them accordingly to increase environmental, economic, and social values; and
- a collection of packaged models, data products, and high-quality user documentation.

Importantly, when further adopted by catchment and resource managers, the Toolkit will greatly assist in sustainable land and water management.

### End-users

Users can be segmented into primary and secondary users:

#### Primary user groups

- Technical planning units within urban, rural and state resource management authorities
- Consultants
- Researchers
- Graduate students

#### Secondary user groups

- Catchment management authorities
- Community-based catchment groups
- Policy and extension groups at all levels of government
- Undergraduates

### Program highlights 2003-2004

- The software modelling framework TIME has undergone further significant development, resulting in improved and expanded functionality. There are now 15-20 researchers within and outside this CRC who are actively developing models using TIME.
- The Catchment Modelling Toolkit now contains seven publicly released products:
  - The Rainfall Runoff modelling Library (RRL);
  - Chute – a rock chute design application;
  - MUSIC – the Model for Urban Stormwater Improvement Conceptualisation;
  - The Sediment Network model (SedNet);
  - The Stochastic Climate Library (SCL);
  - TREND – a suite of statistical tests for trend in data; and
  - The River Analysis Package (RAP).
- TIME has created great interest from Industry Parties, other CRCs and software developers. In particular, the Department of Infrastructure, Planning and Natural Resources, NSW, has adopted the TIME modelling environment for development of some of its models. Two environmental modelling groups working on the European Union Framework Program projects have also expressed interest as have the Qld EPA.
- Protocols and procedures for developing a consistent high quality of software products continued to be developed and tested.
- Conceptual development for production of the CRC whole-of-catchment modelling capability was extended from the Integration Blueprint developed in 2002-3 to an expanded multi-scale modelling system known as E2. This system consists of a range of catchment modelling options of different complexity. Progressive development of this capability, using many of the modules already developed within TIME, will extend over 2004-05.

# Program 1 Predicting Catchment Behaviour

*This Page*  
*Left Project Leader*  
*Joel Rahman –*  
*Project 1.09 (1A)*  
*Right Project Leader*  
*Dr Robert Argent –*  
*Project 1.10 (1B)*



## Project 1.9 (1A) Implementation of the Catchment Modelling Toolkit

Project Leader Joel Rahman,  
CSIRO Land and Water

**Aim** To construct the Catchment Modelling Toolkit using the CRC's TIME modelling framework to interlink models and model support tools developed by other programs.

### Achievements 2003-2004

- Continued development of TIME, with a high level of adoption by both CRC staff, other researchers in this CRC's Parties, and a small but growing number of researchers in outside organisations.
- Development of release versions of the RRL, RAP, SCL, TREND and SedNet.
- Product release of TIME.
- Continued support to Development Projects, including workshop training in the application and calibration of the EMSS software, and eliciting user input on the design of the CRC's whole-of-catchment modelling capability.

## Project 1.10 (1B) Methods for integration in catchment prediction

Project Leader Dr Robert Argent,  
The University of Melbourne

**Aim** Considered the 'engine room' of the CRC's integration activity, this project ensures that the discrete models built by each project will conform to an overall conceptual design that can be encoded into the Catchment Modelling Toolkit.

### Achievements 2003-2004

- The primary role of integration and system coordination continued through 2003-04. This role was expanded to include a fostering role for Catchment Modelling Toolkit products.
- The Integration Blueprint was extended from concepts and inputs/outputs into system design, resulting in initial development of the conceptual and technical structure required to provide this CRC's whole-of-catchment modelling capability.
- Methods were designed for the representation of uncertainty in modelling outputs. Initial implementation has commenced.

# Milestones Program 1

## Milestones

### Years 1 and 2

Conduct a 'stakeholders workshop' and prepare a summary report listing the key catchment management questions being asked of models.

## Progress

Three surveys were conducted instead of a workshop. More than 200 catchment managers, model-users and model-developers were surveyed, with a 44% response rate. Results were compiled and disseminated to respondents. Report published in August 2001.

Conduct a 'modellers' workshop' to assess the suitability of existing models to answer these questions; prepare a summary report which identifies gaps in our ability to model particular problems at particular scales.

A user survey was conducted on existing models. The 'Toolkit team' ran two major sessions at the International MODSIM2001 symposium in December 2001. Two major sessions were run at the IEMSS Conference in Switzerland in June 2002.

Develop specifications for new models to be developed for the modelling Toolkit; these will take advantage of the latest environmental data products such as rainfall radar, laser altimetry, airborne geomagnetics, and hyperspectral scanners.

We have settled on TIME as the modelling framework for the Toolkit, however, other products will also be supported. An integration Blueprint has been written that covers the models that will be developed and how they will link together. Second round projects will build on the research in round 1.

Develop a software engineering strategy for the development and maintenance of the modelling Toolkit.

A software engineering strategy has been agreed to, involving the staged development of models within the TIME environment. The strategy provides for porting routines in existing models such as MUSIC, EMSS and IQQM into the Toolkit. Existing models will still be supported. There will be a coordinated approach to incorporating models developed in the new round of projects into TIME. A designated product manager will support all models.

Develop a 'model documentation' and training strategy.

A standard template for documentation is complete. Toolkit product documentation is at different stages and will need to be standardised.

Commence development of the modelling toolkit, starting with the integration of existing models.

A small number of models in the Toolkit have been implemented including the SedNet erosion model (Program 2). A library of conceptual rainfall/runoff models is complete. There has also been considerable development of the River Analysis Package (RAP) (Program 6) within TIME.

### Years 3, 4 and 5

Adapt existing, and develop new, models of catchment function, applicable to regional scales and suited to co-evaluation of multiple issues (eg. relationship between vegetation management, water yield, salinity, erosion and sedimentation).

Conversion of EMSS to TIME has expanded to include E2 development, requiring development of core functionality as well as EMSS-specific features. Current toolkit products provide a range of models of catchment functions. For example, the River Analysis Package (RAP) allows for investigating relationships between flow, channel geomorphology and the environment.

Link hydrologic, pollutant-transport, ecologic, geomorphic, meteorologic and socio-economic models to enable holistic analyses of catchment behaviour.

Good ecologic links exist in the Local-scale Environment Management Support System (LEMSS) and RAP. Linkages are being developed between industry river basin models (IQQM) and economic models (WRAM). V1 of Blueprint and draft E2 specifications provide broader functions for prediction of catchment behaviour.

Develop techniques to scale detailed process representation to larger scales.

Techniques were developed in Project 1.2; effective demonstration shown in Project 5.1.

Develop and incorporate an uncertainty analysis methodology into the toolkit; this will be used to put error margins on model predictions.

A number of methods for incorporating model uncertainty visualisation into Toolkit products have been developed and will be progressively deployed in E2.

Commence application of the modelling toolkit on the five focus catchments.

Application of tools within development projects is well advanced, with some projects nearing completion.

Conduct first public release of the modelling toolkit.

Seven Toolkit products are now publicly available at [www.toolkit.net.au](http://www.toolkit.net.au), with 11 other products in the restricted area.

Conduct training workshops on the use of the modelling toolkit.

The Catchment Modelling School, February 2004, involved over 300 participants gaining exposure to the most current Toolkit products.

# Program 2 Land-use Impacts on Rivers

*This Page* Left Dr Peter Wallbrink, Program Leader, Land-use Impacts on Rivers. Right Program group, Program 2, Land-use Impacts on Rivers

*Opposite Page* Left Project Leader Dr Evan Christen – Project 2.19 (2A) Centre Project Leader Dr Scott Wilkinson – Project 2.20 (2B). Right Project Leader Dr Mark Littleboy – Project 2.21 (2C)



## Aims

- To develop methods for predicting responses to land-use change.
- To predict the spatial distribution of pollutant sources for three rural focus catchments.
- To integrate these methods into a whole-of-catchment predictive model (primarily E2).

### Program Leader

Dr Peter Wallbrink, CSIRO Land and Water

### Program Output

This Program is:

- Providing a whole-of-catchment modelling capability.
- Identifying catchment ‘hot spots’ that contribute to land and river degradation, and developing effective strategies to treat them.
- Providing the tools to predict at any point:
  - Flow;
  - Sediment load and concentration;
  - Salt load and concentration; and
  - Nutrient load and concentration.
- Providing the capability to predict the impacts of irrigation return flows and the potential for riparian denitrification, as a function of variables such as land-use change.
- Contributing a biophysical understanding of catchment pollutant dynamics, an understanding needed to underpin catchment management plans and major works initiatives such as the Natural Heritage Trust (NHT) program.
- Establishing practical field knowledge and new theory to assist in developing and testing of predictive models.



### Outcomes and benefits

Land-use and management activities are widely recognised as contributing to downstream water quality problems in many catchments.

Considerable national investment is being directed towards salinity and nutrient management strategies and afforestation programs, despite relatively poor knowledge of their efficacy or how they might impact on downstream users.

Broad-scale afforestation is being considered for groundwater recharge control, but the consequent water-yield decreases may exacerbate the salinity problem downstream. For large catchments there is a need to clarify the role of pollutant stores and the manner in which pollutants are conveyed from hill slopes to the channel system.

A critical issue is the extent to which riparian vegetation and aquifer management can mediate sediment or pollutant delivery to channels. Preliminary research suggests that 90 percent of the excessive movement of nutrients from land to streams can be stopped by better management of 10 percent of the land area.

This Program seeks to determine the impact of vegetation and land cover on inter-relationships between catchment water yield, groundwater recharge and salt load concentrations in rivers.

It will also aid in the understanding of pollutant delivery to stream channels and the effect of riparian vegetation in stream health and downstream water quality. Ultimately Program 2 will deliver cost-effective catchment rehabilitation measures to improve river water quality.

### End-users

- Water resource management agencies
- Catchment management authorities
- Consultants
- Researchers

### Program highlights 2003-2004

- Program 2 continues to expand on its links and contributions to the whole-of-catchment model E2 being developed in Program 1. In particular, Program 2 projects are now delivering key understandings and modules at the whole-of-catchment-scale. Ultimately these will allow point-based assessments of sediment and nutrient generation rates and loads, salt load and concentration values, as well as methods for the spatial quantification of riparian denitrification and quality of irrigation return flows.
- SedNet Version 1.0 is now available in the Catchment Modelling Toolkit. It can be used to construct sediment budgets. Initial training and documentation for the use of SedNet has been undertaken in all the focus catchments. Much of the training has occurred at the 2004 Catchment Modelling School and subsequent development project workshops. Valuable feedback from the Catchment Modelling School and project workshops is being incorporated into current developments of SedNet.

- The design specifications for a new salt model have been completed. This model incorporates the best modules from previous salt-related modelling undertaken across Victorian, New South Wales and Queensland jurisdictions. In short, these specifications encapsulate a description of the linkages between existing and proposed activities across project Parties and a clear description of the mathematical functions at each level. The specifications have provided the basis for software coding, which is now largely completed towards having a beta version in the Catchment Modelling Toolkit by late 2004.
- Nitrate is a key pollutant in European and North American catchments. In Program 2, the development of a riparian denitrification model for Australian catchments is now well advanced and has been coded in TIME for inclusion into the Toolkit through E2. Good progress has also been made in assessing techniques for identifying potential areas of groundwater discharge at a catchment scale. This will enable the potential for denitrification by riparian zones to be assessed at the larger basin scale.
- The flow duration curve model can now predict changes to the seasonal patterns of stream flow associated with major changes to land use (such as new plantations). This model is now being prepared to feed into the Catchment Modelling Toolkit through coding into IQQM and as a 'stand-alone' tool.

# Program 2 Land-use Impacts on Rivers

*This Page Left Project Leader Dr Heather Hunter – Project 2.22 (2D). Right Project Leader Dr Lu Zhang – Project 2.23 (2E)*



**Project 2.19 (2A) Reducing the impacts of irrigation and drainage on river water salinity**

**Project Leader** Dr Evan Christen, CSIRO Land and Water

**Aim** To provide the ability to predict the impact of irrigation management on river water quality.

**Achievements 2003-2004**

- Data collection from 12 irrigation areas across Australia is complete. Technical report outline drafted. Processes regarding salt wash-off reviewed.
- The data for six main irrigation areas has been analysed and long-term trends of drainage return flows from irrigated areas analysed and discussed with respect to river water quality and flows.
- A report was published entitled 'The Murray-Darling Basin - A Case Study of Drainage Impacts in a Multi-functional Resource System'.
- Work commenced on the adaptation of the SIMHYD model for whole-of-irrigation and drainage quality predictions.

**Project 2.20 (2B) Improved suspended sediment and nutrient modelling through river networks.**

**Project Leader** Dr Scott Wilkinson, CSIRO Land and Water

**Aim** To deliver to catchment managers the ability to model sediment budgets using the SedNet technique.

**Achievements 2003-2004**

- SedNet v1.0.0b software developed and released at the Catchment Modelling School February 2004.
- Training of 40 stakeholders in SedNet undertaken in February 2004.
- Improvements to SedNet progressing through developing a method for calculating hill-slope sediment delivery ratios (HSDR).
- SedNet documentation completed.

**Project 2.21 (2C) Predicting salt movement in catchments**

**Project Leader** Dr Mark Littleboy, Department of Infrastructure, Planning and Natural Resources, NSW

**Aim** To predict impacts of land-use change on surface and groundwater contributions of catchment-scale salt export.

**Achievements 2003-2004**

- Draft salinity model design specification completed. Model components and structure agreed.
- Model revised following the Murray-Darling Basin Commission Salinity Modelling Forum, June 2003.
- Revised Design Specifications presented to Project Steering Committee, February 2004.
- Background and general concepts 'Design Specifications Document' completed.
- The 'Process specifications' document completed.
- Integration of Version 1.0 of a simplified model into the Catchment Modelling Toolkit underway.
- This Project continues to build on existing modelling tools across CRC Parties.

**Project 2.22 (2D) Modelling and managing nitrogen in riparian zones to improve water quality**

**Project Leader** Dr Heather Hunter, Natural Resources and Mines, Qld

**Aim** To provide the ability to predict nitrogen influx into streams from shallow groundwater, and to estimate the ability of riparian and in-stream areas to 'consume' nitrogen through denitrification.

**Achievements 2003-2004**

- EMSS model developed for the Maroochy catchment. Pilot testing of the Riparian N module continues.

- Denitrification and groundwater flow processes incorporated into a simple model for a perched aquifer system.
- Planning underway with NR&M and CSIRO for developing the spatial analysis tool to assist in identifying stream reaches most at risk of nitrogen-enriched groundwater discharge.

**Project 2.23 (2E) Modulating daily flow duration series to reflect the impact of land-use change**

**Project Leader** Dr Lu Zhang, CSIRO Land and Water

**Aim** To develop a simple method to quantify how the daily flow duration series for a catchment will vary in response to a major change in land use, for example from agriculture to plantation.

**Achievements 2003-2004**

- Model for predicting the changes in flow duration curves due to altered land-use conditions, developed and published.
- International conference poster presented on 'A methodology for predicting the impact of changing vegetation on flow duration curves'.
- Planning underway between staff from Programs 1 and 2 on linking the flow duration curve model with the IQQM and LUOS models.



# Milestones Program 2

## Milestones

### Years 1 and 2

Compilation of the water quantity and water quality measures relevant to ecological response and delivery mechanisms for the three rural focus catchments.

## Progress

In the Murrumbidgee, Brisbane, Fitzroy and Goulburn we have obtained data and quality assured much of it. It is now input to much of the model evaluation which is occurring. There are clear ecological connections in Projects 2.1 and 2.5 with the physical habitat and riparian zone research. A major dataset on hydraulic habitat in the Murrumbidgee has been made available through Project 2.1. A sediment and attached nutrient property dataset is now available for the five major soils in both the Fitzroy and the Murrumbidgee catchments.

Identification and specification of technical impediments to cross-disciplinary transfer functions.

We have very wide-ranging collaboration with many disciplines including ecologists, geomorphologists, climatologists and pollutant chemists. The Fitzroy AEAM stakeholder workshop in May 2003 linked the Program's understanding with that of the coastal zone, estuarine and ecological modellers. This laid the foundation for a development project in this catchment. The modelling workshop jointly hosted by Project 2.3 specified technical impediments to the adoption of the BC2C stream salinity model and laid the foundation for Project 2.21(2C).

Inter disciplinary meeting to evaluate proposed transfer functions across a range of agro-ecological zones.

We continue to be involved in several cross-disciplinary meetings including biophysical and ecological work associated with the LEMSS in the Brisbane, physical habitat work in the Murrumbidgee and AEAM Fitzroy workshops.

### Years 3, 4 and 5

Develop methodology for predicting responses to land-use change.

Four separate products have been developed or enhanced: MAYA (water yield), SedNet (sediment at catchment-scale), ICMS (sediment and nutrients for cropping on hill slopes) and TERRAPENE/BC2C (water yield and stream salinity). SedNet is a NLWRA product developed by CSIRO that we are enhancing. SedNet is now part of the toolkit while EMSS forms a basis of most of the Development Projects. Flow duration curve change prediction is now gaining some maturity. The major delivery mechanism for predicting land-use changes will be through a 'whole-of-catchment model' called E2. Conceptual development is continuing with the Program 1 team as to how sediment, salt and nitrogen generation modules will be incorporated into this model.

Predict the spatial distribution of pollutant sources for the three rural focus catchments.

The above tools make these predictions. They link with important data layers contributed from a range of organisations including the new Ground Water Systems map (from Catchment Categorisation), several NLWRA layers and land-use change scenarios as provided by regional planning groups.

Higher resolution data with local ground truthing have been incorporated in several instances including better gully mapping, land-use mapping and DEM in the Murrumbidgee, and better land-use maps in the Goulburn-Broken.

Links to Development Projects are working well. These projects are providing feedback to current research projects. Appropriate modules for predicting riparian N as well as sediment N and P continue to be developed for incorporation into the Toolkit.

Evaluate spatial predictions of existing land-uses with a range of conventional and new remotely sensed data.

The above products are being tested using a range of available data, primarily in the focus catchments. Recent progress on fine temporal scale water yield predictions has been a highlight. Remotely sensed data is still primarily being used for point input data interpolation. All Focus Catchments are using available in-stream measures of water quality and quantity as evaluation datasets. High-resolution (25 m) RASTER data has been trialled as an input method for interpolating catchment functions in the Fitzroy catchment. This work is on-going.

The riparian zone project continues to feed into our modelling frameworks as planned. The complex issue of scaling remains but assistance of experienced modellers from other parts of the CRC is leading to a pragmatic approach. Spatial predictions of sediment and nutrient sources have also been evaluated against observations undertaken with tracer based approaches in the Brisbane and Murrumbidgee catchments.

# Program 3 Sustainable Water Allocation

*This Page* Dr John Tisdell, Program Leader, Sustainable Water Allocation, and Project Leader, Project 3.09 (3B)

*Opposite Page* Program group, Program 3, Sustainable Water Allocation



**Aim** To provide water managers and users with a set of principles, guidelines, and practical tools for managing water allocation and use in a sustainable and efficient manner.

**Program Leader**

Dr John Tisdell, Griffith University

**Program Output**

In many areas, the economic, practical, and environmentally sustainable extent of water harvesting has now been reached. In the Murray–Darling Basin, for instance, a ‘cap’ on further water diversions has been imposed. Under national policy (COAG), further economic development (while protecting environmental values) will require that better use be made of water already being harvested.

This entails a basin-wide view for hydrologic assessment, consideration of supply uncertainty, a redefinition of water entitlements (allowing for transfers through trading), and an allocation for environmental flows.

Many hydrologic issues need to be resolved before land and water managers can be confident that the current water allocation and trading system is sustainable.

Factors that lead to uncertainty in water availability (eg farm dams, land-use management, forest plantations, and climate variability) are set out in this Program. The Program will also develop and add ‘water trading’ models which interact with existing hydrological models (eg IQQM and REALM). The Program will also provide fundamental insights into the behaviour of water markets.



### Outcomes and Benefits

- A sound hydrologic foundation for a sustainable property rights/water trading framework.
- Increased efficiency of operation using meteorological and hydrologic forecasts.
- Increased efficiency of water delivery.
- On adoption, more profitable irrigated agriculture, more certain environmental allocations.

### End-users

The end-users are likely to include:

- Federal and State natural resource managers
- Water regulators, authorities and agencies
- Peak environmental, farming and irrigator organisations
- Experimental economics groups
- Universities (local and international)
- Water and natural resource management departments
- Environmental protection authorities
- Rural development agencies
- National Competition Council
- Non-government organisations (eg ACF or WWF).

### Program highlights 2003-2004

- The development of an experimental 'water market' environment (Mwater) in which policy makers can explore alternative instruments under controlled conditions.
- The development of the Water Re-Allocation Model (WRAM) which combines an economic model with the hydrological data underpinning IQQM.
- A variety of reports including a comprehensive review of water reform in Australia and models exploring the redistribution of surplus water in catchments.

#### Project 3.1 Integration of water balance, climatic and economic models

Project Leader Assoc Prof Gary Codner, Monash University

Aim To devise and implement an integrated planning and seasonal water allocation modelling approach that allows the optimisation of the economic and environmental value of water, and takes into consideration hydrological and climatic constraints.

#### Achievements 2003-2004

- Modules have been developed to provide sensitivity analysis of REALM and IQQM models, allowing assessments to be made on where calibration effort should be put in applying either model to a catchment.

- A conceptual framework for exchange rates in water trading, with a rationale for exchange rates and a basis for calculation, has been developed.
- Draft reports completed on aspects of modelling the effect of climatic and socio-economic factors on trading behaviour, and the investigation of model sensitivity to parameter and data uncertainty and scaling of demands.
- Final report submitted by ICAM on aspects of the development of a module to calculate economic indicators from model outputs.
- A draft technical report completed on aspects of Farm Dams.
- MEngSc student's thesis approved.
- Project 3.1 is complete apart from continuing postgraduate activity.

# Program 3 Sustainable Water Allocation

*ThisPage Left Project Leader Assoc Prof Gary Codner – Project 3.1 . Right Project Leader Assoc Prof Bofu Yu – Project 3.08 (3A)*



**Project 3.08 (3A) Hydrologic and economic modelling for sustainable water allocation**

**Project Leader Assoc Prof Bofu Yu, Griffith University**

**Aim** To develop a water-trading model that simulates the economic consequences of reallocating water resources through trading in the Goulburn Broken and Murrumbidgee catchments.

**Achievements 2003-2004**

- A proof of concept version of the WRAM water-trading model that interacts with IQQM is complete.
- Version 1.4 of the WRAM software was released at the Global Review in August 2003.
- WRAM v1.4 has been populated with the 12-node and the original 58-node representation of the Murrumbidgee catchment.
- WRAM now has the capability to generate water accounts with or without water trading to integrate with an input-output model for impact analysis.
- A utility program has been developed to manipulate REALM output files to disaggregate water use for individual crop and crop groups.
- WRAM/IQQM interaction is up and running.
- Work has commenced on the development of an input-output table for the Murrumbidgee catchment.

**Project 3.09 (3B) An evaluation of permanent water markets**

**Project Leader Dr John Tisdell, Griffith University**

**Aim** To provide fundamental insights into the behaviour of resource markets (eg water, salt and sediment) and to use this information in building appropriate property right and trading principles and procedures.

**Achievements 2003-2004**

- The experimental methods developed in the first-round Project 3.2 to explore temporary water trading issues have been expanded to evaluate, at a proof of concept level, alternative policy instruments for the management of total suspended solids exiting the Stanley catchment of South East Queensland.
- An integrated IQQM/12 node version of Mwater is complete. Further refinement of the experimental methods is currently under way to experimentally evaluate the consequences of permanent water trading in the Murrumbidgee and Goulburn Broken catchments.

# Milestones Program 3

<b>Milestones</b> <b>Years 1 and 2</b> Assess the implications of the COAG task force recommendations on water in Australia.	<b>Progress</b> The implications of the COAG task force have been included in a detailed review of the literature and commentary on water reform in Australia.
Characterise the nature of the impacts of the various sources of uncertainty in supply, on the performance of surface and groundwater systems.	An extensive survey (leading to three reports) has investigated the behavioural, social and economic characteristics of the Focus Catchments and how they may impact on the development of water allocation strategies.
Review current water entitlement regimes for surface and ground water in the Focus Catchments in terms of their ability to take account of climate variability and hydrological constraints on catchment yield and water supply.	The Program completed a review of IQQM and REALM in terms of their ability to take account of climate variability and hydrological constraints on catchment yield and water supply, as well as socioeconomic factors.
Investigate behavioural, social and economic characteristics of the Focus Catchments and how they may impact on the development of water allocation strategies.	Project 3.1 produced an extensive report on a survey of the behavioural, social and economic characteristics of the Goulburn Broken catchment.
Identify appropriate management techniques to reduce the risk of change and/or to manage change.	The results of an extensive survey of irrigators and community members formed the basis of a number of management techniques to reduce risk of change.
Outline the potential impacts of significant water entitlement movement through trade on supply systems, social structures and efficiency of water use.	Work on identifying appropriate management techniques to reduce the risk of change and/or to manage change commenced.
Commence development of water allocation and trading frameworks that take account of economic efficiency, social interactions and equity issues, environmental flow requirements, hydrological constraints and uncertainties of supply.	A water allocation and trading framework has been developed and is continually evolving. Calibration of the IQQM package on the Murrumbidgee catchment has been completed by DIPNR and has been under review as part of Project 3.1 and Project 3.08 (3A).
Commence development of water allocation models and institutional structures that maximise socioeconomic objectives, given tradeable water entitlements, hydrologic, climatic and other catchment behavioural characteristics.	An extensive series of water allocation and institutional structures evolved from a series of experiments. The results were reported in a CRC Technical Report.  Project 3.1 rejected the use of economic optimisation models as they dis-empower industry stakeholders.
<b>Years 3, 4 and 5</b> Develop a series of socioeconomic water allocation models that integrate the climatic and catchment models derived in the other programs and take account of exchange rates and limits or constraints on trading.	Stage 1 was completed for developing a set of economic indicators. Draft report written by ICAM.  Work on methodologies to calculate exchange rates was completed with PhD studies.
Evaluate the water allocation models for methodological soundness and application to the Focus Catchments.	Modules have been developed to evaluate error levels in IQQM and REALM.
Explore land-use practices and possible constraints to and exchange rates for trade in a sample of Focus Catchments.	PhD work on methodologies to calculate exchange rates was completed.
Model the impact of alternative property right regimes and constraints on trade in focus catchments in terms of supply systems, social structures and efficiency of water use.	Evaluation of alternative property right regimes, including property rights for environmental flow traders is under way.
Test the sensitivity of the supply system performance to modelling assumptions and to changes in physical system factors.	Sensitivity analysis of IQQM and REALM to model parameters complete. Report being written.
Develop improved techniques for managing flows in channel systems, and better match water diverted from rivers to predicted extractive user water needs.	Development of environmental flow policy options is under way in Project 3.09(3B). Proof of concept experiments expected to be done as a primer for a full project in the eWater CRC.
Develop methods to improve efficiency in water use decision-making in order to maximise efficiency and minimise seepage and evaporation losses.  <i>Amendment of Milestone approved by Commonwealth, 16 July 2003 with replacement by: Develop method to improve efficiency in water use decision-making in order to maximise efficiency.</i>	All policy options evaluated in the program will use efficiency of water use as one metric of evaluation.
Involve stakeholders in the development of research, evaluation of the models and development of adoption strategies.	Ongoing through stakeholder meetings.

## Program 4 Urban Stormwater Quality

*This Page* Project Leader John Coleman – Project 4.08 (4A)      *Opposite Page* Program group, Program 4, Urban Stormwater Quality



Aim To develop stormwater management solutions for the protection of environmental and community values.

**Program Leader**

Dr Tim Fletcher, Monash University

**Program Output**

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) has been established to translate stormwater research findings into successful industry application. It will be the principal mechanism for the dissemination of this CRC's research into urban stormwater quality.

MUSIC provides a planning framework and software to support regional planning and the design of wetlands and other stormwater systems to remove pollutants from stormwater. If left unchecked, these pollutants would impact on the quality of stormwater entering streams, rivers, beaches and bays.



**Outcomes and benefits**

Urban stormwater is a major contributor to the pollution of rivers and bays; runoff quality and quantity has been responsible for the degradation of most urban streams. Efforts to capture key pollutants to control urban stormwater pollution do not necessarily match the needs of the downstream environment. The evaluation of stormwater-management techniques is therefore an important economic and environmental objective, particularly in sub-tropical and tropical catchments.

This Program is conducting scientific assessments of stormwater treatment systems and ecologically-based drainage systems. Ultimately it will provide cost-effective strategies and a decision support system employing the use of models to assist end-users and stakeholders to improve urban stormwater quality. The innovative tools developed by this Program will facilitate best practice urban stormwater management. On adoption, this will mean cleaner urban streams, beaches, and bays.

**End-users**

There are a number of users and stakeholders including:

- Local government
- Regional urban catchment management authorities
- State planning and environment protection agencies
- Consultants
- Land developers
- Research organisations

**Program highlights 2003-2004**

- The release of MUSIC v2 in December 2003 was very well received with more than 250 new licensed users for version 2 across Australia. MUSIC v2 incorporated substantial improvements to both its algorithms and interface.
- A lifecycle cost module (supported by an Associated/Additional Project) was developed; this has provided the most comprehensive stormwater management lifecycle cost database in Australia. The module is being incorporated in MUSIC v3.
- Program 4's research was significantly supported by additional funding for Associated/Additional Projects; in particular from the Brisbane City Council, Melbourne Water, Victorian EPA and NSW EPA.
- Program 4 collaborated with CRC for Freshwater Ecology to produce valuable models of ecosystem responses to urbanisation.

**Project 4.08 (4A) Development of integrated stormwater models (Second round project)**

**Project Leader** John Coleman, CSIRO Land and Water

**Aim** To refine and extend the development of MUSIC and promote its use throughout industry.

To integrate MUSIC within the Catchment Modelling Toolkit.

**Achievements 2003-2004**

- MUSIC users from within the CRC provided valuable feedback and ideas for enhancements to the software prior to the scheduled release of MUSIC version 2.
- The Project Team released version 2 of MUSIC in December 2003. Enhancements included the provision of a Generic Source node and significant improvements to the rainfall-runoff algorithm and the derivation and presentation of statistical analysis of water quantity and quality time series data.
- The release of version 2 of MUSIC was used to pioneer software distribution through the Catchment Modelling Toolkit website. Over 400 individuals have downloaded the latest release of MUSIC and over 250 licences issued .

# Program 4 Urban Stormwater Quality

*This Page* Dr Tim Fletcher, Program Leader, Urban Stormwater Quality, and Project Leader, Project 4.09 (4B)



**Project 4.09 (4B) Predicting urban stormwater quality, treatment and impacts**  
(Second round project)

**Project Leader** Dr Tim Fletcher,  
Monash University

**Aim** To improve the reliability of MUSIC using superior algorithms and the acquisition of validation data.

**Achievements 2003-2004**

- This Project is tightly linked to Project 4.08 (4A) with the detailed project integration plan of March 2003 being adopted.
- Significant new data were collected on the quality of stormwater, which was supported by an Associated/Additional Project. This data are now being used to develop better prediction of pollutant loads and characteristics.

- Intensive monitoring of stormwater wetlands was undertaken. This is providing important new information on water quality behaviour during both storm events and base flows. The new data will be used to improve calibration of MUSIC.
- Data were collected on bio-retention systems in both Melbourne and Brisbane.
- Models of the relationship between urbanisation (measured by effective impervious area, and the nature of drainage connection) was developed. This was a collaboration with CRC for Freshwater Ecology.



# Milestones Program 4

## Milestones

### Years 1 and 2

Establish collaborative linkages with other research organisations relevant to the objectives of the Program, specifically the CRC for Freshwater Ecology and the CRC for Coastal Zone, Estuary and Waterway Management.

## Progress

Linkages with CRC for Freshwater Ecology established with very strong ongoing research collaboration. Linkage with CRC for Coastal Zone, Estuary and Waterway Management established, with collaboration on ecological responses of urban estuaries to incidences of sewer overflows.

Collate and review information on stormwater treatment/management options and formulate the basic structures of predictive models for a range of stormwater treatment techniques.

Completed. The information was critically reviewed and used to develop the pilot DSS for urban stormwater quality management.

Develop conceptual models of stormwater quality treatment techniques and the framework for their integration into a decision support system.

Completed. MUSIC was released as a pilot version of the DSS in March 2001, for testing by the Brisbane City Council and Melbourne Water. Public release followed in May 2002.

Establish urban stormwater quality monitoring protocols for use in evaluating pilot stormwater quality treatment facilities in the Focus Catchments.

Completed. Urban stormwater quality monitoring protocol developed after a workshop of industry practitioners and researchers, and published in June 2001.

Select suitable sites and establish stormwater quality monitoring systems for stormwater quality treatment facilities in the Focus Catchments.

Completed. Monitoring sites in Melbourne and sites in Brisbane are operational and providing useful data.

Develop technology transfer and adoption strategy.

Completed. The Communication and Adoption strategy for Program 4 uses MUSIC as one of its main vehicles for engaging industry. Other initiatives include targeted demonstration projects, seminar lectures and collaborative projects with industry.

The pilot version of MUSIC was evaluated by the Brisbane City Council and Melbourne Water and given wider release in 2002. Over 650 attended Industry Seminars for the release of MUSIC, and over 120 have attended training courses.

### Years 3, 4 and 5

Determine critical pollutants and required pollution concentrations versus discharge relationships for the sustainability of healthy urban aquatic ecosystems.

*Amendment of Milestone approved by Commonwealth, 16 July 2003 with replacement by:* Develop approaches to predict ecosystem response to catchment-scale indicators of land use

With MUSIC's release, research activities over the next three years will focus on better defining stormwater management targets for improved urban aquatic ecosystem health.

On-track and being pursued as part of Project 4.09 (4B).

Monitor and evaluate the performance of stormwater treatment facilities at pilot catchment sites in the Focus Catchments.

Progress on-track. Stormwater treatment facilities have been designed and constructed by the Brisbane City Council and Melbourne Water, and have subsequently been the subject of field monitoring and evaluation, and field experiments to improve performance prediction.

The monitoring sites are:

- Ruffeys Creek Wetland, Melbourne
  - Lynbrook Estate Paired Catchment monitoring, Melbourne
  - Pinjarra Hills swale, Brisbane
  - Bridgewater Creek Wetland, Brisbane
  - Hoyland Street Bio-retention System, Brisbane
  - An Associated/Additional project involving the construction of bio-retention systems in Nerang by the Gold Coast City Council.
- Other Melbourne and Brisbane sites under development.

Evaluate the life-cycle cost of stormwater treatment systems investigated.

On track. Initial lifecycle cost estimates have been developed and published for a range of stormwater treatment measures, based on a survey of industry practice. An Associated/Additional Project, funded by Victorian EPA, will enhance these estimates to include social costs/benefits, treatment of externalities for incorporation into MUSIC.

Commence the validation and refinement of conceptual models of stormwater quality treatment techniques.

The testing and validation of the MUSIC's algorithms continues as field experiments and monitoring and evaluation of existing stormwater treatment facilities are undertaken. A combination of field experiments and literature survey is being used, and this activity is on target.

Commence technology transfer activities to provide interim guidelines on the selection and design of stormwater quality treatment measures.

Many activities involving industry seminars, technical publications and industry training courses and field trips have been undertaken, including:

- short course on Planning and Design of Stormwater Management Measures, Brisbane
- Industry Seminar on Urban Stormwater Modelling (involving MUSIC), in Canberra, Sydney, Brisbane, Melbourne, Adelaide and Perth
- MUSIC Training conducted in NSW, Qld, Vic.

There has been very strong adoption of Program 4 research outcomes, for example more than 400 licensed MUSIC users to date, including over 250 for version 2.

## Program 5 Climate Variability

*This Page* Assoc Prof Francis Chiew,  
Program Leader, Climate Variability

*Opposite Page* Left Program group,  
Program 5, Climate Variability. Right  
Project Leader Dr Alan Seed – Project  
5.05 (5A)



**Aim** This Program aims to provide the water industry with tools to quantify climate variability, and through the application of climate forecasting, reduce the hydrologic risk associated with a wide range of water-related issues.

### **Program Leader**

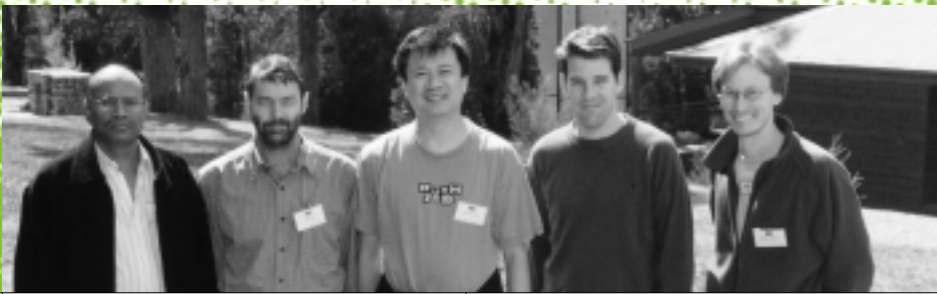
Assoc Prof Francis Chiew,  
The University of Melbourne

### **Program Output**

The considerable variation of rainfall and runoff from year-to-year is part of the natural variability of the climate system. The management of land and water resources involves designing and operating to cope with this variability.

The management challenges in Australia are compounded by Australian streamflow being much more variable than elsewhere in the world.

Program 5 is providing the water industry with models for generating stochastic climate data, and improved models for forecasting rainfall and streamflow for various lead times. These models will be made available via the Catchment Modelling Toolkit.



### Outcomes and Benefits

Program 5 is producing modelling tools that can be used with hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability.

In addition, researchers will improve catchment-scale hydrological modelling and land surface modelling in climate models. The Program will also advance the initialisation of surface variables in numerical weather prediction models, leading to improved weather forecasts.

These outcomes will improve our ability to quantify hydrologic risk associated with climate variability, leading to significant reductions in the economic impact of hydrologic uncertainties.

### End-users

- Land and water agencies
- Water and environmental engineering consultants
- Researchers involved in hydrological modelling, hydroclimatology and hydrometeorology
- Bureau of Meteorology

### Program Highlights 2003-2004

- Program 5 released two model products and one data product through the Catchment Modelling Toolkit:
  - SCL (Stochastic Climate Library) – stochastic models for generating rainfall and climate data;
  - TREND – statistical tests for detecting trend/change and randomness in time series hydrological data; and
  - Spatial vegetation, land-use and soil properties data for Australia.
- The Program team presented three Catchment Modelling School workshops providing training on the models developed in the projects:
  - Stochastic data generation models;
  - Seasonal forecasting models; and
  - Detecting trends/changes in hydrologic data.
- The Murrumbidgee data monitoring program and land surface modelling study in Project 5.05 (5A) are key components of the Murray-Darling Basin Continental Scale Experiment (MDB CSE) in GEWEX (Global Energy and Water Cycle Experiment). There is now more than two years of unique data available to run hydrological models and to test model simulations against runoff and soil moisture.
- Program 5 studies involved significant collaborations with other researchers, in particular Dr Neill Bowler (UK Met Office), Dr Paul Cowpertwaite (Massey University, New Zealand), Prof John Dracup (University of California, Berkeley), Assoc Prof George Kuczera (University of Newcastle), Prof Geoff Pegram (University of Natal, South Africa) and Dr Ashish Sharma (University of New South Wales).

### Project 5.05 (5A) Hydrological Modelling for Weather Forecasting

Project Leader Dr Alan Seed, Bureau of Meteorology

**Aim** To improve catchment-scale hydrological modelling and land surface modelling in numerical weather prediction models and to develop stochastic rainfall nowcasts.

### Achievements 2003-2004

- A modelling toolkit data product is complete for spatial vegetation, land-use and soil properties data for Australia.
- Data sets were compiled for catchment-scale and land surface hydrological modelling for the Murrumbidgee River Basin. The data includes more than two years of climate forcing, soil moisture and temperature, and streamflow data.
- Testing is complete for the VB95 land surface model (used in the Bureau of Meteorology's numerical weather prediction models). Results have been published in the Journal of Hydrometeorology, local conference proceedings, and international GEWEX meetings.
- Development and testing of a non-parametric seasonal forecasting model (NSFM) is complete. Training has been provided on the modelling tool. The tool itself is proposed for release as a product in late 2004.
- Significant advancement has occurred in developing a joint stochastic forecasting engine that gives stochastic rainfall forecasts out to more than six hours. This involved collaboration with researchers from the UK, Canada and USA.

# Program 5 Climate Variability

*ThisPage Left Project Leader Dr Sri Srikanthan – Project 5.06 (5B). Right Visiting researcher Assoc Prof Xiang Zhang, Wuhan University, China with Program Leader Assoc Prof Francis Chiew and researcher Dr Andrew Western*



### Project 5.06 (5B) Stochastic Rainfall Data Generation Models

**Project Leader** Dr Sri Srikanthan, Bureau of Meteorology

**Aim** To continue building and testing a suite of software programs designed to generate stochastic rainfall data at whole-of-catchment scales for input into the CRC's Catchment Modelling Toolkit software products.

#### Achievements 2003-2004

- SCL (Stochastic Climate Library) was released as a Catchment Modelling Toolkit product. SCL has models for generating annual, monthly and daily rainfall and climate data at a site. Other models being developed will be added to later versions of SCL.

- A training workshop on applying SCL was presented at the CRC's Catchment Modelling School.
- A review of stochastic generation of sub-daily rainfall and comparison of two of the more promising sub-daily rainfall models at ten Australian sites is complete. (One of the models is the Disaggregated Rectangular Intensity Pulse (DRIP) model, developed at Newcastle University. The other is the Neyman-Scott Rectangular Pulse (NSRP) model, developed at Massey University, New Zealand.)
- A multi-site two-part model and a random cascade model for generating multi-site/spatial daily rainfall were developed and tested in two focus catchments.
- A comparison is complete for the multi-site two-part model, non-parametric method (developed at the University of New South Wales) and the non-homogeneous hidden Markov model (developed by CSIRO Land and Water).

# Milestones Program 5

<b>Milestones</b> <b>Years 1 and 2</b> Specify through a workshop the boundaries of current data generation algorithms – the climatic and streamflow variables, time steps and spatial scales.	<b>Progress</b> The workshop was held in March 2000 and identified the climatic variables to be generated during the first three years of the Program.
Identify the most appropriate methods to generate stochastically climate and related hydrologic data sequences for any point in Australia. Write and test computer programs to generate climate data. Distribute via targeted workshops to other CRC programs.	The methods were identified via an extensive literature review and tested and compared. For point rainfall, AR(1) and HSM annual models, method of fragments and non-parametric monthly models and TPMb and DMM daily models were recommended for the Catchment Modelling Toolkit. For daily climate, a multivariate model conditioned on the rainfall state was recommended. For multi-site data, the Matalas multi-site annual generator with monthly fragments was recommended. Research on stochastic generation of daily spatial rainfall and sub-daily space-time rainfall is being carried out.
Conduct a stakeholders' workshop to identify key stakeholder interests and involvement in the project. Establish the project as a component of the Global Energy and Water Experiment (GEWEX) CSE by satisfying acceptance criteria.	Several workshops were conducted as part of the Communication and Adoption strategy (Melbourne, March 2000 and July 2001, Brisbane, August 2001 and Tatura, June and December 2001). The Murray-Darling Basin was accepted as a GEWEX CSE basin in March 2002.
Develop a catchment routing scheme to link with the numerical weather prediction (NWP) model output in order to verify gridded model runoff estimates against observations of streamflow at gauging stations. <i>This milestone was deleted from the Commonwealth Agreement Schedule 1 as approved by the Commonwealth on 16 November 2000.</i>	The routing scheme was developed externally from the CRC and a paper about the technique has been published.
Adapt the land surface scheme, currently used in the Bureau's operational forecast model, to improve the NWP capability for the simulation and prediction of the surface water budget on basin and catchment-scales, with a focus on the MDB and Murrumbidgee Catchment.  For climate linked space-time modelling, determine the best way to stratify past climate (eg wet vs dry years) in a way that makes sense from a water management perspective (ie focussing on runoff volumes rather than rainfall).	Testing of the stand-alone land surface scheme in the Bureau of Meteorology's NWP model, using parameters that are dependent on soil and vegetation characteristics, is complete. Monitoring of soil moisture, soil temperature and climate data at 18 sites across the Murrumbidgee commenced in September 2001. The data will be used for more detailed model testing and model improvements.  This research is no longer a priority because approaches for forecasting seasonal rainfall and streamflow have been developed elsewhere in the Program.
Characterise and develop models for spatial and temporal rainfall patterns in terms of their statistical structure for the different climate stratifications identified within a Bayesian or other framework.	MOTIVATE – the space-time rainfall model for homogeneous areas – has been developed and calibrated against radar data from key locations across Australia. The model gives stochastic realisations of design storms.
Examine existing seasonal forecasting techniques suitable for forecasting streamflow for water resources management. <i>(As amended with Commonwealth approval, 16 November 2000)</i>	A non-parametric model has been developed and tested for forecasting exceedance probabilities of rainfall and runoff several months ahead using data from across Australia. The model exploits the relationship between El Niño/Southern Oscillation and rainfall and runoff and the serial correlation in runoff.
<b>Years 3, 4 and 5</b> Review the outputs and outcomes of the stochastic generation software; plan the project expansion to include the development and testing of more accurate algorithms where appropriate.	Project 5.2 has delivered stochastic models of rainfall and climate at a point down to the daily time scale. The models have been incorporated into SCL (Stochastic Climate Library – a CRC Catchment Modelling Toolkit product). A beta version of SCL has been released and presented in a workshop in the CRC's Catchment Modelling School in Feb 2004.
Conduct research as required to develop new stochastic data generation methodologies.	Current research is concentrating on developing multi-site daily rainfall models and sub-daily point rainfall models, as well as improving the models that are currently in SCL.
Test the new climate generation methodologies for areas within the five focussed catchments in addition to regions in Australia that are recognised as having extreme variability.	The models for generating point stochastic climate data have been tested using data from across Australia. The spatial models developed in Project 5.06 (5B) will be tested, where appropriate, on all the focus catchments.
Develop a prototype end-to-end system, incorporating the NWP and hydrological models, to demonstrate an improved predictive capability for catchment management purposes.	Research on hydrological models and NWP models is continuing, using data from the soil moisture monitoring program in the Murrumbidgee River catchment (Projects 5.1 and 5.05 (A)).
Conduct a stakeholder workshop to review progress and outputs and outcomes of the project, with a particular focus on technology transfer to water managers.	Workshops are conducted regularly as part of the Communication and Adoption strategy, to review the projects and to disseminate the models developed. Three workshops were presented on models developed in Program 5 (SCL/MOTIVATE, NSFm and TREND) in the CRC's Catchment Modelling School in February 2004.
Apply, test and refine the space-time climate modelling methodology to one or more of the selected catchments/regions.	The MOTIVATE model (which provides stochastic realisations of space-time rainfall for design storms) and S_PROG model (which nowcasts rainfall up to two hours ahead) have been developed. Current research is concentrating on conditioning the SPROG nowcast on NWP forecast to extend the rainfall forecast lead time to more than six hours.
Package the developed space-time climate model to suit user applications and conduct workshops throughout Australia.	Packaging the models to suit user applications is done on a needs basis. MOTIVATE has been used by Melbourne Water and Sydney Water to obtain stochastic realisations of 1 in 5 year design storms and used as inputs into their models to assess their sewerage network design. The Australian Bureau of Meteorology is developing systems to use S_PROG to generate rainfall nowcasts at each of the 50 radars in the Australian radar network.

## Program 6 River Restoration

*This Page* Left Dr Mike Stewardson, Program Leader, River Restoration, and Project Leader, Projects 6.7, 6.12 (6B). Right Program group, Program 6, River Restoration

*Opposite Page* Left Project Leader Dr Tony Ladson – Project 6.2. Centre Project Leader Assoc Prof Ian Rutherford – Project 6.3. Right Project Leader Prof Stuart Bunn – Project 6.4



Aim River restoration (a term used synonymously with rehabilitation) aims to return natural, environmental values to streams.

This Program's research seeks to provide river managers with a better understanding of river and stream processes.

It also aims to provide them with tools that will lead to more effective expenditure on restoration, and ultimately, healthier streams.

### Program Leader

Dr Michael Stewardson,  
The University of Melbourne

### Program Output

Program 6 is assisting river managers by producing models that predict catchment-scale responses to changes in, and restoration of, river networks within entire catchments.

The River Analysis Package (RAP) software developed by the Program comprises a series of modules used for analysing channel cross-section hydraulics, habitat-discharge relations, streamflow data and streamflow statistics.

The RAP research and development team plans to develop RAP into a key tool for the integration of river science into river restoration and environmental flow planning in Australia.

### Outcomes and benefits

This CRC brings strength to river restoration in disciplines relating to the physical processes of hydrology, hydraulics and geomorphology. Program 6 is devising techniques to better manage stream sediment.



Program 6 is also determining best practice guidelines for land and water managers to adopt in order to maximise environmental benefits of environmental flows.

Assessing the secondary consequences of restoration works on streams is also an important part of this program. By adopting the assessment outcomes, river managers can improve planning, design and implementation of key rehabilitation activities.

**End-users**

- Stream managers
- Catchment management agencies
- Technical staff
- Consultants

**Program highlights 2003-2004**

- In conjunction with the CRC for Freshwater Ecology, the Program 6 team completed development of the River Analysis Package (RAP) as a Catchment Modelling Toolkit product.
- River restoration software (CHUTE, and RAP) was added to, the Catchment Modelling Toolkit with supporting documentation, while software models RIPRAP and MELS were prepared for later inclusion in the Toolkit website.
- RAP continues to provide a tool for communication between technical teams and stakeholders and is being delivered to stakeholders via workshops being run at various locations across the country.
- The Program 6 team has collated a substantial database of channel surveys from across Victoria and derived catchment characteristics for these survey sites from available GIS and other regional data sets.

**Project Group A Stream Restoration – Procedures and Evaluation**

**Project 6.2** Optimising urban stream rehabilitation planning and execution

**Project Leader** Dr Tony Ladson, Monash University

**Aim** To identify constraints to urban stream restoration and to model the effectiveness and feasibility of a stream rehabilitation planning procedure.

**Achievements 2003-2004**

- In association with the CRC for Freshwater Ecology, monitoring of macro-invertebrates upstream and downstream of wetlands is complete. A report has been prepared.
- Water quality monitoring at wetlands is ongoing. An initial report has been prepared.
- A framework for a large-scale experiment on urban stream restoration has been prepared and documented.
- The final project report is complete.

**Project 6.3** Restoration ecology in the Granite Creeks, Victoria

**Project Leader** Assoc Prof Ian Rutherford, The University of Melbourne

**Aim** To implement a rigorously planned, documented and evaluated stream restoration project designed to measure the hydraulic, geomorphic and biological response of streams to timber debris.

**Achievements 2003-2004**

- Six full repeat surveys have been conducted for all 40 in-stream structures installed by the Goulburn-Broken Catchment Management Authority for this project. Continuous monitoring is in place.
- The final report was completed.
- Two conference papers were written.

**Project 6.4** Evaluation of riparian revegetation in a south-east Queensland catchment

**Project Leader** Prof Stuart Bunn, Griffith University

**Aim** To evaluate a whole-of-catchment riparian rehabilitation project at the Echidna Creek catchment, north of Brisbane, Queensland

**Achievements 2003-2004**

- Three years of half-hourly suspended sediment, temperature and discharge sampling and associated data analysis was completed in 2004
- Reporting on the success of revegetation in controlling sediment delivery to streams
- Reporting on the role of revegetation in controlling water temperature
- Development of a series of statistical models for predicting the distribution and abundance of aquatic macrophytes (particularly in response to increased shade from revegetation)

# Program 6 River Restoration

*This Page Left Project Leader Assoc Prof Bob Keller – Projects 6.5, 6.6. Right Project Leader Dr Nick Marsh – Project 6.11 (6A)*



## Project Group B Tools for Stream Restoration

### Project 6.5 Hydraulics and performance of fishways in Australian streams

Project Leader Assoc Prof Robert Keller, Monash University

Aim Concentrating on vertical slot fishways in the River Murray, this Project will:

- Detail hydraulics in existing fishways.
- Investigate conditions that attract native fish to fishway entrances.
- Explore the burst and sustained swimming ability of native and exotic fish.
- Examine the response of fish to local turbulence within fishways.

#### Achievements 2003-2004

- Manual of Best Practice on Fishway Design is being finalised for release in 2004-2005.

### Project 6.6 Developing tools to predict scour of rehabilitation works

Project Leader Assoc Prof Robert Keller, Monash University

Aim To develop tools to predict the probability of various objects surviving in a streambed and strategies to better manage woody debris, snags and other beneficial objects in streams.

#### Achievements 2003-2004

- The Windows-based computer program CHUTE has been developed for the hydraulic design of rock chute bed protection and incorporated into the Catchment Modelling Toolkit. Design guidelines are also complete.
- RIPRAP software is complete and was included in the Catchment Modelling School, February 2004.
- A paper was presented at the Hydrology and Water Resources Symposium, November 2003.
- The final project report was completed.

### Project 6.7 Developing an environmental flow methodology: a trial on the Campaspe River

Project Leader Dr Michael Stewardson, The University of Melbourne

Aim To develop a generic environmental flow methodology that integrates hydrology, geomorphology and ecology.

#### Achievements 2003-2004

- The Flow Events Method (FEM) has been developed and documented. The technique has been applied in several Victorian river studies for determining environmental flows.
- Stream surveys for environmental flow studies have been examined and results are discussed in a technical report (in press).

### Project 6.11 (6A) Development of flow-ecological response models

Project Leader Dr Nick Marsh, Griffith University

Aim To develop software for the Catchment Modelling Toolkit that will allow water managers to quantify the ecological impacts of alternative flow regimes.

#### Achievements 2003-2004

- Delivery of the River Analysis Package (RAP) v1.0.2 computer software, as a Catchment Modelling Toolkit product.
- Delivery of the Hydraulic Analysis module in RAP v1.0.2 for quantifying hydraulic habitat relationships to discharge.
- Delivery of the Time Series Analysis module in RAP v1.0.2 for analysing time series discharge and hydraulic habitat related to environmental flow allocation scenarios.
- Development of a draft modelling structure for predicting ecological response to flow change.
- Training was provided at the 28th International Hydrology and Water Resources Symposium, Wollongong, NSW (November 2003); the Catchment Modelling School (February 2004); and in Perth (May 2004).

### Project 6.12 (6B) Predicting spatial and temporal variations in channel form

Project Leader Dr Michael Stewardson, The University of Melbourne

Aim To develop a channel metrics model for incorporation in the Catchment Modelling Toolkit and for use in large-scale modelling studies. The model will relate changes in river flow to changes in channel geometry and aquatic behaviour.

#### Achievements 2003-2004

- Data for over 80 river channel surveys in Victorian rivers has been collated.
- One-dimensional hydraulic models have been developed for every survey.
- Channel metrics have been calculated for every survey.
- A field program has been completed at the 80 survey sites to characterise bed and bank material, channel morphology and vegetation structure.
- GIS and other regional datasets have been used to calculate hydrometric parameters for all survey sites.
- A preliminary model linking catchment characteristics and channel form has been developed.
- An improved sand-slug model has been developed and is ready for incorporation in SedNet.
- Historical river plans for 28 river reaches have been geo-referenced and digitised in preparation for evaluating historical channel changes and bank erosion rates at the sites.



# Milestones Program 6

<b>Milestones</b> <b>Years 1 and 2</b> Formalise links with partner CRCs in joint projects.	<b>Progress</b> Complete.
Complete evaluation of existing rehabilitation projects in Australia.	<i>Milestone deleted as approved by Commonwealth, 16 November 2000.</i>
Select catchments and sites for trial rehabilitation.	Complete.
Trial stream rehabilitation planning procedure at target sites.	Rehabilitation planning for all relevant projects is complete.
Select models for assessing stream rehabilitation plans in target catchments.  <i>Milestone amended as approved by Commonwealth, 16 November 2000 and replaced by:</i>  Develop improved criteria for rehabilitation planning.	Recommendations for planning evaluation are complete.  Procedure for planning environmental flow regimes is nearing completion.  Flow Events Method for developing environmental flow regimes is complete and has been adopted in Victoria.  Revised CHUTE model for designing rock chutes is complete.  'Guidelines for fishway design' is close to completion.  Improved procedure for scour prediction for rehabilitation planning is under development.
Develop and calibrate hydraulic and hydrological models of rehabilitation sites and assess viability of projects.	<i>Milestone deleted as approved by Commonwealth, 16 November 2000.</i>
Begin construction of works if appropriate.	Complete.
Design associated rehabilitation experiments.	Complete.
Develop a 'stream rehabilitation' training program.	Proceedings published for Environmental Flows seminar and Fishways workshop.  Three workshops have been run in 2003-2004 to provide training in Environmental Flow Analysis and the use of RAP (Wollongong, Melbourne and Perth).  Planning in place for other adoption and training activities.
<b>Years 3, 4 and 5</b> Complete all rehabilitation construction work.	Complete.
Deliver stream rehabilitation training program to target managers in eastern states.  <i>Milestone amended as approved by Commonwealth, 16 July 2003 and replaced by:</i>  Deliver an environmental flow assessment method for natural resources managers.	Flow Events Method (FEM) has been developed and documented in Project 6.7.  Supporting software is complete and available from toolkit website (RAP).  Seminars on FEM given in Victoria, NSW and WA.  Training has been provided at the Hydrology and Water Resources Symposium, Wollongong (November 2003); the Catchment Modelling School (February 2004); and in Perth (May 2004).
Update rehabilitation planning procedures.	Yet to commence.
Complete first round of geomorphic recovery projects  <i>Milestone amended as approved by Commonwealth, 16 November 2000, and replaced by:</i>  Complete development of design models for rehabilitation tools.	RAP, RIP RAP, CHUTE and MELS software all complete.
Complete first round of rehabilitation experiments.	First round experiments have yielded strong results.
Incorporate modelling tools into the toolkit of Program 1: Predicting Catchment Behaviour.	RAP and CHUTE have been included on Catchment Modelling Toolkit website.

## Program 7 Communication and Adoption

*This Page* David Perry, Program Leader, Communication and Adoption

*Opposite Page* Program group, Program 7, Communication and Adoption



Aim To provide leadership and support to the CRC's research programs and projects in planning and implementing industry targeted activities to achieve the highest possible level of adoption of the CRC's research outcomes.

### **Program Leader**

David Perry, Monash University

### **Program Output**

Application of a series of integrated communication and adoption tools and techniques to facilitate the application of research outcomes by end-users.

The Catchment Modelling Toolkit is the key adoption vehicle, and it is ultimately the means by which this CRC will achieve its mission. The Toolkit must deliver knowledge and products of substantial value to meet the needs of the land and water management industry.

### **Outcomes and benefits**

The core business of this CRC is world-class research in land and water issues. A challenge for the CRC is to integrate the various multi-disciplinary threads of its research programs and to achieve a holistic view of catchments.

Through employment of an effective and integrated communication and adoption strategy, the CRC for Catchment Hydrology's research outcomes will improve the understanding and management of Australia's land and water resources.



### Development Projects in Focus Catchments

To demonstrate its commitment to this end, research is targeted on five Development Projects in the CRC's Focus Catchments.

The intent of these projects is to:

- Build the capacity within Industry Parties to apply the CRC's modelling tools;
- Demonstrate the utility of the tools by applying them to a range of problems at whole-of-catchment-scale; and
- Provide researchers with feedback from end-users on the suitability of the models for operational use.

All six research programs target their effort on at least two of the five Focus Catchments. In particular, Program 1 (Predicting Catchment Behaviour) is highly relevant to all five sites.

### Stakeholder and end-user involvement

The Development Projects in the Focus Catchments are vital in driving and supporting the adoption of research outcomes as they provide a means by which modelling products can be tested and applied in the field.

Ultimately the end-users of this CRC's research and modelling tools will include:

- Land and water managers;
- Researchers;
- Government departments;
- Local governments;
- Weather forecasting agencies; and
- Catchment managers.

### Program highlights 2003-2004

- The Catchment Modelling School, held during February 2004, attracted more than 300 participants filling over 500 workshop places. (The School is reported in further detail later in this section).
- The first stage of the development of the Catchment Modelling Toolkit website was completed with seven products now available for downloading by registered Toolkit users. A robust process to guide software development and delivery has been established.
- Program teams have demonstrated excellent commitment to deliver modelling products of a very high professional standard to meet the needs of users.
- The five CRC Development Projects are now well underway and are successfully giving resource managers and Industry Parties the opportunity to apply and test the CRC's modelling tools in real-life situations. Good advances have been made in preparing and applying the whole-of-catchment models in each Focus Catchment.
- There were two special editions this year of *Catchword*, the CRC's monthly newsletter. The February 2004 edition featured a summary of research outcomes for industry for all research programs, and the April 2004 edition featured an update of the impressive work being undertaken in each of the five Development Projects. Both of these editions are available at [www.catchment.crc.org.au/catchword](http://www.catchment.crc.org.au/catchword).

### Selection of Focus Catchments

The five Focus Catchments were selected to:

- Cover a spectrum of spatial scales and catchment characteristics;
- Span the range of issue-based problems confronting catchment managers;
- Build upon existing catchment management initiatives at those sites;
- Link to research networks outside the bounds of the CRC; and
- Satisfy the specific interests of each of the participating industry parties.

Each Focus Catchment or site is managed by a Focus Catchment Coordinator who is selected from relevant Industry Parties. Their task is to:

- Work with the Communication and Adoption Program and regional groups to ensure two-way information flow;
- Assist in the definition of research problems and desired research outcomes;
- Facilitate access to data and field sites managed by the Industry Parties;
- Work with the Program Leaders to ensure integration of our research themes; and
- Lead or assist with the Development Project in the Focus Catchment.

## Program 7 Communication and Adoption

*This Page* Left Chris Carroll, Focus Catchment Coordinator, Fitzroy River . Right Pat Feehan, Focus Catchment Coordinator, Goulburn/Broken Rivers, Development Project Leader, Project 7.11 (7A)

*Opposite Page* Left Carolyn Young, Focus Catchment Coordinator, Murrumbidgee River, Development Project Leader, Project 7.12 (7B). Centre Graham Rooney, Focus Catchment Coordinator, Yarra River, Development Project Leader, Project 7.13 (7C). Right Tony Weber, Focus Catchment Coordinator, Brisbane River, Development Project Leader, Project 7.15 (7E)



- The five Focus Catchments are:
- Brisbane River, Queensland
  - Fitzroy River, Queensland
  - Goulburn–Broken Rivers, Victoria
  - Murrumbidgee River, NSW
  - Yarra River, Victoria

### Brisbane River, Queensland

The Brisbane River Catchment is one of several in South-East Queensland with waterways that discharge into Moreton Bay, a sensitive receiving environment that supports a large commercial and recreational fishery, tourism and large dugong colony. These catchments and waterways provide a variety of valuable services including irrigation water, drinking quality water, recreational opportunities, flood conveyance and ecosystem functions.

*"The Brisbane River Focus Catchment Development Project has proved that the CRC's modelling tools can be used in supporting catchment decisions with this region. The project has really benefited from a high degree of cooperation between researchers, Industry Parties, and the relevant stakeholders. Adoption of research within the Brisbane Focus Catchment has led to actual application in real-world situations."*

Tony Weber, Focus Catchment Coordinator

### Fitzroy River, Queensland

The Fitzroy basin covers area 142,000 km<sup>2</sup> and is the largest river system draining to the east coast of Australia. The community-based natural resource management group in the basin is the Fitzroy Basin Association (FBA) which has recently produced a Natural Resource Management Plan in partnership with indigenous, industry, agency, and community groups. The plan outlines aspirational, condition and management action targets for salinity and water quality in the basin. The Fitzroy has been at the forefront of Council of Australian Governments (COAG) water reform with the first Water Resource Plan (WRP) and Resource Operation Plan in Queensland produced for the basin.

*"The partnership with the CRC and the leadership in natural resource management has laid a foundation for improved land and water management practices in the Fitzroy, informing and influencing regional policy, and facilitating integrated catchment management."*

Chris Carroll, Fitzroy Catchment Coordinator

### Goulburn-Broken Rivers, Victoria

The Goulburn-Broken Catchment is the 'food-bowl' of Victoria, responsible for about \$1.5 billion worth of food production each year. Salinity and nutrient management are key issues here, as are afforestation and water allocation under the tradeable water-rights system. System yield is affected by land use, losses from channels, and operation for irrigation supply.

*"We're now starting to see the outcomes of the work of the CRC. Even better, we're now seeing the CRC's modelling tools applied in catchment contexts, via Development Projects. People are now realising how they can use these tools to assist land and water management decision-making processes in catchments across our region."*

*Having regional staff collaborate with researchers in delivering the Development Project in the catchment has been great."*

Pat Feehan, Focus Catchment Coordinator

### Murrumbidgee River, NSW

The major natural resource management issues in the Murrumbidgee Catchment, as identified by the Murrumbidgee community, are water quality and flow, dryland salinity, soil health, biodiversity and better engagement of the community in natural resource management. The research being done by the CRC is particularly pertinent to the water quality, flow and salinity issues. The CRC's Murrumbidgee Development Project, which commenced in January 2003, is training staff from the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR), in how to use the sediment and nutrient models that the CRC has made available through its modelling toolkit.

DIPNR staff will be able to use these models to help make informed decisions on how best to improve the water quality of the Murrumbidgee catchment streams and elsewhere in NSW.

*"The Development Project concept is proving to be a winning formula for training and engaging CRC industry participants in the CRC research and encouraging the adoption of CRC products."*

Carolyn Young, Focus Catchment Coordinator

### Yarra River, Victoria

There are many rural reaches and tributaries in the Yarra River system but the lower reaches are virtually all urbanised. The suburbs of Melbourne and the satellite towns make up an area of about 1,500 km<sup>2</sup>. It is this strong urban influence that led to the Yarra River system being chosen as a focus catchment.

The impact of urban stormwater quality on the Yarra River and Port Phillip Bay is the key concern for this focus catchment. The Yarra Development Project is about adapting the Environmental Management Support System (EMSS) for the Yarra River and its catchment. A model for the Yarra, YarraSim, has been developed.

*"A range of stakeholders has now seen YarraSim and there appears to be increased interest and adoption of the specific model and for the type of tools emerging from the CRC. With time, that interest should evolve into ownership and the generation of a family of applications."*

Graham Rooney, Focus Catchment Coordinator



**A summary of each Focus Catchment Development Project and highlights for 2003-2004 follows:**

**Project 7.11 (7A)** Development Project for the Goulburn-Broken Focus Catchment – Modelling and managing land-use impacts in and around water storages in Northern Victoria

Project Leader Pat Feehan,  
Goulburn-Murray Water

**Aim** To utilise and further develop the CRC for Catchment Hydrology’s capabilities in predicting land-use impacts on pollutant delivery and transport, and water yield in the Goulburn-Broken catchment.

To aid development of cost-effective, targeted management strategies and guidelines aimed at improving catchment and storage water quality and protect water yield.

**Achievements 2003-2004**

- The CRC’s modelling tools are being used in two case study catchments: the upper-mid Goulburn catchment which includes the Eildon and Goulburn weirs (covering 10,700 km<sup>2</sup>) and the Tullaroop Reservoir in the Loddon River Catchment (730 km<sup>2</sup>). Environmental Management Support System (EMSS) models are underway for these two catchments.
- Establishing the Stakeholder Reference Group has led to a new cohort of Development Project and CRC supporters and a lot of Melbourne-based agencies are having a close look at the CRC’s models and how they might be applied in a statewide context.
- Reservoir simulation models are being developed with the help of the Centre for Water Research at the University of Western Australia to enable the modelling of the movement of pollutants within storages.

**Project 7.12 (7B)** Development Project for the Murrumbidgee Focus Catchment – Modelling sediments and nutrients in the Murrumbidgee Catchment to inform investment

Project Leader Carolyn Young, Department of Infrastructure, Planning and Natural Resources, NSW.

**Aim** To operationalise within the Department of Infrastructure, Planning and Natural Resources (DIPNR), two of the CRC’s modelling tools, EMSS and SedNet, so that the Department can improve estimates of pollutant sources and transport and to target management strategies in order to improve water quality. By the end of the project, DIPNR will have EMSS and SedNet models of the Murrumbidgee valley and the capability to build these models in other catchments across NSW.

**Achievements 2003-2004**

- The Murrumbidgee Development Project started working with the EMSS first and has built two EMSS models at a 250 m resolution; one representing the middle catchments and the other the upper catchments of the Murrumbidgee River. The total area being modelled by both models is approximately 27,000 km<sup>2</sup>.
- The project steering committee was established in June 2003 and has met twice since then. The committee consists of an independent scientist, a representative of the Murrumbidgee Catchment Management Authority, a DIPNR regional representative, and a CRC representative external to the project team.
- The SedNet model for the Toolkit was started in February 2004, following the CRC’s SedNet workshop at the Catchment Modelling School 04. An initial set of coarse data has been prepared and one SedNet model has been refined. The project will build a model using 25 m resolution data so that a better understanding of the sediment and nutrient budgets in a catchment of 2000 km<sup>2</sup> can be achieved.

**Project 7.13 (7C)** Development Project for the Yarra Focus Catchment – Modelling river water quality in the Yarra catchment

Project Leader Graham Rooney,  
Melbourne Water

**Aim** To enable the prediction of water quality in the Yarra River at Yering Gorge by adapting the Environmental Management Support System (EMSS) for the river and its catchment. Water is pumped out of the river at the Yering Gorge, which is a natural choke site and transferred to Sugarloaf Reservoir, where it is stored, treated and distributed to augment Melbourne’s drinking water supply.

**Achievements 2003-2004**

- The Yarra Catchment Development Project started later than the other projects, but by mid-2003 a full-time staff member had been employed and the project is now well underway.
- At the CRC’s Annual Workshop in March 2004, a special workshop was held with key CRC staff to build the first EMSS model. The YarraSim model that was built seems to simulate well the Yarra River and catchment.
- The Steering Committee met twice during the year. The YarraSim model was presented at the May 2004 meeting, where it was well received.
- The YarraSim model has now been presented to a range of key stakeholders. This has generated genuine interest, showing promise for future uptake and increased ownership of the project and its outcomes.

## Program 7 Communication and Adoption



*This Page* Bruce Cowie, Development Project Leader, Project 7.16 (7F)

*Opposite Page* Catchment Modelling Toolkit team meeting, (l to r) Prof Rodger Grayson, Joel Rahman, Geoff Podger, Jake MacMullin, Nick Murray, Dr Robert Argent

### Project 7.15 (7E) Development Project for the Brisbane River Catchment – Enhancing stakeholder capacity in prioritising water quality management actions in South-East Queensland

**Project Leader** Tony Weber, WBM Oceanics – Consultant to Brisbane City Council

**Aim** To promote awareness of existing CRC models within the region by building the technical capacity of land and water agencies to use, modify and interpret these models.

To use the models in regional water quality planning, in the Northern, Western and Lower Brisbane catchments.

#### Achievements 2003-2004

- The Environmental Management Support System (EMSS) models have now been developed for the South-East Queensland region. Of particular interest, an EMSS model of the Maroochy River has been built with the input of the Maroochy Modelling Group, consisting of local government, community and state agency representatives. This has led to the EMSS being used to investigate sustainable loads into the Maroochy River, supporting significant decisions for point and non-point pollutant management.
- Training and building capacity has been a focus for this Development Project. Members of the Maroochy Modelling Group have been trained and can now use the EMSS for the region. This project has shown how capacity can be developed amongst a team of catchment stakeholders and used to influence high level decision-making. It is an excellent example of true adoption.
- To raise the level of awareness of the project, a number of presentations and training sessions have been conducted, in particular with local government. The Gold Coast City Council is now using EMSS to support catchment planning for several local waterways and the Brisbane City Council is using it for both

whole-of-region strategy water management and to support local creek rehabilitation planning.

The Toowoomba City Council is also developing an EMSS for focus on managing its water supply catchments.

- The rate of adoption is gaining momentum as a critical mass of users is developed in the South East Queensland region.

### Project 7.16 (7F) Development Project for the Fitzroy Focus Catchment – Modelling river water quality in the Fitzroy Catchment in partnership with regional strategy groups

**Project Leader** Bruce Cowie, Natural Resources and Mines, Queensland

**Aim** To apply the CRC's water quality models to the Fitzroy Catchment and smaller sub-catchments within it.

#### Achievements 2003-2004

- EMSS models have been built for three sub-catchments of the Fitzroy (Dawson 51,000 km<sup>2</sup>, Nogoia 28,000 km<sup>2</sup> and Comet 17,000 km<sup>2</sup>) and the Fitzroy catchment (141,000 km<sup>2</sup>) as a whole.
- Technical expertise in building and running the EMSS model is now strong after several training workshops. Development Project team members have attended several two and three-day training sessions to build modelling skills. Members also received SedNet training at the Catchment Modelling School 04. The email discussion group is active and enhances learning and problem solving.
- Regional and community capacity building has progressed well through the involvement of the project steering committee. The committee, which is led by the Fitzroy Basin Association (FBA), has representation from the Department of Primary Industries, EPA Qld, and Natural Resources and Mines and sub-catchment groups.
- Groups outside the Development Project are becoming interested in using model predictions and some plan to develop their own modelling capacity.

### Other features of the Communication and Adoption Program

#### Catchment Modelling Toolkit

The CRC's key focus is the development and delivery of the Catchment Modelling Toolkit. All Research Programs have now built specific modelling software for the toolkit and representatives from Industry Parties have been closely involved in the design and evaluation of each software program. There are now nearly 1600 registered users of the Toolkit.

The Toolkit website was launched in mid 2003 and seven modelling programs are currently available on the website: CHUTE, MUSIC, RAP, RRL, SedNet, TREND, and SCL.

Toolkit products are downloadable from the Catchment Modelling Toolkit website at low or no cost.

#### CHUTE is helping to stabilise rivers and stream beds

CHUTE, which was released as a model available on the Catchment Management Toolkit during 2003-2004, is a hydraulic design program for the design of rock chute structures used for stabilising river and stream beds. It is designed for use by engineers in Catchment Management Authorities, local government and consulting firms involved in river and stream rehabilitation and restoration studies.

With its user-friendly interface and supporting documentation, CHUTE is very easy to use. It is an updated, WINDOWS-based, user-friendly version of an earlier DOS-based program of the same name. Many rock chutes have already been designed at locations including the Cann and Mitchell Rivers in Victoria.

A major advantage of the new software is that it identifies the critical flow rate, with respect to the chute design, which is often substantially lower than the maximum design flow rate. The program calculates the required stone size throughout the prescribed flow range and

provides detailed design information at the identified critical flow. The user can select a downstream boundary condition from a range of options.

#### **MUSIC becomes the basis for designing stormwater management systems**

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) has revolutionised access to expertise and technology in the stormwater industry and has been rapidly adopted throughout the industry.

It brings together leading-edge stormwater management technology and the best available data in a user friendly and professionally designed analysis tool. Version 2 was released in December 2003.

By the end of June 2004, over 250 licences for Version 2 had been issued throughout Australia and overseas. Current applications of MUSIC include: Melbourne Water is using it to plan future and assess land development proposals, and to design stormwater treatment strategies for new and existing drainage scheme; Brisbane City Council uses it for urban catchment planning, and to design new stormwater treatment measures in Brisbane; and many engineering consultants have used it to design urban development proposal to meet Water Sensitive Urban Design standards.

Two workshops on MUSIC were held at the Catchment Modelling School 04; 51 attended.

#### **RAP contributing to planning environmental flows in rivers**

The River Analysis Package (RAP) was released as a software product in the Catchment Modelling Toolkit this year. It is already proving to be of great assistance to river and water resource managers undertaking condition assessments, environmental flow planning, and river restoration design.

RAP has an intuitive user interface that assists users to explore cross-section and streamflow data. Extensive background material is being developed and will be provided in RAP's HELP system. In this way RAP is not just a tool for experienced users but a potential learning tool as well.

RAP currently has two linked modules: the hydraulic analysis module, which provides tools for examining hydraulic characteristics of river channels; and the time series analysis module which has been designed to calculate summary metrics of daily discharge data.

#### **RRL simulates runoff**

The Rainfall Runoff Library (RRL) is designed to simulate catchment runoff by using daily rainfall and evapotranspiration data. The models are typically used to fill gaps and extend streamflow records. It is designed for hydrologists needing to simulate streamflows and for students wanting to learn about rainfall runoff models.

The RRL software and supporting documentation enable users to easily calibrate rainfall runoff models of catchments. The RRL does not have any specific example applications, however the models contained with the RRL have been applied to many catchments. The examples provided with the RRL have been compared to results from the original models to ensure that the RRL is accurately reproducing answers.

Features of the RRL include: easy evaluation of different model types, suitability for numerous time-series input formats, display of wettest and driest years, provision for calibration and validation periods, and it also allows automatic setting of warm up periods



#### **SedNet helps to target needed actions**

The fifth product made available on the Catchment Modelling Toolkit in 2003-2004 was SedNet, which constructs sediment budgets for river networks to identify patterns in the material fluxes. This can assist effective targeting of catchment and river management actions to improve water quality and riverine habitat.

A sediment budget is an account of the major sources, stores and fluxes of material. SedNet defines a stream network as a series of links extending between stream junctions. Sediment budgets are computed for each link. SedNet uses spatial modelling to combine measurements of river discharge, a basic understanding of material transport processes, and geographical mapping of soils, vegetation cover, geology, terrain and climate.

SedNet is a regional-scale planning and priority setting technique. It may assist identification of regional patterns in erosion rates, sediment and nutrient fluxes, and the causes of water quality problems.

SedNet can also help to identify erosion hotspots and the major processes involved in the delivery of sediment to rivers within a catchment – this all aids in determining the types of actions likely to be most effective.

#### **TREND assists in testing for changes in our natural resources**

TREND is designed to facilitate statistical testing for trend, change and randomness in hydrological and other time series data. TREND has 12 statistical tests, based on the WMO/UNESCO Expert Workshop on Trend/Change Detection and on the CRC's Hydrological Recipes.

TREND can be used to test for changes in hydrological data caused by climate change, land use change, change in management practices, etc. The software is designed for hydrologists, environmental scientists, consultants and researchers.

## Program 7 Communication and Adoption

*This Page Susan Daly, Website and Graphic Designer*



### Stochastic Climate Library (SCL) quantifies uncertainty

The Stochastic Climate Library (SCL) is a library of stochastic models for generating climate data. This version of SCL has stochastic models for generating rainfall and climate data at a site at annual, monthly and daily time steps.

Stochastic climate data can be used as inputs into hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability. Whereas using historical climate data as inputs into hydrological models provides results that are based on only one realisation of the past climate, stochastic climate data such as SCL provide alternative realisations that are equally likely to occur.

The stochastic climate data used in SCL are random numbers that are modified so that they have the same characteristics (in terms of mean, variance, skew, long-term persistency, etc...) as the historical data from which they are based. Each stochastic replicate (sequence) is different and has different characteristics compared to the historical data, but the average of each characteristic from all stochastic replicates is the same as the historical data.

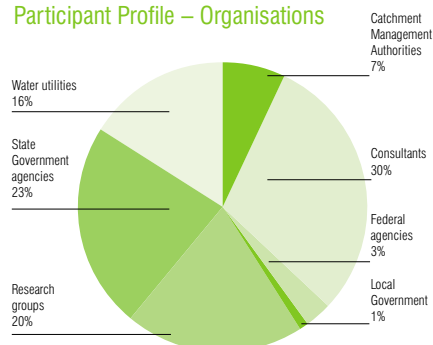
### Catchment Modelling School 04

The CRC ran a highly successful Catchment Modelling School in Melbourne from 9-20 February 2004. Held at The University of Melbourne, the School was a key communication and adoption pathway to realising the CRC's vision.

Over the two weeks of the School, workshops were held on 29 separate topics with a number repeated, and there were 317 registrants. A wide user group was represented: 23 per cent were from State government agencies, 20 per cent from research groups, 16 per cent from water utilities, 7 per cent were from catchment management authorities and 30 per cent were consultants (the remainder were from federal government agencies and local government). Half of the participants were from Victoria, 18 per cent from NSW, 11 per cent from Queensland and 6 per cent were overseas visitors.

Management targeted seminars were held in conjunction with the Catchment Modelling School. External presenters delivered eight seminars on related catchment management topics. Feedback from participants was very positive and there is no doubt that the Catchment Modelling School met its objectives of raising awareness of Catchment Modelling Toolkit products, providing user training, and giving participants wider knowledge and skills.

### Participant Profile – Organisations



### Effective communication

The CRC continued to work towards integrated and effective communication and to promote and encourage acceptance and adoption of research outcomes by end-users. Below is a brief description of the key means that the CRC uses to inform, educate and train current and potential users of CRC tools and products.

#### 1. Catchword

The CRC published 11 issues of its monthly newsletter *Catchword* in 2003-2004. *Catchword* provides regular updates on CRC research and support programs with details on forthcoming workshops and seminars, and information on new publications produced by the Centre.

It continues to be a very effective way for stakeholders and other interested parties to keep in touch with the CRC's progress. Demand remains high with more than 890 people receiving a free printed copy of *Catchword* in the mail and over 600 people receiving it by email.

This year two special editions were produced, each tailored to industry. The February 2004 edition featured a summary of research outcomes for industry for all research programs, and the April 2004 edition featured an update of the impressive work being undertaken in each of the five Development Projects.

#### 2. Websites

This year the CRC's website underwent a significant change, both visually and structurally, to enhance the experience for users and to allow them to get more readily the information they need. A new user interface is the vital element in the re-design. The feedback on the re-design has been very positive.



### 3. Industry seminars, workshops and conferences

Seminars and workshops are an important part of the CRC's communication and adoption strategy. In addition to the Catchment Modelling School 04 which included workshops on 29 separate topics (some repeated) and eight seminars, this year there were 12 other CRC seminars held with nearly 400 participants and 238 people attended nine other CRC workshops.

### 4. Articles, conference papers, presentations

CRC researchers prepared a number of technical reports, presentations and articles during the year. Details of presentations are listed under the Public Presentations, Public Relations and Communication chapter in this annual report and Publications are also listed in a separate chapter.

### 5. Publications and videos

The demand for the CRC technical and industry reports continues to grow. The CRC now has a comprehensive publications list that is regularly accessed via the CRC website at: [www.catchment.crc.org.au/publications](http://www.catchment.crc.org.au/publications).

The CRC sold 320 reports during 2003-04, 7 videos in total and 319 CRC licensed software products. Tracking figures show that CRC software is regularly downloaded from the Toolkit website. Fifteen Technical Reports were produced throughout the year. With increasing use of the CRC website and changes in communication technology, the demand for CRC videos is no longer high. No further video records of CRC workshops are planned.

### 6. Advocacy

The CRC contributed significantly throughout the year to the nationwide debate on water management and associated issues. The CRC is an important position to provide some answers to the public debate and science behind Australia's landscape renewal process.

CRC advocacy in 2003-2004 included:

- Prof Rodger Grayson joined the Board of the East Gippsland Catchment Management Authority.
- Dr Tim Fletcher and Dr Ana Deletic were invited to join Urban Water Data Management Core Group that is part of UNESCO's International Hydrological Programme VI project.
- Dr Mike Stewardson is a member of the Technical Audit Panel that advises the Victorian Minister for the Environment on Streamflow and Groundwater Management Plans.
- Project Leaders Prof Stuart Bunn and Dr Heather Hunter are members of the Scientific Expert Panel for the Moreton Bay Waterways and Catchments Partnerships. Dr Hunter also attended the Queensland Science in Parliament forum in August 2003.
- Dr Mike Stewardson participated on a planning committee developing the Knowledge Partnership for the Murray-Darling Basin Commission's Living Murray Initiative. Dr Stewardson also participated in the EPA (Victoria) Water Forum to discuss research needs in water science.
- Dr Robert Argent continues to sit on the International Panel of Experts for the European Open Modelling Interface and Environment (OpenMI). He also participated on the Grants approval committee of the River Basin Management Society, May 2004.

### 7. Workshops, field tours, demonstrations and continuing professional education

Interaction with community groups, industry practitioners and other stakeholders is an important part of the CRC's adoption goal. Workshops and field tours are an opportunity for sharing information and receiving feedback about the practical use of the CRC's research.

A full list of workshops, field tours, demonstrations and short courses carried out in 2003-2004 can be found in the chapter on Public Presentations, Public Relations and Communication.

### 8. Intellectual property management

A major stage in the CRC's management of intellectual property occurred this year with the appointment of CSIRO as the CRC's Commercial Agent for the Catchment Modelling Toolkit.

As Commercial Agent, the CSIRO has the delegated responsibility to act on behalf of the CRC's cooperative venture in negotiations with users and collaborating organisations, and in administering and arranging licensing arrangements.

In its role as Commercial Agent for the Toolkit, the CSIRO has assisted, through its legal staff and in conjunction with the CRC's Toolkit Strategy Group, in preparing standard licences or agreements for commercial and non-commercial users of the Toolkit and co-developers of software.

The CRC's Catchment Modelling Toolkit website has included the facility for downloading of CRC software under agreed conditions, with the user having to register via the website and agree to the CRC's terms and conditions. These approaches are aimed at safeguarding the CRC's intellectual property interests and facilitating user evaluation of CRC products, yet providing convenient procedures for users wanting access to the CRC products.

Additional intellectual property protection was secured with the formal Commonwealth registration of the trademark for the Catchment Modelling Toolkit and its logo.

### 9. Interaction with research users

The CRC's involvement and interaction with industry and other organisations as research users is outlined in a table on the next page.

The CRC's four Industry Affiliates have agreed to take on the role of MUSIC trainers, further details can be found under Program 8.

### 10. Contract research and consultancies

The CRC was successful in securing \$1.6 million in funding for research contracts this year. Details of contract research projects and consultancies are shown in a table toward the end of this chapter.

## Program 7 Communication and Adoption

### Interaction with Research Users

Research User (Industry and other organisations)	Organisation Size (Small & medium sized enterprises, large firms)	Basis of Interaction (Core participant, consultancy, contract research, grant collaboration)	CRC activity, product or service involved / Principal researchers
Australian National University iCAM (Integrated Catchment Assessment and Management Centre)	SME	Research Affiliate	Interactive Component Modelling System / Sue Cuddy <ul style="list-style-type: none"> <li>• Software being used to model water quality in Ben Chiefly Dam catchment (NSW)</li> <li>• Software also used to model water allocation in Murrumbidgee and Namoi catchments</li> </ul>
Australian Centre for International Agricultural Research (ACIAR)	SME	Contract research, grant collaboration	Land-use impacts on rivers <ul style="list-style-type: none"> <li>• Eucalypts and water: Managing forest plantations in China and Australia for sustained productivity and environmental benefits / Dr Jim Morris</li> <li>• Regional impacts of revegetation on water resources of the Loess Plateau China and the middle and upper Murrumbidgee catchment, Australia / Dr Tim McVicar</li> </ul>
Brisbane City Council	Large	Core participant, grant collaboration	Draft Stormwater Quality Monitoring Protocol <ul style="list-style-type: none"> <li>• Advice to Brisbane City Council on stormwater and SQID monitoring to support the protocol / Program 4 Researchers</li> </ul> Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>• Regional defaults for MUSIC parameters developed for Brisbane users / Program 4 Researchers</li> </ul> Urban Stormwater Quality <ul style="list-style-type: none"> <li>• Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor</li> <li>• Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher</li> </ul> Communication and Adoption <ul style="list-style-type: none"> <li>• Enhancing stakeholder capacity in prioritising water quality management actions / Tony Weber</li> </ul>
Bureau of Meteorology	Large	Core participant	Motivate Program <ul style="list-style-type: none"> <li>• The Motivate Program was applied to a contract between the Bureau of Meteorology and Melbourne Water to determine the time-area rainfall for a one in five storm / Program 5 Researchers</li> </ul>
Bureau of Rural Sciences	SME	User consultant	Zhang model <ul style="list-style-type: none"> <li>• The Bureau of Rural Sciences used the Zhang model in predictions of the performance of plantations in the middle Macquarie catchment (part of a major study) / Program 2 Researchers</li> </ul>
Chinese Academy of Sciences – Institute of Soils and Water Conservation	Large	Grant collaboration	Land-use impacts on rivers <ul style="list-style-type: none"> <li>• Regional impacts of revegetation on water resources of the Loess Plateau China and the middle and upper Murrumbidgee catchment, Australia / Dr Tim McVicar</li> </ul>
Coomes Consulting	SME	Industry user	Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>• Cairnlea Estate, Melbourne / Program 4 Researchers</li> </ul>
CSIRO Land and Water	Large	Core participant	Tarsier software environment <ul style="list-style-type: none"> <li>• CSIRO researcher outside the CRC, applying Tarsier to model salinity for the Water and Rivers Commission (WA)</li> <li>• Staff at CSIRO Townsville using Tarsier for ecological modelling (stock track development)</li> </ul> Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>• Brasil Development, Brisbane application / Program 4 Researchers</li> </ul>
Department of Infrastructure, Planning and Natural Resources, NSW (DIPNR)	Large	Core participant	Sediment tracing budget methodology <ul style="list-style-type: none"> <li>• Involvement of DIPNR staff in CRC research (Geoff Podger, Dr Mark Littleboy, Dr Guy Geeves, Carolyn Young and Christoph Zierholz),</li> <li>• DIPNR (also NSW SF and NSW EPA) reassessing impacts of relevant re-forestation water quality and water quality strategies in the catchment and impacts on water availability to irrigators and Macquarie Marshes / Program 2 Researchers</li> </ul> Strategic Landscape Investment Model (SLIM) <ul style="list-style-type: none"> <li>• Involvement of CRC staff with DIPNR in the SLIM tool that permits multi-criteria analysis to identify revegetation optimal sites and other Murray-Darling Basin investments / Program 2 Researchers</li> </ul> Communication and Adoption <ul style="list-style-type: none"> <li>• Modelling sediments and nutrients in the Murrumbidgee catchment to inform investment / Carolyn Young</li> </ul>
Department of Primary Industries, Vic	Large	Contract research, grant collaboration	Sustainable water allocation <ul style="list-style-type: none"> <li>• Cap and trade for salinity: Property rights and private abatement, a laboratory experiment market / Dr John Tisdell</li> </ul>

### Interaction with Research Users (continued)

Research User (Industry and other organisations)	Organisation Size (Small & medium sized enterprises, large firms)	Basis of Interaction (Core participant, consultancy, contract research, grant collaboration)	CRC activity, product or service involved / Principal researchers
Department of Sustainability and Environment (DSE), Vic	Large	Core participant, Contract research	Flow events methodology (FEM) <ul style="list-style-type: none"> <li>DSE commissioned an independent report to advise on integration of FEM into statewide environmental flow method / Program 6 Researchers</li> </ul> Predicting catchment behaviour <ul style="list-style-type: none"> <li>Victorian Bushfire Recovery Program: Catchment yield and water quality research / Prof Rodger Grayson</li> </ul>
Earth Tech Pty Ltd	SME	Consultant user, Industry Affiliate	Flow events methodology (FEM) <ul style="list-style-type: none"> <li>Report on Evaluation of Method (FEM) / Program 6 Researchers</li> <li>Earth Tech Pty. Ltd. Application of FEM in environmental study of Thomson River / Program 6 Researchers</li> </ul> Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>Accredited by CRC as MUSIC trainer / Dr Tim Fletcher</li> </ul>
Ecological Engineering	SME	Consultant user, Industry Affiliate	Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>Applications in Brisbane and Melbourne – Wakerley Area Wetland &amp; Water Sensitive Urban Design, Brisbane; Police Road Retarding Basin, Melbourne; Association of Bayside Municipalities Project, Melbourne / Program 4 Researchers</li> <li>Accredited by CRC as MUSIC trainer / Dr Tim Fletcher</li> </ul>
Environment Protection Authority, Victoria	Large	Consultancy, contract research, grant collaboration	Urban Stormwater Quality <ul style="list-style-type: none"> <li>Monitoring protocols and selection guidance for primary stormwater treatment measures / Dr Tim Fletcher</li> <li>Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures / Dr Tim Fletcher</li> <li>Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor</li> <li>Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher</li> <li>Predicting performance of bio-filters / Dr Ana Deletic</li> </ul>
Gold Coast City Council	Large	Grant collaboration	EMSS software <ul style="list-style-type: none"> <li>Used EMSS to support catchment planning for several local waterways / Programs 1 and 7 Researchers</li> </ul> Urban Stormwater Quality <ul style="list-style-type: none"> <li>Investigation of the inter-relationship between system hydrology and the physical and biochemical processes of pollutant removal in 'whole-of-catchment' stormwater treatment train approaches / Prof Rodger Tomlinson</li> </ul>
Goulburn Broken Catchment Management Authority	Large	Project collaborator	River Restoration <ul style="list-style-type: none"> <li>Restoration ecology in the Granite Creeks, Victoria / Assoc Prof Ian Rutherford</li> <li>Catchment assessment techniques to help determine priorities for river restoration / Dr Scott Wilkinson</li> <li>To experimentally evaluate the effectiveness of riparian zone restoration in the streams of the Murray Darling Basin / Brett Anderson</li> </ul>
Goulburn-Mallee Water	Large	Core participant	Communication and Adoption <ul style="list-style-type: none"> <li>Modelling and managing land-use impacts in and around water storages in northern Victoria / Pat Feehan</li> </ul>
Gutteridge Haskins & Davey	Large	Consultant user	Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>Application in Brisbane – Park Hill Village, Brisbane / Program 4 Researchers</li> </ul>
Land and Water Australia (LWRRDC)	SME	Grant collaboration, contract research	Predicting catchment behaviour <ul style="list-style-type: none"> <li>Development of a catchment contaminant cycle for stakeholder use / Dr Rob Vertessy</li> </ul> Land-use impacts on rivers <ul style="list-style-type: none"> <li>Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang</li> </ul> Sustainable water allocation <ul style="list-style-type: none"> <li>Enhancement of the water market reform process: A socioeconomic analysis of guidelines and procedures for trading in mature water markets (Project No:[GRU25]) / Dr John Tisdell</li> </ul> River Restoration <ul style="list-style-type: none"> <li>Riparian land management: Concepts, floods and erosion / Assoc Prof Ian Rutherford</li> <li>Catchment assessment techniques to help determine priorities for river restoration / Dr Scott Wilkinson</li> <li>Quantifying health in ephemeral rivers / Justin Costelloe</li> </ul>

## Program 7 Communication and Adoption

### Interaction with Research Users (continued)

Research User (Industry and other organisations)	Organisation Size (Small & medium sized enterprises, large firms)	Basis of Interaction (Core participant, consultancy, contract research, grant collaboration)	CRC activity, product or service involved / Principal researchers
Melbourne Enterprises International	SME	Consultancy	Flow events methodology (FEM) <ul style="list-style-type: none"> <li>• Dr Mike Stewardson led project through Melbourne Enterprises International to apply methodology to the Loddon River for the North Central CMA.</li> </ul>
Melbourne Water	Large	Core participant, grant collaboration	Motivate Program <ul style="list-style-type: none"> <li>• The Motivate Program applied to contract between Bureau of Meteorology and Melbourne Water to determine time-area rainfall for one in five year storm / Program 5 Researchers</li> <li>• Melbourne Water and Brisbane City Council have also adopted protocol for stormwater monitoring programs / Program 4 Researchers</li> </ul> Water Sensitive Urban Design (WSUD) <ul style="list-style-type: none"> <li>• Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD) / Assoc Prof Tony Wong</li> </ul> Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> <li>• Guidelines for MUSIC developed / Program 4 Researchers</li> </ul> Urban Stormwater Quality <ul style="list-style-type: none"> <li>• Monitoring protocols and selection guidance for primary stormwater treatment measures / Dr Tim Fletcher</li> <li>• Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures / Dr Tim Fletcher</li> <li>• Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor</li> <li>• Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher</li> </ul> Communication and Adoption <ul style="list-style-type: none"> <li>• Modelling river water quality in the Yarra catchment / Graham Rooney</li> </ul>
Murray-Darling Basin Commission	SME	Core participant, contract research	MDBC report <ul style="list-style-type: none"> <li>• CRC Report to MDBC has highlighted strategic impact of afforestation on water yield in Murray-Darling Basin / Program 2 Researchers</li> </ul> Flow events methodology <ul style="list-style-type: none"> <li>• Report on Evaluation of Method (FEM) / Program 6 Researchers</li> <li>• Final report to MDBC 'Evaluating the Effectiveness of Habitat Reconstruction' / Program 6 Researchers</li> </ul> Land-use impacts on rivers <ul style="list-style-type: none"> <li>• Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang</li> <li>• Basin-wide mapping of sediment and nutrient exports in dryland regions / Dr Chris Moran</li> <li>• Integrated assessment of the effects of land-use changes on water yield and salt loads / Dr Lu Zhang</li> </ul> River Restoration <ul style="list-style-type: none"> <li>• To experimentally evaluate the effectiveness of riparian zone restoration in the streams of the Murray Darling Basin / Brett Anderson</li> </ul> Predicting catchment behaviour <ul style="list-style-type: none"> <li>• Victorian Bushfire Recovery Program: Catchment yield and water quality research / Prof Rodger Grayson</li> </ul>
Murrumbidgee Catchment Management Board	SME	Activity by core participant DIPNR	SedNet and EMSS <ul style="list-style-type: none"> <li>• Project will demonstrate the relevance and applicability of models to assist in setting end-of-valley targets / Program 2 Researchers</li> </ul>
National Institute for Water and Atmosphere in Wellington, New Zealand	SME	Research Affiliate	Climate variability <ul style="list-style-type: none"> <li>• The National Institute for Water and Atmosphere in Wellington, New Zealand has successfully trialled S_Prog and is investigating its use as the nowcasting component of a flash flood warning system / Program 2 Researchers</li> </ul>
Natural Heritage Trust, Dept of Agriculture, Fisheries and Forestry – Aust.(AFFA)	Large	Grant collaboration	River restoration <ul style="list-style-type: none"> <li>• Research to improve the effectiveness of Australian fishway design / Assoc Prof Bob Keller</li> </ul>
Natural Resources and Mines, Qld	Large	Core participant	Communication and Adoption <ul style="list-style-type: none"> <li>• Modelling river water quality in the Fitzroy catchment in partnership with regional strategy groups / Bruce Cowie</li> </ul>
NSW EPA	Large	Consultancy user	Draft Stormwater Quality Monitoring Protocol <ul style="list-style-type: none"> <li>• NSW EPA adopted draft protocol and now recommended procedure for monitoring stormwater treatment measures by NSW councils / Program 4 Researchers</li> </ul> Urban Stormwater Quality <ul style="list-style-type: none"> <li>• Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor</li> </ul>

### Interaction with Research Users (continued)

Research User (Industry and other organisations)	Organisation Size (Small & medium sized enterprises, large firms)	Basis of Interaction (Core participant, consultancy, contract research, grant collaboration)	CRC activity, product or service involved / Principal researchers
Pine Rivers Shire Council	SME	Consultancy	EMSS software <ul style="list-style-type: none"> <li>Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld / Dr Rob Vertessy</li> </ul>
Sinclair Knight Merz	SME	Industry Affiliate	Predicting catchment behaviour <ul style="list-style-type: none"> <li>General collaboration, including Catchment Modelling Toolkit / Prof Rodger Grayson Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</li> <li>Accredited by CRC as MUSIC trainer / Dr Tim Fletcher</li> </ul>
South East Queensland Water Corporation		Consultancy-user	EMSS Software <ul style="list-style-type: none"> <li>Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld / Dr Rob Vertessy</li> <li>Sustainable water allocation</li> <li>The valuation of the water quality ecosystem service of the mid-Brisbane River / Dr John Tisdell</li> </ul>
South East Queensland Regional Water Quality Management Committee (SEQRWQMC)	SME	Consultancy-user	SedNet – a model that predicts the sources and distribution of sediment through a river network <ul style="list-style-type: none"> <li>The results of the SedNet application and validation in the Brisbane River catchment have formed the basis for targeting catchment works under the SEQRWQMS – this modelling work has formed the basis of the agenda for Phase 4 of the strategy / Program 2 Researchers</li> </ul> EMSS software <ul style="list-style-type: none"> <li>Development of an environmental management support system (EMSS) for catchments in south east Queensland / Dr Rob Vertessy</li> </ul> Predicting catchment behaviour <ul style="list-style-type: none"> <li>Modelling and estimating sediment and nutrient loads in south east Queensland catchments – Phase 1 / Assoc Prof Francis Chiew</li> </ul> Land-use impacts on rivers <ul style="list-style-type: none"> <li>SEQRWQMS, Stage 3, Project Sediment and Nutrient Sourcing / Dr Jon Olley</li> </ul>
State Water, an arm of NRM, Qld	Large	Core participant	Fitzroy catchment survey results <ul style="list-style-type: none"> <li>State Water, an arm of NRM, used the result of the Fitzroy community and irrigator attitude survey to highlight potential issues and problems to the implementation of the Fitzroy Resource Operations Plan (ROP) / Program 3 Researchers</li> </ul>
Sustainable Water Resources Research Centre, Korea	Large	Research Affiliate, International collaboration	Predicting catchment behaviour <ul style="list-style-type: none"> <li>General collaboration, including Catchment Modelling Toolkit / Dr Rob Vertessy</li> </ul>
UK Met Office	Large	International collaboration	Radar forecasting <ul style="list-style-type: none"> <li>UK Met Office requested an MOU with BoM to apply the radar forecasting technology in the UK / Dr Alan Seed</li> </ul>
University of New South Wales	Large	Research Affiliate	Climate Variability <ul style="list-style-type: none"> <li>Collaboration on stochastic rainfall data / Program 5 Researchers</li> </ul>
Urban and Regional Land Corporation (Vic Urban)	SME	User – grant collaboration	Water sensitive urban design <ul style="list-style-type: none"> <li>Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD) / Assoc Prof Tony Wong</li> </ul>
WBM Oceanics	SME	Consultancy, Industry Affiliate	EMSS software <ul style="list-style-type: none"> <li>EMSS (Tarsier) has been delivered and being used by CRC project teams and WBM Oceanics / Program 1 Researchers</li> <li>Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld / Dr Rob Vertessy</li> <li>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</li> <li>Brisbane &amp; Melbourne offices – Lenworth Lake Development, Brisbane; Forrest Lake, Brisbane; Geelong Stormwater Management Plan, Victoria; Craigieburn Bypass Water Sensitive Road Design, Victoria / Program 4 Researchers</li> <li>Accredited by CRC as MUSIC trainer / Dr Tim Fletcher</li> </ul>
Water and Rivers Commission (WA)	SME	Consultancy-user	Tarsier software environment <ul style="list-style-type: none"> <li>Following a Tarsier workshop in Canberra, a workshop participant at CSIRO is applying Tarsier by using it to model salinity for the Water and Rivers Commission (WA) / Program 1 Researchers</li> </ul>
Water Corporation of Western Australia	Large	Collaborative project	CRC Forge Software <ul style="list-style-type: none"> <li>Application of extreme rainfall analysis software developed from initial CRC / Erwin Weinmann</li> </ul>

# Commercialisation, Utilisation and Application of Research

## Program 7 Communication and Adoption

**Contract Research Activity** CRC Associate/Additional Projects, External Funding and Direct CRC Contract Research/Consulting.

CRC Project Number Project Title / Project Leader	Related CRC Focus Catchment(s)	Total Project Resources (\$000s)	Total Funding Agency Resource Input (\$000s)	CRC Resource Input (\$000s)	CRC Input as % Total Project Funding Agency Input (\$000s)	Funding Agency Input for 1999/2000 (\$000s)	Funding Agency Input for 2000/2001 (\$000s)	Funding Agency Input for 2001/2002 (\$000s)	Funding Agency Input for 2002/2003 (\$000s)	Cumulative Funding Agency Input to June 2004 (\$000s)	Project Start // Finish Date	CRC Parties Involved	Principal External Funding Agency		
1.3 Development of an environmental management support system (EMSS) for catchments in south east Queensland/ Dr Rob Vertessy	Brisbane	263	151	112	43%	0	110	41	0	0	151	May 00// Aug 01	CSIRO, Uni Melb, Monash Uni, BCC	South East Queensland Regional Water Quality Management Committee (SEQRWQMC)	
1.4 Modelling and estimating sediment and nutrient loads in south east Queensland catchments – Phase 1/ Dr Francis Chiew	Brisbane	72	54	18	25%	0	54	0	0	0	54	May 00// Jan 01	CSIRO, Uni Melb, Monash Uni, BCC	South East Queensland Regional Water Quality Management Committee (SEQRWQMC)	
1.7 Development of a pilot local-scale. Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld / Dr Rob Vertessy	Brisbane	222	125	97	44%	0	0	125	0	0	125	May 01// Jun 02	CSIRO, QDNRM, BCC	Pine Rivers Shire Council; South East Queensland Water Corporation; WBM Oceanics, Consultants	
1.11 Development of a catchment contaminant cycle for stakeholder use / Dr Rob Vertessy	Brisbane and Murrumbidgee	702	400	106	15%	0	0	0	107	141	248	Dec 02// Jun 05	CSIRO, Monash Uni	Land and Water Australia	
1.14 Victorian Bushfire Recovery Program: Catchment yield and water quality research/ Prof Rodger Grayson	Goulburn/Broken Murrumbidgee	750	500	250	33%	0	0	0	0	50	50	Jan 04// Oct 05	Uni Melb, CSIRO Land and Water, Forest Science Centre DSE, G-MWater, MDBC	Department of Sustainability and Environment, Victoria	
2.6 Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang	Goulburn/Broken Murrumbidgee	812	150	500	62%	0	71	79			150	Jul 00// Jun 02	CSIRO, DNRE, DLWC-NSW, Uni Melb	Land and Water Resources Research and Development Corporation (LWRRDC)	
2.7 Eucalypts and water: Managing forest plantations in China and Australia for sustained productivity and environmental benefits / Dr Jim Morris	Goulburn/Broken	1,621	821	300	19%	223	205	195	198		821	Jul 99// Jun 03	Centre for Forest Tree Technology DNRE, Uni Melb Dept of Forestry, CSIRO	Australian Centre for International Agricultural Research (ACIAR)	
2.10 SEQRWQMS, Stage 3, Project SS: Sediment and Nutrient Sourcing / Dr Jon Olley	Brisbane	397	277	120	30%	223	54	0			277	Aug 99// Jun 01	CSIRO, DNRQ	South East Queensland Regional Water Quality Management Committee (SEQRWQMC)	
2.13 Basin-wide mapping of sediment and nutrient exports in dryland regions / Dr Chris Moran	Goulburn-Murray; Murrumbidgee are addressed by this study. The methodologies are of value to the other focus catchments.	1,500	492	0	0%	24	109	229	130		492	Mar 00// Mar 03	CSIRO, Uni Melb, Monash Uni, MDBC	Murray-Darling Basin Commission (MDBC) Strategic Investigations and Education Program	
2.15 Integrated assessment of the effects of land-use changes on water yield and salt loads / Dr Lu Zhang	Part of work in Murrumbidgee and Goulburn/Broken catchments. Some work in catchments in WA	1,295	753	542	42%	0	0	283	188	282	753	Feb 01// Oct 03	NRE Vic, DLWC NSW, CSIRO Land and Water	Murray-Darling Basin Commission (MDBC) Strategic Investigations and Education Program	
2.24 Regional impacts of re-vegetation on water resources of the Loess Plateau China, and the middle and upper Murrumbidgee catchment, Australia / Dr Tim McVicar	Murrumbidgee	1,945	415	141	7%					81	126	207	Apr 03// Mar 06	CSIRO, [links with DIPNR – NSW]	Chinese Academy of Sciences – Institute of Soils and Water Conservation; Australian Centre for International Agricultural Research (ACIAR)
3.4 Enhancement of the water market reform process: A socioeconomic analysis of guidelines and procedures for trading in mature water markets (Project No:[GRU25]) / Dr John Tisdell	Murrumbidgee	833	208	625	75%	0	60	72	76	0	208	Jul 00// May 03	Griffith Uni, DLWC -NSW, Monash Uni	Land and Water Resources Research and Development Corporation (LWRRDC)	

CRC Project Number Project Title / Project Leader	Related CRC Focus Catchment(s)	Total Project Resources (\$000s)	Total Funding Agency Resource Input (\$000s)	CRC Resource Input (\$000s)	CRC Input as % Total Project	Funding Agency Input for 1999/2000 (\$000s)	Funding Agency Input for 2000/2001 (\$000s)	Funding Agency Input for 2001/2002 (\$000s)	Funding Agency Input for 2002/2003 (\$000s)	Funding Agency Input for 2003/2004 (\$000s)	Cumulative Funding Agency Input to June 2004 (\$000s)	Project Start // Finish Date	CRC Parties Involved	Principal External Funding Agency
3.10 The valuation of the water quality ecosystem service of the mid-Brisbane River / Dr John Tisdell	Brisbane	40	30	10	25%	0	0	0	0	0	30	30 Jun 03// Aug 03	BCC, Griffith Uni	South East Queensland Water Corporation
3.11 Cap and trade for salinity: Property rights and private abatement, a laboratory experiment market / Dr John Tisdell	Goulburn/Broken	373	133	240	64%	0	0	0	0	67	67	Mar 03// Jul 04	Griffith Uni, DPI Vic, Uni Melb	NAP [DPI Vic]
4.3 Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD)/ Assoc Prof Tony Wong	Yarra	106	100	6	6%	0	0	90	0	0	90	Sep 01// Jun 02	Melbourne Water, Monash Uni	Melbourne Water, Urban and Regional Land Corporation
4.4 Monitoring protocols and selection guidance for primary stormwater treatment measures/ Dr Tim Fletcher	Yarra	220	200	20	9%	0	0	200	170	0	370	Sep 01// Jul 03	Melbourne Water, Monash Uni	Environment Protection Authority Victoria
4.5 Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures / Dr Tim Fletcher	Yarra	120	100	20	17%	0	0	100	0	0	100	Sep 01// Jul 02	Melbourne Water, Monash Uni	Environment Protection Authority Victoria
4.10 Tools for evaluating the social and economic performance of stormwater management and Water sensitive urban design / Andre Taylor	Brisbane, Yarra	285	165	44	15%	0	0	0	0	0	165	165 Jul 03// Jul 05	BCC, Melbourne Water, Monash Uni	Environment Protection Authority Victoria
4.11 Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher	Brisbane, Yarra	713	511	284	40%	0	0	0	0	0	205	205 Jul 03// Jul 05	BCC, Melbourne Water, Monash Uni	Environment Protection Authority Victoria
6.8 Research to improve the effectiveness of Australian fishway design / Assoc Prof Bob Keller	Applies generally to Murray-Darling Basin	672	362	310	46%	18	134	210	0	0	362	May 00// Jun 02	Monash Uni, Uni Melb	Natural Heritage Trust, Dept of Agriculture, Fisheries and Forestry – Aust.(AFFA)
6.9 Riparian land management: Concepts, floods and erosion / Assoc Prof Ian Rutherford	Feeds into Project 2.1 – with focus on Murrumbidgee and Goulburn/Broken	691	500	50	7%	0	0	81	196	159	436	July 01// Jun 05	Uni Melb, CSIRO, [Interest expressed by Melb Water, Brisbane CC, NRM Qld]	Land and Water Australia (LWRRDC)
6.14 Quantifying health in ephemeral rivers / Justin Costelloe & Fran Sheldon (CRCFE)	Field sites required by LWA to be located in South Aust ephemeral rivers	885	113	210	24%	0	0	0	0	0	Note 2	Mar 03// Feb 05	Uni Melb, Monash Uni	Land and Water Australia (LWRRDC)
6.15 To Experimentally Evaluate the Effectiveness of Riparian Zone Restoration in the Streams of the Murray Darling Basin / Brett Anderson	Up to five experimental sites will be located in the Murray Darling Basin; Murrumbidgee and Goulburn-Broken sites will be preferentially selected	457	200	0	0%	0	0	0	0	0	137	137 Oct 03// Dec 05	Uni of Melbourne, Monash Uni, Murray Darling Basin Commission	Murray-Darling Basin Commission (MDBC)
<b>Totals</b>		<b>14,974</b>	<b>6,760</b>	<b>4,005</b>		<b>488</b>	<b>797</b>	<b>1,705</b>	<b>1,146</b>	<b>1,362</b>	<b>5,498</b>			
<b>Associate/Additional Projects External Funding Agency Input total (\$000s)</b>						<b>488</b>	<b>797</b>	<b>1,705</b>	<b>1,146</b>	<b>1,362</b>	<b>5,498</b>			
<b>CRC Direct Contract Research/Consulting Income total (\$000s)</b>						<b>32</b>	<b>152</b>	<b>30</b>	<b>125</b>	<b>64</b>	<b>403</b>	<b>[Note 1]</b>		
<b>Other Projected Direct income: Project 2.21[2C]</b>									<b>100</b>	<b>200</b>	<b>300</b>			
Project 6.14									<b>9</b>	<b>21</b>	<b>30</b>			
<b>Total Contract Research/Consulting total (\$000s)</b>						<b>520</b>	<b>949</b>	<b>1,735</b>	<b>1,380</b>	<b>1,647</b>	<b>6,231</b>			
<b>Commonwealth Agreement Contract Research totals (\$000s)</b>						<b>300</b>	<b>700</b>	<b>1,000</b>	<b>1,400</b>	<b>1,800</b>	<b>5,200</b>			

Notes

- Actuals for 99/2000 to 2003/04 as reported in Profit and Loss Account
- Income processed through CRC direct financial reporting for 2003/04

# Milestones Program 7

## Milestones

### Years 1 and 2

All project agreements have a communication and adoption strategy that details the needs of end-users and a strategy for adoption of research outcomes.

## Progress

The Communication and Adoption (C&A) program trialled a C&A framework in conjunction with Program 4 during late 2000. The framework was subsequently implemented by all research programs during 2001. C&A strategies for the first round of research projects have been largely implemented as projects finished during 2002-2003. Remaining C&A activity for first round projects has focussed on delivery through the Catchment Modelling Toolkit website.

Existing Centre communication and adoption activities reviewed in conjunction with existing and new Parties to determine requirements and further improve the communication and adoption strategies during Years 1 and 2.

External communication review by Econnect completed May 2001 and included an assessment of existing communication vehicles and recommendations to improve product range. Assessing the value of each product to target groups is part of the C&A Program's Planning Framework undertaken in each Program.

Development of a communication strategy to engage the interest and collaboration of a wide range of stakeholders in preparation for the delivery of the Centre's research outcomes.

C&A planning framework completed November 2000. The external communication review included recommendations for improvements to developed strategies. A broad communication strategy has been pursued based on the CRC's established communication vehicles, and the activities of Focus Catchment Coordinators.

Communication and adoption activities benchmarked by independent consultants through review after Year 1.

Econnect successfully tendered for the communications review and completed it by May 2001. Key communicators from other similar organisations (10), key CRC investors (25), and internal (73) and external stakeholders (175) were surveyed to benchmark the CRC's communication performance. The results of review were very positive.

Further improvement of the CRC's website to increase access to research outcomes and products.

Stage 1 of CRC website redesign was completed in early 2002 and included improved navigation, research model downloads, technical report summaries, project information, events calendar, news pages, *Catchword* subscription, events notification and publications lists.

Stage 2, construction and deployment of the Catchment Modelling Toolkit website has been completed and will be continuously improved over time. The redesign of CRC website has also been finished and now has an enhanced user interface.

Establish strategy for communication within the CRC Parties and between Focus Catchments to ensure integration with overall Communication and Adoption and research program objectives.

Initial strategy comprises FCCs as communication links via: email newsletters to target audience in catchments; AEAM project in Fitzroy; involvement of FCCs in developing C&A plans; regular FCC meetings in person and via phone. Completed December 2001. Implementation is ongoing.

Level of commitment to contract research is on target set in Strategic Plan.

External projects for endorsement represent 136% of target to June, 2001: SEQRWQMS Projects 1.3, 1.4, 2.10; L&WA Projects 2.6, 3.2; NHT/AFFA Project 6.5; MDBC Project 2.13; ACIAR Project 2.7

### Years 3, 4 and 5

Preparation completed (Year 3) for the communication of research outcomes to targeted end-users. Individual program and project Communication and Adoption strategies commenced.

Preparation/planning for delivery was completed by all programs. First round project delivery completed. Stage 1 (major stage) of Toolkit website development completed and resources are now focussed on the CRC website and consolidation of 'round one' project outcomes for industry use. The Catchment Modelling School was highly successful.

Communication and adoption activities measured by independent consultants (Years 3 and 5).

Year 5 'communication review' commenced; consultant selection process begun with report expected early 2004-2005.

Best practice communication and adoption workshop to assess and implement recommendations from independent reviews (Years 2 and 4).

The Executive Summary of the May 2001 communication review described the CRC as a 'leader in its approach to planning, implementing and evaluating communication'. Subsequent independent CRC reviews have supported this assessment. Very positive review recommendations did not warrant the follow-up best-practice workshop in Year 2. Resources were redirected to the establishment of the Development Projects in the Focus Catchments during 2002.

The need for a best practice workshop will be reappraised in light of the findings of the communication review scheduled in early 2004-2005.

Level of commitment to contract research is on target set in Strategic Plan.

External projects for endorsement represent 120% of the target to June 2004. South East Queensland Regional Water Quality Management Strategy Projects 1.3, 1.4, 1.7, 2.10; Land & Water Australia Projects 1.11, 2.6, 3.4, 6.9, 6.14; Natural Heritage Trust/Agriculture, Fisheries and Forestry - Australia Project 6.8; Murray-Darling Basin Commission Projects 2.13, 2.15, 6.15; ACIAR Projects 2.7, 2.24; URLC/Melbourne Water Project 4.3; EPA Vic Projects 4.4, 4.5, 4.10, 4.11.



# Program 8 Education and Training

*This Page Left David Perry, Program Leader, Education and Training. Right CRC Postgraduates at 'People Skills' workshop, Yarra Valley, March 2004*



**Aim** To increase the knowledge and skills base available for land and water managers in Australia.

### **Program Leader**

David Perry, Monash University

### **Program Output**

The Education and Training Program supports the CRC's research programs and particularly postgraduate students through:

- Delivery of a range of needs-based courses for postgraduate students designed to assist in their professional and personal development.
- Facilitation of industry placements for CRC postgraduates, as opportunities arise.
- Logistical and technical support for the delivery of seminars, short courses and workshops offered by the CRC including the Catchment Modelling School.
- Development and delivery of an education and training framework to ensure a comprehensive and consistent approach to stakeholder education, training and evaluation across all CRC activities.
- Analysis and reporting of the CRC's education and training activities to assist program teams to continuously improve their standard of delivery.

## Program 8 Education and Training

*This Page Left & Right CRC Postgraduates at 'People Skills' workshop, Yarra Valley, March 2004*

*Opposite Page Left Postgraduates at CRC Catchment Modelling School, 2004: Dominic Blackham with Dr Scott Wilkinson. Centre Postgraduates at CRC Catchment Modelling School, 2004: Debbie Woods in workshop session. Right CRC Vacation scholars and researchers, Griffith University, summer 2003/04 (l to r) Sarah Clements, Ashley Von Schwan, Jesse Linton, Chi Ho*



### Outcomes and benefits

The CRC for Catchment Hydrology is committed to ensuring adoption of its integrated modelling capability and supporting tools by the land and water management industry. The main purposes of Program 8 are to more effectively deliver and evaluate education and training in the use of these tools, and postgraduate education and training.

Education and training is a fundamental component of the CRC's process to facilitate adoption. Strong education and training in CRC products will build commitment by end-users for these products, and will establish a satisfactory level of competency in their use.

This CRC continues to offer and broker education and training initiatives such as the Catchment Modelling School to meet the needs of postgraduates, researchers and stakeholders. Another School is being planned for 2005. The CRC is committed to equipping staff with the necessary skills and materials to effectively design, conduct and assess education and training activities for users of the CRC's products.

Providing postgraduate students with additional skills and experiences is also an important focus for Program 8. Where opportunities arise, the CRC organises industry placements and other forms of professional development for students so that they gain invaluable experience and make a contribution to developing future solutions for catchment hydrology in Australia.

CRC postgraduates are highly regarded throughout the industry; many have won or been nominated for science awards over recent years. They are eagerly sought after as employees within industry, government and the research sector.

### End-users

- CRC industry Parties
- Regional catchment management groups
- Federal and State policy and extension agencies
- Local government
- Consultants
- Research organisations
- Non-government organisations
- Communities
- Postgraduates

### Program highlights 2003-2004

- As also noted under Program 7, a major highlight of education and training activity for this year was the Catchment Modelling School held in Melbourne, 9-20 February 2004. During the two weeks of the School, 29 separate catchment modelling and related workshops were held with 308 participants attending 517 workshop places.
- The series of Respect, Reflect, React symposia were held in Melbourne, Canberra, Brisbane and Emerald (Qld). These symposia featured presentations from a variety of speakers on various issues associated with change for healthy environments in Australia. Topics including volunteerism, citizen science, and research collaboration, allowed participants to share their experiences and understandings of different approaches to social and environmental change.

- CRC postgraduates were invited to a special workshop scheduled prior to the CRC's Annual workshop near Yarra Glen in March 2004. The workshop on 'People Skills' was well received by participants and included sessions on personality types, negotiation and conflict resolution skills and professional relationship dynamics. Other activities targeting postgraduate students included a revised student induction kit, an email list group for communication, and support for final year postgraduates entering the Young Water Scientist of the Year Award.
- Sara Lloyd was selected as the CRC's entrant in the Young Water Scientist of the Year Award. Other excellent applicants were Alice Best and Brett Anderson.
- Workshops to 'train the trainers' were held for the CRC Industry Affiliates for accreditation as trainers in the use of the CRC's MUSIC software. Representatives of the Industry Affiliates EarthTech, Ecological Engineering, Sinclair Knight Merz, and WBM attended the workshops for accreditation of their organisations.
- The CRC had an active program of Vacation Studentships over the summer of 2003-2004. Vacation Studentships were awarded to the scholars shown in the table below who assisted with research at the CSIRO and university nodes:

CSIRO Canberra	Griffith University	Monash University	The University of Melbourne
Kristen Feher	Sarah Clements	Rick Williams	Merrick Underwood
Susan Kelly	Chi Ho		James Bentley
Geoff Davis	Kim Markwell		Matt Natonewski
Rob Bridgart	Ashley Lewis		Gregory Fletcher
	Elizabeth Yeo		Rebecca Lillie
			Sarah Drowley
			Paul Nevill
			Fiona Tarquino



Below Sara Lloyd at Lynbrook

## CRC postgraduate research set to influence urban design

There is growing enthusiasm and support not just within the water industry, but also from the broader community, for changes to the way our urban water resources are managed. So what is hindering the adoption and integration of Water Sensitive Urban Design (WSUD) techniques into urban development?

This is the question Sara Lloyd, a PhD student with the CRC for Catchment Hydrology has tried to answer. In her PhD she set out to explore the impediments and opportunities for incorporating sustainable stormwater management schemes into new housing estates. Sara has completed the final stages of her PhD and submitted her thesis in June 2004.

According to Sara, insufficient quantitative data to determine the performance, cost and community acceptance of alternative WSUD strategies has hampered widespread adoption.

*"My research is unique in that it integrates technical, economic and social research boundaries,"* says Sara.

She has explored how effective WSUD is at Lynbrook Estate, in Melbourne's south-eastern growth corridor, where there are 271 medium density allotments on 32 ha. Roof and road runoff are collected and treated using bio-filtration systems that discharge to a series of wetlands and an ornamental lake. At Lynbrook there has been a collaborative approach between the key players – Melbourne Water, as the urban water authority; the developers, VicUrban (formerly the Urban and Regional Land Corporation); engineers KLM Development Consultants; landscape architects Murphy Design Group; and the CRC for Catchment Hydrology - to implement and monitor an integrated stormwater management scheme based on WSUD principles and practices.



Over six months, Sara monitored storm events at Lynbrook Estate comparing flow data and water quality data downstream from a bio-filtration system with that from a concrete pipe system located in adjacent sub-catchments.

Her results demonstrate bio-filtration systems provide flow control for frequently occurring runoff events and reduce the annual litter, suspended sediment and nutrient loads conveyed from urban catchment to downstream waterways.

Sara also looked at the capital and maintenance costs of using bio-filtration systems as the street drainage network compared to traditional concrete pipes with a downstream treatment wetland system. Her findings show a 25 per cent saving in capital cost by using bio-filtration systems distributed across a catchment compared to a downstream treatment approach.

*"Adopting a distributed treatment approach is cheaper for society as a whole, but the sharing of ongoing maintenance costs between stakeholders (urban water authorities and local government) alters. Further consideration on how best to manage these cost shifts is required,"* she says.

By undertaking market research to support her PhD project, Sara also demonstrated the strength

of community support for integrating a variety of WSUD strategies into urban design.

Three hundred property owners and prospective buyers drawn from developments at four green-field sites in Melbourne's growth corridors were surveyed. More than 85 per cent of respondents were supportive of the introduction of wetlands, bio-filtration systems, and water reuse schemes, into their neighbourhood. As a further measure of support, more than half the respondents claimed they were willing to pay an annual fee of at least \$25 for the on-going maintenance of integrated water management schemes.

Sara is now employed by Melbourne Water and has recently started working on an exciting project that aims to calculate the cost-effectiveness of a number of WSUD applications for 'drainage scheme' development. She is also engaged to manage the Victorian WSUD capacity building program as part of the Municipal Association of Victoria's Clearwater Program.

Her PhD research through the CRC has led Sara to a challenging and interesting career with her work being influential for future urban design and development. Sara has been selected as the CRC's entrant in this year's Young Water Scientist of the Year Award.

## Program 8 Education and Training

**Table A Postgraduates – CRC Core Projects 2003-2004**

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Brett Anderson	Melbourne	PhD	I.D. Rutherford (UM) A. Western (UM)	APA#	The impact of riparian vegetation on catchment-scale flood characteristics. (6, 2.1)
Yinbang Bao	Melbourne	PhD	R. Argent (UM) A. Western (UM)	APA#	Scaling and analysis issues of hydrological modelling. (1.1)
Mark Bayley	Griffith	PhD	M. Greenway (Griffith) G. Jenkins (Griffith)	GUPRAΩ	Nitrogen, phosphorus and carbon removal processes in stormwater wetlands. (4)
Alice Best	Melbourne (2)	PhD	L. Zhang (CSIRO) T.A. McMahon (UM) A. Western (UM)	MRS##, UMSPS†	The impact of land use change on seasonal water yield. (2.3)
Margot Biggin	Monash (1)	PhD	G. Codner (Monash) S.Schreider (Monash/RMIT) M.J. Stewardson (UM)	MDS*	Evaluating the impact of water allocations on hydraulic environments. (3, 6)
Dominic Blackham	Melbourne	PhD	I.D. Rutherford (UM) M. J. Stewardson (UM)	MIRSØ	The role of riparian grass in controlling degraded stream recovery. (6)
Daniel Borg	Melbourne	MEngSc	I.D. Rutherford (UM) J.D. Fenton (UM)	UMSPS†, MRS##	Monitoring and modelling the persistence of large woody debris scour. (6)
Tim Capon	Griffith	PhD	J Tisdell (Griffith) A. Arthington (Griffith)	GUPRAΩ	To examine the risks and uncertainties associated with defining property rights for water entitlements and environmental flows. (3)
Daniel Clowes	Griffith	PhD	J. Tisdell (Griffith) G. McDonald (CSIRO)	GUPRAΩ	Integration between catchment biophysical models and economic models for the management of non point-source pollution. (3)
Teri Etchells	Melbourne	PhD	H. Malano (UM) T. A. McMahon (UM) B. James (DSE)	APA#, UMSPS†	A methodology for calculating water trading exchange rates in the Murray-Darling Basin. (3.1)
Matthew Francey	Monash	MEngSc	T. Fletcher (Monash) A.Deletic (Monash) H.Duncan (Monash)	Melbourne Water, VSAP	Investigation into the relationship between rainfall intensity and pollutant generation in urban catchments. (4)
Myriam Ghali	Melbourne	PhD	I.D. Rutherford (UM) R. Grayson (UM) A. Curtis (Bureau of Rural Sciences – BRS)	IPRSØØ, MIRSØ	Evaluating existing prioritisation procedures in the field of stream rehabilitation. (6)
Margaret Gooch	Griffith	PhD	J. Fien (Griffith) J. Warburton (UQ) R Rickson (Griffith)	GUPRAΩ	Volunteers and sustainable catchment management. (8)
Janice Green	Monash	PhD	PE. Weinmann (Monash) R. Nathan (Sinclair Knight Merz)	APAΔ	Estimation of extreme rainfall risk. (10)
Marnie Griffith	Monash	PhD	G. Codner (Monash) S. Schreider (Monash) I. Wills (Monash)	MDS*	Irrigated agriculture and the COAG reforms under uncertainty. (3)
Courtney Henderson	Griffith	PhD	M. Greenway (Griffith) I. Phillips (Griffith)	GUPRAΩ with CRC top-up	Assessing the effect of vegetation in biofiltration devices for nutrient pollution removal from stormwater (4.2).
Elisa Howes	Melbourne	MEngSc	M.J. Stewardson (UM) R. Grayson (UM)	UMSPS†, MRS##	Modelling hydraulic habitat condition within catchments. (6)
Subhadra Jha	Melbourne	PhD	R. Grayson (UM) I.D. Rutherford (UM)	IPRSØØ, MIRSØ	Modelling stream bank erosion at basin scale. (6.6)
Dean Judd	Monash	PhD	R.J. Keller (Monash) I.D. Rutherford (UM) J. Tilleard (Earth Tech)	MDS*, MUGS††	The anastomosing rivers of the Riverine Plain. (6)
Durga Kandel	Melbourne	PhD	R. Grayson (UM) A. Western (UM) H. Turrall (IWMP, Sri Lanka)	IPRSØØ, MIRSØ	Temporal scaling issues in surface runoff and soil erosion modelling. (1.2)
Peter Kolotelo	Monash	MSc	J. Baldwin (Monash) R.J. Keller (Monash)	MDS (AFFA funded)	Improving the effectiveness of Australian fishway design. (6)

Legend follows at end of Table B

**Table A Postgraduates – CRC Core Projects 2003-2004 (continued)**

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Sara Lloyd	Monash	PhD	T.H.F. Wong (Monash)	APA#, MDS*	Exploring impediments and opportunities of sustainable stormwater management schemes. (4.2)
Leo Lymburner	Melbourne (2)	PhD	P.B. Hairsine (CSIRO) A. Held (CSIRO) J. Walker (UM)	UMSPS†	Describing riparian vegetation functions in the Fitzroy catchment using remote sensing and spatial analysis. (2)
Muthukaruppan Muthukumar	Melbourne	PhD	F.H.S. Chiew (UM) T.H.F. Wong (Monash)	MRS# #, UMSPS†	Modelling quality and size distribution of contaminants in stormwater. (4)
David Newton	Griffith	PhD	G.A. Jenkins (Griffith) I. Phillips (Griffith)	GUPRAΩ	The effectiveness of modular porous pavement as a stormwater treatment device. (4)
Nicholas Potter	Melbourne (2)	PhD	L. Zhang (CSIRO) T. A. McMahon (UM) A. Jakeman (ANU)	UMSPS†	Statistical-dynamical modelling of catchment water balance. (2.3)
Marella Rebgetz	Melbourne	PhD	F.H.S.Chiew (UM) H. Malano (UM)	APA#	An investigation of the benefits of seasonal streamflow forecasting for water catchment management. (5)
Gregory Summerell	Melbourne (3)	PhD	R.B. Grayson (UM) N.K. Tuteja (DIPNR) G. Walker (CSIRO)	NSW salinity strategy funds/Department of Infrastructure Planning and Natural Resources /and CRC	Understanding the processes of salt movement from the landscape to the stream. (2)
Geoff Taylor	Monash	PhD	T.H.F. Wong (Monash) T. Fletcher (Monash) P. Breen (EcoEng)	MDS*	Nitrogen composition of urban runoff and treatment processes in constructed wetland that promote nitrogen transformation and removal. (4.1)
Dana Thomsen	Griffith	PhD	J. Fien (Griffith) M. Greenway (Griffith)	GUPRAΩ	Community-based research. (8.2)
Geoff Vietz	Melbourne	PhD	M.J Stewardson (UM) B. Finlayson (UM) I. Prosser (L&WA)	UMSPS† with CRC top-up	Utilising geomorphology to define environmental flow regimes.(6.12 (6B))
Clayton White	Griffith	PhD	J. Fien (Griffith) R. Rickson (Griffith)	GUPRAΩ	The role of communication in citizen participation in catchment management. (8.2)
Debbie Woods	Melbourne	MSc	I.D. Rutherford (UM) M.J. Stewardson (UM)	UMSPS† and CRC	Assessing the capacity to deliver environmental floods from Victorian Dams. (6.7)
Asif Zaman	Melbourne	PhD	H. Malano (UM) B. Davidson (UM)	Northcote Trust (UK) and CRC	Estimating regional impacts of temporary water trading through integrated hydro-economic modelling. (3)

**Table B Postgraduates – CRC Associated/Additional Projects 2003-2004**

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Wijedasa Hewa Alankarage	Melbourne	PhD	H. Malano (UM) H. Turrall (IWMP, Sri Lanka) T.A. McMahon (UM) G. Smith (G-MW)	MRS# #, MIRSØ	Implication of water trading on system management and environmental flow: The case of Goulburn-Murray Irrigation Scheme, Victoria. (3.6)
Josephine Brown	Melbourne	PhD	I. Simmonds (UM)	MRS# #	The response of stable water isotopes in precipitation and the surface ocean to tropical climate variability. (5.3)
Dale Browne	Monash	PhD	A. Deletic (Monash) T. Fletcher (Monash) G. Mudd (Monash)	MDS(A)	Predicting the clogging of stormwater infiltration systems. (4)
Lisa Carpenter	Monash	PhD	A. Ladson (Monash) J. Doolan (DSE)	APAΔ	River indicators: are they useful in environmental management. (6)
Belinda Hatt	Monash	PhD	A. Deletic (Monash) T. Fletcher (Monash) P. Webley (Monash)	MDS(A) James McNeill scholarship	Stormwater treatment for re-use. (4)

Legend follows at end of Table B

## Program 8 Education and Training

**Table B Postgraduates – CRC Associated/Additional Projects 2003-2004 (continued)**

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Pandora Hope	Melbourne	PhD	I. Simmonds (UM)	MRS##	Shifts in Australia's circulation and rainfall source regions. (5.3)
Yong Li	Monash	PhD	A. Deletic (Monash) T. Fletcher (Monash)		Improving the universal stormwater treatment model. (4)
Nilmini Siriwardene	Monash	PhD	A. Deletic (Monash) T. Fletcher (Monash)	MDS(A)	Predicting the clogging of stormwater infiltration systems. (4)

† University of Melbourne Special Postgraduate Studentship supported by CRC

†† Monash University Graduate Scholarship

\* Monash University Departmental Scholarship supported by CRC

\*\* Melbourne University Postgraduate Scholarship

# Australian Postgraduate Award

## Melbourne Research Scholarship

Ø Melbourne International Research Scholarship (fee remission)

ØØ International Postgraduate Research Scholarship

Δ Australian Postgraduate Award Industry

ΔΔ Monash Graduate Scholarship

Ω Griffith University Postgraduate Research Award (ENS Faculty)

(A) Monash University Departmental Scholarship supported by external non-CRC funding

(1) Also located at The University of Melbourne

(2) Also located at CSIRO, Canberra

(3) Also located at DIPNR, Wagga Wagga

**Table C Higher Degrees (Research) Completed and Destination of Postgraduates 2003-2004**

Name	Degree, University	Supervisor(s)	Topic	Date Research Thesis Submitted or Passed	Destination
Wijedasa Hewa Alankarage	PhD, Melbourne	H. Malano (UM) H. Turrall (IWMP, Sri Lanka) T.A. McMahon (UM) G. Smith (G-MW)	Implication of water trading on system management and environmental flow: The case of Goulburn-Murray Irrigation Scheme, Victoria (3.6).	Submitted 15 January 2004	Engineer – Southern Rural Water.
Josephine Brown	PhD, Melbourne	I. Simmonds (UM)	The response of stable water isotopes in precipitation and the surface ocean to tropical climate variability (5.3).	Passed February 2004	Scientist – Centre for Global Atmospheric Modelling, University of Reading.
Teri Etchells	PhD, Melbourne	H. Malano (UM) T. A. McMahon (UM) B. James (DSE)	A methodology for calculating water trading exchange rates in the Murray-Darling Basin (3.1).	Submitted 9 March 2004	Research Fellow – Dept Civil & Environmental Engineering, The University of Melbourne.
Margaret Gooch	PhD, Griffith	J. Fien (Griffith) J. Warburton (UQ) R Rickson (Griffith)	Volunteers and sustainable catchment management (8).	Submitted 22 December 2003	Post doctoral Fellow (Mining & Society) – CSIRO Exploration and Mining.
Durga Kandel	PhD, Melbourne	R. Grayson (UM) A. Western (UM) H. Turrall (IWMP, Sri Lanka)	Temporal scaling issues in surface runoff and soil erosion modelling (1.2).	Submitted 12 September 2003	Researcher – Dept Civil & Environmental Engineering, The University of Melbourne.
Peter Kolotelo	MSc, Monash	J. Baldwin (Monash) R.J. Keller (Monash)	Improving the effectiveness of Australian fishway design (6).	Submitted 23 March 2004	Research Assistant – Dept Civil Engineering, Monash University.
Sara Lloyd	PhD, Monash	T.H.F. Wong (Monash)	Exploring impediments and opportunities of sustainable stormwater management schemes (4.2).	Submitted June 2004	Engineer – Melbourne Water.
Muthukaruppan Muthukumar	PhD, Melbourne	F.H.S. Chiew (UM) T.H.F. Wong (Monash)	Modelling quality and size distribution of contaminants in stormwater (4).	Submitted 17 December 2003	Engineer, Water Recycling – City West Water Ltd.
Dana Thomsen	PhD, Griffith	J. Fien (Griffith) M. Greenway (Griffith)	Community-based research (8.2).	Submitted 25 August 2003	Scientist – Integrating Sciences, within Community and Landscape Sciences, Department of Natural Resources and Mines, Qld

# Milestones Program 8

## Milestones

### Years 1 and 2

Package of courses and industry placements for PhD students in operation.

## Progress

A survey of postgraduate students regarding industry placements was conducted and informed the development of a database of student skills and industry placement preferences. Program 8 has since been involved in the facilitation of industry placements with agencies including Melbourne Water. Industry placement profiles of the CRC postgraduates have been developed and presented to CRC Parties at CRC Board meetings. Several CRC postgraduate students receive industry co-supervision. A range of needs-based courses was delivered for postgraduate students (eg. visual basic). External courses that may be relevant to the PhD cohort were also advertised via the student e-group.

Selected masters coursework subjects available for participating universities to share.

On the basis of a review of postgraduate offerings in this field, the CRC's strategic approach to this milestone has been to negotiate with providers rather than duplicate existing offerings

Framework for collaborative offering of courses developed.

The CRC supports researchers' training by organising regular events, maintaining an email bulletin to alert students to training opportunities, and by organising personal and professional activities in conjunction with the postgraduate support programs of Coastal and Sustainable Tourism CRCs.

Protocols for flexible delivery of courses in place.

On the basis of a review of postgraduate offerings in this field, the CRC's strategic approach to this milestone has been to negotiate with providers rather than duplicate existing offerings.

Training needs analysis for industry completed.

The training needs of industry stakeholders are identified and addressed by each research program through Communication and Adoption planning. "Train-the-trainer" materials were developed as an element of the "We All Use Water" curriculum package.

Action plan for community education, including schools, in catchment hydrology.

The CRC (in partnership with the Australian Water Association) completed a series of five workshops to promulgate the "We All Use Water" community education kit. The participants included approximately 100 local government and industry professionals engaged in community extension and education.

There have also been strong links formed with relevant State and national education curricula.

### Years 3,4 and 5

Regular program of short courses and workshops for all stakeholders operating.

Catchment Modelling School delivered 29 separate workshops (over 500 workshop places) during 9-20 February 2004. Very positive feedback and industry response.

*A new milestone, as follows, was approved by the Commonwealth, 16 July 2003:*

Run social science symposia in major capital cities to disseminate research outputs of social science knowledge developed during the first four years of Program 8 activity.

Series of symposia in CRC focus catchments held to communicate findings of Program 8 social science projects supported between 2000-2003. Brisbane (27/9), Canberra (29/9), Melbourne (30/9) and Emerald (3/10) workshops attracted approximately 120 participants in 2003-2004.

Collaborative delivery of postgraduate coursework programs.

*Deletion of this milestone was approved by the Commonwealth, 16 July 2003 and the following new milestone was approved:*

Development of an education and training framework for a consistent and informed approach to education and training across the CRC, including the development of education and training approaches or templates for use by CRC researchers.

The Education and Training framework has been developed to support CRC project teams in delivering research outcomes. The framework provides for staff training, preparation and analysis of participant feedback forms and support for the inclusion of CRC products in tertiary subject unit delivery.

Action plan to meet the requirements identified in the training needs analysis.

Implementation of action plan complete – the CRC has provided and brokered education and training activities to meet the needs of CRC postgraduates, researchers and stakeholders. Ongoing education and training activities included a 'People Skills' workshop for CRC postgraduates during March 2004.

Guidelines for systems approach to catchment management teaching methodology in undergraduate programs.

*Deletion of this milestone was approved by the Commonwealth, 16 July 2003 and a new milestone as follows approved:*

Provide education and training workshops for CRC researchers to assist them with the delivery of products to end-users.

A series of education and training workshops to Program teams was held during 2003-2004. This included workshops on modelling approaches and training for product managers.

# Management and Operating

*This Page Deputy Director Prof Tom McMahon*    *Opposite Page Left Deputy Director Erwin Weinmann, Right Business Manager, John Molloy*



## New appointments

**Director** Prof. Rodger Grayson  
The University of Melbourne  
(Succeeded Dr. Rob Vertessy, CSIRO, from April 2004)

**Deputy Director** Dr Peter Wallbrink  
CSIRO Land and Water  
(from April 2004)

## Program Leaders

Dr Peter Wallbrink  
CSIRO Land and Water  
Program Leader 2: Land-use Impacts on Rivers  
(Succeeded Dr Peter Hairsine, CSIRO, from January 2004)

David Perry, Monash University  
Program Leader, Program 7: Education and Training (Succeeded Dr Tim Smith and Dr James Whelan, Acting Program Leader, from January 2004)

## Research and Supporting Staff

A total of 162 staff were engaged in CRC activities during the year from the various contributing Parties and at various time fractions. The total full-time equivalent of cash funded and in-kind contributed staff was 52, with 48 involved in research.

## Postgraduates

There were 34 postgraduates active in CRC core programs and projects during 2003-2004.

A further eight were engaged on Associated/Additional research projects.

(Details are outlined in the Education and Training chapter).

## Research Facilities

The principal research facilities for the CRC are located at:

- CSIRO Land and Water, Canberra
- Griffith University, Nathan Campus, Qld
- Monash University, Clayton Campus
- Natural Resources and Mines, Indooroopilly, Qld
- The University of Melbourne, Parkville Campus

Research infrastructure such as laboratories, technical equipment, computer resources and libraries are provided by these principal locations. In addition, other CRC Parties also make significant research facilities available to the CRC.

## Other

The CRC's five Focus Catchments – Brisbane River in Queensland, Yarra River in Victoria, Fitzroy River in Queensland, Goulburn-Broken Rivers in Victoria and Murrumbidgee River in NSW - constitute a major element of the research sites and facilities available to the CRC. The Development Projects within these Focus Catchments are building on the CRC resources that are available in these catchments.

Other important research resources were supplied this year by CRC Parties including Brisbane City Council; Bureau of Meteorology; Department of Infrastructure, Planning and Natural Resources, NSW; Department of Sustainability and Environment, Victoria; Goulburn-Murray Water and Melbourne Water.

## Specified Personnel

**Dr Rob Vertessy**, CSIRO Land and Water  
(Centre Director to March 2004)

**Prof Rodger Grayson**, The University of Melbourne (Centre Director from April 2004)  
(Located at Department of Civil Engineering, Monash University)

**Prof Tom McMahon**, Department of Civil and Environmental Engineering, The University of Melbourne (Centre Deputy Director)

**Dr John Tisdell**, Faculty of Environmental Sciences, Griffith University (Centre Deputy Director, Program 3 Leader – Sustainable Water Allocation)

**Mr Erwin Weinmann**, Department of Civil Engineering, Monash University (Centre Deputy Director to 30 June 2004) (Succeeded by Dr Ana Deletic)

**Mr Geoff Podger**, Department of Infrastructure, Planning and Natural Resources, NSW (Program 1 Leader – Predicting Catchment Behaviour)

**Dr Peter Hairsine**, CSIRO Land and Water (Program 2 Leader - Land-use Impacts on Rivers, to December 2003)





**Dr Peter Wallbrink**, CSIRO Land and Water (Program 2 Leader - Land-use Impacts on Rivers, from January 2004, and Deputy Director from April 2004)

**Dr Tim Fletcher**, Department of Civil Engineering, Monash University (Program 4 Leader - Urban Stormwater Quality)

**Assoc Prof Francis Chiew**, Department of Civil and Environmental Engineering, The University of Melbourne (Program 5 Leader – Climate Variability)

**Dr Mike Stewardson**, School of Anthropology, Geography and Environmental Studies, The University of Melbourne (Program 6 Leader — River Restoration)

**Dr Tim Smith**, Faculty of Environmental Sciences, Griffith University (Program 8 Leader – Education and Training, to August 2003. Dr James Whelan acted as Program Leader to September 2003)

**Mr David Perry**, Monash University (Program 8 Leader - Education and Training, from January 2004)

Researcher	Percentage Time Actual	Agreement
Mr Erwin Weinmann	42	40 (to June 2004)
Mr Geoff Podger	41	50
Prof Tom McMahon	37	10
Assoc Prof Francis Chiew	100	80
Dr John Tisdell	100	70
Dr Rob Vertessy	82	100 (pro rata 75 to March 2004)
Prof Rodger Grayson	56	100 (pro rata 25 from April 2004)
Dr Peter Hairsine	13	75 (pro rata 38 to December 2003)
Dr Mike Stewardson	69	100
Dr Peter Wallbrink		30 (January 2004 to March 2004) (as Program Leader)
	32	70 (total pro rata 32 from April 2004) (also as Deputy Director)
Dr Tim Fletcher	85	100
Dr Tim Smith (Dr James Whelan was acting Program Leader)	20	50 (pro rata 25 to succession date December 2003)
Mr David Perry	100	100
<b>Total percentage</b>	<b>777</b>	<b>745 (total pro rata)</b>

# Public Presentations, Public Relations and Communication

*This Page Left* CRC Annual Workshop – Joel Rahman outlining aspects of Catchment Modelling Toolkit. *Right* CRC Annual Workshop, Yarra Valley – communication across industry and research participants

*Opposite Page Left* Catchment Modelling School 04 – Bob Ford (Central Highlands Water) with CRC staff Hugh Duncan, Dr Tim Fletcher and Dr Graham Jenkins. *Centre* Catchment Modelling School 04 – workshop on MUSIC software in progress. *Right* Presenters (l to r) Assoc Prof Bob Keller, Dr Tony Ladson, and Ross Hardy at workshop on rock chute design, August 2003



## Communication Activities

With land and water management issues now high on the public agenda, CRC staff members were regularly asked to communicate about the research work that the CRC is doing and its practical application.

Progress and the outputs of the Development Projects in the five Focus Catchments are being closely observed by many people in the industry, so staff from the Projects gave numerous presentations to local groups and stakeholders.

CRC staff gave public presentations on a variety of topics throughout the year, primarily on the CRC's research outcomes and modelling capabilities.

The public presentations by CRC staff, an expanded website and the dedicated web site for the CRC's Catchment Modelling Toolkit, contributed to an active and comprehensive communications program.

The CRC's monthly newsletter *Catchword* and the fortnightly internal news bulletin *CatchUp*, continued to provide concise and regular updates of CRC activities for the research community and prospective end-users of the CRC's technologies.

## Website

The CRC website ([www.catchment.crc.org.au](http://www.catchment.crc.org.au)) was revised this year and a new user-interface was introduced to make it easier to navigate and use. The website averages about 5000 visitors per month from across the world. About 30 per cent of the visitors return to the website twice or more each month (based on a monthly audit).

All first round project details were updated on the website during 2003-04. Reports detailing outcomes relevant to industry users were summarised at the Program level and then further end-of-project outcomes were detailed in specific project reports including Development Projects. These were all included on the updated site and are available as Adobe pdf files.



### Newsletters

One of the key communication vehicles for the CRC is the *Catchword* newsletter. In 2003-04, 11 issues were produced. Two 'bumper' issues were produced; the February 2004 edition featured a summary of research outcomes and the April 2004 edition presented detailed updates on the CRC's Development Projects.

At the end of June 2004, about 1500 people received *Catchword* (about 900 receive the newsletter by post and 600 by email). Interested people can request a subscription via the CRC website.

### Catchment Modelling Toolkit and Website

The Catchment Modelling Toolkit website is now running well with more than 1500 registered users. About 70 per cent of these users have become members since December 2003, indicating its increasing profile and product uptake. MUSIC v2 has more than 250 registered users and the number of people joining the MUSIC's eGroup continues to grow rapidly.

An important element of the success of the Toolkit is facilitating efficient communication channels between researchers and the users/user communities. To that end, the CRC is supporting users and developers through training, publications, information and individual response through on-line user support.

### Public presentations, briefings, seminars, workshops

The following tables outline the active communications across the CRC's various programs through public presentations, briefings, seminars and workshops.

### Public relations – interactions with communications media

The CRC used external media to communicate its activities and views. A table at the end of this section lists the newspapers, magazines, websites and TV sessions that featured CRC activities.

# Public Presentations, Public Relations and Communication

## Public Presentations 2003-2004

Date	Speaker(s)	Topic	Venue
10-11 July 2003	Dr Tim Fletcher (Monash)	Stormwater management – MUSIC and Water Sensitive Urban Design	Bendigo Stormwater Forum, LaTrobe University
5 August 2003	Dr Mike Stewardson (Uni Melb), Dan Borg (Uni Melb)	Restoration ecology in the Granite Creeks, Victoria (CRC Project 6.3)	Goulburn Research Day run by the Goulburn Broken Catchment Management Authority (GB CMA), Dookie Campus The University of Melb
8 August 2003	Justin Lewis (Monash)	The effectiveness of litter traps in removing syringes and litter	Association of Bayside Municipalities
12 August 2003	Dr Mike Stewardson (Uni Melb)	A career in water research	Engineers Australia Water Engineering Branch Student Night, Melbourne Town Hall
29 August 2003	Dr Mike Stewardson (Uni Melb)	Rehabilitation of the Snowy River	Lyceum Club
5 September 2003	Dr Mat Gilfedder (CSIRO)	Groundwater flow systems framework	Invited Speaker, University of Sydney
23 September 2003	Dr Andrew Western (Uni Melb)	Terrain analysis	Ian Moore Memorial Symposium, ANU, Canberra
2 October 2003	Prof Stuart Bunn (Griffith)	Monitoring river ecosystem health	Annual Symposium, Water Resources Environment Centre, Kitakyushu, Japan
4 October 2003	Prof Stuart Bunn (Griffith)	Riparian and river linkages: opportunities for restoring aquatic ecosystem health.	Annual Symposium, Ecology and Civil Engineering Society of Japan, Kitakyushu, Japan
9 October 2003	Hugh Duncan (Melb Water)	Urban stormwater management	The University of Melbourne
20 November 2003	Dr Mat Gilfedder (CSIRO)	Broad scale priority setting for land use change to impact river salinity	Deep Drainage Workshop, Cotton CRC, Narrabri
2-4 March 2004	Peter Briggs, Susan Campbell, Dr Edward King, Dr Jenny Lovell, Dr Tim McVicar (all CSIRO)	Applications of the CSIRO AVHRR Time Series: Monitoring the 2002-03 Drought	(Invited presentation) CSIRO Earth Observation Centre Annual Science Meeting, Melbourne, VIC
2-4 March 2004	Dr Tim McVicar, Dr David Jupp (both CSIRO)	Deriving hydrological information from hi-frequency environmental time series earth observation data using thermal and reflective data'	(Invited presentation) CSIRO Earth Observation Centre Annual Science Meeting, Melbourne, VIC
2-4 March 2004	Dr Michael Schmidt, Dr Edward King, Dr Tim McVicar (all CSIRO)	Development of a Web-based data and product delivery system for the CSIRO AVHRR Time Series (CATS): architecture, interface and processing descriptions	(Invited presentation) CSIRO Earth Observation Centre Annual Science Meeting, Melbourne, VIC

## Presentations or Briefings to Government, Industry, Research and other Organisations 2003-2004

Date	Speaker(s)	Topic	Organisation/Venue
16 July 2003	Assoc Prof Brian Finlayson (Uni Melb)	Land-use impacts in the Comet River Catchment, Central Queensland	School of Forestry, The University of Melbourne, Creswick, Vic
21 July 2003	Dr Robert Argent (Uni Melb)	The Catchment Modelling Toolkit... and the TIME model development environment	CSIRO Water for a Healthy Country, Highett, Victoria
18 August 2003	Assoc Prof Brian Finlayson (Uni Melb)	Water research at the University of Melbourne	WASH: Water Sanitation and Hygiene – first steps towards health and sustainability. Workshop presented by AIHI, Water Matters and TEAR Australia. The University of Melbourne,
24 August 2003	Dr Tim Fletcher (Monash)	Water Sensitive Urban Design	Coliban Regional Water Board Meeting
4 September 2003	Assoc Prof Brian Finlayson (Uni Melb)	Water - issues and reflections	Joint Standing Policy Committee of the Liberal Party (Victorian Division)
16 September 2003	Dr Tim Fletcher (Monash)	Water Sensitive Urban Design	South West Water Board
23 September 2003	Dr Jim Morris (DSE)	Water use by eucalypt plantations	Phoenix Pulp & Paper Co, Thailand (visiting delegation)
24 September 2003	Assoc Prof Brian Finlayson (Uni Melb)	Water policy in Victoria	Australian Labor Party, Ascot Vale Branch Meeting
2 October 2003	Dr John Tisdell (Griffith)	EMSS and Mwater models of the Stanley Catchment	Moreton Bay Waterways and Catchments Partnership
10 October 2003	Dr John Tisdell (Griffith)	EMSS and Mwater models of the Stanley Catchment	Moreton Bay Waterways and Catchments Partnership Scientific Advisory Group
17 October 2003	Dr Alan Seed (Bureau Met)	A model to generate stochastic nowcasts of rainfall: a work in progress	Bureau of Meteorology Research Centre workshop, BoM Head Office, Melbourne
22 October 2003	Dr Alan Seed (Bureau Met)	Advanced Forecaster Course	Bureau of Meteorology Training School

### Presentations or Briefings to Government, Industry, Research and other Organisations 2003-2004 (continued)

Date	Speaker(s)	Topic	Organisation/Venue
28 October 2003	Dr Mike Stewardson (Uni Melb) and Assoc Prof Brian Finlayson (Uni Melb)	RAP, Flow Events Method, Environmental Flows, Catchment Modelling School	Victorian Waterway Managers Forum, Dept Sustainability and Environment, Vic, East Melbourne
3 November 2003	Dr Robert Argent (Uni Melb)	Australia's Catchment Modelling Toolkit	International Water Management Institute (IWMI) Colombo, Sri Lanka
11 December 2003	Assoc Prof Brian Finlayson (Uni Melb)	The Snowy River Debate: which river would you like to "save"?	Royal Society of Victoria
15 December 2003	Prof Stuart Bunn (Griffith)	Riparian issues & opportunities for restoring aquatic ecosystem health in SEQ	Western Catchments NRM Group, Gatton, Qld
15 December 2003	Dr Jim Morris (DSE)	Plantation Investment Strategy – modelling plantation impacts	Dept Sustainability and Environment, Vic
28 January 2004	Prof Rodger Grayson (Univ Melb), Dr Robert Argent (Univ Melb)	Environmental management challenges for the Gippsland Lakes catchments	Combined meeting of the CRC for Clean Power from Lignite and the CRC for Catchment Hydrology, Churchill, Vic.
1– 5 February 2004	Prof Rodger Grayson (Uni Melb)	Progress through integration of models, data and field experiments	Australia – Japan, International Workshop on Prediction in Ungauged Catchments, Perth
1– 5 February 2004	Assoc Prof Francis Chiew (Univ Melb)	Hydrological modelling and Australian datasets for modelling	Australia – Japan, International Workshop on Prediction in Ungauged Catchments, Perth
16 February 2004	Prof Rodger Grayson (Uni Melb)	Water yield and water quality impacts of land-use change	West Gippsland Catchment Management Authority, Traralgon, Vic.
4 March 2004	Dr Robert Argent (Uni Melb)	Catchment Modelling Toolkit and E2 whole-of-catchment modelling	Dairy Catchments Project Workshop, Dairy Australia, Melbourne Airport
5 March 2004	Dr Christy Fellows (Griffith)	Riparian nutrient movement processes	Dairy Catchments Project Workshop, Dairy Australia, Melbourne Airport
11 March 2004	Assoc Prof Francis Chiew (Uni Melb)	Seasonal streamflow forecasts for water resources management	Water Liaison Committee, Murray-Darling Basin Commission, Canberra
12 March 2004	Dr Tim Fletcher (Monash), Dr Tony Ladson (Monash) Dr Chris Walsh (CRC for Freshwater Ecology, Monash)	Potential for retro-fitting urban areas to improve stream health	Maroochy Council, Maroochydore, Qld
22 March 2004	Scott Stevens, Bruce Cowie, Ken Rohde, Cameron Dougall (all NRM, Qld)	Fitzroy EMSS	Fitzroy Basin Association, Rockhampton
23 March 2004	Prof Rodger Grayson (Uni Melb)	Effects of land-use change on water yield	East Gippsland Catchment Management Authority, Bairnsdale, Vic.
23, 24 March 2004	Dr Robert Argent (Uni Melb)	Catchment Modelling Toolkit and E2 whole-of-catchment modelling	Land and Water Australia, Contaminants modelling workshop, Canberra
2 April 2004	Assoc Prof Bofu Yu (Griffith)	IQQM, WRAM and input-output analysis for Murrumbidgee catchment	DIPNR, Murrumbidgee Irrigation, Coleambally, River Jumper Association, and CSIRO; Sydney
23 April 2004	Chris Carroll (NRM, Qld)	Fitzroy Catchment and EMSS	Center for Integrated Resource Management (CIRM) Townsville
20 May 2004	Bruce Cowie (NRM, Qld)	Fitzroy EMSS erosion map	Fitzroy Basin Association, Rockhampton
2 June 2004	Dr Robert Argent (Uni Melb)	Overview and options for Gippsland Lakes and catchment modelling	Gippsland Lakes Task Force, Victoria
10 June 2004	André Taylor (Monash)	Use of non-structural measures to improve urban waterway health in SE Queensland.	The regional 'Urban Stormwater Information Group', Brisbane.

# Public Presentations, Public Relations and Communication

## CRC Seminars 2003-2004

Date	Speakers(s)	Topic	Venue
9 July 2003	Joel Rahman, (CSIRO)	A brief overview of TIME	CSIRO, Canberra
24 July 2003	Dr Mike Stewardson (Uni Melb)	Environmental Flows	MDBC, Canberra
31 July 2003	Dr Mike Stewardson (Uni Melb), Nick Marsh (Griffith)	RAP, Flow Events Method, Environmental Flows	DIPNR, Sydney
15 August 2003	Assoc Prof Bob Keller (Monash), Dr Tony Ladson (Monash)	CHUTE	Melbourne
7 October 2003	Dr Mike Stewardson (Uni Melb)	RAP, Flow Events Method, Environmental Flows	CSIRO Perth
15 October 2003	Dr Mike Stewardson (Uni Melb)	RAP, Flow Events Method, Environmental Flows	Dept of Environment, Perth
20-21 November 2003	Joel Rahman(CSIRO), Nick Murray (CSIRO) and Jean-Michel Perraud (CSIRO)	Model development using TIME	CSIRO Land and Water, Canberra
2-5 December 2003	André Taylor (Monash), Dr Eva Abal (Moreton Bay Waterways and Catchments Partnership)	CRC short-course presentations. Modules delivered included: "An Introduction to Life Cycle Costing Involving Structural Stormwater Quality Management Measures"; "The Scientific, Legislative, Policy and Administrative Framework for Stormwater Management In South East Queensland" and "Non-structural Best Management Practices for Urban Stormwater Quality Improvement"	'Chifley on Lennons' Hotel, Brisbane
2-5 December 2003	Dr Tim Fletcher (Monash) Assoc Prof Tony Wong (Monash), André Taylor (Monash), Dr Graham Jenkins (Griffith)	Stormwater management and water sensitive urban design	Brisbane City Council
10 December 2003	Dr Tony Ladson (Monash),	Retrofitting to reduce drainage connections	Melbourne
9 February 2004	Prof Russell Mein (Monash),	Catchment modelling capability for managers – an evolution upon us	Catchment Modelling School, University of Melbourne
10 February 2004	Dr Rob Vertessy (CSIRO)	How will the Catchment Modelling Toolkit support integrated catchment management?	Catchment Modelling School, University of Melbourne
11 February 2004	Dr Tim Fletcher (Monash), Dr Grace Mitchell(CSIRO)	Modelling tools for water resource management in urban areas	Catchment Modelling School, University of Melbourne
12 February 2004	Graeme Hannan (Goulburn-Murray Water)	The role of water allocation models in supporting water management decisions	Catchment Modelling School, University of Melbourne
14 February 2004	Dr Rob Vertessy Director CRC (CSIRO) Dr Kim Sung, Director SWRRC	Korean /Australian Symposium First Joint Symposium between the Sustainable Water Resources Research Centre (SWRRC), Korea, and the CRC for Catchment Hydrology Opening of Symposium	University of Melbourne
	Dr Kim Sung (SWRRC)	Sustainable Water Resources Research and Development Project	
	Dr Rob Vertessy (CSIRO)	Research programs of the CRC for Catchment Hydrology	
	Dr Ko Ickwhan (SWRRC)	Development of real-time water resources management system	
	Dr Robert Argent (Uni Melb)	The Toolkit Integration Blueprint	
	Dr Lee Jongkook (SWRRC)	Technology for hydrologic data acquisition and monitoring	
	Dr Tim Fletcher (Monash)	MUSIC and urban stormwater	
	Dr Namwon Kim (SWRRC)	Analysis and modelling for surface water hydrological components	
	Prof Rodger Grayson (Uni Melb)	An introduction to the E2 model	
	Prof Seo Ilwon (SWRRC)	Analysis and modelling of river flow and bed changes	
	Dr Mike Stewardson (Uni Melb)	Flow ecology relationships and the RAP software	
	Dr Rob Vertessy (CSIRO)	Closing address	
16 February 2004	Assoc Prof Francis Chiew (Uni Melb)	Stochastic climate data – how can it help to quantify uncertainty in hydrologic systems affected by climate variability	Catchment Modelling School, University of Melbourne
17 February 2004	Prof Sam Lake (Monash CRCFE), Dr Mike Stewardson (Uni Melb)	Environmental Flows	Catchment Modelling School, University of Melbourne
18 February 2004	Prof Rodger Grayson (Uni Melb)	Water quality modelling – matching models to applications	Catchment Modelling School, University of Melbourne
19 February 2004	Dr Tony Ladson (Monash),	Catchment-scale adaptive management and modelling	Catchment Modelling School, University of Melbourne

**Other Seminars 2003-2004**

Date	Speakers(s)	Topic	Venue
18 September 2003	Dr Mike Stewardson (Uni Melb)	Environmental Flows in Victoria: Recent developments and the Goulburn River scientific panel study	Water Engineering Branch, Engineers Australia University of Melbourne
15 October 2003	Dr Rob Vertessy (CSIRO)	The Catchment Modelling Toolkit – An update	Water Engineering Panel, Engineers Australia, Sydney Division, Sydney
6 November 2003	Dr Tony Ladson (Monash), Brett Anderson (Uni Melb)	Roughness characteristics of Victorian Rivers	Water Engineering Branch Meeting, Engineers Australia, Melbourne
29 January 2004	Dr Christy Fellows (Griffith)	Understanding nitrogen and carbon cycling to improve management of aquatic ecosystems	Meeting with Delegation from Ecology and Civil Engineering Society, Japan, and Foundation of Riverfront Improvement and Restoration, Japan; Griffith University, Nathan, Qld
3 May 2004	Dr Mike Stewardson (Uni Melb)	Recent Development in Environmental flow analysis	Engineers Australia, Perth
13 May 2004	Assoc Prof Tony Wong (Monash, Ecological Engineering), Hugh Duncan (Melb Water), Dr Grace Mitchell (CSIRO), Dr Peter Breen (Ecological Engineering)	Australian Runoff Quality Seminar	Engineers Australia, Melbourne Town Hall

**CRC Workshops/Field trips 2003-2004**

Date	Speakers(s)	Topic	Venue
30 June–4 July 2003	Joel Rahman (CSIRO) Shane Seaton (CSIRO) Nick Murray (CSIRO)	Constructing EMSS Models	CSIRO Land and Water, Canberra
15 August 2003	Assoc Prof Bob Keller (Monash) Ross Hardy (Earth Tech) Dr Tony Ladson (Monash) Dr John Tilleard (Earth Tech)	Design of rock chutes for stream bed stabilisation	Melbourne
23,24 September 2003	Dr Nanda Nandakumar (DIPNR) Erwin Weinmann (Monash)	CRC Forge	Water and Rivers Commission, WA
28, 29, 30 September, 3 October 2003	Dr James Whelan (Griffith) Dr Tim Smith (Griffith) CRC postgrads and CRC for Coastal Zone staff	Reflect, Respect and React 2003 (RRR03)	Melbourne, Canberra, Brisbane, Emerald - Qld
29, 30 October 2003	Joel Rahman (CSIRO) Shane Seaton (CSIRO) Nick Murray (CSIRO) Sue Cuddy (CSIRO)	TIME development with Visual Basic.NET	CSIRO Land and Water, Canberra
9 December 2003	Sara Lloyd (Melb Water) Peter Poelsma (Monash)	The function of Hampton Park wetland and the research and findings of the monitoring at this wetland	Clearwater WSUD and CRC field tour, Hampton Park
10 November 2003	Dr Mike Stewardson (Uni Melb), Dr Nick Marsh (Griffith)	River Analysis Program, Flow Events Method	Wollongong University
9 February 2004	Assoc Prof Bob Keller (Monash)	Basic flow profile modelling using HEC-RAS	Catchment Modelling School, University of Melbourne
9 February 2004	Assoc Prof Francis Chiew (Uni Melb)	Detecting trend and other changes in hydrological data	Catchment Modelling School, University of Melbourne
9,10 February 2004	Geoff Podger (DIPNR)	River basin and water allocation using the IQQM software (Integrated Quantity and Quality Model)	Catchment Modelling School, University of Melbourne
9,10,16,17 February 2004	Dr Tim Fletcher (Monash)	MUSIC (Version 2.0.0)	Catchment Modelling School, University of Melbourne
9,16 February 2004	Dr Nick Marsh (Griffith)	Environmental Flow Methodologies and the River Analysis Package (RAP)	Catchment Modelling School, University of Melbourne
10 February 2004	Assoc Prof Bob Keller (Monash)	Advanced flow profile modelling using HEC-RAS	Catchment Modelling School, University of Melbourne
10 February 2004	Dr Jeff McDonnell (Oregon State University)	Isotope tracers in Catchment Hydrology	Catchment Modelling School, University of Melbourne
11 February 2004	Assoc Prof Tony Wong (Monash)	Advanced MUSIC modelling	Catchment Modelling School, University of Melbourne
11,12 February 2004	Geoff Podger (DIPNR)	River management using the IQQM software (Integrated Quantity and Quality Model)	Catchment Modelling School, University of Melbourne

# Public Presentations, Public Relations and Communication

## CRC Workshops/Field trips 2003-2004 (continued)

Date	Speakers(s)	Topic	Venue
11,12,18,19 February 2004	Joel Rahman (CSIRO), Nick Murray (CSIRO), Jean-Michel Perraud (CSIRO), Shane Seaton (CSIRO), Jake MacMullin (CSIRO)	Model development using the Invisible Modelling Environment (TIME)	Catchment Modelling School, University of Melbourne
11,12,16,17, 18 February 2004	Dr Scott Wilkinson (CSIRO), Shane Seaton (CSIRO), Harold Hotham (CSIRO)	SedNet – sediment and nutrient budgets for river networks	Catchment Modelling School, University of Melbourne
11,12,13 February 2004	Assoc Prof Chris Perera (Victoria University of Technology)	Water supply system modelling using REALM	Catchment Modelling School, University of Melbourne
12,13 February 2004	Dr Grace Mitchell (CSIRO)	UVQ (Urban volume and quality): Conceptual modelling of innovative urban water servicing approaches	Catchment Modelling School, University of Melbourne
13 February 2004	Dr Christopher Clarke (Murdoch Uni, WA), Dr Robert Argent (Uni Melb)	Flowtube v2.1 – a simple groundwater computer model for assessing the impact of treatments on dryland salinity	Catchment Modelling School, University of Melbourne
13 February 2004	Assoc Prof Bofu Yu (Griffith)	Water Reallocation Model (WRAM)	Catchment Modelling School, University of Melbourne
16 February 2004	John Doherty (Watermark Numerical Computing)	Identifying and managing uncertainty in ground and surface water models	Catchment Modelling School, University of Melbourne
16,17 February 2004	Geoff Podger (DIPNR), Jean-Michel Perraud (CSIRO)	Rainfall Runoff Library (RRL) Software	Catchment Modelling School, University of Melbourne
16,19 February 2004	Tony McAlister (WBM), Joel Rahman (CSIRO), Dr Rob Argent (Uni Melb)	Using the EMSS	Catchment Modelling School, University of Melbourne
17 February 2004	Sue Cuddy (CSIRO)	Catchment Management Support System (CMSS)	Catchment Modelling School, University of Melbourne
17 February 2004	Dr Nick Marsh (Griffith)	Using the Hydraulic Analysis Module of the River Analysis Package (RAP)	Catchment Modelling School, University of Melbourne
17 February 2004	Assoc Prof Bob Keller (Monash)	Design of rock chutes for stream bed stabilisation using CHUTE; River bank stability and protective design using the program RIPRAP	Catchment Modelling School, University of Melbourne
17 February 2004	Assoc Prof Francis Chiew (Uni Melb)	Stochastic data generation models	Catchment Modelling School, University of Melbourne
18 February 2004	Dr Tim Fletcher (Monash), Assoc Prof Tony Wong (Monash)	MUSIC Trainer Accreditation course	The University of Melbourne
18 February 2004	Dr Nick Marsh (Griffith)	Using the Time Series Analysis Module of the River Analysis Package (RAP)	Catchment Modelling School, University of Melbourne
18 February 2004	Assoc Prof Bob Keller (Monash)	Stream crossing design using Minimum Energy Loss Structures (MELS)	Catchment Modelling School, University of Melbourne
18 February 2004	Dr Barry Croke (ANU)	IH ACRES rainfall-runoff model	Catchment Modelling School, University of Melbourne
18,19 February 2004	Dr Peter Coombes (University of Newcastle)	Rainwater tank and wastewater reuse modelling, key elements in water cycle analysis and sustainable development (PURRS)	Catchment Modelling School, University of Melbourne
19 February 2004	Assoc Prof Francis Chiew (Uni Melb)	Seasonal forecasting models	Catchment Modelling School, University of Melbourne
19,20 February 2004	Dr Lu Zhang (CSIRO)	WAVES – An integrated energy and water balance model	Catchment Modelling School, University of Melbourne
20 February 2004	Dr Lachlan Newham (ANU)	CatchMODS – a tool for catchment scale management of diffuse pollutant sources	Catchment Modelling School, University of Melbourne
1 March 2004	Dr Ana Deletic (Monash), Dr Tim Fletcher (Monash)	Integrated Stormwater Treatment and re-use	Brisbane City Council
23-25 March 2004	Dr Rob Vertessy (CSIRO)* Dr Emmett O'Loughlin* Dr Jim Gould (CSIRO)* Prof Peter Kanowski (ANU)* (* Keynote speakers)	Forest Management Workshop (organised by University of New South Wales, CRC for Catchment Hydrology, Forest Science Centre, New South Wales State Forests)	CSIRO Land and Water, Canberra
1, 2 April 2004	Joel Rahman (CSIRO) Nick Murray (CSIRO)	TIME workshop	CSIRO Land and Water Canberra
3-7 May 2004	Dr Mike Stewardson (Uni Melb)	Environmental Flows and the RAP	Perth Computer Training Centre
24, 25 June 2004	Joel Rahman (CSIRO) Nick Murray (CSIRO)	TIME workshop (Repeat workshop)	CSIRO Land and Water Canberra



### CRC Media References 2003-2004

Date (Page)	Medium	Title	CRC Representative/Aspect
July 2003 (21)	Australian R&D Review	Catchment Hydrology CRC to test modelling toolkit	Catchment Modelling Toolkit and research projects
23 July 2003	The Weekly Times	Tree farms should pay – expert (Article by Paul Sellars)	Dr Rob Vertessy (Plantation water use)
23 and 24 September 2003	Channel 10, Totally Wild	Research activity at Bridgewater Creek Wetland	Assoc Prof Margaret Greenway and Carolyn Polson
3 October 2003	Queensland Government website (www.smartstate.qld.gov.au/ssproject)	Finding ways to help our precious water catchments and streams	Local scale environment management support system (LEMSS), with comments by Peter Loose, Pine Rivers Shire Council
October 2003 (4)	Land and Water News (LAWN)	Report on afforestation impact on seasonal flow	Comments on study undertaken in Goulburn Broken Focus Catchment
October 2003, Issue 87 (12)	Letter from Melbourne	Technical bits – one of the best on-line newsletters	<i>Catchword</i> website referenced under 'Utilities – Water'
October 2003, Issue 28 (5)	FOCUS on Salt, Newsletter of Australia's National Dryland Salinity Program	Good news for catchment managers	Outline by Prof John Langford and Dr Rob Vertessy of new project portfolio
April 2004 (4)	Land and Water News (LAWN)	New Chief of CSIRO Land and Water	Dr Rob Vertessy's appointment
April 2004, Edition No 9 (5)	Water Ways Clearwater (www.clearwater.asn.au)	CRC Non-Structural BMP Reports	Details of CRC reports available

# Grants and Awards

*This Page* Left Teri Etchells, awarded postdoctoral fellowship by The University of Melbourne. Right Assoc Prof Francis Chiew, winner of Tison Award 2004



## Awards 2003-2004

**Assoc Prof Francis Chiew,**  
The University of Melbourne:  
*Tison Award 2004 (for best paper published by the International Association of Hydrological Sciences)*

**Teri Etchells,**  
The University of Melbourne:  
*Awarded, in March 2004 by The University of Melbourne, Faculty of Engineering, one of three postdoctoral fellowships made available for women only after an exemption from the Equal Opportunity Act was granted.*

**Assoc Prof Brian Finlayson,**  
The University of Melbourne:  
*Royal Society of Victoria Research Medal for 2002 (Category III: Earth Sciences) – awarded December, 2003*

**Dr Jim Morris,**  
Department of Sustainability and Environment, Vic, and staff of the Eucalypts and Water project (CRC Associated/Additional Project 2.7)  
*Department of Sustainability and Environment Recognition Program, Leadership Award December 2003.*

## Grants 2003-2004

No.	Name of the Researcher(s) Awarded the Grant	Researcher's Organisation	Title of project for which Grant is awarded	Source of the Grant	Period of the Award	Amount of the Grant \$000's
1	Assoc Prof Francis Chiew	The University of Melbourne	Hydroclimate variability and Melbourne's water resources	Melbourne Water	2004	100
2	Assoc Prof Francis Chiew (with Prof Anthony Jakeman, Australia National University)	The University of Melbourne	Improved water management incorporating risk and climate awareness	Land and Water Australia	2003	50
3	Dr Ana Deletic	Monash University	Predicting the clogging of stormwater infiltration systems	ARC Discovery	2004-06	181
4	Dr Ana Deletic and Dr Tim Fletcher	Monash University	Development of novel integrated stormwater treatment and re-use technologies	Victorian Stormwater Action Program	2003-05	57
5	Dr Ana Deletic and Dr Tim Fletcher	Monash University	Development of novel integrated stormwater treatment and re-use technologies	Brisbane City Council & Queensland EPA	2004-06	140
6	Dr Ana Deletic and Dr Tim Fletcher	Monash University	Development of novel integrated stormwater treatment and re-use technologies	NSW EPA	2003-2004	45
7	Dr Ana Deletic, Dr Tim Fletcher, Dr Tony Ladson	Monash University	Institute for Sustainable Water Resources	Monash Research Fund: New Research Areas	2004-05	550
8	Dr Tim Fletcher	Monash University	Understanding stormwater treatment wetland behaviour – improving nitrogen removal efficiency	Melbourne Water	2003-2004	25
9	Dr Tim Fletcher	Monash University	Identifying and overcoming barriers to adoption of water sensitive urban design	Melbourne Water	2003-2004	63
10	Dr Tim Fletcher	Monash University	Understanding wetland inter-event behaviour	Melbourne Water	2003-2005	80
11	Prof Rodger Grayson	The University of Melbourne	Arid zone salt processes	ARC Discovery	2004-2006	267
12	Prof Rodger Grayson	The University of Melbourne	Use of gravity (GRACE) for soil moisture monitoring over large scales	ARC Discovery	2003-2005	358
13	Prof Rodger Grayson	The University of Melbourne	PLMR – airborne radio	ARC Infrastructure	2004	689
14	Prof Rodger Grayson	The University of Melbourne	River health indicators for arid zone rivers	Land and Water Australia	2003-2005	350
15	Prof Rodger Grayson (awarded with Prof Barry Hart, Monash University)	The University of Melbourne	NRM risk management	Land and Water Australia	2003-2004	500
16	Prof Rodger Grayson	The University of Melbourne	Remote sensing and data assimilation for coastal modelling	CSIRO – The University of Melbourne Joint research program	2004	25
17	Prof Rodger Grayson (awarded with Assoc Prof Francis Chiew)	The University of Melbourne	Pilot study of producing soil moisture maps for Australia	CASS foundation	2004	50
18	Dr Tim McVicar (with Mr Peter Briggs, Dr Edward King and Dr Michael Raupach)	CSIRO Land and Water	Review of monitoring and predictive modelling from a natural resource management perspective: the role of remote sensing of the terrestrial environment	Bureau of Rural Sciences, Canberra, Australia	2003-2004	10
19	Dr Jim Morris (with Dr Pat Lane, DSE; Dr Lu Zhang, CSIRO; Dr Craig Beverly, Department of Primary Industries, Vic)	Department of Sustainability and Environment (DSE)	Predicting and managing the impacts of commercial plantations on catchment water balances	Forest and Wood Products R&D Corporation (FWPRDC)	2004-2006	250
20	Dr Andrew Western (with Dr Alessandro Simoni, University of Bologna)	The University of Melbourne	Visiting Research Scholar Award	The University of Melbourne	2003	6

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# Glossary

<b>AEAM</b>	Adaptive Environmental Assessment Modelling
<b>AFFA</b>	Agriculture, Fisheries and Forestry – Australia (Commonwealth Department)
<b>BCC</b>	Brisbane City Council
<b>BC2C</b>	Biological capacity to change – software model for catchment land and water analysis
<b>BoM</b>	Bureau of Meteorology
<b>BRS</b>	Bureau of Rural Sciences
<b>CHUTE</b>	Computer program for hydraulic design of rock chute for stream stabilisation
<b>CCDSM</b>	Catchment Categorisation for Dryland Salinity Management project
<b>COAG</b>	Council of Australian Governments
<b>CRC</b>	Cooperative Research Centre
<b>CRC-Forge</b>	Computer software methodology for extreme rainfall analysis
<b>DIPNR</b>	Department of Infrastructure, Planning and Natural Resources, NSW
<b>DSE</b>	Department of Sustainability and Environment, Vic
<b>DSS</b>	Decision Support System
<b>EMSS</b>	Environmental Management Support System
<b>ET</b>	Evapotranspiration
<b>FCC</b>	Focus Catchment Coordinator
<b>GEWEX</b>	Global Energy and Water Experiment (a component of the World Climate Research Program)
<b>ICMS</b>	Interactive Component Modelling System (formerly Integrated Catchment Management System); one of three frameworks for building and linking catchment hydrology models being used by the CRC Toolkit Project (see also TARSIER and TIME)
<b>IQQM</b>	Integrated Quantity and Quality Monitoring – water allocation software methodology and model
<b>L&amp;WA</b>	Land and Water Australia (formerly Land and Water Resources Research and Development Corporation) (Commonwealth R&D Corporation)
<b>LEMSS</b>	Local-Scale Environmental Management Support System
<b>LUOS</b>	Land Use Options Simulator, software model for land use including salinity aspects
<b>Macaque</b>	Computer model for forest hydrology applications in large catchments
<b>MDBC</b>	Murray-Darling Basin Commission
<b>MUSIC</b>	Model for Urban Stormwater Improvement Conceptualisation – CRC computer software methodology
<b>Mwater</b>	A water market experimental methodology to evaluate alternative water trading rules and procedures in mature water markets
<b>NHT</b>	Natural Heritage Trust (Commonwealth Government)
<b>NLWRA</b>	National Land and Water Resources Audit (Commonwealth Government, funded by NHT)
<b>NRM</b>	Natural Resources and Mines, Qld
<b>NWP</b>	Numerical Weather Prediction
<b>RRL</b>	Rainfall Runoff Library – a catchment modelling tool containing several rainfall runoff models
<b>RAP</b>	River Analysis Package – software to combine hydraulic models, visualisations and analysis of time series with aquatic ecology/ habitat requirements
<b>R&amp;D</b>	Research and development
<b>REALM</b>	Computer model for predicting catchment water balance
<b>SCL</b>	Stochastic Climate Library – stochastic models for generating rainfall and climate data
<b>SedNet</b>	Software to assist in building sediment and nutrient budgets
<b>SEQRWQMS</b>	South East Queensland Regional Water Quality Management Strategy
<b>S_PROG</b>	Model for nowcasting (forecasting rainfall one to two hours in advance)
<b>TAG</b>	Technical Advisory Group (expert panel for CRC projects)
<b>TARSIER</b>	A framework for building and linking catchment hydrology models; one of three being used by the CRC Catchment Modelling Toolkit Project (see also TIME and ICMS)
<b>TIME</b>	The Invisible Modelling Environment; one of three frameworks for building and linking catchment hydrology models being used by the CRC Catchment Modelling Toolkit Project (see also TARSIER and ICMS)
<b>TOPOG</b>	Computer model developed for forest hydrology applications in small or experimental catchments
<b>TREND</b>	Statistical tests for detecting trend/change and randomness in time series hydrological data
<b>WRAM</b>	Water Re-Allocation Model, an economic optimisation model to simulate water demand and trading
<b>WSUD</b>	Water Sensitive Urban Design

# Performance Indicators 2003 – 2004

# Performance Indicators

## Objectives of the Centre

Nature of Indicator	Performance Target over life of Centre	Measure Leading	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Outcome</b>									
Economic benefit to Centre	Adding value to intellectual capital at least equal to CRC Commonwealth funding	Building intellectual capital	Maximising value of intellectual capital	Demonstrated application of Centre's public good research	11 major collaborative research projects. Research projects (11) underway. Further 3 in July 2000.	19 collaborative core research projects and 5 major contract research projects (17 core projects) underway.	19 collaborative core research projects and 11 major contract research projects with two completed.	34 collaborative core research projects including 15 new projects and 13 major contract research projects 9 core research projects completed.	34 collaborative core research projects including 15 new projects and 16 major contract research projects (\$0.15m funding and above). 5 Development projects underway. 11 core research projects completed.
Additional income (contract research) of \$10.1 m over life of Centre	Additional income provision	Budget	Additional contract income in year	Cumulative income	Research Contracts with AFFA, LWRADC, MDIBC, SEQRWQMS. Contract income \$0.05m for 99/2000 of total \$0.92m in contracts to date. [Includes \$0.03m from direct CRC contract/consulting work]	Research Contracts with AFFA, LWRADC, MDIBC, SEQRWQMS. Contract income \$0.79m for 2000/01 of total \$1.47m in contracts to date. [Includes \$0.18m from direct CRC contract/consulting work]	Research Contracts with AFFA, LWA, MDIBC, SEQRWQMS. EPA. Contract income \$1.70m for 2001/02 of total \$3.20m in contracts to date. [Includes \$0.21m from direct CRC contract/consulting work]	Research Contracts with AQIAR, AFFA, LWA, MDIBC, SEQRWQMS. EPA. Contract income \$1.65m for 2003/4 of total \$6.23m in contracts to date. [Includes \$0.73m to date from direct CRC contract/consulting work]	Research Contracts including AQIAR, AFFA, LWA, MDIBC, EPAVIC. Contract income \$1.65m for 2003/4 of total \$6.23m in contracts to date. [Includes \$0.73m to date from direct CRC contract/consulting work]
Economic benefit to user core participants	Actual or future potential benefits more than 3 times total resources committed	Dissemination of Centre IP to Parties.	Access to Centre IP and know-how	Actual benefit achieved or achievable by core user participants	IP access: Communication and Adoption Program underway. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing. Toolkits and involvement in Development Projects also benefits core participants.
Economic benefit to Australia	Actual or future potential benefits more than 5 times total resources committed	Potential economic benefit assessed	Completed economic benefit assessments for projects	Actual benefit achieved or achievable	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan and in application for successor CRC, eWater CRC.
Economic benefit — other	Public benefit from positive environmental impact	Potential economic benefit assessed	Completed assessments of public good potential benefit for projects	Public good benefit achieved	Overall indicative economic benefits highlighted in Business Plan. Assessments of national economic benefits to follow project completions	Overall indicative economic benefits highlighted in Business Plan. Assessments of national economic benefits to follow project completions	Overall indicative economic benefits highlighted in Business Plan. Assessments of national economic benefits to follow project completions	Overall indicative economic benefits highlighted in Business Plan. Assessments of national economic benefits to follow project completions	Overall indicative economic benefits highlighted in Business Plan and in application for successor CRC, eWater CRC.
<b>Input</b>									
Total resources	\$67.7 m total resources	Agreement	Actually committed	Cumulative resources	Parties/Grant Total Agreement commitment of \$57.6m.	Parties/Grant Total Agreement commitment of \$57.6m.	Parties/Grant Total Agreement commitment of \$57.6m.	Parties/Grant Total Agreement commitment of \$57.6m.	Parties/Grant Total Agreement commitment of \$57.6m.
Cash resources	Total leverage > 4:1 vs Commonwealth cash \$33.6m cash resources 49% of total resources	Agreement	Actually committed	Cumulative resources	\$6.1 m committed to 30 June 2000.	\$11.8 m committed by Parties to 30 June 2001.	\$18.0m committed by Parties to 30 June 2002.	\$24.1m committed by Parties to 30 June 2003.	\$31.3m committed by Parties to 30 June 2004.
<b>Process</b>									
Program/Project Management	Project initiation, management, review and evaluation systems	Adoption of project management approach	Quarterly reports Regular project reviews	Projects completed on time and on budget	Monthly Project finance reporting continuing. Quarterly Project reporting format upgraded.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.

## Objectives of the Centre (continued)

Nature of Indicator	Performance Target over life of Centre	Measure Leading	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Outputs</b>	Centre Publications transferring research outcomes & technology to industry	50 Centre reports planned	Number in preparation	Number issued	3 Industry Reports (one 2nd Ed), 14 Technical Reports, 5 videos and 5 Working Documents published since July 99. Email notification and database established with 590 recipients. 11 issues of monthly newsletter issued (890 in hard copy, 200 emailed – includes Website posting).	12 Technical Reports and 2 videos published. Email notification and database established with 760 recipients. 11 issues of monthly newsletter issued (890 in hard copy, 360 emailed – includes Website posting). Approx 2000 visits to CRC website per month with over 700 visiting more than twice per month.	10 Technical Reports and 1 Manual published. Email notification and database established with 850 recipients. 11 issues of monthly newsletter issued (950 in hard copy, 450 emailed – includes Website posting). Approx 3000 visits to CRC website per month with over 900 visiting more than once.	11 Technical Reports and one Industry Report published. Email notification and database established with 850 recipients. 11 issues of monthly newsletter issued (780 in hard copy, 540 emailed – includes Website posting). Approx 3500 visits to CRC website per month with over 900 visiting more than twice per month.	15 Technical Reports published. Email notification and database established with 850 recipients. 11 issues of monthly newsletter issued (890 in hard copy, 600 emailed – includes Website posting). Approx 5000 visits to CRC website per month with over 1600 visiting more than twice per month. 4000 visits per month to Catchment Modelling Toolkit website.
Industry Seminars	50 Seminars	Number planned	Number each year	Total number completed	5 Industry Seminars presented since July 99. 14 Technical Seminars	19 CRC Technical Seminars presented	31 CRC Technical Seminars presented	8 CRC Technical Seminars presented	19 CRC Technical Seminars presented
Industry Workshops	20 Workshops	Number planned	Number each year	Total number completed	7 CRC workshops since July 99	14 CRC Workshops/field tours given	18 CRC Workshops/field tours given	30 CRC Workshops/field tours/short courses given	42 CRC Workshops/field tours/short courses given
<b>Quality and Relevance of the Research Program</b>									
<b>Outcome</b>	Scientific status and user satisfaction	Demonstrated research quality	Scientific review of planned projects	Annual review for scientific status and user satisfaction	Cumulative results	Technical Advisory Groups involved in developing projects. Project review panels established for projects. Independent science review included in project review panel tasks.	Technical Advisory Groups involved in developing projects. 11 Project review panels held in year to June 2002. Independent science review included in project review panel tasks.	Technical Advisory Groups involved in developing projects. 13 Project review panels held in year to June 2003. Independent science review included in project review panel tasks.	Technical Advisory Groups involved in developing projects. Global review held in two stages in year to June 2004 with very positive outcomes.
<b>Input</b>	Research program resources	\$46m total cash and in-kind resources on research program	Technical Advisory Groups (TAGs) for Research Programs	User input to planned projects	Strategic plan	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels	User satisfaction with Catchment Modelling Toolkit assessed in part with supportive feedback on Catchment Modelling School.
<b>Process</b>	Advisory committees/groups	Technical Advisory Groups (TAGs) for Research Programs	Roles defined, meetings scheduled	Membership, meetings held	Extent of involvement and contribution to research directions and management	Technical Advisory Groups established and used in developing projects.	Technical Advisory Groups established and used in developing projects.	Technical Advisory Groups established and used in developing projects.	Technical Advisory Groups established and used in developing projects.
<b>Outputs</b>	Involvement of research users	User driven selection, review and termination of applied projects	Project selection	Consultation and project monitoring	Project reviews	Research users strongly represented in project formulation stages and Technical Advisory Groups and review panels established for projects. Independent science review included in project review panel tasks	Research users strongly represented in project formulation stages. Technical Advisory Groups and Communication and Adoption Plans. Project review panels held for core projects. Independent science review included in project review panel tasks	Research users strongly represented in project formulation stages. Technical Advisory Groups and Communication and Adoption Plans. Project review panels held for core projects. Independent science review included in project review panel tasks	Research users strongly represented in project formulation stages. Technical Advisory Groups and Communication and Adoption Plans. Independent Global Review held for core projects.
<b>Outputs</b>	External publications	100 publications in refereed journals	100 papers in international conferences	100 papers in national conferences	Total number published	69 refereed papers published/accepted in 2000/01.	33 refereed papers published/accepted in 2001/02.	66 refereed papers published/accepted in 2002/03.	30 refereed papers published/accepted in 2003/04.
					Number of publications submitted	Over 40 refereed papers submitted 99/2000.	24 international conference papers submitted 2000/01	35 international conference papers accepted/published in 2002/03	21 international conference papers accepted/published in 2003/04
					Number planned	41 Australian conference papers submitted 99/2000	37 Australian conference papers in 2000/01	41 Australian conference papers in 2002/03.	56 Australian conference papers in 2003/04

# Performance Indicators

## Strategy for Utilisation and Application of Research Outputs

Nature of Indicator	Performance Target over life of Centre	Measure Leading	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Outcome</b>	Development of approaches to improve land and water management and adoption by end-users	Demonstration of approaches to improve land and water management catchments in Centre's focus	Communication and adoption activities planned	Communication and adoption of Centre research outcomes and end-users in focus catchments	Communication and Adoption planning framework developed for new Programs. Pilot undertaken with industry users for Urban Stormwater Quality Program.	Communication and Adoption planning framework adopted for Programs.	Communication and Adoption planning framework adopted for Programs.	Communication and Adoption planning framework adopted for Programs.	Communication and Adoption planning framework adopted for Programs.
<b>Input</b>	Resources devoted to communication and adoption program	Minimum \$1m cash and in-kind on communication and adoption program	Strategic plan – Commercialisation and adoption strategy	Cumulative resources	Total \$1.5m cash and in-kind expenditure for 99/2000 on Communication and Adoption Program	Total \$2.2m cash and in-kind expenditure for 2000/01 on Communication and Adoption Program	Total \$3.1m cash and in-kind expenditure for 2001/02 on Communication and Adoption Program	Total \$2.8m cash and in-kind expenditure for 2002/03 on Communication and Adoption Program	Total \$3.5m cash and in-kind expenditure for 2003/04 on Communication and Adoption Program
<b>Process</b>	User core participant resources	\$21m core user participant resources	Agreement	Cumulative resources	Total \$21.8m committed by core user Parties in Agreement. Contributions of \$2.3 m 99/2000. 47% of total contributions by core users, 99/2000.	Total \$21.8m committed by core user Parties in Agreement. Contributions of \$3.2m 2000/01. Cumulative total \$5.5m	Total \$21.8m committed by core user Parties in Agreement. Contributions of \$3.3m in 2001/02. Cumulative total of \$9.3m.	Total \$21.8m committed by core user Parties in Agreement. Contributions of \$3.3m in 2002/03. Cumulative total of \$12.6m.	Total \$21.8m committed by core user Parties in Agreement. Contributions of \$4.5m in 2003/04. Cumulative total of \$17.1 m. 63% of total contributions by core users, 2003/04.
<b>Process</b>	Communication and implementation of Centre research outcomes & technology	Integration of communication and adoption (technology transfer) principles into Programs/projects and focus catchments	Appointment of Program Leader – Communication and Adoption. Appointment of 5 site coordinators.	External independent review of Communication and Adoption Program at end of years 1, 3 & 5	Appointments completed for Program Leader and Focus Catchment Coordinators. Meetings held Dec. 99 and February 2000. Workshop early April 2000 for Program Leaders and Focus Catchment Coordinators.	Workshops held October 2000, early April 2001 for Program Leaders and Focus Catchment Coordinators.	Workshops held October 2001, January 2002 and April 2003 for Program Leaders and Focus Catchment Coordinators.	Workshops held September 2002, October 2002 and April 2003 for Program Leaders and Focus Catchment Coordinators.	Major software products and approaches presented at Catchment Modelling School, February 2004. Program Leaders and Focus Catchment Coordinators Workshop held March 2004 and CRC Annual Workshop for all participants also held March 2004. Research and technology, including postgraduate projects, presented.
<b>Outputs</b>	Centre products	Monthly newsletter to over 1400 industry end-users. 14 Major updates of Centre Web site, 20 Industry seminars, 30 Technical seminars, 15 Industry reports and videos, 35 Technical reports, 15 Field tours and demonstrations of Centre products, 20 Workshops, 20 Targeted short courses, 4 Contributions to influential trade journals.	Number planned	Total number completed	Monthly newsletter continuing: copies to 1000 subscribers (surveyed need) and available on CRC website. Since July 99, second major update of Website underway. 5 Industry Seminars presented since July 99. 14 technical seminars since July 99, 3 Industry Reports, 14 Technical Reports, 5 Videos and 5 Working Documents issued since July 99. 2 Field Tours held since July 99, 4 day Stormwater Management short course planned for October 2000. 5 industry articles. CRC contribution/ features for AWA Journal. 'Water' being prepared for Nov/Dec 2000 issue	Monthly newsletter continuing: copies to 1250 subscribers (surveyed need) and available on CRC website. Second major update of Website completed. 19 Technical seminars, 12 Technical Reports, 2 Videos issued, 1 Field Tour, 13 CRC workshops held, 15 industry articles, 9 CRC contribution/ features in AWA Journal. 'Water'.	Monthly newsletter continuing: copies to 1400 subscribers (surveyed need) and available on CRC website. 30 Technical seminars, 10 Technical Reports, 1 Manual, 3 Field Tours, 18 CRC workshops held, 6 industry articles.	Monthly newsletter continuing: copies to 1320 subscribers (surveyed need) and available on CRC website. 8 Technical seminars, 11 Technical Reports and one Industry Report, 3 Short Courses [1 field course, 2 training courses], 27 CRC workshops held, 4 industry articles.	Monthly newsletter continuing: copies to 1490 subscribers and available on CRC website. 19 Technical seminars, 15 Technical Reports, 2 Short Courses [training courses], 1 Field tour, 39 CRC workshops held, 4 major website upgrades, 0 industry articles. Cumulative totals: 6 Website upgrades, 5 Industry Seminars, 90 Technical Seminars, 4 Industry Reports, 62 Technical Reports, 5 short courses, 7 Field Tours, 102 Workshops, 30 Industry/trade articles



## Collaborative Arrangements

Nature of Indicator	Performance Target over life of Centre	Measure Leading	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Outcome</b>	Cooperation in research within Australian and overseas and more efficient use of resources	Number planned	Number implemented	Total number completed	New collaborative arrangements being established with ANU; Coastal Zone CRC and Freshwater Ecology CRC; others being planned	New collaborative arrangements being established with ICAM(ANU); NAWA(NZ); close collaboration with University of Texas and Univ Nth Carolina, USA.	New collaborative arrangements being established with UNSW; close collaboration with University of Natal Univ Nth Carolina, USA, Univ of Leuven, Belgium.	New collaborative arrangements being established with WBM, Earth Tech, Ecological Engineering, SKM, and Sustainable Water Resources Research Centre, Korea, joined as Research Affiliates. Close collaboration with University of Natal, SA; Univ of Rhodes Univ, S. Africa; State Univ Calif –Monterey; Univ of Leuven, Belgium; Met Office UK; NIWA NZ; ICAM ANU.	WBM, Earth Tech, Ecological Engineering, SKM, joined as Industry Affiliates. Sustainable Water Resources Research Centre, Korea, joined as Research Affiliates. Close collaboration with University of Natal, SA; Univ of Rhodes Univ, S. Africa; State Univ Calif –Monterey; Univ of Leuven, Belgium; Met Office UK; NIWA NZ; ICAM ANU; Univ California, Berk; Univ Newcastle, NSW;
<b>Input</b>	Research providers contributed resources	\$19.5m total cash and in-kind	Agreement	Cumulative resources	\$2.6m committed by Research providers to 99/2000.	\$3.1m committed by Research providers in 2000/01.	\$3.0m committed by Research providers in 2001/02.	\$2.8m committed by Research providers in 2002/03.	\$2.6m committed by Research providers in 2003/04.
	Research providers FTEs in-kind	11.4 FTE in-kind	Agreement	Cumulative resources	10.6 FTE for 99/2000 Increased level expected for later years.	12.7 FTE for 2000/01 23.3 FTE Cumulative	13.0 FTE for 2001/02 36.3 FTE Cumulative	11.7 FTE for 2002/03 48.0 FTE Cumulative	10.5 FTE for 2003/04 58.5 FTE Cumulative
<b>Process</b>	Collaboration between researchers	All projects to involve two or more Parties	Average number of Parties proposed per agreement	Average cumulative number of Parties per project	Average of 5 Parties for 11 Agreements signed February 2000.	Average of 4.4 Parties for 11 Agreements signed February 2000 to June 2001.	Average of 4.4 Parties for 21 Core Project Agreements signed to June 2002.	Average of 4.1 Parties for 41 Core Project Agreements signed to June 2003.	Average of 4.1 Parties for 41 Core Project Agreements signed to June 2004.
	Participants workshop each year	Workshop planned for year	Number attending	Total number of participant workshops held and cumulative attendance	Workshop held 4-6 April 2000 (Mt Buffalo)	Workshop held 3-5 April 2001 (Cobram-Barooga)	Workshop held 16-18 April 2002 (Ballarat)	Workshop held 8-10 April 2003 (Yanco, NSW)	Annual Workshop held 15-18 March 2004 (Yarra Valley, Dixons Creek, Vic)
	Collaboration between researchers and research users	University and non-University supervisors for 75% of postgraduate students	Percentage planned	Cumulative percentage of students with university and non-university supervisors	Currently over 50% of postgraduates have both university and non-university supervisors	Currently over 34% of postgraduates have both university and non-university supervisors	Currently 29% of postgraduates have both university and non-university supervisors	Currently 36% of postgraduates have both university and non-university supervisors	Currently 36% of postgraduates have both university and non-university supervisors
	International collaboration Associate membership program	Centre researchers involved in 3 international collaborations per year	Number planned for year	Cumulative number of international collaborations	Collaborative arrangements developed for projects including Projects 1.1(Univ Edinburgh), 4.1(Univ Essen), 5.1(WMO), 6.5 (Univ Alberta). Other collaborations occurred with Prog 1 – IUFRO (Vertessy), Prog 2 – NIWA, NZ (Seed). 6 in total listed	Collaborative arrangements developed for projects including Projects 1.1(Univ of Texas, Univ of N. Carolina), 1.2 (Univ of Vienna, Univ of Uppsala), 2.2 (C. Univ of Leuven) 4.1/4.2 (Colorado State Univ), 5.1 (Univ Calif.) (WMO), 5.2 (Univ of Natal), 6.5 (Univ Alberta). Other collaborations occurred with Prog 1 – Univ of Cincinnati (Vertessy); Prog 5 – NIWA, NZ (Seed). 12 in total listed	Collaborative arrangements developed for projects including Projects 1.1 (HTW, Saarlandes, Germany; RIZA, Netherlands; California State Univ, Univ of Cincinnati; Univ of N. Carolina, Univ of Texas), 1.2 (Univ of Vienna), 2.2 (C. Univ of Leuven), 5.1 (Univ of Leuven), 5.1 (Univ Alberta). Other collaborations occurred with Prog 1 – Catalonia, Spain; Met Office UK), 5.2 (Univ of Natal), 6.7 (CEMAGREF, France). 12 in total listed	Collaborative arrangements developed for projects including Program 1 (California State Univ; Pusan National University, Korea; SWRRDC, Korea; Univ of Vienna); Program 2 (China Eucalypt Centre, Leizhou Forest Bureau, Institute of Soils and Water Conservation, China; Drainage Research Institute, Egypt); Program 4 (Chalmers Univ Sweden; INSA, France; Penine Water Research Group); Program 5 (McGill Univ, Canada; Massey Univ, NZ; Met Office UK; Univ California, Berkeley; Univ of Natal, South Africa). 15 in total listed 60 cumulative.	Collaborative arrangements developed including Program 1 (California State Univ; Pusan National University, Korea; SWRRDC, Korea; Univ of Vienna); Program 2 (China Eucalypt Centre, Leizhou Forest Bureau, Institute of Soils and Water Conservation, China; Drainage Research Institute, Egypt); Program 4 (Chalmers Univ Sweden; INSA, France; Penine Water Research Group); Program 5 (McGill Univ, Canada; Massey Univ, NZ; Met Office UK; Univ California, Berkeley; Univ of Natal, South Africa). 15 in total listed 60 cumulative.
	75% of postgraduate students to present at one international conference	Number planned for year	Number attended in year	Cumulative number	Presentations in 99/2000 by 5 postgraduates at Intl confs: Haupt, Hoang, Jordan, McLannet, Wilkinson.	Presentations in 2000/01 by 2 postgraduates at Intl confs: Lloyd, Wilkinson. 7 Cumulative.	Presentations in 2001/02 by 3 postgraduates at Intl confs: Bartley, Eley, McKergow. 10 Cumulative.	Presentations in 2002/03 by 2 postgraduates at Intl confs: Barton, Lloyd. 12 Cumulative.	Presentations in 2003/04 by postgraduate at Intl conf: M.Francey 13 cumulative.

# Performance Indicators

## Collaborative Arrangements (continued)

Nature of Indicator	Performance Target over life of Centre	Measure Leading	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Process</b> of industry staff to research providers	5 Associates (by Year 4)	Number planned in year	Number of secondments in year	Total number	SA Water joined. State Forests of NSW renewed.	SA Water continuing involvement. State Forests of NSW renewed.	WA Water Corporation joined as Associate.	WA Water Corporation continuing involvement as Associate.	WA Water Corporation continuing involvement as Associate.
<b>Outputs</b> 12 secondments to research providers	12 secondments to research providers	Secondments planned in year	Number of secondments in year	Cumulative number of secondments	H Duncan (Melb Water) and J Green (DLWC) (part of year) at Monash Univ.	H Duncan (Melb Water) and (part of year) R O'Neill (DLWC), M Selzer (Goulburn-Murray Water), B James (DNPRE) at Monash Univ.	H Duncan (Melb Water), J Green (DLWC) at Monash Univ.	H Duncan (Melb Water) and M Francey (Melb Water) (part-time) at Monash; G Podger and M Littleboy (DIPNR) part-time at CSIRO.	H Duncan (Melb Water) and M Francey (Melb Water) (part-time) at Monash; G Podger and M Littleboy (DIPNR) part-time at CSIRO. Cumulative 16 (part) secondments
Secondments of research provider staff to industry	12 secondments to industry	Secondments planned in year	Number of secondments in year	Cumulative number of secondments	L Sriwardana located at Bureau of Met for part of year	S Lloyd and J Lewis located at Melbourne Water for part of year	Cumulative 3 (part) secondments.	J-M Perraud (CSIRO) part-time at DIPNR offices in Parramatta, NSW	T. Fletcher (Monash) part-time at Brisbane City Council, Qld. Cumulative 5 (part) secondments
Collaborative publications and authors from other organisations)	100 collaborative publications	Number planned in year	Number published in year	Total number	10 refereed journal papers and 12 conference papers – all with external collaborators	14 refereed journal papers and 12 conference papers – all with external collaborators	14 refereed journal papers and 23 conference papers – all with external collaborators	11 refereed journal papers and 17 conference papers – all with external collaborators	11 refereed journal papers and 11 conference papers – all with external collaborators. Cumulative 135 collaborative publications
<b>Education and Training</b>									
<b>Outcome</b> Training and equipping postgraduate students as future leaders in research & management	All postgraduates employed	Students trained in job skills	Employment of graduating students	Number employed.	Postgraduate skills training being planned. Further interaction with industry provided in Annual workshop.	Postgraduate skills workshop held April 2001. Further interaction with industry provided in Annual workshop.	Postgraduate Project Management workshop held April 2002. Further interaction with industry provided in Annual workshop.	Postgraduate Numerical modelling - Visual Basic workshop held April 2003. Further interaction with industry provided in Annual workshop.	Postgraduate People Skills workshop held March 2004. Further interaction with industry provided in Annual workshop.
Education benefit – postgraduate students employed in user or related industry	50% of postgraduate students employed in user or related industry			% employed in user or related industry	Postgraduates*: Feikema, Haupt, Jordan, Richards, Sriwardhana, Sornes with user industry. Davis, Heron, McClannet, Scanton, and Stewardson with research providers *Submitted theses in 99/2000	Postgraduates*: Hoang, Lewis, Sabaratham, Tilleard with user industry. Roberts with research providers. *Submitted theses in 2000/01	Postgraduates*: Akeroyd, Bailey, Linton, Vaze with user industry. Bartley, Marsh, Motha, Peilheram, Thomas, Wilkinson with research providers. *Submitted theses in 2001/02	Postgraduates*: White, Woods with user industry. Barron, McKergow with research providers. *Submitted theses in 2002/03	Postgraduates*: Alankarage, Lloyd, Muthukumar with user industry. Brown, Etchells, Gooch, Kandel, Koletelo, Thomsen with research providers. *Submitted theses in 2003/04

## Education and Training (continued)

Nature of Indicator	Performance Target over life of Centre	Measure Leading	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Outcome</b>	Increase in knowledge and skill base available for land and water management in Australia. Education benefit - other	Number planned	Number per year and number attending	% employed in user or related industry Cumulative number of courses and attendees	208 attended courses/workshops on: Continuous simulation system for design flood estimation Nov 99(15), Planning and design of stormwater management measures, Nov 99 (30); Settling priorities for stream restoration, Dec 99(25); Hydrology and Hydraulics for Floodplain Managers May 2000 (33); Urban stormwater monitoring Protocol workshop May 2000 (25); Urban Stormwater Field workshop – examples of best practice (80)	Over 490 attended courses/workshops on: Hydrology and Hydraulics for floodplain managers - Design flood flow estimation, July 2000(45); Water sensitive urban design – Field trip, July 2000 (90); Murrumbidgee 2000, July 2000 (85); Water sensitive urban design, Aug 2000 (90); Hydrology and hydraulics for floodplain managers – Flood level estimation, Oct 2000(35); Regional Planning and design of urban stormwater management measures, Oct 2000 (17); Hydrology and hydraulics for floodplain managers – Design of flood mitigation measures, Nov 2000 (31); Stochastic hydrology, Feb 2001 (25); Environmental management support system: March 2001 (25); MUSIC(Model for urban stormwater improvement conceptualisation, April 2001 (12); MUSIC(Model for urban stormwater improvement conceptualisation, May 2001(14); Tarsier developers workshop, May 2001 (12); Future issues workshop, May 2001(38); 698 Cumulative	Over 640 attended courses/workshops on: MUSIC, 8-9 July 2002 (30); MUSIC, 10-12 July 2002 (30); Water Trading, 15 July 2002 (12); Water Trading, 16 July 2002 (12); MUSIC, 15-16 July 2002 (30); Water Trading, 18 July 2002 (12); MUSIC, 18-19 July 2002 (30); Field methods for data acquisition, 23-26 July 2002 (40); We all use water, August 2002 (25); Characteristics of effective NRM groups, 5 Sept 2002 (80); Local scale EMSS, 11 Sept 2002 (15); MUSIC, 16 Sept 2002 (20); MUSIC, 23 Sept 2002 (12); Stormwater quality monitoring, 4 Oct 2002 (6); Mwater Murrumbidgee, 5-6 Nov 2002 (14); Mwater G-MW, 7 Nov 2002 (10); Stream restoration products, 12 Nov 2002 (30); MUSIC users forum, 27 Nov 2002 (35); MUSIC training, 28-29 Nov 2002 (25); MUSIC users forum, 10 Dec 2002 (35); CRC-Forge, 10 Dec 2002 (9); River Analysis Package, 10 Feb 2003 (6); EMSS development project training, 20-21 Feb 2003 (20); Biometrics methods, 11 Mar 2003 (10); Water markets – Mwater, 28 Mar 2003 (12); Numerical modelling – Visual basic, 6-7 April 2003 (24); SMHYD for EMSS, 29-30 April 2003 (18); CRC-Forge, 14-15 May 2003 (7); Experimental data analysis, 4-5 June 2003 (4); Water quality modelling decision support, 24 June 2003 (30). 1778 Cumulative	Total 705 attended courses/workshops on: EMSS Models, 30 June-4 July 2003 (12); Rock chutes, 15 Aug 2003 (40); CRC-FORGE Application in WA, 23-24 Sept 2003 (6); Reflect, Respect and React 2003, 28, 29, 30 Sept, 3 Oct 2003 (142); TIME development, 30 Oct 2003 (6); Hampton Park wetland, 9 Dec 2003 (40); Catchment Modelling School (29 separate topics), 9-18 Feb 2004 (317); Stormwater Treatment and Re-use, 1 Mar 2004 (20); Forest Management Workshop, 23-25 March 2004 (76); TIME, 1-2 April 2004 (4); Environmental Flows, RAP, 3-7 May 2004 (30); TIME, 24-25 June 2004 (12) 2483 Cumulative	
<b>Input</b>	Education and training Program resources	\$6.1m cash and in-kind resources	Strategic plan	Actually committed	Cumulative resources used	\$1.05m for 2000/01 \$1.58m Cumulative	\$1.09m for 2001/02 \$2.67m Cumulative	\$1.20m for 2002/03 \$3.87m Cumulative	\$1.25m for 2003/04 \$5.12m Cumulative
<b>Process</b>	Industry training	All students to undergo industry induction	Planning of induction	Number of students inducted in year	Cumulative number inducted	Industry placements program being developed (S. Lloyd with Melbourne Water on specific project)	Industry placements program developed (S. Johnson at Melbourne Water)	Industry placements program commenced.	Industry placements program on hold.
<b>Outputs</b>	PhD program	12 full scholarships	Number planned	Number in year	Cumulative number Awarded	Five rounds of scholarships advertised [Aug/Sept, Oct, Nov 2000; Mar/April 2001]. Best, Etchells, Gooch, Guzdinski, Lyburner, Newton, Rancburn, Thomsen, White C. awarded scholarships and/or top-ups.	One round of scholarships advertised [Oct 2001] Biggin, Griffin, Henderson, Johnson, Jurd, Potter, Taylor, Woods awarded scholarships and/or top-ups.	One round of scholarships advertised [Oct 2002] Bayley, Borg, Capon, Clowes, Francey, Howes, Rebegetz, Vietz, Zaman awarded scholarships, industry support, and/or top-ups.	No further scholarships sought as projects move into final stages. 30 Cumulative total scholarships /top-ups/industry support.

# Performance Indicators

## Management Structure and Arrangements

Nature of Indicator	Measure Target over life of Centre	Measure Real Time	Measure Lagging	Report of Activities and Achievements for 99/00	Report of Activities and Achievements for 00/01	Report of Activities and Achievements for 01/02	Report of Activities and Achievements for 02/03	Report of Activities and Achievements for 03/04
<b>Outcome</b> Continuity of long term research effort	Satisfaction of Parties	Annual Party survey results	Cumulative results	Survey to be planned.	Survey to be planned. (CRC Parties included in Communications survey in 2000/01)	Board reviewed its performance in 2001/02. Parties' further survey to be planned.	Parties confirmed support and involvement with three-year projects.	Parties confirmed support and involvement with: Active support and in-kind resources for Development Projects; Planning for extension of Development Projects by 3 Industry Parties; Commitment by all existing Parties to successor CRC application.
<b>Input</b> Total cash and in-kind resources in general administration program	\$2m cash and in-kind resources	Strategic plan	Cumulative resources	\$0.54m total expenditure 99/2000.	\$0.35m total expenditure 2000/01. Cumulative total \$0.89m	\$0.41m total expenditure 2001/02. Cumulative total \$1.30m	\$0.43m total expenditure 2002/03. Cumulative total \$1.73m	\$0.43m total expenditure 2003/04. Cumulative total \$2.16m
<b>Process</b> Governing Board	Representatives for each Party Majority of user and independent members on Governing Board	Chair and number of members	Performance review	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (*3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (*3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (*3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (*3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (*3 Rural Water Authorities share one Board representative)
Occupation at Health and Safety	Incident and accident free workplaces	OH&S training, Risk identification and assessment procedures	OH&S incident/accident performance	First Aid courses attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses/ laboratory safety training/defensive driving/4WD training attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses/ laboratory safety training/defensive driving/4WD training attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses/ laboratory safety training/defensive driving/4WD training attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers
Project management skills	All program/project leaders attend one course	Selection and planning of Project Management /leadership training for Program/projects	Cumulative number of program/project leaders who attended courses	New Program/Project leaders to be invited to attend training courses where appropriate.	New Program/Project leaders to be invited to attend training courses where appropriate.	Project management course held for postgraduates, April 2002 Budget provided for Program/Project leaders to attend training courses where appropriate.	Program/Project leaders funded to attend training courses where appropriate.	Program/Project leaders funded to attend training courses where appropriate.
<b>Outputs</b> Financial management	Programs and projects within budget	Program budgeting for year ahead and three years	Budget versus actual performance within year	Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2000 Board (14 projects) Project Budget performance: All projects under budget for 99/2000.	Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2001 Board (21 projects) Project Budget performance: 17 projects under cash budget for 2000/01. Total cash 83% of budget.	Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2002 Board (22 projects) Project Budget performance: 12 projects under cash budget for 2001/02. Total cash 95% of budget.	Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2003 Board (22 projects) approved Nov 2002, and May 2003 Board Project Budget performance: 20 projects under cash budget for 2002/03. Total cash 96% of budget.	Program budgeting: Program budgeting included in planning for next two years as part of budget approved June 2004. Project Budget performance: 18 projects under cash budget for 2003/04. Total cash 100% of budget.
Monthly, quarterly and Annual report on time	Completion by required dates each year	Preparation of reports	Timeliness within year	Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time.	Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time.	Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time.	Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time.	Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time.

Financial Information, Audit  
Financial Information (Tables) 2003 – 2004  
and Report to Commonwealth

# Financial Information (Tables) 2003 – 2004 and Report to Commonwealth

**Table 1(a) In-Kind Contributions from Parties (Dollars in \$'000's)**

Participant	ACTUAL EXPENDITURE					CUMULATIVE TOTAL TO DATE		04/05 YEAR 6		05/06 YEAR 7		GRAND TOTAL		
	99/00 YEAR 1 Actual	00/01 YEAR 2 Actual	01/02 YEAR 3 Actual	02/03 YEAR 4 Actual	03/04 YEAR 5 Actual	Actual	Agrmt	Budget	Agrmt	Budget	Agrmt	Total 7 Yrs	Diff 7 Yrs	
<b>Brisbane City Council</b>														
Salaries	147	11	12	34	46	250	140	28	28	28	28	306	196	110
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	263	359	364	376	403	1,765	1,860	372	372	372	372	2,509	2,604	(95)
<b>Total</b>	<b>410</b>	<b>370</b>	<b>376</b>	<b>410</b>	<b>449</b>	<b>2,015</b>	<b>2,000</b>	<b>400</b>	<b>400</b>	<b>400</b>	<b>400</b>	<b>2,815</b>	<b>2,800</b>	<b>15</b>
<b>Bureau of Meteorology</b>														
Salaries	80	189	142	124	135	670	685	137	137	137	137	944	959	(15)
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	160	358	293	268	282	1,361	1,420	284	284	284	284	1,929	1,988	(59)
<b>Total</b>	<b>240</b>	<b>547</b>	<b>435</b>	<b>392</b>	<b>417</b>	<b>2,031</b>	<b>2,105</b>	<b>421</b>	<b>421</b>	<b>421</b>	<b>421</b>	<b>2,873</b>	<b>2,947</b>	<b>(74)</b>
<b>CSIRO Land &amp; Water</b>														
Salaries	417	451	470	381	273	1,992	2,115	423	423	423	423	2,838	2,961	(123)
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	552	598	623	505	361	2,639	2,805	561	561	561	561	3,761	3,927	(166)
<b>Total</b>	<b>969</b>	<b>1,049</b>	<b>1,093</b>	<b>886</b>	<b>634</b>	<b>4,631</b>	<b>4,920</b>	<b>984</b>	<b>984</b>	<b>984</b>	<b>984</b>	<b>6,599</b>	<b>6,888</b>	<b>(289)</b>
<b>Department of Infrastructure, Planning &amp; Natural Resources NSW (formerly DLWC)</b>														
Salaries	107	77	167	159	505	1,015	755	151	151	151	151	1,317	1,057	260
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	74	58	112	107	314	665	510	102	102	102	102	869	714	155
<b>Total</b>	<b>181</b>	<b>135</b>	<b>279</b>	<b>266</b>	<b>819</b>	<b>1,680</b>	<b>1,265</b>	<b>253</b>	<b>253</b>	<b>253</b>	<b>253</b>	<b>2,186</b>	<b>1,771</b>	<b>415</b>
<b>Department of Natural Resources, Mines &amp; Energy, Qld.</b>														
Salaries	110	94	447	249	306	1,206	900	180	180	180	180	1,566	1,260	306
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	189	216	727	439	522	2,093	1,690	338	338	338	338	2,769	2,366	403
<b>Total</b>	<b>299</b>	<b>310</b>	<b>1,174</b>	<b>688</b>	<b>828</b>	<b>3,299</b>	<b>2,590</b>	<b>518</b>	<b>518</b>	<b>518</b>	<b>518</b>	<b>4,335</b>	<b>3,626</b>	<b>709</b>

**Table 1(b) In-Kind Contributions from Parties (Dollars in \$'000's)**

Participant	ACTUAL EXPENDITURE										CUMULATIVE TOTAL TO DATE		04/05 YEAR 6		05/06 YEAR 7		GRAND TOTAL		
	99/00 YEAR 1	00/01 YEAR 2	01/02 YEAR 3	02/03 YEAR 4	03/04 YEAR 5	03/04 YEAR 5	03/04 YEAR 5	03/04 YEAR 5	03/04 YEAR 5	03/04 YEAR 5	Actual	Agrmt	Budget	Agrmt	Budget	Agrmt	Total	Diff	
	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Agrmt	Agrmt	Budget	Agrmt	Budget	Agrmt	7 Yrs	7 Yrs	
<i>Department of Sustainability and Environment, Vic.</i>																			
Salaries	75	318	194	158	202	187	187	947	935	187	187	187	187	187	187	1,321	1,309	12	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	122	356	236	202	231	230	1,147	1,150	230	230	230	230	230	230	230	1,607	1,610	(3)	
<b>Total</b>	<b>197</b>	<b>674</b>	<b>430</b>	<b>360</b>	<b>433</b>	<b>417</b>	<b>2,094</b>	<b>2,085</b>	<b>417</b>	<b>417</b>	<b>417</b>	<b>417</b>	<b>417</b>	<b>417</b>	<b>417</b>	<b>2,928</b>	<b>2,919</b>	<b>9</b>	
<i>Griffith University</i>																			
Salaries	200	237	255	246	233	231	1,171	1,148	231	231	231	231	231	231	231	1,633	1,610	23	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	214	344	317	308	295	292	1,478	1,453	292	292	292	292	292	292	292	2,062	2,037	25	
<b>Total</b>	<b>414</b>	<b>581</b>	<b>572</b>	<b>554</b>	<b>528</b>	<b>523</b>	<b>2,649</b>	<b>2,601</b>	<b>523</b>	<b>523</b>	<b>523</b>	<b>523</b>	<b>523</b>	<b>523</b>	<b>523</b>	<b>3,695</b>	<b>3,647</b>	<b>48</b>	
<i>Melbourne Water</i>																			
Salaries	69	93	100	106	155	76	523	380	76	76	76	76	76	76	76	675	532	143	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	93	236	244	250	286	226	1,109	1,130	226	226	226	226	226	226	226	1,561	1,582	(21)	
<b>Total</b>	<b>162</b>	<b>329</b>	<b>344</b>	<b>356</b>	<b>441</b>	<b>302</b>	<b>1,632</b>	<b>1,510</b>	<b>302</b>	<b>302</b>	<b>302</b>	<b>302</b>	<b>302</b>	<b>302</b>	<b>302</b>	<b>2,236</b>	<b>2,114</b>	<b>122</b>	
<i>Monash University</i>																			
Salaries	334	257	292	250	258	270	1,391	1,350	270	270	270	270	270	270	270	1,931	1,890	41	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	384	305	340	298	306	318	1,633	1,590	318	318	318	318	318	318	318	2,269	2,226	43	
<b>Total</b>	<b>718</b>	<b>562</b>	<b>632</b>	<b>548</b>	<b>564</b>	<b>588</b>	<b>3,024</b>	<b>2,940</b>	<b>588</b>	<b>588</b>	<b>588</b>	<b>588</b>	<b>588</b>	<b>588</b>	<b>588</b>	<b>4,200</b>	<b>4,116</b>	<b>84</b>	
<i>Goulburn-Murray Water</i>																			
Salaries	18	16	23	22	101	22	180	110	11	11	11	11	11	11	11	202	132	70	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	52	50	59	48	152	48	361	266	24	24	24	24	24	24	24	409	314	95	
<b>Total</b>	<b>70</b>	<b>66</b>	<b>82</b>	<b>70</b>	<b>253</b>	<b>70</b>	<b>541</b>	<b>376</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>611</b>	<b>446</b>	<b>165</b>	

# Financial Information (Tables) 2003 – 2004 and Report to Commonwealth

**Table 1 (c) In-Kind Contributions from Parties (Dollars in \$'000's)**

Participant	ACTUAL EXPENDITURE										CUMULATIVE TOTAL TO DATE		04/05 YEAR 6		05/06 YEAR 7		GRAND TOTAL	
	99/00 YEAR 1 Actual	00/01 YEAR 2 Actual	01/02 YEAR 3 Actual	02/03 YEAR 4 Actual	03/04 YEAR 5 Actual	03/04 YEAR 5 Agrmt	Actual	Agrmt	Budget	Agrmt	Budget	Agrmt	Total 7 Yrs	Diff 7 Yrs	Total 7 Yrs	Diff 7 Yrs		
<b>The University of Melbourne</b>																		
Salaries	112	306	184	234	265	200	1,101	1,000	200	200	200	1,501	1,400	101				
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Other	116	316	190	241	273	206	1,136	1,030	206	206	206	1,548	1,442	106				
Total	228	622	374	475	538	406	2,237	2,030	406	406	406	3,049	2,842	207				
<b>Total In-Kind Contributions</b>																		
Salaries	1,669	2,049	2,286	1,963	2,479	1,905	10,446	9,518	1,894	1,894	1,894	14,234	13,306	928				
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Other	2,219	3,196	3,505	3,042	3,425	2,977	15,387	14,904	2,953	2,953	2,953	21,293	20,810	483				
<b>Grand Total In-Kind (T1)</b>	<b>3,888</b>	<b>5,245</b>	<b>5,791</b>	<b>5,005</b>	<b>5,904</b>	<b>4,882</b>	<b>25,833</b>	<b>24,422</b>	<b>4,847</b>	<b>4,847</b>	<b>4,847</b>	<b>35,527</b>	<b>34,116</b>	<b>1,411</b>				



**Table 2 Cash Contributions (Dollars in \$'000's)**

Participant	ACTUAL EXPENDITURE							CUMULATIVE TOTAL TO DATE Actual	04/05 YEAR 6 Budget	05/06 YEAR 7 Budget	Total Agrmt 7 Yrs	Diff 7 Yrs
	99/00 YEAR 1 Actual	00/01 YEAR 2 Actual	01/02 YEAR 3 Actual	02/03 YEAR 4 Actual	03/04 YEAR 5 Actual	03/04 YEAR 5 Agrmt	04/05 YEAR 6 Agrmt					
Brisbane City Council	50	50	50	50	50	50	250	50	50	50	350	-
Bureau of Meteorology	50	50	50	50	150	100	350	-	50	-	350	-
CSIRO Land & Water	100	100	100	100	100	100	500	100	100	100	700	-
Dept. Infrastructure, Planning & Natural Resources, NSW	100	100	100	100	125	125	525	525	100	75	700	-
Dept. Natural Resources, Mines & Energy, Qld.	100	100	100	100	100	100	500	500	100	100	700	-
Dept. Sustainability & Environment, Vic.	100	100	100	100	100	100	500	500	100	100	700	-
Griffith University	50	50	50	50	50	50	250	250	50	50	350	-
Melbourne Water	50	50	50	50	50	50	250	250	50	50	350	-
Monash University	100	100	100	100	150	150	550	550	100	50	700	-
Murray-Darling Basin Commission	50	50	50	50	100	100	300	300	50	-	350	-
Goulburn-Murray Water	150	150	150	150	150	150	750	750	150	150	1,050	-
Southern Rural Water	30	30	30	30	30	30	150	150	30	30	210	-
Wimmera Mallee Water	60	60	60	60	60	60	300	300	60	60	420	-
The University of Melbourne	50	50	50	50	75	75	275	275	50	25	350	-
<b>Total Cash from Participants</b>	<b>1,040</b>	<b>1,040</b>	<b>1,040</b>	<b>1,040</b>	<b>1,290</b>	<b>1,240</b>	<b>5,450</b>	<b>5,400</b>	<b>990</b>	<b>1,040</b>	<b>7,280</b>	<b>7,280</b>
<b>Other Cash</b>												
Non-participants	78	83	30	-	-	-	191	-	-	-	191	-
External Grants	-	-	-	-	-	-	-	-	-	-	-	-
Contract Research (See Note B Below)	32	152	30	125	284	1,800	623	5,200	2,300	2,600	5,523	(4,577)
Commercialisation	61	-	118	176	247	-	602	-	-	-	602	-
Education	-	-	-	-	-	-	-	-	-	-	-	-
Interest	66	118	105	68	41	-	398	-	-	-	398	-
<b>Total Other Cash</b>	<b>237</b>	<b>353</b>	<b>283</b>	<b>369</b>	<b>572</b>	<b>1,800</b>	<b>1,814</b>	<b>5,200</b>	<b>2,300</b>	<b>2,600</b>	<b>6,714</b>	<b>(3,386)</b>
CRC Grant	2,242	2,600	2,600	2,600	2,600	2,600	12,642	12,642	2,600	1,000	16,242	-
<b>Total CRC Cash Contribution (T2)</b>	<b>3,519</b>	<b>3,993</b>	<b>3,923</b>	<b>4,009</b>	<b>4,462</b>	<b>5,640</b>	<b>19,906</b>	<b>23,242</b>	<b>5,890</b>	<b>4,440</b>	<b>30,236</b>	<b>(3,386)</b>
Cash From Previous Year	527	1,775	2,118	1,388	528	-	-	-	-	-	-	-
Less Unspent Balance	1,775	2,118	1,388	528	543	-	-	-	-	-	-	-
<b>Total Cash Expenditure (T3)</b>	<b>2,271</b>	<b>3,650</b>	<b>4,653</b>	<b>4,869</b>	<b>4,447</b>	<b>5,640</b>	<b>19,890</b>	<b>23,242</b>	<b>5,890</b>	<b>4,440</b>	<b>30,220</b>	<b>(3,402)</b>
<b>Allocation of Cash Expenditure Between Heads of Expenditure</b>												
Salaries	1,232	2,067	2,349	2,424	2,308	3,005	10,380	12,382	3,165	2,366	15,911	(2,002)
Capital	-	-	-	27	-	-	27	-	-	-	27	-
Other	1,039	1,583	2,304	2,418	2,139	2,635	9,483	10,860	2,725	2,074	14,282	(1,427)
<b>Total Cash Expenditure (T3)</b>	<b>2,271</b>	<b>3,650</b>	<b>4,653</b>	<b>4,869</b>	<b>4,447</b>	<b>5,640</b>	<b>19,890</b>	<b>23,242</b>	<b>5,890</b>	<b>4,440</b>	<b>30,220</b>	<b>(3,402)</b>

Note A: Changes in timing of cash contributions for years 5 and 7 approved by Commonwealth, 16 July 2003 Note B: See also Contract Research listed in chapter on "Commercialisation, Utilisation and Application of Research".

# Financial Information (Tables) 2003 – 2004 and Report to Commonwealth

**Table 3 Summary of Resources Applied to Activities of Centre (Dollars in \$'000's)**

	ACTUAL EXPENDITURE										GRAND TOTAL			
	99/00	00/01	01/02	02/03	03/04	03/04	03/04	04/05	05/06	Total		Diff 7 Yrs		
	YEAR 1 Actual	YEAR 2 Actual	YEAR 3 Actual	YEAR 4 Actual	YEAR 5 Actual	YEAR 5 Actual	YEAR 5 Actual	YEAR 6 Budget	YEAR 7 Budget	7 Yrs Agrmt	7 Yrs Agrmt			
Grand Total In-Kind Table 1 (T1)	3,888	5,245	5,791	5,005	5,904	4,882	25,833	24,422	4,847	4,847	4,847	35,527	34,116	1,411
Grand Total Cash Table 2 (T3)	2,271	3,650	4,653	4,869	4,447	5,640	19,890	23,242	5,890	4,440	4,440	30,220	33,622	(3,402)
Total Resources Applied to Activities of Centre (T1 + T3)	6,159	8,895	10,444	9,874	10,351	10,522	45,723	47,664	10,737	9,287	9,287	65,747	67,738	(1,991)

Allocation of Total Resources  
Applied to Activities of Centre Between Heads of Expenditure

Total Salaries (Cash and In-Kind)	2,901	4,116	4,635	4,387	4,787	4,910	20,826	21,900	5,059	4,260	4,260	30,145	31,219	(1,074)
Total Capital (Cash and In-Kind)	-	-	-	27	-	-	27	-	-	-	-	27	-	27
Total Other (Cash and In-Kind)	3,258	4,779	5,809	5,460	5,564	5,612	24,870	25,764	5,678	5,027	5,027	35,575	36,519	(944)

Page 5 of 9

**Table 4 Allocation of Resources Between Categories of Activities (Dollars in \$'000's)**

Program	\$ Cash (1)			Resource Usage		Cash Funded Staff (2)
	\$ In-kind	Contributed Staff (2)	\$ In-kind	Contributed Staff (2)		
Research	1,953	3,160	21.32	15.81		
Education	597	654	0.29	0.35		
External Communication	1,268	1,338	6.38	3.07		
Commercialisation/Tech. Transfer	280	669	1.60	0.77		
Administration	349	83	0.59	2.10		
<b>Total</b>	<b>4,447</b>	<b>5,904</b>	<b>30.18</b>	<b>22.10</b>		

(1) Cash from all sources, including CRC Program

(2) Person years, Professional and support staff (total as in "Staff Resources" table)

(3) Resources allocated to "Commercialisation / Technology Transfer" and "Education"

also cover relevant Research Program / Project resources including part of time by contributed and funded staff under Research in columns 3 and 4.

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# Financial Information (Tables) 2003 – 2004 and Report to Commonwealth

## CRC for Catchment Hydrology

### Note 1 – Basis of Accounting

The tables have been prepared on an accrual basis up until the 2002/2003 financial year. From 1 July 2003, the Commonwealth have requested that the tables be prepared on a cash basis and accordingly the 2003/2004 tables have been prepared on an adjusted cash basis. The adjusted cash basis does not reflect solely the cash flows received during the year as there is a 'one off' catch up adjustment resulting from the change in basis from accrual to cash during the financial year.

The reconciliation between amounts disclosed in the financial statements on an accruals basis to amounts disclosed in the Commonwealth Tables on an adjusted cash basis is as follows:

#### Cash Contributions:

	\$ ('000's)
Contributions per the financial statements	1,240
Add: Contributions received in advance at 30/6/04	50
<b>Contributions per the Commonwealth Tables</b>	<b>1,290</b>

#### Other Revenue:

	\$ ('000's)
Interest revenue per the financial statements	46
Other revenue per the financial statements	707
	753
Less: Receivables at 30/6/04	(181)
<b>Total other cash per the Commonwealth Tables</b>	<b>572</b>

#### Expenditure:

	\$ ('000's)
Salary & related expenses of researchers	3,021
Operating expenses of researchers	1,390
	4,411
Add: GST receivable	36
<b>Total cash expenditure per the Commonwealth Tables</b>	<b>4,447</b>

The reconciliation between amounts disclosed in the Commonwealth Tables on an adjusted cash basis to amounts disclosed in the Statement of Cash Flows in the financial statements is as follows:

#### Cash Contributions:

	\$ ('000's)
Contributions per the Commonwealth Tables	1,290
Less: Contributions received in advance at 30/6/03	(462.5)
Add: Contributions receivable at 30/6/03	62.5
<b>Contributions per the Statement of Cash flows</b>	<b>890</b>

Page 7 of 9

#### Other Revenue:

	\$ ('000's)
Total other cash per the Commonwealth Tables	572
Add: Receivables at 30/6/03	154.5
<b>Total other income per the Statement of Cash flows</b>	<b>726.5</b>

#### Expenditure

	\$ ('000's)
Total cash expenditure per the Commonwealth Tables	4,447
Add: Payables at 30/6/03	22
Less: GST receivable at 30/6/03	(79)
<b>Total payments for research per the Statement of Cash flows</b>	<b>4,390</b>

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## Statement by Governing Board of the Centre

In the opinion of the Governing Board of the CRC for Catchment Hydrology, the financial information, as set out in Tables 1 to 4, presents fairly the sources of funding and the application of funding of the Centre in accordance with Applicable Accounting Standards, and in terms of clauses 4, 5.1, 5.2, 5.3, 9.1, 9.5 and 12.2 of the Commonwealth Agreement. The financial information has been prepared on a cash basis.

In particular:

1. The Researchers' Contributions were made in accordance with the Budget as specified in the Agreement and their total value has equalled or exceeded the Grant (Clause 4). The actual cash and in-kind contributions compared to the amounts committed in the Agreement are shown in Table 1 and Table 2.
2. The valuation of In-kind contributions, including where appropriate, the use of salary multipliers has been in accordance with that specified in the Agreement and such valuations have been made on a fair and reasonable basis.
3. The Researcher has used the Grant and the Researchers' Contributions only for the Activities of the Centre and not for any other purpose (Clause 5.1).
4. A comparison of actual to agreement expenditure by Heads of Expenditure as shown in Table 3 for the 12 months to 30 June 2004 shows that the variation between actual and agreement figures is within the limits imposed by Clause 5.2
5. Capital Items, as defined by Clause 5.3, acquired from the Grant or the Researchers' Contributions are vested as provided in the Joint Venture Agreement.
6. Intellectual Property in all Contract Material is vested as provided in the Joint Venture Agreement and no Intellectual Property has been assigned or licensed without the prior approval of the Board and the Commonwealth (Clause 9.1, 9.5)
7. Proper accounting standards and controls have been exercised in respect of the Grant and Researchers' Contributions and income and expenditure in relation to the Activities of the Centre has been recorded separately from other transactions of the Researcher (Clause 12.2).

This statement is made in accordance with a resolution of the Governing Board and is signed on behalf of the Governing Board by:

**John Langford** Chairman, Governing Board



**Professor Rodger Grayson**, Chief Executive Officer



Dated this 27<sup>th</sup> day of August 2004

## INDEPENDENT REVIEW REPORT

### TO THE COOPERATIVE RESEARCH CENTRES PROGRAM, DEPARTMENT OF EDUCATION, SCIENCE AND TRAINING REPRESENTING THE COMMONWEALTH IN RESPECT OF COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

#### FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2004

##### Scope

We have reviewed the financial information of the Cooperative Research Centre for Catchment Hydrology ("CRC") for the financial year ended 30 June 2004 as set out on pages 1 to 9. The parties to the CRC are responsible for the preparation and presentation of the financial information and fulfilling the requirements of the Commonwealth Agreement. These tables have been prepared under a cash basis of accounting. We have performed an independent review of the financial information in order to state whether, on the basis of the procedures described, anything has come to our attention that would indicate that the financial information is not presented fairly in accordance with the requirements of the Commonwealth Agreement in terms of Clauses 4, 5(1), 5(2), 5(3), 9(1), 9(5) and 12(2).

The financial information has been prepared for the parties to the CRC for the purposes of fulfilling their annual reporting obligations under clause 14(1)(f) of the Commonwealth Agreement and for distribution to the Cooperative Research Centres Program, Department of Education, Science and Training, representing the Commonwealth of Australia. We disclaim any assumption of responsibility for any reliance on this review report or on the financial information to which it relates to any person other than the parties to the CRC, or for any purpose other than that for which it was prepared.

Our review has been conducted in accordance with Australian Auditing Standards applicable to review engagements. The review was limited to specific procedures consisting primarily of:

- inquiries of and written representations from CRC personnel as to:
  - the continued effectiveness of internal accounting controls;
  - the existence of material matters relating to the financial position and results of the CRC;
  - compliance with the terms of Clauses 4, 5(1), 5(2), 5(3), 9(1), 9(5) and 12(2) of the Commonwealth Agreement; and
- analytical procedures applied to the financial data.

##### Inherent Limitations

Because of the inherent limitations of any internal control structure it is possible that fraud, error, or non-compliance with laws and regulations may occur and not be detected. Further, the internal control structure, within which the control procedures that we have reviewed operate, has not been reviewed and no view is expressed as to its effectiveness.

A review is not designed to detect all weaknesses in control procedures as it is not performed continuously throughout the period and the tests performed are on a sample basis. Also, a review does not provide all the evidence that would be required in an audit, thus the level of assurance provided is less than given in an audit. We have not performed an audit and, accordingly, we do not express an audit opinion.

Any projection of the evaluation of control procedures to future periods is subject to the risk that the procedures may become inadequate because of changes in conditions, or that the degree of compliance with them may deteriorate.

#### Qualification

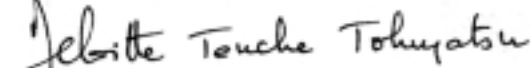
1. As a result of our review, we noted three instances of non-compliance with clause 4 of the Commonwealth Agreement, whereby the Parties' In Kind Contributions were lower than the amount agreed with the Commonwealth.

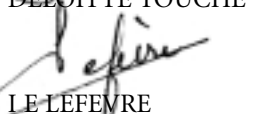
Party	Amount Committed (\$000's)	Amount Contributed (\$000's)
Bureau of Meteorology	421	417
CSIRO Land & Water	984	634
Monash University	588	564

#### Qualified Statement

Based on our review, which is not an audit, except for the effects on the financial information of the matters referred to in the qualification paragraph, nothing has come to our attention that causes us to believe that:

- the multipliers adopted by the Centre to value in-kind contributions other than salary costs do not have a sound and reasonable basis, and each parties component of the Researchers' Contributions for the year ended 30 June 2004 has not been provided at least to the value for that period committed in the Budget as specified in the Commonwealth Agreement;
- the total value of all contributions for the year under review does not equal or exceed the amount of the grant paid during the year;
- the Researcher has used the Grant and the Researcher's Contributions for activities other than for the Centre;
- there are material reporting irregularities;
- capital items acquired from the Grant and Researchers' Contributions are not vested as provided in the Joint Venture Agreement;
- proper accounting standards and controls have not been exercised in respect of the Grant and Researchers' Contributions;
- income and expenditure in relation to the activities of the Centre have not been recorded separately from other transactions of the Researcher;
- the Researchers' allocations of the budgetary resources between Heads of Expenditure have been lower or higher than the allocation in the budget by \$100,000 or 20% (whichever is the greater amount) without prior approval by the Commonwealth;
- intellectual property in all contract material is not vested as provided in the Joint Venture Agreement and intellectual property has been assigned or licensed without the prior approval of the Commonwealth.

  
DELOITTE TOUCHE TOHMATSU

  
I E LEFÈVRE  
Partner  
Chartered Accountants

Melbourne, 10<sup>th</sup> September 2004

Financial Information, Audit  
Financial Statements 2003 – 2004  
and Report to Parties

# Statement of Financial Performance

For the Year Ended 30 June 2004

	Note	2004 \$	2003 \$
<b>Revenue From Ordinary Activities</b>			
Commonwealth Grant		2,600,000	2,600,000
Interest		45,984	67,663
Other		707,247	301,373
		3,353,231	2,969,036
<b>Expenses From Ordinary Activities</b>			
Salary and Related Expenses of Researchers		(3,021,262)	(3,233,685)
Operating Expenses of Researchers		(1,390,309)	(1,635,262)
Inkind Research Expenses		(5,904,013)	(5,005,077)
		(10,315,584)	(9,874,024)
Loss From Ordinary Activities Before Income Tax Expense		(6,962,353)	(6,904,988)
Income Tax Expense		—	—
<b>Net Loss</b>	5	(6,962,353)	(6,904,988)
<b>Total Changes in Equity Other Than Those Resulting From Transactions with Participants as Participants</b>		(6,962,353)	(6,904,988)

Notes to the financial statements are included on pages 4 to 7



# Statement of Financial Position

as at 30 June 2004

	Note	2004 \$	2003 \$
<b>Current Assets</b>			
Cash Assets	3(a)	543,198	715,957
Receivables	4	215,112	295,411
Total Current Assets		758,310	1,011,368
<b>Total Assets</b>		758,310	1,011,368
<b>Current Liabilities</b>			
Payables		13	22,230
Party Contributions in Advance		50,000	462,500
<b>Total Current Liabilities</b>		50,013	484,730
<b>Total Liabilities</b>		50,013	484,730
<b>Net Assets</b>		708,297	526,638
<b>Researchers' Funds</b>			
Contributions by Parties	2	31,760,735	24,616,723
Accumulated losses	5	(31,052,438)	(24,090,085)
		<b>708,297</b>	<b>526,638</b>

Notes to the financial statements are included on pages 4 to 7

# Statement of Cash Flows

For the Year Ended 30 June 2004

	Note	2004 \$	2003 \$
<b>Cash Flows from Operating Activities</b>			
Receipts from the Commonwealth Government		2,600,000	2,600,000
Interest Received		47,373	67,871
Other Income		679,553	298,747
Payments for Research		(4,389,685)	(4,868,506)
<b>Net Cash Used in Operating Activities</b>	3(b)	(1,062,759)	(1,901,888)
<b>Cash Flows from Financing Activities</b>			
Cash Contributions by Parties		890,000	1,077,500
<b>Net Cash Provided by Financing Activities</b>		890,000	1,077,500
<b>Net Decrease in Cash Held</b>		(172,759)	(824,388)
Cash at the Beginning of the Financial Year		715,957	1,540,345
<b>Cash at the End of the Financial Year</b>	3(a)	543,198	715,957

Notes to the financial statements are included on pages 4 to 7

## Notes to the Financial Statements

### 30 June 2004

#### Note 1 Summary of Accounting Policies

##### Financial Reporting Framework

The Cooperative Research Centre for Catchment Hydrology (CRC) is not a reporting entity because in the opinion of the Governing Board there are unlikely to exist users of the financial report who are unable to command preparation of reports tailored so as to satisfy specifically all of their information needs.

Accordingly, this "special purpose financial report" has been prepared to satisfy the Governing Board's reporting requirements under the Commonwealth Agreement.

The financial report has been prepared on the basis of historical cost and except where stated, does not take into account changing money values or current valuations of non-current assets. Cost is based on the fair values of the consideration given in exchange for assets.

The financial report has been prepared in accordance with the basis of accounting and disclosure requirements specified by all Accounting Standards and UIG Consensus Views, except the disclosure requirements of:

AAS1	Statement of Financial Performance	AAS15	Revenue
AAS16	Financial Reporting by Segments	AAS22	Related Party Disclosure
AAS33	Presentation and Disclosure of Financial Instruments	AAS36	Statement of Financial Position
AAS37	Financial Report Presentation and Disclosure		

#### Significant Accounting policies

The following significant accounting policies have been adopted in the preparation and presentation of the financial statements.

##### (a) Income Tax

The Cooperative Research Centre for Catchment Hydrology (CRC) is an unincorporated Joint Venture and is defined as a Partnership for income tax purposes. The CRC does not lodge a Partnership tax return as it has been granted an exemption from doing so by the Australian Taxation Office, on the basis that all of the parties to the Joint Venture are tax exempt entities. As the CRC is not a separate tax paying entity it has not provided for income tax expense in the financial statements.

##### (b) Revenue Recognition

###### Commonwealth Grants

Grant revenue is recognised on an accrual basis.

###### Rendering of Services

Revenue from a contract to provide services is recognised by reference to the stage of completion of the contract.

###### Interest

Interest revenue is recognised on an accrual basis.

# Notes to the Financial Statements

30 June 2004

## Note 1 Summary of Accounting Policies (continued)

### (c) Inkind Contributions

Pursuant to an agreement between the parties, Inkind contributions to the Centre have been included in the Statement of Financial Performance as expenditure on behalf of the Centre. The value of In-kind contributions has been credited to the parties' equity in the Joint Venture and is included in Researchers' Funds in the Statement of Financial Position.

### (d) Research and Development

The Governing Board of the Centre have considered the requirements of Australian Accounting Standard 13 (AAS 13) Accounting for Research and Development and have resolved that none of the expenditure by the Centre meets the requirements of AAS 13 concerning deferral of expenditure to future years. Accordingly all expenditure has been recorded in the Statement of Financial Performance as an expense from ordinary activities.

### (e) Accounts Payable

Trade payables and other accounts payable are recognised when the Centre becomes obliged to make future payments resulting from the purchase of goods and services.

### (f) Goods and Services Tax

Revenues, expenses and assets are recognised net of the amount of goods and services tax (GST), except:

- i. where the amount of GST incurred is not recoverable from the taxation authority, it is recognised as part of the cost of acquisition of an asset or as part of an item of expense; or
- ii. for receivables and payables which are recognised inclusive of GST

The net amount of GST recoverable from, or payable to, the taxation authority is included as part of receivables or payables.

### (g) Receivables

Receivables are recorded at amounts due less any allowance for doubtful debts.

# Notes to the Financial Statements

30 June 2004

**Note 2 Contributions by Parties** (Excluding advance contributions)

	2004 \$	2003 \$
<b>Cash</b>		
Brisbane City Council	50,000	50,000
Bureau of Meteorology	100,000	50,000
CSIRO Land & Water	100,000	100,000
Department of Infrastructure, Planning & Natural Resources, NSW	125,000	100,000
Department of Natural Resources, Mines & Energy, Qld.	100,000	100,000
Department of Sustainability & Environment, Vic.	100,000	100,000
Griffith University	50,000	50,000
Melbourne Water Corporation	50,000	50,000
Monash University	150,000	100,000
Murray-Darling Basin Commission	100,000	50,000
Goulburn-Murray Rural Water Authority	150,000	150,000
Gippsland & Southern Rural Water Authority	30,000	30,000
Wimmera-Mallee Rural Water Authority	60,000	60,000
The University of Melbourne	75,000	50,000
	<b>1,240,000</b>	<b>1,040,000</b>
<b>In-Kind</b>		
Brisbane City Council	448,453	409,665
Bureau of Meteorology	417,316	392,416
CSIRO Land & Water	634,316	886,441
Department of Infrastructure, Planning & Natural Resources, NSW	819,187	265,751
Department of Natural Resources, Mines & Energy, Qld.	828,573	688,347
Department of Sustainability & Environment, Vic.	432,721	359,827
Griffith University	527,890	554,024
Melbourne Water Corporation	440,887	356,376
Monash University	563,603	547,412
Murray-Darling Basin Commission	-	-
Goulburn-Murray Rural Water Authority	253,167	69,690
Gippsland & Southern Rural Water Authority	-	-
Wimmera-Mallee Rural Water Authority	-	-
The University of Melbourne	537,900	475,128
	<b>5,904,013</b>	<b>5,005,077</b>
<b>Total Cash and In-Kind Contributions</b>		
Brisbane City Council	498,453	459,665
Bureau of Meteorology	517,316	442,416
CSIRO Land & Water	734,316	986,441
Department of Infrastructure, Planning & Natural Resources, NSW	944,187	365,751
Department of Natural Resources, Mines & Energy, Qld.	928,573	788,347
Department of Sustainability & Environment, Vic.	532,721	459,827
Griffith University	577,890	604,024
Melbourne Water Corporation	490,887	406,376
Monash University	713,603	647,412
Murray-Darling Basin Commission	100,000	50,000
Goulburn-Murray Rural Water Authority	403,167	219,690
Gippsland & Southern Rural Water Authority	30,000	30,000
Wimmera-Mallee Rural Water Authority	60,000	60,000
The University of Melbourne	612,900	525,128
	<b>7,144,013</b>	<b>6,045,077</b>
Opening balance Party Contributions	24,616,723	18,571,646
Contributions this year, cash and in-kind	7,144,013	6,045,077
Closing balance Party contributions	31,760,736	24,616,723

**Notes to the Financial Statements**

30 June 2004

	2004	2003
	\$	\$

**Note 3: Notes to the Statement of Cash Flows****(a) Reconciliation of Cash**

Cash at the end of the financial year as shown in the Statement of Cash Flows is reconciled to the related items in the Statement of Financial Position as follows:

Cash Assets	<b>543,198</b>	<b>715,957</b>
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**(b) Reconciliation of Loss from Ordinary Activities after Related Income Tax Expenses To Net Cash Flows from Operating Activities**

Loss from Ordinary Activities after related income tax.	(6,962,353)	(6,904,988)
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Non cash flow items in Loss from Ordinary Activities after income tax:

In-Kind expenditure	5,904,013	5,005,077
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Changes in assets and liabilities:

Increase / (Decrease) in Payables	(22,217)	(33)
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(Increase) / Decrease in Receivables	17,798	(1,944)
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Net cash used in Operating Activities	<b>(1,062,759)</b>	<b>(1,901,888)</b>
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**Note 4: Receivables**

Interest Receivable	4,813	6,202
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Other Receivables	175,942	210,748
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Goods & Service Tax (GST) Receivable	34,357	78,461
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	<b>215,112</b>	<b>295,411</b>
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**Note 5: Accumulated Losses**

Balance at beginning of the financial year	(24,090,085)	(17,185,097)
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Net Loss	(6,962,353)	(6,904,988)
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<b>Balance at end of the financial year.</b>	<b>(31,052,438)</b>	<b>(24,090,085)</b>
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## Statement by Governing Board of the Centre

As detailed in Note 1 to the financial statements, the CRC for Catchment Hydrology is not a reporting entity because in the opinion of the Governing Board there are unlikely to exist users of the financial report who are unable to command the preparation of reports tailored so as to satisfy specifically all of their information needs. Accordingly, this "special purpose financial report" has been prepared to satisfy the Governing Board's reporting requirements under the Commonwealth Agreement.

The Governing Board declares that:

- a) the attached financial statements and notes thereto comply with accounting Standards;
- b) the attached financial statements and notes thereto give a true and fair view of the financial position and performance of the CRC;
- c) in the Governing Board's opinion, the attached financial statements and notes thereto are in accordance with the Commonwealth Agreement; and
- d) in the Governing Board's opinion, there are reasonable grounds to believe that the CRC will be able to pay its debts as and when they become due and payable.

This statement is made in accordance with a resolution of the Governing Board and is signed on behalf of the Governing Board by:

**John Langford** Chairman, Governing Board



**Professor Rodger Grayson**, Chief Executive Officer



Dated this 27<sup>th</sup> day of August 2004

## INDEPENDENT REVIEW REPORT

### TO THE PARTIES OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

#### Scope

We have reviewed the special purpose financial report of the Cooperative Research Centre for Catchment Hydrology ("CRC") for the financial year ended 30 June 2004 as set out on pages 1 to 8. The Governing Board to the CRC is responsible for the financial report and has determined that the accounting policies used and described in Note 1 to the financial statements are appropriate to meet the needs of the parties. We have performed an independent review of the financial report in order to state whether, on the basis of the procedures described, anything has come to our attention that would indicate that the financial report is not presented fairly in accordance with the accounting policies described in Note 1 to the financial statements.

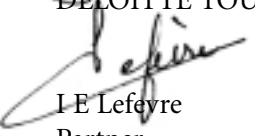
The financial report has been prepared to satisfy the parties' financial reporting requirements under clause 14(1)(f) of the Commonwealth Agreement and for distribution to the Cooperative Research Centres Program, Department of Education, Science and Training, representing the Commonwealth of Australia. We disclaim any assumption of responsibility for any reliance on this review report or on the financial report to which it relates to any person other than the parties to the CRC, or for any purpose other than that for which it was prepared.

Our review has been conducted in accordance with Australian Auditing Standards applicable to review engagements. A review is limited primarily to inquiries of CRC personnel and analytical procedures applied to the financial data. These procedures do not provide all the evidence that would be required in an audit, thus the level of assurance provided is less than given in an audit. We have not performed an audit and, accordingly, we do not express an audit opinion.

#### Statement

Based on our review, which is not an audit, nothing has come to our attention that causes us to believe that the financial report of Cooperative Research Centre for Catchment Hydrology does not present fairly the financial position of the CRC as at 30 June 2004 and the results of its operations and its cash flows for the financial year ended on that date in accordance with the accounting policies described in Note 1 to the financial statements.

  
DELOITTE TOUCHE TOHMATSU

  
I E Lefevre  
Partner  
Chartered Accountants

Melbourne, 10<sup>th</sup> September 2004



## Appendix – Staff Resources 2003 – 2004

# Staff Resources 2003 – 2004

## Research Staff – Contributed as In-Kind Resources (100% = 1 person year)

Name	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
			Subprograms										
			1	2	3	4	5	6	10				
<b>Brisbane City Council</b>													
Chandler, Ms F.	R	9	0	0	0	6	0	0	0	6	0	3	0
Peljo, Ms L.	R	15	0	0	0	14	0	0	0	14	0	1	0
Weber, Mr T.	C	28	0	0	0	2	0	0	0	2	0	26	0
<b>Total</b>		<b>52</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>22</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>22</b>	<b>0</b>	<b>30</b>	<b>0</b>
<b>Bureau of Meteorology</b>													
Ebert, Dr E.	R	12	0	0	0	0	12	0	0	12	0	0	0
Elliott, Mr J.	R	2	0	0	0	0	1	0	0	1	0	1	0
Manton, Dr M.	R	6	0	0	0	0	6	0	0	6	0	0	0
Mills, Dr G.	R	11	0	0	0	0	11	0	0	11	0	0	0
Seed, Dr A.	R	79	0	0	0	0	79	0	0	79	0	0	0
Srikanthan, Dr S.	R	94	0	0	0	0	88	0	0	88	0	6	0
Stewart, Mr B.	C	2	0	0	0	0	0	0	0	0	0	2	0
<b>Total</b>		<b>206</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>197</b>	<b>0</b>	<b>0</b>	<b>197</b>	<b>0</b>	<b>9</b>	<b>0</b>
<b>CSIRO Land &amp; Water</b>													
Chen, Dr Y.	R	12	0	12	0	0	0	0	0	12	0	0	0
Christen, Dr E.	R	22	0	22	0	0	0	0	0	22	0	0	0
Coleman, Mr J.	R	36	0	0	0	36	0	0	0	36	0	0	0
Cuddy, Ms S.	R	7	7	0	0	0	0	0	0	7	0	0	0
Dawes, Mr W.	R	24	0	24	0	0	0	0	0	24	0	0	0
Gilfedder, Dr M.	R	15	0	15	0	0	0	0	0	15	0	0	0
Hairsine, Dr P.	R	13	12	1	0	0	0	0	0	13	0	0	0
Khan, Dr S.	R	4	0	4	0	0	0	0	0	4	0	0	0
Miller, Mr T.	R	21	0	0	0	0	0	21	0	21	0	0	0
Murray, Mr N.	R	25	25	0	0	0	0	0	0	25	0	0	0
Rahman, Mr J.	R	39	39	0	0	0	0	0	0	39	0	0	0
Seaton, Mr S.	R	35	35	0	0	0	0	0	0	35	0	0	0
Stenson, Mr M.	R	4	0	4	0	0	0	0	0	4	0	0	0
Vertessy, Dr R.	A	39	5	0	0	0	0	0	0	5	0	7	27
Viney, Dr N.	R	5	0	0	0	0	5	0	0	5	0	0	0
Walker, Dr G.	R	4	0	4	0	0	0	0	0	4	0	0	0
Wallbrink, Dr P.	R	33	0	15	0	0	0	0	0	15	6	6	6
Wilkinson, Dr S.	R	21	0	21	0	0	0	0	0	21	0	0	0
Zhang, Dr. L	R	4	0	4	0	0	0	0	0	4	0	0	0
<b>Total</b>		<b>363</b>	<b>123</b>	<b>126</b>	<b>0</b>	<b>36</b>	<b>5</b>	<b>21</b>	<b>0</b>	<b>311</b>	<b>6</b>	<b>13</b>	<b>33</b>
<b>Dept. Infrastructure, Planning &amp; Natural Resources, NSW.</b>													
Beale, Mr G.	R	53	0	53	0	0	0	0	0	53	0	0	0
Geeves, Dr G.	C	30	0	1	0	0	0	0	0	1	0	29	0
Herron, Dr N.	R	1	1	0	0	0	0	0	0	1	0	0	0
Ivailovski, Mr Y.	R	62	0	62	0	0	0	0	0	62	0	0	0
Littleboy, Dr M.	R	57	0	57	0	0	0	0	0	57	0	0	0
Murphy, Dr B.	R	41	0	30	0	0	0	0	0	30	0	11	0
Nandakumar, Dr N.	C	10	0	0	0	0	0	0	0	0	0	10	0
Podger, Mr G.	R	17	17	0	0	0	0	0	0	17	0	0	0
Salbe, Dr I.	R	8	0	0	8	0	0	0	0	8	0	0	0
Summerell, Mr G.	R	62	0	56	0	0	0	0	0	56	0	6	0
Teng, Ms J.	R	68	0	68	0	0	0	0	0	68	0	0	0
Tuteja, Dr N.	R	45	0	45	0	0	0	0	0	45	0	0	0
Vaze, Dr J.	R	47	0	47	0	0	0	0	0	47	0	0	0
Young, Ms C.	C	35	0	0	0	0	0	0	0	0	0	35	0
Zierholz, Mr C.	C	76	0	0	0	0	0	0	0	0	0	76	0
<b>Total</b>		<b>612</b>	<b>18</b>	<b>419</b>	<b>8</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>445</b>	<b>167</b>	<b>0</b>

**Research Staff – Contributed as In-Kind Resources (100% = 1 person year) (continued)**

Name	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
			Subprograms										
			1	2	3	4	5	6	10				
<b>Department of Natural Resources &amp; Mines, Qld</b>													
Bloesch, Mr P.	R	10	0	10	0	0	0	0	0	10	0	0	0
Carroll, Mr C.	C	24	0	8	0	0	0	0	0	8	1	15	0
Cowie, Mr B.	C	24	0	1	0	0	0	0	0	1	0	23	0
DeHayr, Mr R.	R	40	0	40	0	0	0	0	0	40	0	0	0
Freebairn, Dr D.	R	8	0	8	0	0	0	0	0	8	0	0	0
Gooda, Mr M.	R	4	4	0	0	0	0	0	0	4	0	0	0
Hunter, Dr H.	R	38	0	38	0	0	0	0	0	38	0	0	0
Kent, Mr D.	C	2	0	0	0	0	0	0	0	0	0	2	0
Millar, Mr G.	C	78	0	0	0	0	0	0	0	0	0	52	26
Owens, Ms J.	R	10	0	10	0	0	0	0	0	10	0	0	0
Park-Weir, Mr W.	R	1	0	0	1	0	0	0	0	1	0	0	0
Rassam, Dr D.	R	34	0	24	0	0	0	0	0	24	0	10	0
Ruffini, Mr J.	C	5	0	0	0	0	0	0	0	0	0	5	0
Salloway, Mr M.	C	26	0	1	0	0	0	0	0	1	0	25	0
Searle, Mr R.	C	73	0	0	0	0	0	0	0	0	0	73	0
Silburn, Dr M.	R	18	0	18	0	0	0	0	0	18	0	0	0
Stevens, Mr S.	C	57	0	0	0	0	0	0	0	0	0	57	0
Thornton, Mr C.	R	14	0	9	0	0	0	0	0	9	0	5	0
Vieritz, Dr A.	C	2	0	0	0	0	0	0	0	0	0	2	0
<b>Total</b>		<b>468</b>	<b>4</b>	<b>167</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>172</b>	<b>1</b>	<b>269</b>	<b>26</b>

**Department of Sustainability & Environment, Vic.**

Bethune, Mr M.	R	49	0	49	0	0	0	0	0	49	0	0	0
Beverly, Dr C.	R	28	0	28	0	0	0	0	0	28	0	0	0
Christy, Mr B.	R	32	0	32	0	0	0	0	0	32	0	0	0
Duke, Ms C.	R	52	0	0	52	0	0	0	0	52	0	0	0
Duncan, Ms R.	R	23	0	23	0	0	0	0	0	23	0	0	0
Eigenraam, Mr M.	R	2	0	0	2	0	0	0	0	2	0	0	0
James, Mr B.	R	23	0	12	11	0	0	0	0	23	0	0	0
Kesari, Mr K.	R	7	1	1	5	0	0	0	0	7	0	0	0
Lane, Dr P.	R	37	11	26	0	0	0	0	0	37	0	0	0
Morris, Dr J.	R	26	0	26	0	0	0	0	0	26	0	0	0
Sheridan, Mr G.	R	10	10	0	0	0	0	0	0	10	0	0	0
Wang, Dr Q.	R	2	1	1	0	0	0	0	0	2	0	0	0
Wimalasuriya, Mr R.	R	4	0	0	4	0	0	0	0	4	0	0	0
<b>Total</b>		<b>295</b>	<b>23</b>	<b>198</b>	<b>74</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>295</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Goulburn-Murray Water**

Feehan, Mr P.	C	16	0	0	0	0	0	0	0	0	0	16	0
Hannan, Mr G.	C	1	0	0	0	0	0	0	0	0	0	1	0
Huggins, Mr C.	C	25	0	0	0	0	0	0	0	0	0	25	0
Kellock, Ms L.	C	2	0	0	1	0	0	0	0	1	0	1	0
Papworth, Mr S.	C	53	0	0	0	0	0	0	0	0	0	53	0
Savage, Mr G.	C	25	0	0	0	0	0	0	0	0	0	25	0
Seker, Dr M.	R	2	0	0	2	0	0	0	0	2	0	0	0
<b>Total</b>		<b>124</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>121</b>	<b>0</b>

# Staff Resources 2003 – 2004

## Research Staff – Contributed as In-Kind Resources (100% = 1 person year) (continued)

Name	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
			Subprograms										
			1	2	3	4	5	6	10				
<b>Griffith University</b>													
Bunn, Prof S.	R	7	0	4	0	0	0	3	0	7	0	0	0
Fellows, Dr C.	R	15	0	15	0	0	0	0	0	15	0	0	0
Fien, Prof J.	R	10	0	0	0	0	0	0	0	0	10	0	0
Greenaway, Assoc Prof M.	R	46	0	0	0	46	0	0	0	46	0	0	0
Phillips, Dr I.	R	3	0	0	0	3	0	0	0	3	0	0	0
Rickson, Prof R.	C	10	0	0	0	0	0	0	0	0	0	10	0
Thomlinson, Prof R.	R	6	0	0	0	6	0	0	0	6	0	0	0
Tisdell, Dr J.	R	49	0	0	41	0	0	0	0	41	3	5	0
Yu, Assoc Prof B.	R	42	0	0	42	0	0	0	0	42	0	0	0
<b>Total</b>		<b>188</b>	<b>0</b>	<b>19</b>	<b>83</b>	<b>55</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>160</b>	<b>13</b>	<b>15</b>	<b>0</b>
<b>Melbourne Water</b>													
Duncan, Mr H.	R	100	0	0	0	100	0	0	0	100	0	0	0
Francey, Mr M.	R	33	0	0	0	33	0	0	0	33	0	0	0
Hughes, Ms C.	C	86	0	0	0	0	0	0	0	0	0	86	0
Rooney, Mr G.	C	13	0	0	0	2	0	0	0	2	0	11	0
<b>Total</b>		<b>232</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>135</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>135</b>	<b>0</b>	<b>97</b>	<b>0</b>
<b>Monash University</b>													
Codner, Assoc Prof G.	R	10	0	0	9	1	0	0	0	10	0	0	0
Deletic, Dr A.	R	52	2	0	0	45	0	0	0	47	0	5	0
Fletcher, Dr T.	R	21	0	0	0	21	0	0	0	21	0	0	0
Keller, Assoc Prof R.	R	37	3	0	0	0	0	16	2	21	1	15	0
Ladson, Dr A.	R	41	0	0	0	10	0	28	0	38	0	3	0
Mudd, Dr G.	C	11	0	0	0	4	0	0	0	4	0	7	0
Weinmann, Mr E.	R	42	0	0	26	0	0	0	2	28	1	13	0
Wills, Assoc Prof I.	R	1	0	0	1	0	0	0	0	1	0	0	0
Wong, Assoc Prof T.	R	25	0	0	0	19	0	0	0	19	0	6	0
Wootton, Mr R.	R	4	0	0	0	3	0	0	0	3	0	1	0
<b>Total</b>		<b>244</b>	<b>5</b>	<b>0</b>	<b>36</b>	<b>103</b>	<b>0</b>	<b>44</b>	<b>4</b>	<b>192</b>	<b>2</b>	<b>50</b>	<b>0</b>
<b>The University of Melbourne</b>													
Argent, Dr R.	C	11	3	0	0	0	0	0	0	3	0	8	0
Chiew, Assoc Prof F.	R	14	0	0	0	3	11	0	0	14	0	0	0
Downes, Dr B.	R	2	0	0	0	0	0	2	0	2	0	0	0
Fenton, Prof J.	R	1	0	0	0	0	0	1	0	1	0	0	0
Finalyson, Assoc Prof B.	R	10	0	1	0	0	0	8	0	9	0	1	0
Grayson, Prof R.	R	26	9	6	0	0	1	3	2	21	2	3	0
Lin, Dr J.	R	1	0	0	0	0	0	1	0	1	0	0	0
Malano, Assoc Prof H.	R	25	0	0	23	0	0	0	0	23	1	1	0
McMahon, Prof T.	R	29	0	16	3	0	1	0	0	20	1	8	0
Peel, Dr M.	R	8	0	0	0	0	8	0	0	8	0	0	0
Rutherford, Assoc Prof I.	R	25	0	0	0	0	0	21	0	21	1	3	0
Simmonds, Assoc Prof I.	R	9	0	0	0	0	9	0	0	9	0	0	0
Siriwardena, Mr L.	R	47	0	0	0	7	36	0	0	43	1	3	0
Weaver, Dr T.	R	1	0	0	0	0	0	0	0	0	1	0	0
Western, Dr A.	R	13	3	3	0	0	3	4	0	13	0	0	0
Zhou, Dr S.	R	12	0	0	0	0	12	0	0	12	0	0	0
<b>Total</b>		<b>234</b>	<b>15</b>	<b>26</b>	<b>26</b>	<b>10</b>	<b>81</b>	<b>40</b>	<b>2</b>	<b>200</b>	<b>7</b>	<b>27</b>	<b>0</b>

### Research Staff – CRC Funded Resources (100% = 1 person year)

Name	Employing Organisation	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
				Subprograms										
				1	2	3	4	5	6	10				
Frost, Dr A.	Bureau of Met	R	100	0	0	0	0	100	0	0	100	0	0	0
Richter, Dr H.	Bureau of Met	R	75	0	0	0	0	75	0	0	75	0	0	0
Austin, Ms J.	CSIRO	R	2	0	2	0	0	0	0	0	2	0	0	0
Chen, Dr Y.	CSIRO	R	10	0	4	0	0	0	6	0	10	0	0	0
Christen, Dr E.	CSIRO	R	12	0	12	0	0	0	0	0	12	0	0	0
Coleman, Mr J.	CSIRO	R	36	0	0	0	36	0	0	0	36	0	0	0
Cuddy, Ms S.	CSIRO	R	8	8	0	0	0	0	0	0	8	0	0	0
Dawes, Mr W.	CSIRO	R	25	0	25	0	0	0	0	0	25	0	0	0
DeRose, Mr R.	CSIRO	R	100	0	0	0	0	0	100	0	100	0	0	0
Ellis, Dr T.	CSIRO	R	31	0	6	0	0	0	25	0	31	0	0	0
Gallant, Dr J.	CSIRO	R	0	0	0	0	0	0	0	0	0	0	0	0
Gilfedder, Dr M.	CSIRO	R	25	0	25	0	0	0	0	0	25	0	0	0
Hayes, Ms S.	CSIRO	R	8	0	0	0	0	0	8	0	8	0	0	0
Hornbuckle, Mr J.	CSIRO	R	56	0	56	0	0	0	0	0	56	0	0	0
Hotham, Mr H.	CSIRO	R	42	27	6	0	0	0	0	0	33	0	9	0
Khan, Dr S.	CSIRO	R	5	0	5	0	0	0	0	0	5	0	0	0
Lu, Dr Hua	CSIRO	R	9	0	9	0	0	0	0	0	9	0	0	0
MacMullin, Mr J.	CSIRO	C	73	0	0	0	0	0	0	0	0	0	73	0
Miller, Mr T.	CSIRO	R	2	0	0	0	0	0	2	0	2	0	0	0
Murray, Mr N.	CSIRO	R	27	27	0	0	0	0	0	0	27	0	0	0
Perraud, Mr J.-M.	CSIRO	R	45	45	0	0	0	0	0	0	45	0	0	0
Rahman, Mr J.	CSIRO	R	30	30	0	0	0	0	0	0	30	0	0	0
Rassam, Dr D.	CSIRO	R	3	0	3	0	0	0	0	0	3	0	0	0
Seaton, Mr S.	CSIRO	R	46	38	8	0	0	0	0	0	46	0	0	0
Vertessy, Dr R.	CSIRO	C	43	0	0	0	0	0	5	0	5	5	23	10
Zhang, Dr L.	CSIRO	R	4	0	4	0	0	0	0	0	4	0	0	0
Podger, Mr G.	DIPNR, NSW	R	24	21	0	0	0	3	0	0	24	0	0	0
de Voil, Mr P.	DNRM, Qld	R	17	0	17	0	0	0	0	0	17	0	0	0
Owens, Ms J.	DNRM, Qld	R	25	0	25	0	0	0	0	0	25	0	0	0
Paul, Miss L.	DNRM, Qld	R	4	0	4	0	0	0	0	0	4	0	0	0
Rassam, Dr D.	DNRM, Qld	R	15	0	15	0	0	0	0	0	15	0	0	0
Alder, Ms L.	Griffith Uni	R	13	0	0	13	0	0	0	0	13	0	0	0
Capon, Mr T.	Griffith Uni	R	11	0	0	11	0	0	0	0	11	0	0	0
Clements, Ms S.	Griffith Uni	R	10	0	0	10	0	0	0	0	10	0	0	0
Conway, Ms C.	Griffith Uni	R	13	0	13	0	0	0	0	0	13	0	0	0
English, Ms C.	Griffith Uni	R	3	0	0	3	0	0	0	0	3	0	0	0
Lin, Mr P.	Griffith Uni	R	0	0	0	0	0	0	0	0	0	0	0	0
Lindberg, Ms D.	Griffith Uni	R	5	0	0	5	0	0	0	0	5	0	0	0
Markwell, Ms K.	Griffith Uni	R	3	0	3	0	0	0	0	0	3	0	0	0
Marsh, Dr N.	Griffith Uni	R	100	0	0	0	0	0	100	0	100	0	0	0
Matthews, Dr C.	Griffith Uni	R	22	0	0	22	0	0	0	0	22	0	0	0
Murphy, Mr B.	Griffith Uni	R	2	0	0	2	0	0	0	0	2	0	0	0
Picket, Mr T.	Griffith Uni	R	0	0	0	0	0	0	0	0	0	0	0	0
Polson, Ms C.	Griffith Uni	R	25	0	0	0	25	0	0	0	25	0	0	0
Tisdell, Dr J.	Griffith Uni	R	51	0	0	38	0	13	0	0	51	0	0	0
Whelan, Dr J.	Griffith Uni	R	20	0	0	0	0	0	0	0	0	20	0	0
Wos, Ms M.	Griffith Uni	R	1	0	0	0	1	0	0	0	1	0	0	0
Yu, Assoc Prof B.	Griffith Uni	R	10	0	0	10	0	0	0	0	10	0	0	0
Fletcher, Dr T.	Monash Uni	R	64	0	0	0	64	0	0	0	64	0	0	0
Perry, Mr D.	Monash Uni	C	100	0	0	0	0	0	0	0	0	10	90	0
Poelsma, Mr P.	Monash Uni	R	75	0	0	0	75	0	0	0	75	0	0	0

# Staff Resources 2003 – 2004

## Research Staff – CRC Funded Resources (100% = 1 person year) (continued)

Name	Employing Organisation	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
				Subprograms										
				1	2	3	4	5	6	10				
Schreider, Dr S.	Monash Uni	R	58	0	0	58	0	0	0	0	58	0	0	0
Wong, Assoc Prof T.	Monash Uni	R	4	0	0	0	4	0	0	0	4	0	0	0
Argent, Dr R.	Uni Melb	R	56	56	0	0	0	0	0	0	56	0	0	0
Chiew, Assoc Prof F.	Uni Melb	R	86	0	0	0	0	67	0	0	67	0	10	9
Costelloe, Mr J.	Uni Melb	R	8	0	0	0	0	0	8	0	8	0	0	0
Grayson, Prof R.	Uni Melb	R	30	30	0	0	0	0	0	0	30	0	0	0
McMahon, Prof T.	Uni Melb	C	8	0	0	0	0	0	0	0	0	0	4	4
Siriwardena, Mr L.	Uni Melb	R	22	0	0	0	15	7	0	0	22	0	0	0
Stewardson, Dr M.	Uni Melb	R	69	0	0	0	0	0	69	0	69	0	0	0
Western, Dr A.	Uni Melb	R	57	0	0	0	0	57	0	0	57	0	0	0
Young, Mr R.	Uni Melb	R	20	0	0	0	0	20	0	0	20	0	0	0
<b>Total</b>			<b>1,848</b>	<b>282</b>	<b>242</b>	<b>172</b>	<b>220</b>	<b>342</b>	<b>323</b>	<b>0</b>	<b>1,581</b>	<b>35</b>	<b>209</b>	<b>23</b>

## Summary of Contribution in Person Years

	Total Equivalent Person Years	Person Years Spent on Research Programs							Total on Research	Person Years Spent on Education Program	Person Years Spent on Commercialisation Program	Person Years Spent on Administration Program
		Subprogram										
		1	2	3	4	5	6	10				
Total Contributed as In-Kind	30.18	1.88	9.55	2.31	3.61	2.83	1.08	0.06	21.32	0.29	7.98	0.59
Total Funded by CRC	18.48	2.82	2.42	1.72	2.20	3.42	3.23	0.00	15.81	0.35	2.09	0.23
<b>Grand Total</b>	<b>48.66</b>	<b>4.70</b>	<b>11.97</b>	<b>4.03</b>	<b>5.81</b>	<b>6.25</b>	<b>4.31</b>	<b>0.06</b>	<b>37.13</b>	<b>0.64</b>	<b>10.07</b>	<b>0.82</b>

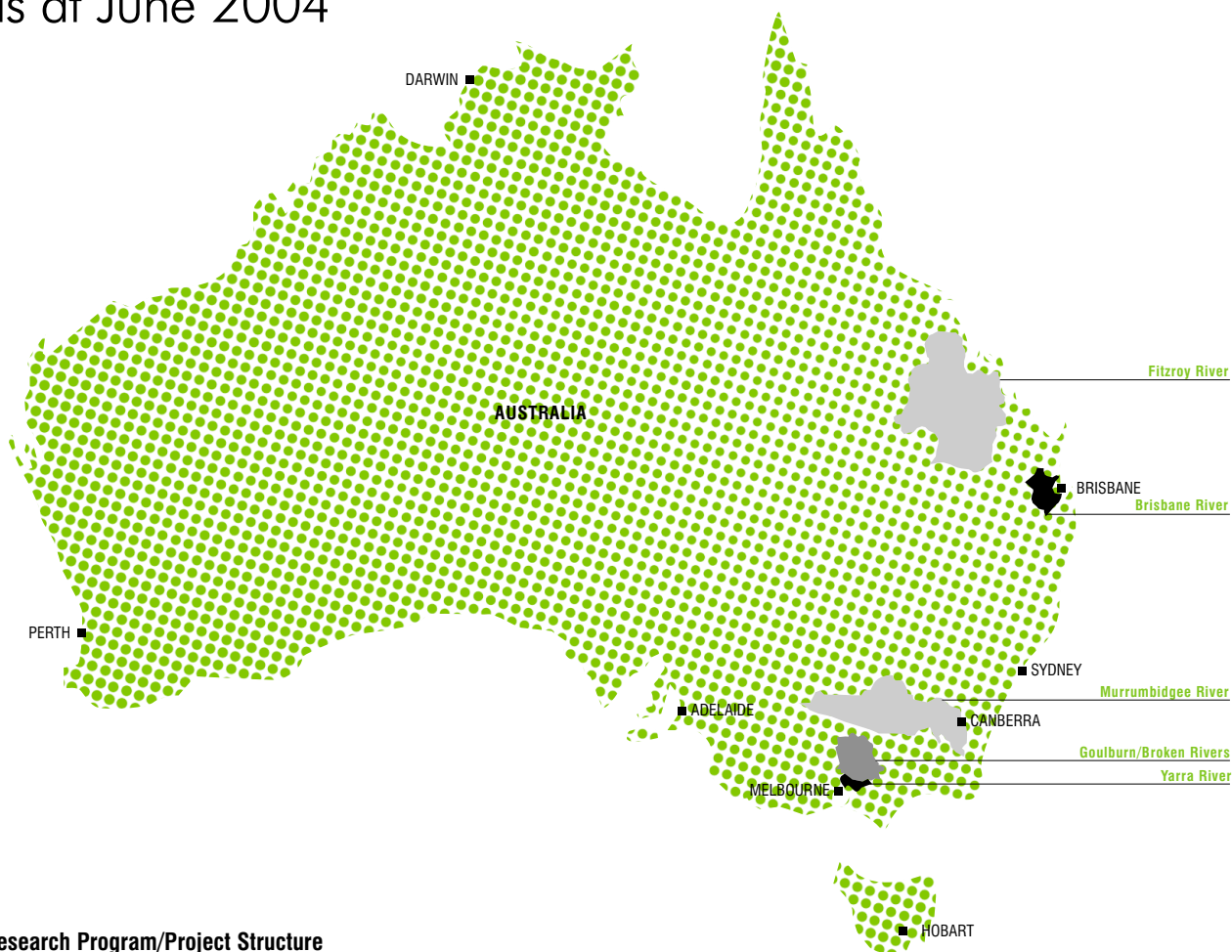
*Proportion of total professional staff resources in each activity*    100    10    25    8    12    13    9    0    76    1    21    2

## Support Staff (100% = 1 person years)

(1) Contributed		(2) CRC Funded	
Organisation	Number of Staff Person Years	Organisation	Number of Staff Person Years
CSIRO	0.00	CSIRO	0.58
Griffith University	0.00	Griffith University	0.00
Monash University	0.00	Monash University	3.04
The University of Melbourne	0.00	The University of Melbourne	0.00
<b>TOTAL</b>	<b>0.00</b>	<b>TOTAL</b>	<b>3.62</b>

# Focus Catchments

as at June 2004



## Research Program/Project Structure

### Core Projects and Major Contract Research Activity

#### Program 1

##### Predicting Catchment Behaviour

- 1.1 Development of a catchment modelling toolkit
- 1.2 Scaling procedures to support process-based modelling at large scales

**1.09(1A)** Implementation of the Catchment Modelling Toolkit

**1.10(1B)** Methods for integration in catchment prediction

#### Program 2

##### Land-use Impacts on Rivers

- 2.1 Sediment movement, water quality and physical habitat in large river systems
- 2.2 Managing pollutant delivery in dryland upland catchments
- 2.3 Predicting the effects of land-use changes on catchment water yield and stream salinity
- 2.5 Nitrogen and carbon dynamics in riparian buffer zones
- 2.19(2A)** Reducing the impacts of irrigation and drainage on river water salinity
- 2.20(2B)** Improved suspended sediment and nutrient modelling through river networks
- 2.21(2C)** Predicting salt movement in catchments
- 2.22(2D)** Modelling and managing nitrogen in riparian zones to improve water quality
- 2.23(2E)** Modulating daily flow duration curves to reflect the impact of land-use change

#### Program 3

##### Sustainable Water Allocation

- 3.1 Integration of water balance, climatic and economic models
- 3.2 Enhancement of the water market reform process
- 3.08(3A)** Hydrologic and economic modelling for water allocation
- 3.09(3B)** An evaluation of permanent water markets

#### Program 4

##### Urban Stormwater Quality

- 4.1 Stormwater pollutant sources, pathways and impacts
- 4.2 Stormwater best management practices
- 4.08(4A)** Development of integrated stormwater models
- 4.09(4B)** Predicting urban stormwater quality, treatment and impacts

#### Program 5

##### Climate Variability

- 5.1 Modelling and forecasting hydroclimate variables in space and time
- 5.2 National data bank of stochastic climate and streamflow models
- 5.05(5A)** Hydrological modelling for weather forecasting
- 5.06(5B)** Stochastic rainfall data generation models

#### Program 6

##### River Restoration

###### Project Group A: Stream Restoration - Procedures and Evaluation

- 6.1** Developing criteria and concepts for planning the evaluation of stream rehabilitation projects
- 6.2** Optimising urban stream rehabilitation planning and execution
- 6.3** Restoration ecology in the Granite Creeks, Victoria
- 6.4** Evaluation of riparian revegetation in a south-east Queensland catchment

###### Project Group B: Tools for Stream Restoration

- 6.5** Hydraulics and performance of fishways in Australian Streams
- 6.6** Developing tools to predict scour of rehabilitation works
- 6.7** Developing an improved method for designing and optimising environmental flow
- 6.11(6A)** Development of flow-ecological response models
- 6.12(6B)** Predicting spatial and temporal variations in channel form

*(Projects current for 2003-2004 in Black)  
(Completed Projects in Grey)*

**The Cooperative Research Centre for Catchment Hydrology is a cooperative venture formed under the Australian Government's CRC Programme between:**

- Brisbane City Council
- Bureau of Meteorology
- CSIRO Land and Water
- Department of Infrastructure, Planning and Natural Resources, NSW
- Department of Sustainability and Environment, Vic
- Goulburn-Murray Water
- Grampians Wimmera Mallee Water Authority
- Griffith University
- Melbourne Water
- Monash University
- Murray-Darling Basin Commission
- Natural Resources and Mines, Qld
- Southern Rural Water
- The University of Melbourne

**Associate:**

- Water Corporation of Western Australia

**Industry Affiliates:**

- EarthTech
- Ecological Engineering
- Sinclair Knight Merz
- WBM

**Research Affiliates:**

- Australian National University
- National Institute of Water and Atmospheric Research, New Zealand
- Sustainable Water Resources Research Centre, Republic of Korea
- University of New South Wales

COOPERATIVE RESEARCH CENTRE FOR



CATCHMENT HYDROLOGY



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