

Cooperative Research Centre for Catchment Hydrology Annual Report 2004-2005



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, environmental values, water allocation, river management and hydrologic risk.

VISION

Sustainable management of the nation's water resources through adoption of an integrated approach to land use, water allocation, hydrologic risk, and environmental values.

To achieve its mission, the 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 is the key

One of the main deliverables expected from this CRC between 2003 and 2005 was the application of sustainable water resource management by catchment managers through the provision of modelling capability designed to support the prediction of catchment behaviours.

This Centre's Catchment Modelling Toolkit has been the key to this capability. The Toolkit has been comprehensively delivered with twenty products made available via a dedicated website.

PROGRAMS: CHALLENGES

Predicting catchment behaviour
Land-use impacts on rivers
Sustainable water allocation
Urban stormwater quality
Climate variability
River restoration

Portfolio of research projects

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

The Centre's portfolio comprised:

- Six multi-disciplinary research programs comprising 15 linked research 15 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—a feature of this portfolio.

The Development Projects involve five Focus Catchments 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 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 2004-2005**

This CRC is a cooperative venture between:

- Brisbane City Council
- Bureau of Meteorology
- CSIRO Land and Water
- Department of Natural Resources, NSW
- Department of Sustainability and Environment, VIC
- Goulburn-Murray Water
- Grampians Wimmera Mallee Water
- 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



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Successor Organisation

In September 2005 the CRC for Catchment Hydrology will cease.

Its successor is the eWater CRC.

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Chairman's Foreword

This is my final foreword as Chairman of the CRC for Catchment Hydrology and it gives me great pleasure to reflect on the life and achievements of this highly successful CRC.

I have been Chairman of the CRC since its inception and although the CRC is now winding up, I feel very proud of the contribution it has made to Australia's natural resource management sector and also very positive about the future of its successor, the eWater CRC.

Achievements of the CRC

The CRC has been extremely successful in building major collaborative partnerships and links between a broad range of players in the water sector. It has brought together industry, water authorities, the Bureau of Meteorology, water resource departments and research organisations to deliver concrete benefits for the Australian community.

Rarely has research been so closely involved with industry, producing valuable tools for application and adoption. Three practical examples of what the CRC has done are the use of MUSIC in planning urban subdivisions in Melbourne and Brisbane, the use of CRC-Forge (computer software methodology for extreme rainfall analysis) for designing and renewing dam spillways more cost-effectively to meet modern flood standards, and the Catchment Modelling Toolkit.

The interest in the Catchment Modelling Toolkit and its relevance to industry is reflected in the large number of people attending workshops, the Catchment Modelling Schools, and the number of licences issued for the software products. The predictive tools developed and facilitated by this Toolkit are having, and will continue to have, a major impact on Australian water management.

The Development Projects in the Focus Catchments are now widely using the CRC's tools, giving them a 'real life' workout, providing vital feedback to researchers and supporting broader adoption. These projects are essentially the CRC's work in action, which is very exciting.

The collaborative culture, networks and institutional connections that have been forged and nurtured through the life of this CRC are outstanding and put Australian hydrology in a good position for the coming years.

It is timely to reflect on the comments of the Independent Global Review in 2003-2004. "The extent of effective collaboration and involvement across different agencies, institutions, and disciplines is a particularly striking feature of the CRC for Catchment Hydrology."

It is my firm belief that the public good CRCs in water (CRC for Catchment Hydrology and CRC for Freshwater Ecology) have been two of the most successful CRCs – their work has been very important and beneficial for the water sector. It concerns me that the push for a more commercial focus for CRCs in the future could result in the loss of public benefits.

Opportunity for creative renewal

While we might feel sad about end of the CRC after 13 years, we should celebrate its achievements and view the formation of the new CRC for eWater as a creative renewal process. The CRC for Catchment Hydrology has a long and proud tradition of making a valuable contribution to the water industry and through eWater it will continue to do so. Formulating the purpose and direction of the new CRC is a bit like a bushfire in a forest – it is a painful thing whilst you go through it, but it is a regenerative process. The establishment of eWater is in fact a very exciting and creative period with a lot of new ideas, new concepts and thoughts stimulated by this regenerative process.

We shouldn't be mourning the demise of the CRC for Catchment Hydrology and the CRC for Freshwater Ecology because out of them eWater has been born and it is set to continue and expand on the excellent work that the two CRCs have achieved. I am passing the Chairman's baton on to Don Blackmore, who together with Gary Jones, the Chief Executive Officer, will set a new agenda and direction for water research in Australia.

Thank you

After 13 years, it isn't possible to thank everyone who has made a contribution to the CRC, but there are some obvious and well deserved people I would like to acknowledge.

In 13 years, we have had four directors head the CRC; Emmett O'Loughlin, Russell Mein, Rob Vertessy and Rodger Grayson. All have left their mark and led the CRC admirably. Their leadership has made the CRC the success it is today. This year, I would particularly like to thank Rodger who's had the difficult task of managing the transition and the closure of the CRC.

I would also like to thank the CRC's staff and researchers who have worked so hard to achieve so much. Your efforts are very much appreciated.

Many thanks go to the Parties of the CRC, most of whom have been with us from the start. Their ongoing support has been invaluable and has ensured that our research is relevant to the needs of industry.

CRC Chairman, Prof John Langford



To the many Board members over the years, my sincere gratitude for your commitment and support. In particular, I'd like to thank the independent Board members and the Visitors, who've gone out of their way to contribute and be involved with the guidance of the CRC. I also appreciate the Hon David Wotton's contribution and efforts as Centre Visitor since March 2003.

I can't conclude without thanking John Molloy who has served the CRC and the Board for the entire CRC journey. The efficiency and smooth running of the CRC owes a lot to him. Good management is basically 'seen and not heard' and that is reflected in John's work.

I would also like to thank and acknowledge the Cooperative Research Centres Programme in the Department of Education, Science and Training and the earlier CRC Secretariat for their support over the years. Of note, is the particular support of Geoff Vaughan, Chair of CRC Programme Committee, who, when he was Deputy Vice Chancellor of Monash, assisted and gave wise counsel regarding the successful bid preparation for the CRC. We have been fortunate to have his support and guidance over the life of CRC.

Board's acknowledgement of CRC management

I am pleased to include the CRC Board's acknowledgement of the CRC's management, passed with acclamation:

'At its final meeting the Governing Board formally acknowledged and expressed its appreciation of the outstanding performance of the CRC's Directors, Deputy Directors, Program and Project Leaders, Focus Catchment Coordinators, Centre Agent, Visitor, and Business Manager with support staff at various nodes, who have led and managed the CRC over the past thirteen years.

Their leadership, professionalism, effort and commitment to delivery have underpinned the Centre's exemplary performance which has been recognised as outstanding by both a series of formal reviews and in the wider community of stakeholders.'

Farewell

As I say goodbye to the CRC, I feel a great sense of satisfaction that it is internationally recognised as a leader in hydrological research. It is known for its close connection between industry and researchers. The benchmark of a cooperative research organisation like the CRC is its contribution to water industry and the community; we can be proud that we have lived up to this standard.

I've really enjoyed my time as Chair of the CRC for Catchment Hydrology. No doubt I will miss CRC activities, but there will be plenty of new opportunities for me and continued informal connections with eWater and its staff. I look forward to following the careers of the CRC for Catchment Hydrology family in the future.

I have really appreciated the opportunity to contribute to Australian hydrology and this country's water sector through the CRC.

A handwritten signature in black ink, appearing to read 'John Langford'. The signature is stylized and cursive, written over a light background.

John Langford
Chairman

Director's Report

The announcement in December 2004 of the successful bid for the eWater CRC heralds an exciting future for cooperative land and water research. Built on the success of CRC for Freshwater Ecology and our CRC for Catchment Hydrology, plus the expanded expertise from new collaborators, a new era dawns for the delivery of integrated and comprehensive research to industry, and ultimately, improved environmental outcomes for Australia.

Delivering our Mission

This past year has been an extraordinary period of delivery for our CRC as we completed key milestones and laid a solid foundation for eWater. We knew that our CRC would end in June 2005 if eWater was successful, or a year later if the bid was unsuccessful. To minimise uncertainty for staff and ensure we delivered on our key milestones, twelve months ago we developed a plan to re-arrange all key activities so that they would be complete by the end of June 2005, irrespective of the outcomes of the eWater bid. This required a reassessment by all teams of their work schedules and a mammoth effort across all the Parties. All that hard work paid terrific dividends with a flood of new products and final reports.

The Catchment Modelling Toolkit now boasts more than 20 products and over 4000 registered members. Given that our early objective was for five products and 400 members, we have done rather well! Of course, producing many products does not guarantee their use, yet this year we have seen some excellent models making a difference on the ground. In Queensland, the Development Project concept has expanded significantly with fabulous support and commitment from our Parties in that State. In the Maroochy catchment we have seen changes in investment decisions resulting from modelling work undertaken as part of the Brisbane River Development Project. Also in Queensland, SedNet is being used throughout the catchments of the Great Barrier Reef to assist with initial target setting. In Victoria, the modelling tools are influencing expenditure on recovery activities from the 2003 Alpine bushfires.

Increasingly, the problems to which our modelling tools are being applied, require integrated assessment of many options or impacts. This year, we released our modelling platform for developing integrated catchment models known as E2. E2 is rapidly developing into a powerful tool for assessing the impacts of catchment management on a range of different outputs including water quantity and quality. It is structured to enable integration of outputs from other widely used models such as SedNet, 2CSalt (a model for assessing the effects of land-use change on stream salinity) and MUSIC, as well as interfacing with RAP and industry models such as IQQM and REALM. E2 is also a 'home' for specific modules developed by research teams to enable whole-of-catchment analysis. E2 is being used as a platform for development of non-CRC tools and will provide an 'engine' for future eWater products.

The application of our modelling tools and the development of platforms like E2 are driven by a more general industry move towards the use of models and modelling as an integral part of management decision making. This includes using models to

determine priorities for investment, assisting with target setting and as part of monitoring design. This broader use of models places considerable responsibility on us to improve the general level of understanding about models and modelling and what they can and cannot do. This year we began our 'Model Choice Series' – a range of documents designed to improve knowledge; we hope the eWater CRC continues with this role of building increased understanding.

Another key component of our education role is the Catchment Modelling Schools. This year we held two schools, one in Brisbane and the other in Sydney, with a total of 576 workshop places. These were an outstanding opportunity for professionals from around the country to network and learn about the new generation of tools designed to underpin improved catchment management. The Schools embody the CRC's mission to 'deliver capability'.

The Development Projects are also a vital way to 'deliver capability'. The great success of these projects, in both guiding tool development and building capability amongst the Parties, has ensured that the concept will be an important part of eWater activity. It has been particularly pleasing to see several of these projects extend well beyond their initial scope, as Parties develop internal skills to roll out the tools to more and more areas.

Software development is another area where we have seen our influence extend beyond CRC Parties. Several groups outside the CRC, including consultants and government agencies, have picked up our development platform TIME (The Invisible Modelling Environment) and our integrated catchment modelling platform E2. The Catchment Modelling Toolkit is also being used to distribute products developed by groups outside the CRC.

Only a few years ago, the Catchment Modelling Toolkit concept was developed to tackle the issues of:

- low level of literacy regarding models and their use in industry;
- poor coordination across scientists resulting in duplication, unhelpful disputes, and confusion amongst users;
- poor integration of models with different capabilities;
- limited transparency in models and inconsistent standards; and
- limited pool of people skilled in the art and science of modelling.

It is great to see the community of model developers has expanded so quickly. I think we can confidently say that we are well on the way to addressing these issues, with eWater well placed to continue this push.

CRC Director, Prof Rodger Grayson



Communication and Adoption Review

Independent evaluation of performance has been an important part of our CRC and this year we commissioned a review of our communication and adoption activities. A company specialising in market research and communication, with wide experience in the commercial arena, undertook the survey. We deliberately chose consultants not directly associated with natural resource management to enhance independence and provide an opportunity for us to learn from their broader experience. Key results included:

- more than 90% of external stakeholders considered that our research is relevant;
- approximately 70% have applied CRC outputs themselves;
- more than 80% believe that the application of CRC outputs has had an impact, with half of these believing the impact was "major or strong";
- more than 80% intend to use CRC outputs and virtually all expect some impact (65% expecting "major or strong" impact); and
- overall satisfaction with our communication activities was also very high (greater than 80%) and we are extremely well regarded when compared to similar organisations.

Clearly, these results were extremely pleasing and reflect the importance placed on communicating results right across the CRC, from the project teams to the Board.

A great effort

As part of the final wind-up of our CRC, through May and June I presented an overview of 13 years of the CRC for Catchment Hydrology to our Parties. We compiled statistics on various aspects of the organisation which are pretty impressive. We have supported the training of around 100 graduate students. More than 3000 people have attended training courses. Around 12,000 reports have been sold and many more downloaded from the web site. More importantly, we can point to some tangible effects on land and water management in Australia and improved environmental outcomes as a result of applying methods developed in our CRC. These include changes to manuals of practice (eg. Australian Rainfall and Runoff) and new guidelines and manuals (eg. river restoration), application of Water Sensitive Urban Design for stormwater management (via MUSIC), as well as examples arising from the Development Projects.

It has been a great honour and enormously satisfying to be the Director over the last year or so. My task to guide the final delivery phase has been made much simpler thanks to the enthusiasm, excellence and sheer hard work of all Project

teams and Program Leaders. Indeed, as the external Review Panel noted last 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 unity of purpose that has underpinned our endeavours over the last 13 years has been a hallmark of our CRC and has built a wonderful foundation for eWater and the future.

I wish eWater all the best for an exciting and productive seven years of collaborative research and delivery. I have no doubt that eWater will have an enormous impact on our industry and keep Australia at the forefront internationally of collaboration between industry and research in the land and water management sector.

Thank you

Finally, my sincere thanks to all those associated with our CRC, from project teams and support staff to Board members. I wish you all the best in your future endeavours.


I'd like to take the opportunity to especially thank some special individuals:

To John Langford, for not only being a great mentor and guide this past year, but also for his incredible contribution to the CRC since its very beginning. A contribution recognised along with his many other impacts on industry in his AM, granted in the 2005 Queen's Birthday honours list. (It was a delight to learn that Russell Mein, our Director from 1995 to 2002, was also awarded AM, a fitting tribute to his role in the CRC and water research and practice generally).

To John Molloy, who has been business manager throughout the life of the CRC and who has played a critical role in our success.

To the Program Leaders, Geoff Podger, Robert Argent, Peter Wallbrink, John Tisdell, Tim Fletcher, Francis Chiew, Mike Stewardson and David Perry, who, along with all the project teams have worked tirelessly this year to 'bring home' our CRC – it's been a great effort.

As many of you know, I am taking a break for a few years, but I look forward catching up with you all down the track.



Rodger Grayson
Director

1992-1999, and 1999-2005

Research – Science Highlights

In the initial CRC for Catchment Hydrology from 1992 to 1999, the research Programs embraced Salinity, Forest Hydrology, Waterway Management, Urban Hydrology, and Flood Hydrology.

With the successful bid in 1998-1999 for a further round of funding, the CRC's Programs evolved to include research on Predicting Catchment Behaviour, Land-use Impacts on Rivers, Sustainable Water Allocation, Climate Variability, and River Restoration.

Highlights over the two Grant Periods, 1992-1999, and 1999-2005 included:

CRC-Forge Computer Software Methodology for Extreme Rainfall Analysis

The CRC developed its CRC-Forge methodology for reliably extending design frequency curves for rainfall. This approach led to reductions in the estimated extreme event rainfall/flood definition, saving some millions of dollars on the anticipated spillway expenditures around Australia based on earlier methods of estimating extreme flows.

Revised Areal Reduction Factors based on Australian data were also developed as part of the Flood Hydrology Program. These factors are lower than the previously used USA-based factors and also affect the expenditure related to extreme events.

These developments were built into industry practice via revisions to ARR (Australian Rainfall and Runoff).

A key outcome is the major savings on infrastructure investment across Australia.

Improved understanding of water use by forests and other vegetation

The variations in water use from different sorts of vegetation were a major focus of the Forest Hydrology Program.

The CRC work contributed substantially to understanding why forests with different age stands use different amounts of water.

The research also covered the:

- water use of grass versus trees,
- impact on water availability of logging, fires, regrowth, and afforestation
- trade-off in quantity and quality from tree planting

Tools were developed to estimate the effect of different land uses at several scales – from stand and forest scale, through catchment scale to the assessment of regional impacts.

This work has had a major impact on policy directions in Australian such as planning the future water availability in the Murray-Darling Basin and threats to the long-term sustainability of resources, the Victorian White Paper on Water, and the National Water Initiative.

Improving water quality in reservoir catchments

Work in the Waterway Management Program on understanding the sources and mechanisms for sediments and nutrients transported to waterways led to a CRC Association Award for Technology Transfer.

The 1999 Award acknowledged the success in having had 90% of a target market – the 100 or so landholders within Victoria's Tarago catchment in west Gippsland – implement remediation works as part of a catchment-wide strategy to improve water quality in the Tarago Reservoir.

Water sensitive urban design

The CRC's work in its Urban Hydrology and Urban Stormwater Quality Programs was reflected in the construction of an integrated urban design project involving a bioretention stormwater quality treatment system and a wetland built at Lynbrook, east of Melbourne. The system, serving part of a 300-lot residential development, was an Australian first and used an ecologically-sustainable stormwater drainage system built to initial CRC specifications.

CRC research and development with Melbourne Water, the Urban and Regional Land Corporation, Victoria (now VicUrban), and Brisbane City Council challenged conventional approaches to urban stormwater management by applying Water Sensitive Urban Design in Melbourne and Brisbane suburbs.

In 2001, the CRC was awarded a CRC Association Technology Transfer Award for excellence with its work on Water Sensitive Urban Design.

More accurate short-term forecasts for rainfall

A central part of the CRC's Climate Variability Program was to develop methods for forecasting weather, seasonal climate and streamflow from several hours to several months ahead.

At the Sydney Olympic Games, the CRC's S_PROG rainfall forecasting (nowcasting) model and five other nowcasting systems from Canada, the US and the UK were tested as part of the World Weather Research Program Field Demonstration Project.

The systems were connected to the Bureau of Meteorology network in Sydney during the Games, to demonstrate state-of-the-art forecasting of rainfall amounts.

EMSS – predicting the impacts of land management on water quality

An Environmental Management Support System (EMSS) was developed by the CRC to predict land management impacts of water quality in 175 sub-catchments covering 22,670 km² of south-east Queensland.

This regional water quality model was applied in the Brisbane Focus Catchment to predict sediment and nutrient fluxes through the river network and into Moreton Bay.

From its initial application in 2001-2002, the EMSS was also being used by a Brisbane-based consultancy group, WBM, as part of the South East Queensland Regional Water Quality Management Strategy (now Moreton Bay Waterways and Catchment Partnership). EMSS provided invaluable experience to guide development of E2.

Environmental flows in streams

A methodology was developed, as part of the River Restoration Program, for determining and establishing appropriate environmental flows in streams. The approach, the CRC's Flow Events Method, was applied in several Victorian studies and recommended for use as part of a State-wide environmental flow setting procedure.

After holding a workshop on Environmental Flows in November 2001, understood to be the largest such event in Australia to that date, the CRC team published a special issue of the 'Australian Journal of Water Resources', on 'Environmental Flows'.

Mwater – experimental water markets

In 2002-2003 the operational development of an experimental water market environment, 'Mwater', was completed in the Sustainable Water Allocation Program.

The software and methodology allows policy makers to explore alternative water trading instruments under controlled conditions.

Mwater has been used in several irrigation areas, including Emerald, Qld; Goulburn-Murray, Vic; and Yanco, NSW, and to provide examples of simulated water trading markets.

MUSIC – decision support system for urban stormwater management

The decision support system MUSIC for planning and managing urban stormwater was launched to 700 urban stormwater managers in May 2002.

The MUSIC software and methodology brought together the CRC's Water Sensitive Urban Design research, and supports stormwater managers in a risk-based approach to water quality target setting and evaluating stormwater treatment options.

MUSIC consolidated its position as a leading-edge tool for analysis of urban stormwater management improvement strategies. With a third version released in 2005 and some 400 licensed users, the software is in widespread use within Melbourne Water, Brisbane City Council and other water and land managers, and by consulting engineers throughout Australia.

Catchment Modelling Toolkit – prediction tools in an efficient modelling framework

The CRC's Catchment Modelling Toolkit marked a major development in 2002-2003 with the adoption of TIME ('The Invisible Modelling Environment') as the framework for the development of CRC software modelling products.

The functionality of TIME was improved and expanded with Industry Parties, other CRCs, and software developers having shown strong interest in using the modelling framework.

Using TIME, the Catchment Modelling Toolkit was developed and expanded via a dedicated website.

From an initial three products by 2003, the Catchment Modelling Toolkit has over 20 products to assist land and water managers in predicting catchment behaviour. There are more than 4000 registered users of the Toolkit.

A major focus for 2004-2005 has been integration of CRC products. A software platform, E2, was developed for integration modelling capability. E2 enables users to build 'tailored' whole-of-catchment models to suit their particular modelling objectives. The CRC's E2 platform for integrated modelling capability arrived at a time when there was no capability of that sort available on the market.

Industry Reports and Industry Seminars

The CRC developed its popular Industry Report and Industry Seminar series, which aimed to bridge the gap between research outcome and industry practice.

For example, seminars held in 1998-1999 each attracted an average of 120 people, with some attracting more than 200. The CRC worked with other organisations including the CRC for Freshwater Ecology, to present industry seminars in Melbourne, Canberra, Sydney, and Brisbane on 'Constructed Stormwater Wetlands: from Design to Construction' and a series on 'Rehabilitating Streams in your Catchment: Priorities and Possibilities.'

Second Year Review highlights

The November 2001 Second Year Review Panel noted that 'the CRC has achieved a number of important awards and achievements, eg:

- the CRC Association Excellence in Technology Transfer Award 2001;
- uptake of Environmental Management Support Systems (EMSS) by South East Queensland (SEQ) stakeholders;
- evapotranspiration maps of Australia; and
- establishment of focus catchments as a means of ensuring that research produces outcomes in addition to outputs.'

Development Projects in Focus catchments

In 2002-2003, the CRC established Development Projects in each of the five Focus Catchments. The projects have provided a focus for the delivery of the CRC's catchment modelling capability and its development to address local catchment issues.

Development projects were set up in the Fitzroy, Brisbane, Murrumbidgee, Goulburn-Broken, and Yarra River catchments.

By June 2005, the Development projects had proved an outstanding model for adoption of CRC research and technology and providing user feedback.

Substantial involvement of Industry Parties including Brisbane City Council, Natural Resources and Mines, Department of Natural Resources, NSW, and Goulburn-Murray Water provided the resources to build up modelling capability within those organisations and to successfully extend the scope of the Development Projects.

Communication and Adoption

Catchword

The CRC's monthly newsletter *Catchword* was established in 1992 and regularly produced throughout the life of the CRC.

It continued to be a very effective way for stakeholders and other interested parties to keep in touch with the CRC's activities, people, and progress. Demand remained high with more than 680 people receiving a free printed copy of *Catchword* in the mail and over 740 people receiving it by email.

Several special issues were produced, each tailored to industry applications.

CRC website

A CRC website was set up in the initial CRC and became the major communications focus for CRC publications.

In the wake of the devastating bushfires over the 2002-2003 summer the CRC launched a website, called 'Bushfires and Hydrology' at www.catchment.crc.org.au/bushfires, in response to a huge demand for technical input from catchment managers, the community and the media. The information on this website assisted land and water managers with their impact assessment and rehabilitation planning.

During 2003-2004 the website underwent substantial change in its appearance and structure. A new user interface was introduced in the re-design to allow users to get information more readily.

By mid-2004, the CRC website was receiving some 5000 visits per month with more than 1600 visiting more than twice per month.

Catchment Modelling Toolkit

The central objective of the CRC has been to produce an integrated, whole-of-catchment modelling capability for land and water managers, and to deliver this to them via the Catchment Modeling Toolkit.

From the science building blocks of the initial CRC, progress on the Catchment Modelling Toolkit accelerated, culminating in the delivery of 20 products via a dedicated Toolkit website, with over 4000 registered users at June 2005, as noted above.

Through this website the CRC has been able to provide end users with access to the CRC models, as well as supporting documentation and data sets. Of the 4000 registered members, over 1000 have visited the Catchment Modelling Toolkit website, www.toolkit.net.au, five times or more.

By June 2005 there have been 17,000 downloads of software and data products.

Approaching 100 postgraduates

Since its inception, the CRC for Catchment Hydrology has trained almost 100 postgraduates.

As the 1997 Fifth-Year Review Panel concluded, the CRC's education and training program 'far exceeded its objectives in attracting students for postgraduate study and has from the outset applied policies which will contribute to (the students') attractiveness to industry and to academia as employees after graduation. These include the adoption of co-supervision involving the CRC Parties and a commitment to giving students experience in industry and in the field during the term of their study.'

The International Panel for the CRC for Catchment Hydrology Global Internal Review of August 2003 noted in its Final Report: 'During the period 2000-2003, 29 postgraduates completed, and currently some 37 PhD and Masters students are studying at Monash, Melbourne and Griffith Universities and CSIRO. The Panel was impressed that around half of the postgraduates studying with CRC for Catchment Hydrology in the period 2000-2003 had been recruited from the water industry or from consultancy organisations.'

Award winning postgraduates

CRC postgraduates achieved several awards.

In early 1998, Lindsay White won the A C Waters Scholarship awarded by the Institution of Engineers, Australia. The scholarship was awarded to Institution members under the age of 30 to fund overseas travel for research of benefit to the Australian community. Dr White's thesis concerned 'Hydraulic information to improve the effectiveness of fishways in Australia'.

Helen Locher was awarded the inaugural CRC Water Forum 'Young Water Scientist of the Year Award' in April 1998

Dr Locher's PhD research focussed on Tasmania's King River, which was heavily sedimented with tailings from past copper mine activities. The work involved collaboration with the State's Hydro-Electric Corporation (HEC), government agencies and the copper mining company.

Santosh Aryal won Monash University's 1998 'Professor K.H. Hunt Award' for excellence in research, the highest research award given by the Monash Faculty of Engineering. Dr Aryal's thesis was on 'A similarity approach to characterise the hydrologic behaviour of landscapes'.

Fiona Dyer won the CRC Water Forum's 'Young Water Scientist of the Year Award' in April 1999 for her work in the CRC's Tarago catchment project in south-west Gippsland. Dr Dyer's study involved chemical 'fingerprinting' of soils from areas suspected of contributing excessive nutrients to the reservoir. These fingerprints were then matched with reservoir sediments. The findings enabled Melbourne Water to make substantial savings by targeting identified problem areas for sediment control works.

Education and Training

Philip Jordan won an award for best postgraduate paper at the Hydro 2000, 3rd International Hydrology and Water Resources Symposium, Institution of Engineers, in November 2000. Philip was co-author of a paper on 'Errors in radar measurement – Effect on flood forecasting.'

Rebecca Bartley won the CRC Water Forum's Young Water Scientist of the Year Award and the Showcasing CRC Postgraduate Students Award after being invited to present at the CRC Association Conference in May 2001. Rebecca's PhD research concerned sediment slugs (large pulses of coarse material) in rivers and a river's ability to recover.

Lucy McKergow won the Meridian Energy and New Zealand Hydrological Society Student Research Prize (PhD) at the November 2001 'Just Add Water' Joint Conference of the New Zealand Hydrological Society and New Zealand Limnological Society.

Teri Etchells won the Australian Postgraduate Award for the Best Presentation at the 27th Hydrology and Water Resources Symposium in Melbourne in May 2002 for her work on 'A methodology for calculating water trading exchange rates in the Murray-Darling Basin'

Dana Thomsen was awarded an international conference grant from Griffith University. Dana used the grant to attend the 9th International Symposium of Society and Resource Management in June 2002 at Indiana University, USA.

Daniel Clowes was awarded a grant in 2003 from the Moreton Bay Waterways and Catchment Partnership to support his PhD studies as part of the Sustainable Water Allocation research program.

Sara Lloyd won the CRC Water Forum's 'Young Water Scientist of the Year' in September 2004. Dr Lloyd's thesis from Monash University was entitled: 'Exploring impediments and opportunities of sustainable stormwater management schemes'.

Catchment Modelling Schools 2004, 2005 – training land and water managers

The CRC ran a highly successful Catchment Modelling School in Melbourne during 2004. The School attracted over 300 participants attending over 500 workshop places. Held at The University of Melbourne during 9-20 February, the School was a key vehicle for training land and water managers.

A further Catchment Modelling School was presented in 2005 and attracted 428 individuals registered for 576 individual workshop places. Held in Brisbane and Sydney during 30 June to 22 July 2005, the CRC delivered 48 workshops in total.

Management targeted seminars were also held in conjunction with each of the Catchment Modelling Schools.

The Catchment Modelling Schools comprehensively met their objectives of raising awareness of the Catchment Modelling Toolkit and its products, providing user training, and giving participants wider knowledge and skills in predicting catchment behaviour.

Enhanced cooperation between industry and research

As a top priority, the CRC has encouraged and developed a collaborative approach as a central part of its culture.

The benefits of this management style have been immense, with greatly enhanced cooperation between Universities, between Agencies within States, and between States. With its Australia-wide participants such as CSIRO and the Bureau of Meteorology, and Development Projects from Queensland to Victoria, the CRC has been able to provide a national perspective on land and water issues.

A respect for real differences across States has developed as participants from research and industry have tackled CRC projects spanning national issues.

From the Governing Board to individual participants, trust and goodwill across all aspects of operation has been emphasised as a central basis for CRC activities. Built through face-to-face contacts, this approach has enabled collaboration to become, for the CRC, simply "the way we do things".

Industry Affiliates

In 2002-2003, and 2003-2004 the CRC welcomed Earth Tech, Ecological Engineering, Sinclair Knight Merz, and WBM as Industry Affiliates.

The Industry Affiliate arrangement has provided a collaborative opportunity for industry stakeholders. It has also enabled the CRC to establish strategic relationships with some of Australia's leading environmental engineering consultants.

The firms have helped the CRC evaluate and promote the use of its catchment modelling tools. The firms have also worked with the CRC on joint consulting projects and training activities. For example, training of Industry Affiliate staff in the CRC's MUSIC software and methodology enabled the firms to run general industry training for MUSIC in Brisbane, Melbourne and Sydney.

Cooperative Linkages – A Culture of Collaboration

International linkages

Collaboration and linkages with international groups and researchers in land and water management has been a feature of CRC activity since the initial CRC.

Leading international researchers and specialists have participated in CRC review panels at major stages over the life of the CRC, providing comprehensive advice on the direction, nature and quality of the science being undertaken.

Exchanges of staff and postgraduate scholars have also enriched the intellectual and collaborative environment of the CRC's work.

The CRC's group of Research Affiliates has included two international organisations, the National Institute of Water and Atmospheric Research, New Zealand, and the Sustainable Water Resources Research Centre, Republic of Korea.

During 2003-2004 the Sustainable Water Resources Research Centre (SWRRC) held a joint symposium with the CRC and 17 staff from SWRRC attended the CRC's Catchment Modelling School in Melbourne during February 2004.

Links with the SWRRC were strengthened in October 2004 when Dr Rob Vertessy, Chief CSIRO Land and Water, and former CRC Director, led an Australian delegation on a DEST-funded "Water Resources Science and Technology Mission to South Korea". The group comprised representatives from both the public and private water sectors including CRC Industry Affiliates. Major groups visited included the SWRRC, Data PCS, and the Korean Water Corporation (KOWACO).

The CRC was honoured to welcome the Director of the SWRRC Dr Sung Kim, together with his wife and two colleagues, to the CRC's Annual Workshop in June 2005. Dr Kim presented an 'Overview of the Sustainable Water Resources Research Program' to the Workshop and outlined the successful collaboration between the CRC and the SWRRC as a Research Affiliate of the CRC.

Program Highlights 2004-2005

Program 1

Predicting Catchment Behaviour

- The development of E2, the whole-of-catchment modelling software, was the primary focus for Program 1 during 2004-05. The first public release was in February 2005. E2 includes all the capabilities of the EMSS, along with pre-processing tools to support transfer of EMSS projects to E2. The system consists of a range of catchment modelling options of different complexity. It includes the ability to integrate calibration and water ordering routines and it incorporates a plug-in method that allows ready integration of other Catchment Modelling Toolkit products, such as RAP and SCL. Training material was developed that covers a range of model problems of significantly different complexity.
- The software modelling framework TIME was further developed to give improved and expanded functionality. Around 15 to 20 CRC and external researchers are actively developing models using TIME. It has created great interest from Industry Parties, other CRCs and software developers. In particular, the Department of Natural Resources, NSW and Queensland Natural Resources and Mines have adopted the TIME modelling environment to develop some of their models. Two environmental modelling groups working on the European Union Framework Program projects have also expressed interest, as has the Queensland EPA.
- The Catchment Modelling Toolkit now contains 20 publicly released products.
- Protocols and procedures for developing a consistent high quality of software products continued to be developed and tested.

Program 2

Land-use Impacts on Rivers

- Program 2 continued to contribute to the whole-of-catchment model E2 developed by 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.
- A Version 1.4.0 of SedNet 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 were undertaken in all the Focus Catchments. Much of the training was delivered at the 2004 Catchment Modelling School and subsequent development project workshops. Further training on the latest versions was provided in the 2005 Catchment Modelling School.

- The design specifications for a new salt model were completed and incorporate the best modules from previous salt-related modelling undertaken across Victoria, New South Wales and Queensland. 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 provided the basis for software coding. A restricted access version was included in the Catchment Modelling Toolkit, with a public release planned for late 2005.
- 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 was 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 (FCFC) is now available in Catchment Modelling Toolkit.

Program 3

Sustainable Water Allocation

Program 3 has developed an important knowledge base of socio-economic water management issues in Australia and internationally. The value of this knowledge is vital for informed decision-making and the development of sound and well crafted water policies. Issues explored this year include:

- The principles and issues surrounding the effective reduction of point and non-point pollution entering rivers and streams in our focus catchments. Significant progress has been made in experimentally exploring the issues of moral hazard and adverse selection which can arise when developing land management and water policy to address sediment and pollution loads.
- Effective policies to deal with the associated risks and uncertainties resulting from the fleeting and interdependent nature of its supply. Significant progress has been made in understanding risk preferences and their impact on better ways to manage water allocations.
- Assessment of the impact of large players in relatively thin water markets, where transactions are almost totally confined within the irrigation sector. This is a great concern to both water authorities and farmers. Research over the past twelve months has provided important insights into how best to design water markets to minimise the impact of large players operating in a probabilistic or stochastic way.
- Separation of water entitlements into component parts raises the potential for multiple markets. How to develop such markets and operationalise them has been a significant part of the Program's research. While there are many questions still to be answered the findings to date have proved critical in developing proofs of concept for the industry.

Program 4

Urban Stormwater Quality

- Program 4 released MUSIC v3 in May 2005. This version incorporates substantial improvements to algorithms, calibration and interface. MUSIC v3 also incorporates a Lifecycle Costing Module, allowing users to predict the costs of alternative stormwater treatment strategies.
- Program 4 PhD student, Sara Lloyd, won the CRC Association 'Young Water Scientist of the Year' award for 2004.
- Substantial industry support for the Urban Stormwater Quality Program's work was expressed through contributions to a number of Associated / Additional Projects, including Socio-Economic Assessment of Stormwater Management, Integrated Stormwater Treatment and Re-use, and Stormwater Quality Assessment.
- Ongoing collaboration with CRC for Freshwater Ecology refined models of ecosystem responses to urbanisation, and helped to develop guidelines and objectives for water sensitive urban design.
- Program 4 research was widely published in a number of leading peer-reviewed journals and presented at conferences.
- Close collaboration with Brisbane City Council and Melbourne Water allowed monitoring of a number of stormwater quality treatment systems.

Program 5

Climate Variability

- Program 5 released three model products through the Catchment Modelling Toolkit this year:
 - SCL – a library of stochastic models for generating climate data;
 - TREND – statistical tests for detecting trend / change in environmental time series data; and
 - NSFM – a nonparametric model for forecasting streamflow several months ahead.
- Program 5 released three data products:
 - SHPA – soil hydrological properties for Australia;
 - LIZA – land cover type for the Intensive Use Zone of Australia; and
 - SIMHYDpar – SIMHYD parameter values for use in ungauged catchments.
- The Murrumbidgee River Basin data monitoring program and land surface modelling 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 about three years of unique data available to run hydrological models and to test model simulations against runoff and soil moisture.
- Program 5 continued to work collaboratively with leading researchers in Australia and overseas.

Program 6

River Restoration

- In conjunction with the CRC for Freshwater Ecology, the Program 6 team developed the Ecological Response Module and Time Series Manager for the River Analysis Package (RAP).
- Two data products have been added to the Catchment Modelling Toolkit website:
 - (i) a database of river channel surveys and
 - (ii) a river network for Victoria with derived hydrological attributes for each network link.

- 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 contributed to improved flow ecology modelling by deriving physical habitat parameters to be related to biological data collected in Victoria (invertebrate community) and Queensland (fish community). This study has resulted in predictive models relating invertebrate community characteristics to flow metrics.
- Empirical hydraulic geometry models have been developed for Australian streams. Models relate channel dimensions, bankfull discharge and other channel metrics to catchment parameters with a known level of uncertainty.

Program 7

Communication and Adoption

- At the end of June 2005, more than 4000 registered users could download 20 public software products and two public data products available from the Catchment Modelling Toolkit.
- The E2 integrated whole-of-catchment modelling software was officially launched at the Catchment Management School 2005.
- The five Development Projects are demonstrating how the CRC's research and modelling tools can be used and applied meaningfully for catchment management decision-making. All Development Projects have made significant progress.

There are now at least 11 Environmental Management Support System (EMSS) models for South-East Queensland region catchments. EMSS and SedNet models have been built for the Fitzroy and the Mackay/Whitsunday catchments and SedNet models have been developed for the high priority Great Barrier Reef catchments. In Victoria, the YarraSim EMSS model has been built using current land-use information to generate hydrological and water quality responses for the Yarra River catchment and EMSS models have been developed for the upper-mid Goulburn catchment (including the Eildon and Goulburn weirs) and the Tullaroop Reservoir in the Loddon River Catchment. In the Murrumbidgee Catchment in NSW, a SedNet model has been successfully developed.

- A market research consulting company assessed the CRC's communication and adoption performance in August 2004, which followed a review done in 2001. Overall the results were very positive. Responses, particularly from stakeholders, indicated an improvement on the already high level achieved three years ago. The results will contribute to identifying opportunities for communication and adoption activities for the eWater CRC.

Program 8

Education and Training

- Building on the success of the inaugural Catchment Modelling School in Melbourne in 2004, the 2005 School was held in Brisbane (30 June to 8 July) and in Sydney (14 to 22 July). 428 people participated in the 2005 School over both locations which offered a total of 48 workshops. The feedback from this year's School was, again, very positive, and reflects the continued interest by the water industry to use the CRC's modelling tools.
- On 3 September 2004, Sara Lloyd won the Young Water Scientist of the Year award.
- A new publication series was launched this year. The Model Choice Series is designed to assist industry professionals who are commissioning or involved with catchment modelling to better understand how the tools developed by the CRC can help them. In 2004-2005 two publications in the series were produced. These are available at www.toolkit.net.au/modelchoice.

Structure and Management

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 Natural Resources, NSW
Department of Sustainability and Environment, Victoria
Goulburn-Murray Water
Grampians Wimmera Mallee Water
Murray-Darling Basin Commission
Natural Resources and Mines, Queensland
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 2005 was:

Professor John Langford (Independent Chairman),
The University of Melbourne

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

Dr Colin Chartres, Director, Government Interactions and
International, CSIRO Land and Water (alternate Dr James Moody)

Mr Geoff Earl, Manager, Water Systems and Environment,
Goulburn-Murray Water (succeeded by Mr Pat Feehan
from August 2005)

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

Professor Rodger Grayson, CRC Director, The University
of Melbourne

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

Professor Jane Hughes, Faculty of Environmental Sciences,
Griffith University

Mr Denis Hussey (Independent Board Member)

Professor Graham Hutchinson, Department of Civil and
Environmental Engineering, The University of Melbourne

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

Mr Scott Keyworth, Murray-Darling Basin Commission
(succeeding Ms Louise Rose)

Ms Rae Moran, Department of Sustainability and Environment,
Vic (alternate Ms Tracey Walker)

Mr Chris Robson, Executive Director, Natural Resources and
Sciences, Natural Resources and Mines, Qld
(alternate Mr Don Begbie)

Mr Graham Rooney, Waterways and Wetlands Research,
Melbourne Water

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

Mr Ross Williams, Acting Director Water and Landscape
Sciences, Office of Knowledge, Science and Information,
Department of Natural Resources, NSW (alternate
Dr Dugald Black)

Professor William Young, Head of Department of Civil
Engineering, Monash University

The Governing Board met on the following dates:

27 August 2004

19 November 2004

16 March 2005

3 June 2005

Centre Management

The CRC's Director, Professor Rodger Grayson, 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; and the Department of
Sustainability and Environment, Tatura and Rutherglen, Vic.

Deputy Directors oversee the operations at the four sites –
Assoc Professor Francis Chiew at The University of Melbourne,
Dr Ana Deletic at Monash University, Dr John Tisdell at Griffith
University and Dr Peter Wallbrink at CSIRO.



CRC Governing Board, Canberra, June 2005



CRC Focus Catchment Coordinators, Program Leaders and Executive,
Woodend, March 2005

Strategic Directions

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

The CRC officially terminated on 30 June 2005, after its successful joint bid with the CRC for Freshwater Ecology and new Partners to form the eWater CRC. Winding-up activities will continue as the transition is made to the new CRC.

Research Programs

The Centre supported 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

Highly skilled and experienced Program and Project Leaders managed these research programs and projects on behalf of the Centre. They met regularly in conjunction with the meetings of the Centre Executive and prepared reports for them. There are five Focus Catchment Coordinators who provided ongoing feedback to the Executive about the progress and issues within each catchment including the CRC Development Projects in the catchments.

These research programs were complemented by further activities in the following programs:

- Program 7** Communication and Adoption
- Program 8** Education and Training

The five Development Projects in the focus catchments were key vehicles for further adoption and application of CRC research. They contributed to capacity building within their communities and increasingly have the involvement and support of key stakeholders.

Annual Workshop

This year's annual workshop was held from 14-16 June 2005 at The Cumberland in Marysville, east of Melbourne. Over 120 industry participants, research scientists, postgraduate students and CRC staff attended the workshop.

As the wrap-up of the CRC for Catchment Hydrology was imminent, the workshop was an opportunity to reflect on the CRC's successes over the years and also the learnings that can be taken into the eWater CRC.

One interesting workshop session focused on the organisational culture of the CRC and how it has contributed to the CRC's success and achievements. It was an opportunity to reflect on what elements will be important to continue with in eWater.

The last day of the workshop provided opportunities to hear more about the direction and research agenda of eWater, as well as learn more detail about the products, programs and the proposed commercialisation activities of the new CRC. Professor Gary Jones, eWater Chief Executive, gave a presentation as well as other key eWater staff.

Below left and right: Workshop sessions March and June 2005 for CRC leadership group



As usual, the workshop provided postgraduates an opportunity to present their research outcomes and to benefit from networking with CRC research leaders and scientists.

The workshop had a very positive and celebratory atmosphere with participants enjoying a big final, farewell.

Participation Arrangements

Organisations have been able to 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;
- as an independent, experienced and objective advisor.



CRC Visitor, the Hon David Wotton

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. For example, 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.

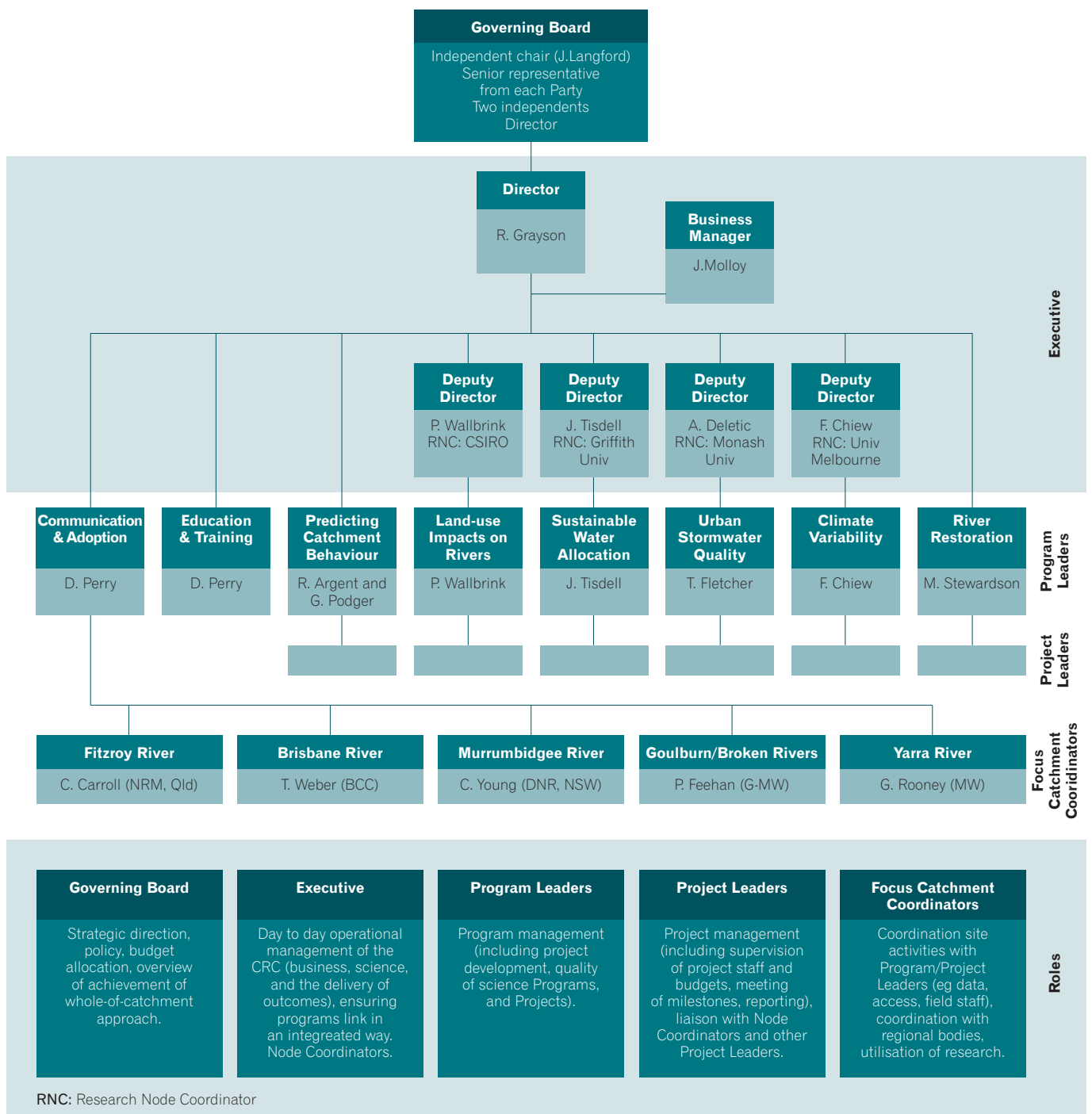
He is the Presiding Member, SA Murray Darling Basin Natural Resource Management Board, and the Presiding Member, River Murray Catchment Board. David is also a member of the eWater CRC Board.

Below: Presentation by Dr Rory Nathan (SKM) at Annual Workshop





CRC Annual Workshop participants, Marysville, June 2005



RNC: Research Node Coordinator

New from existing CRC – Transitional Arrangements

Transitional arrangements implemented during the year to form the new Centre.

During 2004-2005, the CRC for Catchment Hydrology worked with the CRC for Freshwater Ecology and new partners in planning and putting in place transitional arrangements for the formation of, and hand-over to, the successor CRC, the eWater CRC.

Key arrangements included:

Development of Business Case for the eWater CRC, mid 2004

- CRC Teams developed the major program activity and milestones required for the Stage 2 case. Most of the CRC for Catchment Hydrology Program Leaders and some key Party researchers were directly involved with the CRC for Freshwater Ecology in this planning work during June 2004. This work built on the outcomes from a workshop of key research groups was held on 10 and 11 May 2004 to develop research activities to both support the immediate needs of the product portfolio and to underpin likely future needs of the eWater CRC
- Joint development of the eWater CRC commercialisation and utilisation strategy by Program Leader David Perry with his counterpart at the CRC for Freshwater Ecology, Assoc Prof Ralph Ogden.
- Preparation of the management sections of the eWater CRC business case with the CRC Business Manager John Molloy assisting the CRC for Freshwater Ecology Business Manager Charlie Robinson.
- Joint work by the CRC for Freshwater Ecology CEO Prof Gary Jones and CRC for Catchment Hydrology Director, Prof Rodger Grayson on organisational matters for the new CRC and reviewing the drafts of the business case.

Planning for Annual Workshop 2005

- In August 2004, with the approach of the Federal election on 9 October 2004, and later scheduled interviews for the new CRC applications (originally expected in September 2004), the CRC recognised that there was a chance that the final decisions on selection of new CRCs may not have been known until the New Year 2005.

Originally, the CRC for Catchment Hydrology planned for its Annual Workshop to be in June 2005 (as a "grand finale") with a contingency for one in February 2005 in the case of eWater being unsuccessful. The CRC Annual workshop was an important milestone in marking the closure of the CRC for Catchment Hydrology and the transition to the eWater CRC.

Preparation for eWater CRC selection interview

- The CRC for Catchment Hydrology Director and Program Leaders were actively involved with Prof Gary Jones and his CRC for Freshwater Ecology team in the preparation for and conduct of the interview for the eWater CRC in October 2004. Under the chairmanship of Mr Don Blackmore, in the lead-up to the interview, a substantial effort was put into the refinement and articulation of the eWater CRC business case and supporting activities.

Response to announcement of successful eWater CRC bid

- On 21 December 2004, The Hon Dr Brendan Nelson, the Australian Government Minister for Education, Science and Training announced 'grants of \$407 million for world-class research and innovation under the Australian Government's Cooperative Research Centres (CRC) Programme.'
- The CRCs for Catchment Hydrology and Freshwater Ecology were delighted to learn that the successful grants included:
- '\$40.25 million for an eWater CRC to build on the success of the existing Catchment Hydrology and Freshwater Ecology CRCs. This CRC will develop products that will help government and industry deliver quality water, more efficiently and more cheaply.'
- The announcement of the successful bid represented the hard work of many people over the previous nine months in putting the proposal together, and a great effort from Prof Gary Jones and Don Blackmore in presenting the case. From the CRC for Catchment Hydrology perspective, the successful outcome was in part due to the focussed efforts and substantial outcomes of the CRC's team in building the Catchment Modelling Toolkit to that time.
- The CRC for Catchment Hydrology leadership team was determined to remain very focussed on delivery of Catchment Modelling Toolkit products over the final six months as a central part of the completion of the CRC's core projects and the planned hand-over to the eWater CRC.

Focus on wrap-up and learnings for the new CRC from Focus Catchment Coordinators, Program Leaders, Executive workshop.

- CRC for Catchment Hydrology Focus Catchment Coordinators, Program Leaders, and Executive reviewed activities and objectives for the transition period to the commencement of the eWater CRC during a workshop held on 15-16 March 2005.

Planning for the July-September 2005 wind-down period

- With the eWater a reality, the CRC Executive and Board revisited and updated the preliminary budget estimates and arrangements for the July to September 2005 wind-down period.



eWater CRC Executive members Prof Gary Jones, David Perry, Assoc Prof Ralph Ogden and Dr Peter Wallbrink gave a briefing on eWater at the Annual Workshop, June 2005

Establishing eWater CRC Executive

- In April 2005, the eWater Executive was set up, comprising Prof Gary Jones, Charlie Robinson, and Assoc Prof Ralph Ogden from the CRC for Freshwater Ecology and Dr Peter Wallbrink, David Perry, and Prof Rodger Grayson from the CRC for Catchment Hydrology.

This group met weekly, generally as a phone hook-up, but wherever possible, face to face. The major activities were:

- finalising details of Agreements
- undertaking further refinement of Product Plans
- finalising recommendations for Themes (Programs) and Theme leaders
- defining a process for setting up the Initial Projects (July-Dec, 2005)
- finalising details of strategic and operational organisational structures
- developing a strategic business plan based on the submitted business case
- working with eWater CRC participant organisations to ensure a successful start

Developing Centre Termination Agreement

- Following initial drafting in August 2004, work by the CRC Parties and Executive continued on developing an agreement for the termination of the CRC for Catchment Hydrology's unincorporated joint venture.

The agreement included aspects of transition to the new CRC, for example, intellectual property, and winding-up aspects.

Briefing on eWater CRC at CRC for Catchment Hydrology final Annual Workshop

- During 14-16 June 2005, the CRC held its final Annual Workshop. The workshop, at Marysville Victoria, was the eleventh for the CRC.

Prof Gary Jones, the CEO-elect of the eWater CRC, and members of the eWater Executive, outlined the future directions for the CRC and the key elements of its business strategy.

The workshop was also an important phase in developing the links between researchers and industry participants for the existing and new CRCs.

Collaboration – Cooperative Linkages

CRC Associates

Organisations can join the CRC as Associates giving them a direct link to individual projects (whereas Parties are linked to all projects). Current CRC Associates are:

Water Corporation of Western Australia

CRC 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

CRC Industry Affiliates

Earth Tech

Ecological Engineering

Sinclair Knight Merz

WBM

Research Affiliates

The CRC's group of Research Affiliates has included two international organisations, the National Institute of Water and Atmospheric Research, New Zealand, and the Sustainable Water Resources Research Centre (SWRRC), Republic of Korea.

Links with the SWRRC were strengthened in October 2004 when Dr Rob Vertessy, Chief CSIRO Land and Water, and former CRC Director, led an Australian delegation on a DEST-funded "Water Resources Science and Technology Mission to South Korea". The group comprised representatives from both the public and private water sectors including CRC Industry Affiliates. Major groups visited included the SWRRC, Data PCS, and the Korean Water Corporation (KOWACO).

The CRC was honoured to welcome the Director of the SWRRC Dr Sung Kim, Dr Kim's wife, Kyung-Jin Lee, and colleagues Dr Jong-Kook Lee, and Dr Kyu-Cheoul, to the CRC's Annual Workshop in June 2005. Dr Kim presented an overview of SWRRC research and outlined the successful collaboration between the CRC and the SWRRC as a Research Affiliate of the CRC.

Industry Affiliates

Having this Industry Affiliate arrangement provides the CRC with 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 the significant benefits to Australia's land and water management industry.



Research Affiliate representatives from SWRRC, Korea, Dr Sung Kim, Director of SWRRC (second from right), Dr Kim's wife, Kyung-Jin Lee, and colleagues Dr Kyu-Cheoul Shim and Dr Jong-Kook Lee at CRC Annual Workshop.

Representatives from Industry Affiliates Earth Tech, Ecological Engineering, Sinclair Knight Merz and WBM participated in the CRC's Annual Workshop at Marysville, 14-16 June 2005. Mr Tony McAlister, WBM, and Dr Rory Nathan, Sinclair Knight Merz, gave presentations on CRC/Industry interaction.

Industry Affiliates were actively involved in the Catchment Modelling School 2005 held in Brisbane and Sydney through staff participating in workshops and their specialists presenting workshops.

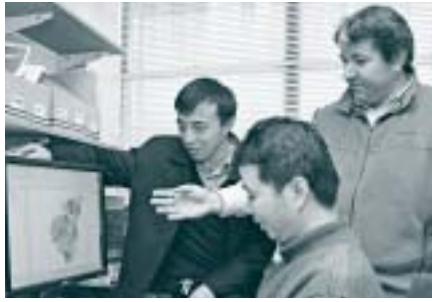
Links between Parties

This CRC 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 involve at least two Parties;
- research and industry representatives jointly formulate CRC research projects;
- projects are reviewed at least twice a year or are part of a Global Review
- the Focus Catchments are a major opportunity to bring industry, researchers and regional representatives together;
- CRC staff are seconded from industry to research sites and vice versa;
- Postgraduate supervisory panels include non-university members;
- CRC Parties participate in the Centre's Annual Workshop;
- The CRC's monthly newsletter, *Catchword*, and the internal news bulletin, *CatchUp*, regularly report on Parties' involvement in the CRC.



Industry Affiliate representatives Dr Rory Nathan (Sinclair Knight Merz) and Tony McAlister (WBM) at CRC Annual Workshop.



(Right) Dr Tim McVicar and Loess Plateau, China project colleagues, (Centre) Lingtao Li, CSIRO, and (Left) Dr Zhongming Wen, Chinese Academy of Sciences.



Sylvain Arene, Program 6 researcher from University of Metz, France.

Working with other research groups and agencies

This CRC works closely with leading Australian and international land and water research organisations and management authorities. Interactions included:

Program 1 'Predicting catchment behaviour'

- Dr Robert Argent is working on a project for Department of Primary Industry (Vic) that is testing Best Management Practices for fertiliser application on irrigated agriculture. E2 has been used to construct the model.
- Joel Rahman is working on a project for Sinclair Knight Merz to assist in development of a catchment planning model for the Hornsby Shire Council. E2 has been used to construct the model.

Program 2 'Land-use Impacts on Rivers':

- Dr Tim McVicar (CSIRO) and colleagues spent time in China with collaborators from the Chinese Academy of Sciences working on the Loess Plateau project.
- Dr Lu Zhang (CSIRO) also worked in China with Academy researchers on land-use changes in catchments.
- Dr Christy Fellows participated in a workshop (8 March 2005) advising the Maroochy Shire Council on the development of their Waterways Monitoring Program. The Shire is in the process of developing a comprehensive freshwater monitoring program, including assessment of ecosystem health response of streams and riparian zones to catchment pressures such as sediment and nutrient inputs.
- As part of the Queensland Government's commitment to the Great Barrier Reef Water Quality Protection Plan, Dr Heather Hunter is leading the development of a proposed water quality monitoring and modelling framework for GBR catchments.

Program 3 'Sustainable Water Allocation':

- Collaboration with CSIRO Sustainable Ecosystems Division was a central feature of work by Dr John Tisdell and the Program 3 team on experiment water trading with Mwater. CSIRO's Ecosystem Services Project are using Mwater to study alternate market mechanisms for overcoming downstream salinity problems in the Upper Bet Bet catchment. Dr Tisdell also collaborated with the Department of Primary Industries, Victoria, and Charlotte Duke on cap and trade for salinity, using a laboratory experiment market for property rights and private abatement.

Program 4 'Urban Stormwater Quality':

- Dr Ana Deletic and Dr Tim Fletcher coordinated the UNESCO's IHP project working group on Data Requirements for Integrated Urban Water Management in Paris, France. Dr Fletcher also spent time in Lyon, France on related work, including further collaboration with UNESCO colleagues.
- Program 4 also interacted with New Zealand organisations involved in urban stormwater management, particularly, Auckland Regional Council and Landcare Research.

- Dr Deletic and Dr Fletcher were also involved with the Program 4 team in organising a workshop session for the International Urban Stormwater Conference in Denmark, in August 2005.

Program 5 'Climate variability'

- Program 5 has continued to work collaboratively with leading researchers in Australia and overseas, in particular Prof John Dracup (University of California, Berkeley), Prof George Kuczera (University of Newcastle), Prof Geoff Pegram (University of KwaZulu-Natal, South Africa), Dr Clive Pierce (UK Met Office), Dr Ashish Sharma (University of New South Wales) and Prof Isztar Zawadzki (McGill University, Canada).

Program 6 'River Restoration'

- Dr Nick Marsh established closer links with the Queensland EPA with his appointment to the Agency in 2004. Catchment Modelling work with the QEPA progressed in conjunction with Program 1.
- Links with river restoration researchers in France were enhanced with Dr Mike Stewardson's six month collaboration with the CEMAGREF group in Lyon during 2004.
- Sylvain Arene from the University of Metz contributed to the River Restoration models in the toolkit.

Location of staff with other Parties

Further collaboration between industry and research Parties was assisted with the location of staff at other Parties' centres.

Geoff Podger (DNR, NSW, now with CSIRO) spent time at CSIRO together with Dr Mark Littleboy (DNR, NSW).

Hugh Duncan (Melbourne Water) was located full time at Monash University. Matt Francey (Melbourne Water) was also at Monash on a part-time basis.

The Director, Prof Rodger Grayson (The University of Melbourne) is based at the Centre office, Monash University.



Colleagues from workshop on Heuristic Probabilistic Forecasting at McGill University, May 2005 run by Dr Alan Seed. (L to R) Dr C Nueller (NCAR), Dr J Wilson (NCAR), Dr A Seed, Dr G Lee (McGill) and Prof I Zawadzki (McGill).

International Visitors

Prof Li Rui, China, visited CRC Program 2 researchers, Dr Lu Zhang and Dr Tim McVicar, CSIRO Land and Water, Canberra, from 12 July 2004 and returned to China after a 10-day planning visit including discussions on land-use impacts on rivers.

Dr Tim Fletcher and Dr Ana Deletic (Program 4) hosted Swedish PhD researcher, **Camilla Westerbund**, at Monash University on 6 August 2004.

André Taylor (Urban Stormwater Quality Program) and Monash colleague Dr Rebekah Brown met with **Prof Richard Ashley**, University of Sheffield, during his visit to Australia on 26 August 2004 to discuss Australian and European research on triple-bottom line assessment methods and research on institutional impediments to more sustainable urban water management arrangements.

Assoc Prof Francis Chiew (Climate Variability Program) and Assoc Prof Hector Malano (Sustainable Water Allocation Program) hosted on 13 October 2004, at The University of Melbourne, visiting scientists from Vietnam: **Prof Le Kim Truyen**, **Assoc Prof Nguyen Quang Kim**, **Dr Tran Vu Hop**, and **Assoc Prof Pham Ngoc Quy** from the Water Resources University; **Assoc Prof Le Manh Hung** from the Southern Institute of Water Resources Research; and **Mr Dong Quang Sun** from the Ministry of Science and Technology. Research discussions included hydroclimate variability, seasonal forecasting, catchment modelling and water allocation in large river systems.

CRC Director, **Prof Rodger Grayson**, participated in a two day symposium during 17-18 October 2004 hosted by the Australian Academy of Technological Sciences and Engineering and the Australian Academy of Science, on behalf of DEST, for invited Australian and Chinese research and industry leaders to explore current and future developments in the inter-related topics of Water; Environment and Energy; Sustainable Agriculture and Ecosystem Restoration.

The aim of the symposium was to "to act as a platform to develop strategic relationships". The Water Theme was led by Prof John Langford, The University of Melbourne, CRC Board Chairman. Other Australian participants were Prof Tom McMahon, and Don Blackmore, eWater CRC Chair. The session on water research highlighted the enormous potential for collaboration with a great deal of common interest, particularly in the areas of catchment prediction and developing institutions to manage the challenges facing the water sector.

A delegation of four staff from **KOWACO** (the Korean Water Corporation), visited CSIRO Land and Water and the CRC during 24-28 January 2005. Most of the time was spent in Canberra discussing a range of activities from the Water Resources Observation Network and remote sensing, to the CRC's TIME as a software development environment.



Australia China Symposium October 2004, Prof Rodger Grayson and Dr Li Xin

The delegation visited Melbourne on 27 January 2005 and talked about flood estimation, radar rainfall estimation, climate variability and catchment modelling. The few days were an excellent opportunity for exchange of ideas, with the Koreans showing some very impressive results of real time monitoring, data and systems management. The visitors were impressed with the modelling activities within the CRC.

Dr Liu Wengzhao, and **Dr Mu Xinming**, Institute of Soil and Water Conservation, Chinese Academy of Sciences, visited Dr Lu Zhang and Dr Tim McVicar, CSIRO Land and Water, Canberra during 2 February – 1 March 2005 in relation to stream-flow response to land-use change in the Loess Plateau, China.

Prof Kurt Fausch from Colorado State University, Colorado, USA and **Assoc Prof Tom Turner** from the University of New Mexico, New Mexico, USA visited the Centre for Riverine Landscapes at Griffith University 7 – 11 February 2005. Both researchers work on river management, including the implications of flow alteration and riparian zone condition on in-stream organisms. Prof Stuart Bunn, Dr Christy Fellows, and Carol Conway (CRC Researchers in Programs 2 and 6) had the opportunity to discuss their research on riparian zone nutrient cycling in CRC Project 2.22 (2D), and hear about their research projects both in informal discussions and formal seminars. The exchange was very valuable because they both conduct research in climates which are relatively arid, and show parallels with Australian systems in terms of catchment management and water resource development.

Prof Geoffrey Pegram, University of KwaZulu-Natal, Durban, South Africa, visited Assoc Prof Francis Chiew, The University of Melbourne, during 10 January 2005 – 4 March 2005. Collaborative work continued on hydroclimatic variability and water resources management.

Prof Howard Wheeler, University College London, visited Prof Rodger Grayson, The University of Melbourne, at the CRC Office, Monash University on 7 April 2005 for discussions on environmental research.

Dr Zhongming Wen visited Dr Lu Zhang and Dr Tim McVicar, CSIRO Land and Water, Canberra, from 28 December 2004 for collaborative research. Dr Wen returned to China in June 2005, after a six-month long visit to study spatial model vegetation suitability for the Loess Plateau, China.

Dr Sung Kim, Director, Sustainable Water Resources Research Centre (SWRRC), Republic of Korea, Dr Kim's wife, **Kyung-Jin Lee**, and colleagues **Dr Jong-Kook Lee**, and **Dr Kyu-Cheul Shim** visited Australia to attend the CRC's Annual Workshop at Marysville, 14-16 June 2005. Dr Kim presented an 'Overview of the Sustainable Water Resources Research Program' to the Workshop and outlined the successful collaboration between the CRC and the SWRRC as a Research Affiliate of the CRC. Future collaboration with the eWater CRC was also being actively pursued.



Australia China Symposium, October 2004 Water Workshop participants: (Back L-R) Prof Liu Baoyuan, Dr Li Xin, Prof Rodger Grayson, Prof Qin Boqiang, Tang Jian, Prof Kang Shaozhong, Prof Cao Jinghua, (Front L-R) Prof Tom McMahon, Prof Xia Jun, Prof John Langford, Don Blackmore

International Visits

Dr Tim Fletcher, Monash, Program 4 Leader, worked at INSA (Institute Nationale Scientifique Application) in Lyon, France, 14 June – 14 July 2004 on Urban Stormwater Quality research

Dr Mike Stewardson, The University of Melbourne, CRC Program Leader for River Restoration, undertook research during July-December 2004 with CEMAGREF (Institut de recherche pour l'ingénierie de l'agriculture et de l'environnement), Quantitative Hydrobiology Group, in Lyon, France.

Dr Alan Seed, Bureau of Meteorology, presented a summary of the Murray-Darling Basin Water Balance Project at the 10th GEWEX Hydrometeorology Panel Meeting, Montevideo, Uruguay, 15-16 September 2004.

Li Lingtao, Tom Van Niel, Dr Lu Zhang and Dr Tim McVicar, CSIRO Land and Water, visited China during 2-17 October 2004 for a familiarisation field trip of the Loess Plateau; and an ACIAR (Australian Centre for International Agricultural Research) formal mid-term project review with ACIAR Program Leader **Dr Ian Willett**. The ACIAR project, titled: Regional impacts of re-vegetation on water resources of the Loess Plateau, China and the Middle and Upper Murrumbidgee Catchment, Australia, is a CRC Associated /Additional project.

During 8-18 October 2004, **Dr Rob Vertessy**, Chief CSIRO Land and Water, and former CRC Director, led an Australian delegation on a DEST-funded "Water Resources Science and Technology Mission to South Korea". The group comprised representatives from both the public and private water sectors including **Prof Gary Jones** (CRC for Freshwater Ecology and eWater), **Dr Peter Osman** (CSIRO), **Dr Bohdan Durnota** (Tjurunga Research), **Dr Tim Ellis** (CSIRO), **Dr Sharon Davis** (MDBC), and CRC for Catchment Hydrology Industry Affiliate representatives: **Dr Rory Nathan** (SKM), **Dr John Tilleard** (EarthTech), **Tony Weber** (WBM) and **Dr Tony Wong** (Ecological Engineering).

The objective of the trip was to better understand the Korean research programs in river basin management and water resources technology and investigate potential areas for collaboration. There were many opportunities for information exchange in areas common to both the Korean and Australian research groups through seminars and meetings. Major groups visited included the Sustainable Water Resources Research Centre (SWRRC), Data PCS and the Korean Water Corporation (KOWACO).

Dr Tim Fletcher, Monash, met with Prof David Butler's group, Imperial College, London on 1 December 2004. Prof Butler is Professor of Water Engineering and heads the Urban Water Research Group



Delegation to Korea including CRC Industry Affiliates, eWater CRC, CSIRO; with SWRRC colleagues, Oct 2004

Assoc Prof Francis Chiew, The University of Melbourne, visited Prof John Dracup, University of California, Berkeley, USA, during 7-10 December 2004 for collaborative work on hydroclimatic variability and water resources management.

Dr Tim Fletcher and André Taylor, Monash, during a visit to present a two-day workshop in New Zealand 14-16 February 2005, met with researchers from Landcare Research in New Zealand. The NZ researchers are undertaking a six-year research program on low impact development (water sensitive urban design).

Dr Tim Fletcher, Monash, visited Auckland Regional Council to advise them on stormwater management during February and May 2005.

Dr Tim Fletcher and Dr Grace Mitchell, Monash, ran a two-day workshop for the UNESCO International Hydrologic Program VI, on Data Requirements for Integrated Urban Water Management, in Paris, France, 14-15 March 2005. The international project is led by Dr Tim Fletcher, Dr Ana Deletic and Dr Grace Mitchell at Monash, members of the CRC's Urban Stormwater Quality Program, Program 4.

During 21 December 2004 – 6 January 2005, **Dr Lu Zhang**, CSIRO, CRC Project Leader in Program 2: Land-use impacts on rivers, visited the Institute of Geographical Science and Natural Resources Research, Chinese Academy of Sciences, Beijing, China. Research collaboration on stream-flow responses to land-use change was pursued with Prof Xia Jun.

Dr Lu Zhang, CSIRO, visited Prof Dennis Lettenmaier, Department of Civil and Environmental Engineering, University of Washington, Seattle, USA, during 11-19 March, 2005, for research on the impact of climate change on hydrology.

Dr Alan Seed, Bureau of Meteorology, CRC Project Leader in Program 5: Climate variability, visited Prof Zawadzki, Dept Oceanic and Atmospheric Science, McGill University, Montreal, Canada, over 1-14 May 2005.

Dr Ana Deletic, Monash, visited Landcare Research, Auckland, New Zealand, and Auckland Regional Council, during 9-10 June 2005 for discussions on urban stormwater management.

During 6 June – 2 July 2005, **Dr Lu Zhang**, CSIRO, discussed research on low flow analysis with Prof David Chen, The Chinese University of Hong Kong, Hong Kong.

Dr Lu Zhang, CSIRO, collaborated with Prof Kang, China Agricultural University, Beijing, on distributed hydrologic modelling, on 3-9 July 2005.



Dr Lu Zhang with fellow research collaborators, Dr Liu Wenzhao (left) and Dr Mu Xingmin (right), Institute of Soil and Water Conservation, Chinese Academy of Sciences, Beijing.



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 Leaders

Dr Robert Argent, Department of Civil and Environmental Engineering, The University of Melbourne.

Geoff Podger, CSIRO Land and Water (formerly with Department of 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



Above Left: Dr Robert Argent, Joint Program Leader, Predicting Catchment Behaviour and Project Leader, Project 1.10 (1B).



Above Right: Geoff Podger, Joint Program Leader, Predicting Catchment Behaviour.

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 2004-2005

- Continued development of TIME, with a high level of adoption by both CRC staff, other researchers in this CRC's Parties, and an expanding number of researchers in outside organisations. There are currently more than 30 active TIME developers.
- Development of release versions of 20 Catchment Modelling Toolkit products.
- Continued support to Development Projects 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, E2.



Project Leader, Joel Rahman, Project 1.09 (1A)

Program highlights 2004-2005

- 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 have been actively developing models using TIME.
- The Catchment Modelling Toolkit now contains twenty publicly released products:
 - Aquacycle – an urban water cycle model; and
 - CHUTE – a rock chute design application;
 - CLASS-CGM – a crop growth model;
 - CLASS-PGM – a pasture growth model;
 - CLASS-U3M-1D – a 1-dimensional Unsaturated Moisture Movement Model;
 - CatchmentSIM – a hydrological 3D GIS application;
 - E2 – software for whole-of-catchment modelling;
 - IHACRES – a catchment-scale rainfall-streamflow modelling method;
 - LIZA – a data set of landcover type for the intensive use zone of Australia;
 - LUOS – the land-use options simulator;
 - MELS – a design spreadsheet for minimum energy loss structures;
 - MUSIC – the Model for Urban Stormwater Improvement Conceptualisation;
 - RAP – a River Analysis Package;
 - RIPRAP – a design tool for riprap in streams;
 - RRL – The Rainfall Runoff modelling Library;
 - SCL – the Stochastic Climate Library;
 - SedNet – a sediment network model;
 - SHPA – a data set of soil hydrological properties of Australia.
 - TREND – a suite of statistical tests for trend in data;
 - WRAM – a water allocation and trading model;
- Protocols and procedures for developing a consistent high quality of software products continued to be developed and tested.
- E2, the whole-of-catchment modelling software has been developed to include all the capabilities of the EMSS, along with pre-processing tools to support transfer of EMSS projects to E2.
 - Completion of the Integration Blueprint and incorporation into the design of E2;
 - Development of tools for visualising uncertainty in model outputs;
 - Support for implementation of EMSS and SedNet in the CRC Focus Catchments;
 - Program 1 members conducted training in E2, TIME and RRL.
- Development of E2, the catchment modelling software, became a primary focus for Program 1 during 2004-05. Latest E2 developments include:
 - The first public release, in February 2005;
 - Inclusion of all the capabilities of the EMSS model;
 - Integration of calibration and water ordering routines;
 - Provision of training material that covers a range of model problems of significantly different complexity;
 - Incorporation of a plug-in method that allows ready integration of other Catchment Modelling Toolkit products, such as RAP and SCL.



Program group, Program 1, Predicting Catchment Behaviour



Waterlogged data site

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 2004-2005

- The primary role of integration and system coordination continued through 2004-05. 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, now embodied in the E2 catchment modelling software.
- Methods were designed for the representation of uncertainty in modelling outputs. Initial implementation commenced.

Milestones Program 1

| Milestones | Progress |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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) | Version 1 of E2 was released early in 2005. E2 can currently generate pollutant loads from a catchment and route flow through a node link network. Development is based on existing models such as CMSS, EMSS and IQQM. |
| Link hydrologic, pollutant-transport, ecologic, geomorphic, meteorologic and socio-economic models to enable holistic analyses of catchment behaviour | E2 links models of irrigation/crop growth (2A), SedNet (2B), salinity (2C), river networks (IQQM), land-use change (2E), river analysis (RAP) and stochastic climate (SCL). Water ordering and supply, and channel metrics linkages are being developed for E2. WRAM and IQQM have been linked. |
| Develop techniques to scale detailed process representation to larger scales | Techniques were developed in Project 1.2. Further developments of these are planned for the eWater CRC. |
| Develop and incorporate an uncertainty analysis methodology into the toolkit; this will be used to put error margins on model predictions | A document describing ways of visualising uncertainty has been prepared. E2 has tools that support the communication of estimated uncertainty in outputs. |
| Commence application of the modelling toolkit on the five focus catchments | Development projects have used EMSS and SedNet in the five Focus Catchments. Tools are being developed in E2 to support transfer from EMSS to E2. |
| Conduct first public release of the modelling toolkit | Over 20 Toolkit products are now publicly available at www.toolkit.net.au |
| Conduct training workshops on the use of the modelling toolkit | Catchment Modelling School Feb 2004 (Melbourne) |
| Years 6 and 7 | |
| Complete development of the modelling toolkit | Completion plan has been included in Year 6 termination planning. |
| Demonstrate utility of the toolkit via intensive applications on the five focus catchments | Focus Catchment applications are at various stages of completion. |
| Assess commercial value of the toolkit and develop commercialisation strategy if necessary | Commercialisation analysis was undertaken at CRC for Catchment Hydrology level, and some assessment also included in eWater business case. |
| Run national and international training workshops on the use of the modelling toolkit | February 2005 (Canberra). Catchment Modelling School Jun-Jul 2005 (Brisbane, Sydney) |

Program 2

Land-use Impacts on Rivers

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 has been directed to:

- 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 better management of 10 percent of the land area can stop 90 percent of the excessive movement of nutrients from land to streams.

This Program sought 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



Dr Peter Wallbrink, Program Leader Land-use Impacts on Rivers.



Program group, Program 2, Land-use Impacts on Rivers.

Program highlights 2004-2005

- Program 2 continued 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.
- A Version 1.4.0 of SedNet 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 Victoria, New South Wales and Queensland. 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 2005.
- 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, FCFC.

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 2004-2005

- Irrigation return module now coded and working.
- Final decisions on integration into E2.
- Documentation underway.
- Stand-alone version possibly based on stripped down E2 almost complete.
- The key appointment of John Hornbuckle, who has made a valuable contribution.
- Data collection from 12 irrigation areas across Australia is complete. Technical report outline drafted. Processes regarding salt wash-off reviewed.

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 and nutrient budgets using the SedNet technique.

Achievements 2004-2005

- Mini modelling school well attended.
- Contributor module coded, tested and delivered.
- Temporal disaggregation now available as a demonstrable tool (Integration into E2 sorted).
- SedNet v1.4.0 released.
- Tiling capability of Sednet now available.
- Sand slug module due for delivery in 2005-2006.
- Hillslope sediment module (HSDR) under development.



Above left: Dr Evan Christen, Project Leader, Project 2.19 (2A)

Above right: Dr Scott Wilkinson, Project Leader, Project 2.20 (2B)

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

Project Leader

Dr Mark Littleboy, Department of Natural Resources, NSW

Aim

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

Achievements 2004-2005

- Work progressing well on the first stage of integration into the modelling framework E2.
- Working version of salt or salinity management model now being used by all Parties. Restricted version on Catchment Modelling Toolkit website.
- Trialling of the salt model underway in catchments in Victoria, NSW and Queensland.
- This Project continues to build on existing modelling tools across CRC Parties.



Above left: Dr Mark Littleboy, Project Leader, Project 2.21 (2C)

Above right: Dr Heather Hunter, Project Leader, Project 2.22 (2D)

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 2004-2005

- Riparian model has been built as a TIME module.
- Spatial assessment of riparian N condition and application will occur in E2.
- Model integrated into E2.
- Major technical report produced – The riparian N model.



Well installation for riparian zone studies, Rob de Hayr and Michael Daly, NRM

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 2004-2005

- The flow duration curve model has been incorporated into the Catchment Modelling Toolkit as a stand alone product named FCFC (Forest Cover Flow Curve).
- Three technical reports produced and a final report is under way.



Dr Lu Zhang, Project Leader, Project 2.23 (2E) (L) with visiting colleagues from China and Dr Tim McVicar, CSIRO



Program 2 discussions, Annual Workshop, June 2005

Milestones Program 2

| Item | Status |
|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 hillslopes) and TERRAPENE/BC2C (water yield and stream salinity). SedNet is a NLWRA product developed by CSIRO that has enhanced. 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 being coded into TIME. The major delivery mechanism for predicting land-use changes is through a 'whole of catchment model' called E2. Development continues with the Program 1 team as to how salt and nitrogen generation modules will be incorporated into this model. |
| Predict the spatial distribution of pollutant sources for the three rural focus catchments | <p>The above tools make these predictions. They link with important data layers contributed from a range of organisations including the Ground Water Systems map (from Catchment Categorisation), several NLWRA layers and land-use change scenarios as provided by regional planning groups and State agencies.</p> <p>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.</p> <p>Links to Development Projects are working well and EMSS has now been successfully applied to the majority of them. These projects are providing feedback to current research projects. Modules for predicting riparian N as well as sediment N and P continue to be developed for incorporation into the Toolkit. SedNet is now being applied in the Murrumbidgee and Fitzroy catchments.</p> |
| Evaluate spatial predictions of existing land uses with a range of conventional and new remotely sensed data | <p>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 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.</p> <p>Spatial predictions of sediment and nutrient sources have also been evaluated against observations undertaken with tracer based approaches in the Brisbane and Murrumbidgee catchments.</p> |
| Years 6 and 7 | |
| Further evaluation of spatial predictions in collaboration with Program 1 focussing on robustness across a range of spatial scales | Evaluations of spatial predictions of salt are under way in the Victorian and NSW catchments. These will shortly be used by state agencies in risk assessment and rectification assessments. SedNet is being enhanced by co-projects with QEPA to assist in their target setting and priority assessments. |
| Linkage of methodologies with agency land use planning tools | Spatial predictions of salt transport are now being developed through application of the new 2CSalt model. Results were very useful in terms of consistency with real data and 2cSalt is being integrated with the DNR, NSW LUOS planning model. |
| Production of forecasts of river impacts using a range of land use change scenarios | Program 2 provided modules to the Program 1 whole-of-catchment predictive capacity 'E2', in particular: irrigation return flows, salt movement, riparian nitrogen denitrification and water yield change following land use vegetation changes. |

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 Output

The overall objective of the sustainable water allocation program for the past seven years has been to provide practical tools to policy makers for the allocation and use of water in a sustainable manner. Two vital tools have been developed – WRAM and Mwater. These tools complement and integrate with existing hydrological models such as IQQM and REALM. User-friendly interfaces and linkages have facilitated a high adoption rate by key stakeholders. Integration with mainstream industry planning models ensures the tools will have a long life and provide a legacy for the CRC into the future. The latest techniques and scientific information underpin the tools, along with extensive case information on the social and economic dimensions of water reform issues.

Markets for water are maturing and continue evolving to meet increasing extractive and environmental demands for water. It is expected that the tools produced by this program and adopted by industry will increasingly become an integral part in the decision-making process of meeting the increasing demands for water in the years ahead.

The tools and knowledge capital produced by the program have been impressive. The tools have become the standard for research institutions, receiving accolades from Australian and international researchers. The knowledge capital in the technical reports has been widely cited in industry briefing papers, conference and journal articles. In particular, the technical report "Review of Water Management in Australia" is seen as a must-read for staff entering the industry or those needing a comprehensive snapshot of the state of play of the industry.

The most important knowledge capital resides in our postgraduate students, who will take the CRC's knowledge into the future of Australia's water management decision-making. The program has produced an extremely talented group of postgraduates to secure the future of sustainable water management in Australia.

Outcomes and benefits

- The program has produced two tools – WRAM and Mwater.
- Significant improvements in both the functionality and industry adoption of these tools have been achieved in the past year.
- In 2004-2005 WRAM has been integrated with the Murrumbidgee version of IQQM through collaboration with toolkit staff.
- Data runs are now easily transferred between WRAM and IQQM thereby allowing policy makers to predict optimal outcomes from trade and, as a result, changes in water demands and extraction node demand levels.



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



Program group, Program 3, Sustainable Water Allocation

- The delivery consequences of such trade in an IQQM simulation can be determined. Within WRAM, the regional consequences of trade can be estimated using an integrated catchment calibrated input-output model.
- Significant improvements have been made to Mwater in 2004-2005. The model, once constrained to twelve traders and twelve trading periods, now has the capacity to include an infinite number of traders and trading periods. The interface for the traders now includes pull-down menus and flash messaging. Players can play different roles, such as towns or factory point source polluters or non-point farming communities. The hardware behind Mwater has been improved to provide an extremely stable platform, accessible throughout the world and seamless integration and version controls to allow integration of field and remote experiments with data from laboratory trials.

Program highlights 2004-2005

- Adoption has been increased through improvements in the functionality and user-friendly interfaces. In the case of WRAM, significant improvements have been to the interface which greatly enhances the functionality of the program. Mwater, while an extremely complex suite of integrated programs, maintains an end-user simple excel data interface requiring only very simple knowledge of spreadsheet commands and functions.
- Current hydrologic river network models (i.e. IQQM and REALM) determine water demand from the existing entitlements and crop mix. They do not simulate changes to cropping pattern, and temporary and permanent trade of water entitlement for economic gains. Enhancing the existing capabilities of hydrologic network models in terms of crop mix (IQQM) and/or water demand (REALM) by providing a dynamic link between hydrologic and economic models for water allocation, WRAM has made a significant difference to the ability of water to model the linkages between economic and hydrological drivers in the catchment.
- Issues addressed with Mwater were concerned with the separation of water entitlements, market concentration, point and non-point pollution trading, and the management of risk and uncertainty in the choice of water entitlement regimes. To undertake analysis and experimental work on these more complex markets required taking Mwater to a new level. Existing experimental economic platforms are not capable of simulating beyond single unit trades. For example, to effectively evaluate alternative allocation and market systems required the development of multiple unit double auction environments in which the traders could take differing roles. The software has provided insights which otherwise could not be modelled. Enhancing the capabilities of Mwater provides a legacy and demonstrated greater adoption which will ensure its use well beyond the life of the CRC.

In essence, the Program has delivered to the water and natural resource industry the tools, knowledge and future staff to effectively manage Australia's water in a sustainable manner.

End-users

Primary users of Program 3 products include:

- Catchment management authorities and State and federal agencies
- Researchers in CSIRO and Universities, both in Australia and overseas
- Consultants
- Postgraduates and indirectly, organisations outside the CRC where the postgraduates work
- Community-based catchment groups.

Program 3 has developed an important knowledge base of socio-economic water management issues in Australia and internationally. The value of this knowledge is vital for informed decision-making and the development of sound and well crafted water policies. Issues explored this year include:

- The principles and issues surrounding the effective reduction of point and non-point pollution entering rivers and streams in our focus catchments. Significant progress has been made in experimentally exploring the issues of moral hazard and adverse selection which can arise when developing land management and water policy to address sediment and pollution loads.
- Effective policies to deal with the associated risks and uncertainties resulting from the fleeting and interdependent nature of its supply. Significant progress has been made in understanding risk preferences and their impact on better ways to manage water allocations.
- Assessment of the impact of large players in relatively thin water markets, where transactions are almost totally confined within the irrigation sector. This is a great concern to both water authorities and farmers. Research over the past twelve months has provided important insights into how best to design water markets to minimise the impact of large players operating in a probabilistic or stochastic way.
- Separation of water entitlements into component parts raises the potential for multiple markets. How to develop such markets and operationalise them has been a significant part of the program's research. While there are many questions still to be answered, the findings to date have proved critical in developing proofs of concept for the industry.

Project 3.08 (3A) – Hydrologic and Economic Modelling for Water Allocation

Project Leader

Assoc Prof Bofu Yu, Griffith University

Aim

To develop an integrated economic/hydrological model to stimulate the impact of changes in climate, land use and policy on water resources and the regional economies in a selection of focus catchments.

Achievements 2004-2005

- Developed modules to evaluate the impact of changes in climate, land use, and policy instruments on regional economy.
- Maintained the stand-alone version of WRAM for Toolkit
- Validated and tested WRAM for the Murrumbidgee (for DNR, NSW), and the Goulburn-Broken catchments (for G-M Water), Nogo-a-McKenzie (for NRM).
- Developed an integrated WRAM IQQM model.
- Developed a livestock module in WRAM (for DSE).
- Developed tools to simulate water trading among 'nodes' representing irrigation areas.
- Delivered WRAM to users directly via WRAM-IQQM, and WRAM-REALM.
- Included WRAM as part of the Catchment Modelling Toolkit.

Project 3.09 (3B) – An Evaluation of Permanent Water Markets

Project Leader

Dr John Tisdell, Griffith University

Aim

To further develop tools to explore more complex economic issues surrounding water allocation, water and other natural resource trading environments in our focus catchments.

The emphasis has been on the performance of natural resource markets for resources such as water, salt, and sediment and nutrient through the combined use of optimisation models and development of Mwater.

Achievements 2004-2005

- Inclusion of hydrological constraints to trade.
- Developed a permanent water market experimental methodology.
- Inclusion of trader behavior in hydrological network models.
- Calibrated permanent water market models at a zonal level.
- Developed an integrated IQQM/REALM experimental methodology to evaluate the regional impacts of water policy change.
- Methodologies to assist managers understand the linkages between water stress, land-use change, water markets and regional economies.
- Expansion of the model into multiple crops and trading rounds.

These advanced models have been used to:

- evaluate sediment/nutrient trading options
- assess decision-making under risk and uncertainty within alternative property rights regimes for water resources, and
- estimate the impacts of temporary and permanent water trading through hydro-economic modelling.



Dr Bofu Yu, Project Leader, Project 3.08 (3A)



Program 3 discussions, Annual Workshop, June 2005

Milestones Program 3

| Milestones | Progress |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Years 3, 4 and 5 | |
| Develop a series of socio-economic 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 completed for developing a set of economic indicators. Report written by ICAM. |
| 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 completed. |
| 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 completed. |
| 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 underway in Project 3B. Proof of concept experiments have been completed and papers arising have been submitted for peer review prior to release and will be released as part of a EIO project in the eWater CRC. |
| <p>Develop methods to improve efficiency in water use decision making in order to maximise efficiency and minimise seepage and evaporation losses.</p> <p><i>Amendment of Milestone approved by Commonwealth, 16 July 2003 with replacement by:</i></p> <p>Develop method to improve efficiency in water use decision making in order to maximise efficiency.</p> | 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 meetings with stakeholders. CSIRO is currently using Mwater in two market based instrument projects. CRC for Catchment Hydrology staff members are assisting. |
| Years 6 and 7 | |
| Based on the findings of the models refine the proposed integrated property right regimes and trade conditions to capture economic and social objectives, given climatic and hydrologic constraints. | Work has commenced on developing integrated property right regimes and trade conditions to capture economic and social objectives, given climatic and hydrologic constraints. |
| Evaluate the property right regimes and models developed through a series of stakeholder workshops to promote technology transfer. | Stakeholder workshops have been conducted in Brisbane and further workshops planned. |
| Promote distribution of the finding of the program through publications and promotion materials | Work is continuing on writing and disseminating the findings of the project into the first six months of eWater CRC. |

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 is 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



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



Program group, Program 4, Urban Stormwater Quality

Program highlights 2004-2005

- The release of MUSIC v3 in May 2005 incorporated substantial improvements to algorithms, calibration and interface. MUSIC v3 also incorporated a Lifecycle Costing Module, allowing users to predict the costs of alternative stormwater treatment strategies.
- Program 4 PhD student, Sara Lloyd, won the CRC Association's 'Young Water Scientist of the Year' award.
- Substantial industry support for the Urban Stormwater Quality Program's work was expressed through contributions to a number of Associated/Additional Projects, including Socio-Economic Assessment of Stormwater Management, Integrated Stormwater Treatment and Re-use, and Stormwater Quality Assessment.
- Ongoing collaboration with CRC for Freshwater Ecology refined models of ecosystem responses to urbanisation, and helped to development guidelines and objectives for water sensitive urban design.
- Program 4 research was widely published in a number of leading peer-reviewed journals (e.g. Water Research, Journal of Hydrology) and conferences.
- The Program 4 team provided key input to the new Australian Runoff Quality guidelines, published by Engineers Australia.
- Close collaboration with Brisbane City Council and Melbourne Water allowed monitoring of a number of stormwater quality treatment systems.

Project 4.08 (4A) – Development of integrated stormwater models

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 2004-2005

- MUSIC version 2.1 was released in February 2005 to correct an error in the algorithms that predicted Total Phosphorus (TP) and Total Nitrogen (TN) removal through the filter medium of bioretention systems. It also corrected an occasional error with flow mass-balance calculations in treatment systems, which occurred under unusual circumstances (usually when outlet sizes were very small). Almost 1000 users downloaded this revised version within weeks of its release.
- The project team released MUSIC version 3 in May 2005. The major extension to the product was the inclusion of comprehensive Life Cycle Costing algorithms for the full range of urban stormwater treatment features modelled.
- Additional enhancements in MUSIC version 3 included two additional treatment nodes (rainwater tanks and infiltration basins), further options to import and export model data and to enhance interoperability with other Toolkit products, and revised default k-C* (or treatment) parameters for those treatment features modelled using the Universal Stormwater Treatment Model.
- Several modelling components developed for MUSIC have been recoded in the software language C+ to enable them to be exploited by other Catchment Modelling Toolkit products.



John Coleman, Project Leader Project 4.08 (4A)

Project 4.09 (4B) – Predicting urban stormwater quality, treatment and impacts

Project Leader

Dr Tim Fletcher, Monash University

Aim

To improve the reliability of MUSIC by collecting data to improve the algorithms and calibrate the model

To better understand stormwater quality and treatment processes, and ecological responses to urbanisation and water sensitive urban design

To develop a series of tools for the social and economic evaluation of stormwater management.

Achievements 2004-2005

- Through an Associated/Additional Project, this project collected an internationally valuable dataset on urban stormwater quality from catchments of varying land use, and related pollutant concentrations to short-duration climate data.
- Developed a lifecycle costing module for incorporation into MUSIC, using resources from an Associated / Additional Project, and prepared a protocol for “Triple Bottom Line” evaluation of stormwater management measures.
- Intensive monitoring of stormwater wetlands and bioretention systems was undertaken in both Brisbane and Melbourne. This is providing important new information on water quality behaviour during both storm events and base flows. The new data were used to improve calibration of MUSIC (released in Version 3).
- Data were collected on bio-retention systems in both Melbourne and Brisbane.
- Through an Associated/Additional Project, undertook an extensive review of integrated stormwater treatment and re-use in Australia, and used this to build a targeted research program to tackle the identified gaps.
- In partnership with the CRC for Freshwater Ecology, refined models which predicted the ecological consequences to streams, from urbanisation. This was used to develop a set of guidelines for stormwater management and water sensitive urban design.
- The Project 4.09 (4B) team provided key input to the new Australian Runoff Quality guidelines, published by Engineers Australia.
- Developed an impressive suite of postgraduate research projects at both Griffith and Monash universities, focussed around processes involved in stormwater quality and treatment.



Wetlands research, Geoff Taylor



Program 4 discussion, Annual Workshop, June 2005

Milestones Program 4

| Milestones | Progress |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Years 3, 4 and 5 | |
| <p>Determine critical pollutants and required pollution concentrations vs discharge relationships for the sustainability of healthy urban aquatic ecosystems.</p> <p><i>Amendment of Milestone approved by Commonwealth, 16 July 2003 with replacement by:</i></p> | <p>Joint project with CRCFE is progressing well. Spatial data compilation going well, hydrologic models under development.</p> |
| <p>Develop approaches to predict ecosystem response to catchment-scale indicators of land use.</p> | <p>Project on-track, with substantial field monitoring in Brisbane and Melbourne (with good support from BCC and MWC). Bridgewater wetland and macroinvertebrate surveys near completion. Survey of phytoplankton, bacterioplankton and periphyton survey.</p> |
| <p>Monitor and evaluate the performance of stormwater treatment facilities at pilot catchment sites in the Focus Catchments.</p> | <p>Griffith honours student studying pathogen distribution.</p> |
| <p>Evaluate the life-cycle cost of stormwater treatment systems investigated.</p> | <p>MUSIC v3. has LCC module incorporated (public release May 2005)</p> |
| <p>Commence the validation and refinement of conceptual models of stormwater quality treatment techniques.</p> | <p>Ongoing activity, using data from Hampton Park wetland, Brisbane swales, Ruffeys Creek wetland. New insights used to modify algorithms and treatment options in MUSIC v3: release.</p> |
| <p>Commence technology transfer activities to provide interim guidelines on the selection and design of stormwater quality treatment measures.</p> | <p>Ongoing MUSIC training, provided by Industry Affiliate Trainers, and Griffith University.</p> <p>Very strong research output, with over 30 papers and 8 journal papers in group over last 12 months.</p> |
| Years 6 and 7 | |
| <p>Complete validation and refinement of models of stormwater quality treatment techniques</p> | <p>New understanding incorporated into MUSIC v3. released May 2005</p> |
| <p>Develop a multi-criteria decision support system to facilitate the management of urban stormwater for sustainable protection or rehabilitation of aquatic ecosystems.</p> | <p>Combination of MUSIC, the CRC for Freshwater Ecology collaboration on ecosystem responses, and the socio-economic Associated/Additional Project being led by André Taylor delivers this. Pilot test of protocols highly successful.</p> |
| <p>Undertake activities set out in the technology transfer and adoption strategy to enable the effective adoption of design guidelines and modelling toolkit into practice.</p> | <p>Strong ongoing involvement in Communication and Adoption, including conferences, industry workshops and scoping meeting. Very strong representation at recent conferences.</p> |

Program 5

Climate Variability

AIM

- **This Program aims to provide the water industry with tools to quantify climate variability, and through the application of hydroclimate 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 in the climate system. The management of land and water resources involves designing and operating systems to cope with hydroclimatic variability over different time scales. The management challenges in Australia are compounded by Australian streamflow being much more variable than elsewhere in the world.

Program 5 has provided the water industry with models for generating stochastic climate data, and models for forecasting rainfall and streamflow for various lead times. These models are made available via the Catchment Modelling Toolkit.

Outcomes and Benefits

Program 5 has produced modelling tools that can be used with hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability. Researchers in Program 5 have also improved catchment-scale hydrological modelling and land surface modelling in climate models.

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.

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 2004-2005

- Two model products (NSFM and TREND) and three data products (SHPA, LIZA, SIMHYDpar) were released via the Catchment Modelling Toolkit (see Program Highlights).
- Data sets from the Murrumbidgee River Basin monitoring program were compiled, allowing for development and testing catchment-scale and land surface hydrological modelling. The data includes about three years of climate forcing, and soil moisture, temperature and streamflow data for model testing.
- The conceptual daily rainfall-runoff model, SIMHYD, was applied and tested on more than 300 catchments across Australia, resulting in recommended parameter values for use in ungauged catchments.



Above left: Assoc Prof Francis Chiew, Program Leader Climate Variability
Above right: Project Leader Dr Alan Seed, Project 5.05 (5A)



Program group, Program 5, Climate Variability

- The VB95 land surface model (used in the Bureau of Meteorology's numerical weather prediction models) and the initialisation of surface variables in numerical weather prediction models were tested and improved upon, potentially leading to improved weather forecasts in the future.
- A prototype of the Short Term Ensemble Prediction System (STEPS) was completed and tested using one month of data from the UK Met Office. The deterministic component of the forecasting system has been included into Rainfields, the Bureau of Meteorology system for operational real-time radar rainfall estimation and forecasting.

Program highlights 2004-2005

- Program 5 released three model products through the Catchment Modelling Toolkit:
 - SCL – a library of stochastic models for generating climate data;
 - TREND – statistical tests for detecting trend/change in environmental time series data; and
 - NSFM – a nonparametric model for forecasting streamflow several months ahead.
- Program 5 released three data products:
 - SHPA – soil hydrological properties for Australia;
 - LIZA – land cover type for the Intensive Use Zone of Australia; and
 - SIMHYDpar – SIMHYD parameter values for use in ungauged catchments.
- The Murrumbidgee River Basin data monitoring program and land surface modelling 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 about three years of unique data available to run hydrological models and to test model simulations against runoff and soil moisture.

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 2004-2005

- SCL (Stochastic Climate Library) Version 2.0 was released as a Catchment Modelling Toolkit product. SCL has models for generating single-site and multi-site annual, monthly and daily rainfall (and climate), and single-site sub-daily rainfall.
- A multi-site two-part model was developed and tested using data from several large catchments in eastern Australia. The multi-site two-part model is now in SCL. Model comparisons (with the random cascade model used in The University of Melbourne, non-parametric method developed at the University of New South Wales and non-homogeneous hidden Markov model developed by CSIRO Land and Water) indicate that the two-part model generally performed best.
- The DRIP (Disaggregated Rectangular Intensity Pulse) model, developed at The University of Newcastle, for generating single-site sub-daily rainfall was added to SCL. The DRIP parameter values were derived for locations across Australia. The DRIP model was also compared with the NSRP model (Neyman-Scott Rectangular Pulse, developed at Massey University, New Zealand).
- Recommendations for modelling climate change impact on hydrologic variables were established.



Project Leader, Dr Sri Srikanthan, Project 5.06 (5B)



Program 5 discussions, Annual Workshop, June 2005

Milestones Program 5

| Milestone | Progress |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Years 3, 4 and 5 | |
| 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 are part of the computer software SCL (Stochastic Climate Library – a modelling toolkit product). A stochastic modelling workshop was held in the Catchment Modelling School in Feb 2004. SCL was released in June 2004, and is now a product in the modelling toolkit. Other models developed in Project 5B will be added to later versions of SCL. |
| Conduct research as required to develop new stochastic data generation methodologies. | Project 5.06 (5B) developed multi-site daily rainfall models and sub-daily point rainfall models, as well as improved the models in SCL from Project 5.2. |
| 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) were tested using data from most of 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 has improved understanding of hydrological modelling and soil moisture initialisation in NWP models, using data from the soil moisture monitoring program in the Murrumbidgee River catchment (Projects 5.1 and 5.05 (5A)). |
| 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 were conducted regularly as part of the Communication and Adoption strategy, to review the projects and to disseminate the models developed. Training workshops on the model products SCL, NSFMM and TREND were held in the Melbourne (Feb 2004), Brisbane (Jul 2005) and Sydney (Jul 2005) Catchment Modelling Schools. |
| Apply, test and refine the space-time climate modelling methodology to one or more of the selected catchments/regions. | MOTIVATE (provides stochastic realisations of space-time rainfall for design storms) and STEPS (probabilistic space-time rainfall forecasts up to six hours ahead) were developed. STEPS is currently being ported into the SX6 Supercomputers run by the Bureau of Meteorology. Research on improving STEPS will continue in the Bureau of Meteorology. |
| 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 was 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 STEPS to generate rainfall nowcasts at each of the 50 radars in the Australian radar network. |
| Years 6 and 7 | |
| Package the stochastic data generation models to suit user applications and hold workshops in key centres throughout Australia | SCL (Stochastic Climate Library) is a model product in the Catchment Modelling Toolkit, designed to facilitate the generation of stochastic climate data. SCL is a library of stochastic models for generating various types of stochastic climate data. SCL has robust stochastic climate data generation models that have been extensively tested using data from across Australia. SCL training workshops were held in Melbourne (Feb 2004 Catchment Modelling School), Canberra (Feb 2005) and Brisbane (Jul 2005 Catchment Modelling School). |
| Organise a major conference on continental scale modelling (GEWEX) to share the results of the work both nationally and internationally. | The Murray-Darling Basin Continental Scale Experiment (MDB CSE) is now a project in GEWEX (Global Energy and Water Cycle Experiment). Research in Projects 5.1 and 5.05 (5A) and the Murrumbidgee field monitoring program are part of the MDB CSE. The research results have been, and will continue to be, presented in national and international conferences. |

Program 6

River Restoration

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 river restoration and other catchment interventions.

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 core module of RAP is a library of ecological response models. These models can be applied to time-series of flow for a particular channel to evaluate stream habitat conditions.

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 has devised techniques to better manage sediment transport, river channels, stream temperature and physical habitat conditions.

Program 6 is also leading best practice 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

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

Project Leader

Dr Nick Marsh, Griffith University (now with Qld EPA)

Aim

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

Achievements 2004-2005

- Delivered the Ecological Response Module and Time Series Manager for River Analysis Package (RAP) computer software, as a Catchment Modelling Toolkit product.
- Developed and applied a procedure for quantified uncertainty in an environmental flow recommendation.

- Developed help manuals for RAP (River Analysis Module).
- Developed a new procedure for analysing flow spells and incorporated into RAP (River Analysis Package).
- Developed models relating invertebrate communities to hydraulic metrics for upland rivers in the LaTrobe basin.
- Derived flow statistics for invertebrate monitoring sites in Victoria for subsequent analysis and development of flow-ecology models.



Above left: Dr Mike Stewardson, Program Leader, River Restoration, and Project Leader, Project 6.12 (6B)
Above right: Dr Nick Marsh, Project Leader, Project 6.11 (6A)



Program group, Program 6, River Restoration



Goulburn River field studies

Program highlights 2004-2005

- In conjunction with the CRC for Freshwater Ecology, the Program 6 team developed the Ecological Response Module and Time Series Manager for the River Analysis Package (RAP).
- Two data products have been added to the Catchment Modelling Toolkit website:
 - (i) a database of river channel surveys and
 - (ii) a river network for Victoria with derived hydrological attributes for each network link.
- 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 contributed to improved flow ecology modelling by deriving physical habitat parameters to be related to biological data collected in Victoria (invertebrate community) and Queensland (fish community). This study has resulted in predictive models relating invertebrate community characteristics to flow metrics.
- Empirical hydraulic geometry models have been developed for Australian streams. Models relate channel dimensions, bankfull discharge and other channel metrics to catchment parameters with a known level of uncertainty.

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 2004-2005

- Completed the 'Properties of Victorian Rivers' (PRV) data product. This is a node-link network for Victorian streams with catchment areas greater than 2 km². Hydrological and other catchment parameters were derived for every link in the network from available regional data sets.
- Completed the 'River Channel Survey' (RCS) data product: which includes surveys of 114 river channels for Victorian rivers. It also includes modelled water surface profiles for each survey over the range of in-channel flows.
- Channel metrics have been derived for 114 river reaches across Victoria. Uncertainty analysis was used to establish confidence intervals for these reach hydraulic metrics.
- Hydraulic geometry models have been finalised linking channel metrics to the catchment parameters. Regression models are available with a known error term.
- Historical river plans for 15 river reaches have been geo-referenced and digitised in preparation for evaluating historical channel changes and bank erosion rates at the sites.



River measurements, Geoff Taylor and Geoff Vietz



Program 6 discussions, Annual Workshop, June 2005

Milestones Program 6

| Item | Status |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Years 3, 4 and 5 | |
| Complete all rehabilitation construction work. | All complete. |
| Deliver an environmental flow assessment method for natural resources managers. <i>Milestone amendment as approved by Commonwealth, 13 July 2003</i> | 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 or is in planned for all mainland States except Northern Territory. |
| Update rehabilitation planning procedures. | Incorporated into toolkit products, supporting software and training. |
| Complete development of design models for rehabilitation tools. <i>Milestone amendment as approved by Commonwealth, 16 November 2000</i> | RAP, RIP RAP, CHUTE and MELS software all complete. |
| Complete first round of rehabilitation experiments. | Experiments have yielded strong results. |
| Incorporate modelling tools into the toolkit of Program 1: Predicting Catchment Behaviour. | RAP, RIP RAP, CHUTE and MELS have been included on toolkit website. |
| Years 6 and 7 | |
| Complete evaluation of rehabilitation projects in target catchments. | Complete. |
| Have developed skills and tools that are able to develop stream rehabilitation plans for any stream (in cooperation with ecological partners). | Complete. Toolkit website includes four software products and two data product developed by Program 6. Program 6 researchers have written numerous reports and industry conference papers. There is strong on-going demand for training to support adoption of RAP and other outcomes from the program. |

Program 7

Communication and Adoption

Program Leader

David Perry, Monash University

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 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 catchments.

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.



David Perry, Program Leader Communication and Adoption



Program group, Program 7, Communication and Adoption

Program highlights 2004-2005

- External consultants conducted a comprehensive assessment of the CRC's communication and adoption activities in August 2004, which builds on a similar review in 2001. The results of this assessment were very positive and indicate that the CRC's efforts to communicate and encourage uptake and adoption are well regarded by users and stakeholders in the water and natural resource management sector. Details of this review are outlined later in this report on Program 7.
 - As part of its increasing commitment to training industry professionals, the CRC offered a number of training opportunities in addition to the Catchment Modelling School 2005. Five workshops on the Catchment Modelling Toolkit were offered in conjunction with the Hydrology and Water Resources Symposium in Canberra in February 2005. These workshops attracted 47 participants. One workshop on MUSIC Version 3.0 was held in Melbourne during May 2005 with the following day held just for accredited MUSIC trainers to understand the more detailed aspects of the new version and the workshop delivery. An introductory TIME (The Invisible Modelling Environment) workshop was held in Canberra during September 2004.
 - The CRC's five Development Projects progressed well this year, in particular the Fitzroy Development Project has expanded its influence to other catchments in Queensland. An EMSS and SedNet model has been built for both the Fitzroy (142,000 km²) and Mackay/ Whitsunday (9400 km²) catchments and SedNet models for the high priority Great Barrier Reef catchments.
 - At the end of June 2005, there were 20 public software products and one public data product available on the Catchment Modelling Toolkit. There were more than 4000 registered users and more than 10,000 downloads had been made. New Catchment Modelling Toolkit products in 2004-2005 were:
 - LUOS (Land-Use Option Simulator) – designed to help rank land-use change options on the basis of the environmental services provided by the land use change.
 - WRAM (Water Reallocation Model) – designed to determine optimal water allocation and reallocation in terms of crop planting decisions and irrigation water requirements.
 - A beta version of E2, the CRC's whole-of-catchment modelling software product, was released in early 2005. The design has been developed to support a flexible range of modelling approaches through integration of alternative component models. E2 is a major achievement for the CRC.
 - CMSS (Catchment Management Support System) – designed to provide long-term, broad area prediction of the impacts of different nutrient management strategies on water quality in Australian catchments.
 - NSFM (Non-parametric Seasonal Forecast Model) is a non-parametric seasonal forecasting model that forecasts continuous exceedance probabilities of streamflow (or any other hydroclimate variable). NSFM forecasts the exceedance probabilities of streamflow several months ahead by exploiting the lag relationship between streamflow and ENSO (El Niño/Southern Oscillation) and the serial correlation in streamflow.
 - MELS – is a hydraulic design and analysis suite that enables designers to quickly trial several alternative Minimum Energy Loss culvert designs, checking for basic structure dimensions, performance under adverse conditions such as high or low flow and sedimentation issues.
 - CatchmentSIM – is a stand-alone 3D-GSI application specifically tailored to hydrology-based applications. It is designed for use by anyone interested in automated catchment delineation and parameterisation from GIS data.
 - CLASS (Catchment Scale Multiple Land-use Atmosphere Soil Water and Solute Transport Model) is a distributed, eco-hydrological modelling framework that deals with water and solute movement from hillslope to catchment scale. Three CLASS products are available.
 - Aquacycle – a daily urban water balance model which has been developed to simulate the total urban water cycle as an integrated whole and provide a tool for investigating the use of locally generated stormwater and wastewater and wastewater as a substitute for imported water alongside water use efficiency.
 - IHACRES – a catchment-scale rainfall-streamflow modelling methodology whose purpose is to characterise the dynamic relationship between rainfall and streamflow, using rainfall and temperature (or potential evaporation) data, and to predict streamflow.
 - TREND is designed to facilitate statistical testing for trend, change and randomness in hydrological and other time series data. It contains 12 statistical tests.
- Two data products were made available during 2004-2005 on the Catchment Modelling Toolkit:
- SHPA (Soil Hydrological Properties for Australia) provides continental coverage of soil properties relevant to catchment modelling. The data set provides estimates of 12 properties in total along with information on uncertainty of the property estimates.
 - LIZA – the Toolkit's second data product covers the intensive use zone of Australia. The data provide cover type estimated for 1990 and 1995, along with a first estimate of woody vegetation canopy cover percentage and canopy height. Data are available in both Geographic (on GDA93) and Map Grid of Australia coordinate systems. The spatial resolution is 0.01 degrees or 1km.
- Version 3.0 of MUSIC was released and includes a number of significant new features and enhancements:
 - A Lifecycle Costing Module, which allows the lifecycle costs of a treatment node, or an entire stormwater treatment train, to be analysed.
 - The MUSIC development team have reviewed recent calibration studies, to provide new default k and C* values for MUSIC's Universal Stormwater Treatment Model.
 - New treatment nodes (Infiltration, Rainwater Tank)
 - Modifications to the bioretention node to allow user-specification of the height of the collection pipe (in order to simulate flow-losses below the perforated collection pipe, where appropriate or desired).
 - Increased precision on the specification of re-use demands.
 - New Imported Data Source Node which allows an observed time series (of flow and pollutants) to be imported, for simulating situations such as point-source, or for calibrating the model to observed data.
 - Improved capability to export simulation results from nodes, allowing the user to specify the timestep at which the export is done.
 - Revised calculation of meteorological statistics to include zero-rainfall timesteps

Program highlights 2004-2005

There were also updated releases of the following products:

- SCL
- SedNet v1.2.0 includes the contribution module which calculates the contribution of each link or sub-catchment to suspended sediment load at a specified point.
- Aquacycle
- RAP v1.3.0 contains contains a new module called Time Series Manager which includes tools for filling gaps in time series, changing the timestep of time series, modifying and combining timeseries using a calculator and a rating curve for transforming time series. The Time Series Analysis Module now includes an 'event domain' feature for visualising spell analysis results. The Hydraulic Analysis Module now allows point velocity to be considered when generating hydraulic habitat preference curves.
- A CRC Technical Report (04/12) and downloads on the sophisticated CLASS modelling framework (Catchment Scale Multiple-Land-use Atmosphere Soil Water and Solute Transport Model) is now available on the CRC website. Three models from the CLASS product group were released and made available on the Toolkit in March 2005). CLASS was developed by the NSW Department of Natural Resources through a CRC Associated/ Additional Project.
- The CRC's Model Choice Series was launched in December 2004. This series of publications is designed to assist industry professionals who are commissioning or involved with catchment modelling to better understand how the tools developed by the CRC can help them.
- To support Toolkit products, comprehensive support materials are available on the Toolkit website. Support includes user manuals, guidelines, case studies and examples, eGroup forums, and articles from publications on the modelling tools.
- The Catchment Modelling Toolkit has become recognised as 'the' central repository for hydrologic modelling software tools in Australia. It is not just CRC-developed programs that are available on the Toolkit. A number modelling tools developed by non-CRC producers have become part of the Toolkit family during 2004-2005. This is an indication of the reputation and success of the Toolkit.

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.

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 a 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 for 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



Tony Weber, Focus Catchment Coordinator, Brisbane River, Development Project Leader, Project 7.15 (7E)

Fitzroy River, Queensland

The Fitzroy basin covers an area of 142,000 km² 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 the 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 Development Projects have been a valuable mechanism to achieve adoption of CRC tools. The training and expertise generated through the project in the Fitzroy Focus Catchment is now being successfully transferred to other catchments, departmental staff and regional bodies."

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 apply the CRC's Toolkit. Being able to demonstrate how these modelling tools can work in a catchment is exciting. It's even more interesting when we start linking catchment management tools to storage management tools."

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 teaching staff from the NSW Department of Natural Resources (DNR) how to use the sediment and nutrient models that the CRC has made available through its modelling toolkit. DNR 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.

"As a result of the CRC Development Project, NSW DNR has been able to develop new skills in catchment modelling and pass their knowledge onto the Catchment Management Authority."

"The CRC Toolkit website and the Catchment Modelling School are excellent platforms for promoting and providing industry partners with access to the CRC's 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 km². 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. An additional challenge is to re-build the model using the E2 framework.

"Capacity building is a difficult pursuit. It is all well and good to provide the 'push' but if an adoption project is to succeed then genuine 'pull' is essential. I am aware that there is more than one way to generate pull and my thinking has been to create the vision and use that as the selling point. The vision – the end product – now exists and it is time to re-visit the potential users and see whether the pull materialises."

Graham Rooney, Focus Catchment Coordinator



Above left: Chris Carroll, Focus Catchment Coordinator, Fitzroy River, Development Project Leader, Project 7.16 (7F)

Above right: Pat Feehan, Focus Catchment Coordinator, Goulburn/Broken Rivers, Development Project Leader Project 7.11 (7A)



Above left: Carolyn Young, Focus Catchment Coordinator, Murrumbidgee River, Development Project Leader, Project 7.12 (7B)

Above right: Graham Rooney, Focus Catchment Coordinator, Yarra River, Development Project Leader, Project 7.13 (7C)

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 2004-2005

- 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 km²) and the Tullaroop Reservoir in the Loddon River Catchment (730 km²). Environmental Management Support System (EMSS) models were developed for these two catchments. Model outputs have been used to determine sub catchments producing sediment and nutrient yields.
- A reservoir simulation model (DYRESM) has been developed for Lake Eildon with the help of the Centre for Water Research at the University of Western Australia to enable the modelling of the effects of pollutants within storages. The Lake Eildon DYRESM model uses outputs from the Goulburn EMSS model. A similar model is being developed for Lake Tullaroop.
- Over the life of the project more than 150 communication activities have taken place.

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 Natural Resources, NSW

Aim

For the NSW Department of Natural Resources staff to have the skills to build water quality models of large catchments, and intelligently interpret the modelling results to help set water quality targets and priorities for on-ground works.

Achievements 2004-2005

- A SedNet model for the Murrumbidgee Catchment has been successfully developed.
- The project team trained regional DNR staff in how to run the Murrumbidgee SedNet model and interpret the results.
- The CSIRO, DNR and Murrumbidgee Catchment Management Authority staff have used the SedNet model to help set water quality targets for the Murrumbidgee River and set funding priorities for on-ground works aimed at improving river health.
- The Project team gave a seminar to the Murrumbidgee Catchment Management Authority on sediment processes, sediment budgets, the Murrumbidgee SedNet model and modelling results.
- A project steering committee meeting was held to ensure that the project aims remained relevant to the project client needs.

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 2004-2005

- Key CRC staff (Francis Chiew) made a significant contribution to overcoming problems with rainfall-runoff calibration in November 2004.
- Another potential application emerged within Melbourne Water – that being the ability to simulate impact of riparian revegetation upon in-stream water quality.
- A key stakeholder – the Port Phillip and Westernport Catchment Management Authority – showed genuine interest in using the model.
- The project lost the in-house modeller, however, expertise from CRC Industry Affiliate WBM was used to complete runoff-quality calibration with in-stream quality at specific long-term monitoring sites.
- The YarraSim EMSS model has now been built using current land-use information to generate hydrological and water quality responses.

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 – 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 2004-2005

- There are now at least 11 Environmental Management Support System (EMSS) models for South-East Queensland region catchments. These are being used in a wide variety of applications, including setting sustainable loads for receiving waters, strategic planning initiatives, investigating pollutant sources in drinking water supply catchments and quantifying the impacts of land use change.
- Expanding on the training sessions run in the previous year, more than 100 participants have been trained in the use of the software, mostly from local government and community groups (catchment care and Landcare groups). Further information and awareness sessions have also been conducted.
- Several pivotal applications of EMSS as a decision support tool have been implemented. These include the use of the community group developed Maroochy EMSS, which was used to support decision making regarding significant wastewater treatment plant upgrades within the Maroochy Shire. Coupled with receiving water quality models, the modelling showed that a large investment in catchment management to reduce diffuse pollutant loads was just as important as upgrading point source infrastructure.

- The EMSS has been used extensively to assist land-use planning for the future (2026) as part of a draft Regional Plan for South East Queensland.

Project 7.16 (7F) – Development Project for the Fitzroy Focus Catchment – Modelling river water quality in the Fitzroy and Mackay / Whitsunday Catchments in partnership with regional strategy groups

Project Leader

Chris Carroll, Natural Resources and Mines, Queensland

Aim

To apply the CRC's water quality models to the Fitzroy and Mackay/Whitsunday Catchments and smaller sub-catchments within it.

Achievements 2004-2005

- EMSS and SedNet models have been built for the Fitzroy catchment (142,000 km²), the Mackay / Whitsunday catchments (9400 km²), and SedNet models for the high priority Great Barrier Reef catchments.
- Technical expertise in building and running the EMSS and SedNet models has been built in NRM staff in the Mackay/Whitsunday, and Far North Queensland regions. The NRM staff in these regions attended training workshops run by internal Development Project officers.
- Regional and community capacity building has been transferred outside the Fitzroy focus catchment to the Mackay/Whitsunday, and Far North Queensland regional bodies.
- Regional bodies are becoming interested in using the CRC toolkit models to guide water quality target setting.

Catchment Modelling Toolkit

A major way for the CRC to deliver on its mission is through the Catchment Modelling Toolkit. There are now 20 modelling software programs currently available on the website with products downloadable at low or no cost.

CRC Research Programs have built specific modelling software for the Toolkit and there are also other externally-developed software models available.

There are now over 4000 registered users of the Toolkit.

E2, the integrated whole-of-catchment modelling software, was released as a beta version in early 2005 and the product was officially launched at the Catchment Modelling School 2005.

E2 has been designed to provide a flexible capability to support construction of models for analysis of the impacts of land use and water management decisions at the whole-of-catchment scale. This concept of 'flexible capability' combined with a 'land and water' modelling system is what sets E2 ahead of other major models and modelling systems used in hydrology and land management today.

A new area on the Toolkit website was built to assist in planning CRC training to make sure that what is offered meets demand. Visitors to the site were able to register for an advertised CRC workshop, express an interest in a repeat of a workshop, and request assistance in sourcing training that better met their organisation's need.

MUSIC v3

Version 3.0 of MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) was released in May 2005.

By the end of June 2005, there were over 400 licensees in Australia and internationally for MUSIC. It is now widely used for new urban developments in Brisbane and Melbourne.

Four workshops on MUSIC were held at the Catchment Modelling School 2005, including a one-day Version 3 Upgrade day for experienced MUSIC users; the two courses delivered in both Sydney and Brisbane were attended by a total of 86 people.

Catchment Modelling School 2005

The highly successful Catchment Modelling School 2005 was held in two locations – in Brisbane from 30 June – 8 July and in Sydney from 14-22 July.

A total of 48 workshops were held and there were 576 workshop registrations.

A wide user group was represented: 28 per cent were from State government agencies, 11 per cent from research groups, 8 per cent from water utilities, 4 per cent were from catchment management authorities and 37 per cent were consultants (the remainder were from federal government agencies and local government). 4 per cent of the participants were from Victoria, 28 per cent from NSW, 55 per cent from Queensland, 3 per cent from Tasmania, 3 per cent from Western Australia and 1 per cent were overseas visitors.

More about the Catchment Modelling School 2005 can be found under Program 8.



Sediment discharge – subject of Fitzroy study (Burdekin River view)



Toolkit Product Managers' Workshop, Canberra, July 2004



Catchment Modelling School 2005 team members, Prof Rodger Grayson, Geoff Podger, Geoff Davis and Jean-Michel Perraud, Brisbane



Catchment Modelling School 2005 workshop session, Brisbane

Effective communication

1. Communications and Adoption Review

In August 2004, the CRC engaged market research group Newton Wayman Chong (NWC) to conduct an assessment of the CRC's communication and adoption performance. This communications' review was a follow-up to one that was done in 2001. The results provided a comparison with the results from three years previously and was also a way of identifying opportunities for the future, particularly for communication and adoption activities for eWater.

NWC evaluated the CRC's communication activities across a number of fronts, including the Toolkit website and the 2004 Catchment Modelling School. Three methods were used: an e-mail survey to staff, students and CRC parties; a ten-minute telephone survey to 300 randomly selected people from the CRC's mailing and contact lists; and in-depth telephone interviews with key stakeholders (eg Board members and senior executives from major land and water management organisations).

Overall, the results were very positive. More than 90% of external stakeholders considered that the CRC's research is relevant. Overall satisfaction with the CRC communication activities was very high (more than 80%) and respondents indicated that the CRC is extremely well regarded when compared to similar organisations. Results from internal stakeholders indicated an improvement on the already high level achieved in 2001.

The process of evaluating the external perceptions of the CRC's communication activities proved to be an affirmation of the excellent work done by the CRC's research and industry teams.

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.

2. Catchword

Catchword, the CRC's monthly newsletter, continues to be popular. Ten issues were published in 2004-2005. *Catchword* provides regular updates on CRC research and support programs with details on forthcoming workshops and seminars, and information on new publications.

The external communication reviews indicates that it is a very effective way for stakeholders and other interested parties to keep in touch with the CRC's progress. Demand remains high with 683 people receiving a free printed copy of *Catchword* in the mail and 747 people receiving it by email.



Jake MacMullin, CRC website manager

3. Websites

The CRC's website was redesigned and updated in 2004. The new site contains additional information about the CRC's research outcomes from 1999-2002 as well as the current round of CRC projects. The site includes past copies of *Catchword*, all CRC publications since 1999, a contact directory for CRC staff, news and events page and a Google powered search engine that includes Adobe Acrobat files.

4. Industry seminars, workshops and conferences

One result of the communications review was stakeholders' emphasis that workshops are the key means of learning how to apply CRC research.

During 2004-05, the CRC worked hard to deliver many workshops and training courses to encourage widespread adoption and improve the understanding and capability of users of the CRC's modelling tools.

In addition, to the Catchment Modelling School 2005 that offered 48 workshops and was attended by 429 people, the CRC ran 24 other workshops and 6 seminars, with 923 participants in total.

5. Articles, conference papers, presentations

CRC researchers prepared a number of technical reports, presentations and articles during the year. Of particular note, was the new Model Choice Series which is designed to assist industry professionals to better understand CRC modelling tools.

Details of presentations are listed under the Public Presentations, Public Relations and Communication chapter in this annual report. Publications are also listed in a separate chapter.

6. Publications and software

CRC technical and industry reports continue to be in demand. A comprehensive publications list is available on the CRC website, which web usage statistics show is regularly accessed.

During 2004-2005, the CRC sold 290 reports and 296 CRC licensed software products. 18 Technical Reports and one Industry Report were published or are in press.

7. Advocacy

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

CRC advocacy in 2004-2005 included numerous presentations or briefings to Government, industry, research and other organisations. A listing is included in the chapter on Public Presentations, Public Relations and Communication

8. Workshops, field tours, demonstrations and continuing professional education

The CRC continued to offer workshops, field tours and short courses as a primary way of encouraging adoption. These are also an important opportunity for industry practitioners and stakeholders to share information and for researchers to receive feedback about practical use of the CRC's research.

A full list of workshops, field tours, demonstrations and short courses carried out in 2004-2005 can be found in the chapter on Public Presentations, Public Relations and Communication.

9. Intellectual property management

Catchment Modelling Toolkit – Licensing for MUSIC version 3

A central focus of the CRC for Catchment Hydrology's research and adoption effort has been the development of a 'Catchment Modelling Toolkit' to assist land and water managers. The Toolkit has been made available to users via a website created specifically by the CRC. The Toolkit has been developed as a critical part of the evaluation and 'pre-commercialisation' stage of the CRC's software products.

With the Toolkit now at a more mature stage, Commonwealth licensing approval was sought for a Toolkit product moving to the commercialisation stage, ie version 3 of the software package MUSIC.

The Toolkit website was launched in mid 2003 and several modelling programs in the evaluation and essentially pre-commercialisation stages are currently available on the website. These include the software programs/products: CHUTE, E2, MELS, RAP, RIPRAP, RRL, SCL, SedNet, TREND, and WRAM. These products will be made available to the successor CRC, the eWater, CRC for further development.

There are now over 4000 registered users of the Toolkit. The up-take of CRC modelling tools continues to increase, and support has rapidly expanded.

Toolkit products are downloadable from the Catchment Modelling Toolkit website at low or no cost, consistent with the CRC's public good approach to adoption.

Protection of intellectual property has been maintained through agreements with users; all users are required to register and accept the CRC's agreement conditions on downloading products.

Advanced products for licensing approval. Version 3 of MUSIC, CRC software product for modelling and planning urban stormwater facilities

The CRC software product for modelling and planning urban stormwater facilities, MUSIC, was developed to a third version.

With the completion of two stages in the evaluation and pre-commercialisation stages, as part of the development of the commercialisation potential of this product, Commonwealth approval of licensing arrangements for version 3 of MUSIC was sought.

Commonwealth approval was given on 28 June 2005.

Licensees or assignees and their association with the CRC

As with 'pre-commercialisation' products, MUSIC version 3 is being licensed via the Catchment Modelling Toolkit. Prospective users register as a member of the Toolkit community by entering their personal details.

CSIRO was appointed CRC Commercial Agent for the Toolkit, and Monash University was appointed CRC Commercial Agent for stand-alone activity with MUSIC.

In handling Toolkit member registration data, the CRC for Catchment Hydrology operates under the provisions of the CSIRO Privacy Statement provided at <http://www.csiro.au>

Licensees come from many areas. CRC Parties are strongly represented in the Toolkit users group together with CRC Affiliates such as consulting engineering firms. There are other users at 'arms length' from the CRC.

10. 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.

11. Contract research and consultancies

The CRC was successful in achieving a cumulative total of \$7.62 million in funding for research to 30 June 2005. This is 102% of the CRC's Target as set out in the Commonwealth Agreement. Details of contract research projects and consultancies are shown in a table toward the end of this chapter.

Interaction with Research Users

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Australia National University iCAM (Integrated Catchment Assessment and Management Centre) | SME | Research Affiliate | Interactive Component Modelling System / Sue Cuddy <ul style="list-style-type: none"> • Software being used to model water quality in Ben Chifley Dam catchment (NSW) • Software also used to model water allocation in Murrumbidgee and Namoi catchments |
| Australian Centre for International Agricultural Research (ACIAR) | SME | Contract research, grant collaboration | Land-use impacts on rivers <ul style="list-style-type: none"> • Eucalypts and water: Managing forest plantations in China and Australia for sustained productivity and environmental benefits / Dr Jim Morris • Regional impacts of revegetation on water resources of the Loess Plateau China and the middle and upper Murrumbidgee catchment, Australia / Dr Tim McVicar |
| Brisbane City Council | Large | Core participant, grant collaboration | Draft Stormwater Quality Monitoring Protocol <ul style="list-style-type: none"> • Advice to Brisbane City Council on stormwater and SQID monitoring to support the protocol / Program 4 Researchers Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> • Regional defaults for MUSIC parameters developed for Brisbane users / Program 4 Researchers Urban Stormwater Quality <ul style="list-style-type: none"> • Development of integrated stormwater models / John Coleman • Predicting urban stormwater quality, treatment and impacts / Dr Tim Fletcher • Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor • Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher • Development of novel integrated stormwater treatment and re-use systems / Dr Ana Deletic Communication and Adoption <ul style="list-style-type: none"> • Enhancing stakeholder capacity in prioritising water quality management actions / Tony Weber |
| Bureau of Meteorology | Large | Core participant | Motivate Program <ul style="list-style-type: none"> • 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 |
| Bureau of Rural Sciences | SME | User consultant | Zhang model <ul style="list-style-type: none"> • 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 |
| Chinese Academy of Sciences – Institute of Soils and Water Conservation | Large | Grant collaboration | Land-use impacts on rivers <ul style="list-style-type: none"> • Regional impacts of revegetation on water resources of the Loess Plateau China and the middle and upper Murrumbidgee catchment, Australia / Dr Tim McVicar |

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Coomes Consulting | SME | Industry user | Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> • Cairnlea Estate, Melbourne / Program 4 Researchers |
| CSIRO Land and Water | Large | Core participant | Tarsier software environment <ul style="list-style-type: none"> • CSIRO researcher outside the CRC, applying Tarsier to model salinity for the Water and Rivers Commission (WA) • Staff at CSIRO Townsville using Tarsier for ecological modelling (stock track development) Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> • Brasil Development, Brisbane application / Program 4 Researchers Mwater <ul style="list-style-type: none"> • CSIRO Land and Water have adopted Mwater as their main software package for conducting economic experiments / Dr John Tisdell |
| CSIRO Sustainable Ecosystems, Ecosystem Services Project | Large | Research collaborator | Mwater <ul style="list-style-type: none"> • CSIRO Ecosystem Services and CSIRO Land and Water are using Mwater to conduct field experiments in the pilot project "Tradable recharge credits in the Coleambally Irrigation Area / Dr John Tisdell • CSIRO Ecosystem Services are using Mwater to study alternate market mechanisms for overcoming downstream salinity problems in the upper Bet Bet catchment / Dr John Tisdell • CSIRO Ecosystem Services have adopted Mwater as their main software package for conducting economic experiments / Dr John Tisdell |
| Department of Natural Resources, NSW (DNR) | Large | Core participant | Sediment tracing budget methodology <ul style="list-style-type: none"> • Involvement of DNR staff in CRC research (Geoff Podger, Dr Mark Littleboy, Dr Guy Geeves, Carolyn Young and Christoph Zierholz). • DNR (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 Strategic Landscape Investment Model (SLIM) <ul style="list-style-type: none"> • Involvement of CRC staff with DNR in the SLIM tool that permits multi-criteria analysis to identify revegetation optimal sites and other Murray-Darling Basin investments / Program 2 Researchers Sustainable water allocation <ul style="list-style-type: none"> • Hydrologic and economic modelling for water allocation; validated and tested WRAM for Murrumbidgee catchment / Dr Bofu Yu River restoration <ul style="list-style-type: none"> • Catchment assessment techniques to help determine priorities for river restoration / Dr Scott Wilkinson Communication and Adoption <ul style="list-style-type: none"> • Modelling sediments and nutrients in the Murrumbidgee catchment to inform investment / Carolyn Young |

| Research User (Industry and other organisations) | Organisation size (Small and 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 Primary Industries, Vic | Large | Contract research, grant collaboration | <p>Predicting catchment behaviour</p> <ul style="list-style-type: none"> Quantifying the catchment scale impacts of selected 'Best Management Practices' on water quality / Dr Robert Argent <p>Sustainable water allocation</p> <ul style="list-style-type: none"> Cap and trade for salinity: Property rights and private abatement, a laboratory experiment market / Dr John Tisdell |
| Department of Sustainability and Environment (DSE), Vic | Large | Core participant, Contract research | <p>Predicting catchment behaviour</p> <ul style="list-style-type: none"> Victorian Bushfire Recovery Program: Catchment yield and water quality research / Prof Rodger Grayson <p>Flow events methodology (FEM)</p> <ul style="list-style-type: none"> DSE commissioned an independent report to advise on integration of FEM into statewide environmental flow method / Program 6 Researchers <p>River restoration</p> <ul style="list-style-type: none"> Catchment assessment techniques to help determine priorities for river restoration / Dr Scott Wilkinson |
| Earth Tech Pty. Ltd. | SME | Consultant user, Industry Affiliate | <p>Flow events methodology (FEM)</p> <ul style="list-style-type: none"> Report on Evaluation of Method (FEM) / Program 6 Researchers Earth Tech Pty. Ltd. Application of FEM in environmental study of Thomson River / Program 6 Researchers <p>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</p> <ul style="list-style-type: none"> Accredited by CRC as MUSIC trainer / Dr Tim Fletcher |
| Ecological Engineering | SME | Consultant user, Industry Affiliate | <p>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</p> <ul style="list-style-type: none"> Applications in Brisbane and Melbourne – Wakerley Area Wetland and Water Sensitive Urban Design, Brisbane; Police Road Retarding Basin, Melbourne; Association of Bayside Municipalities Project, Melbourne / Program 4 Researchers Accredited by CRC as MUSIC trainer / Dr Tim Fletcher |
| Environment Protection Authority Victoria | Large | Consultancy, contract research, grant collaboration | <p>Urban Stormwater Quality</p> <ul style="list-style-type: none"> Monitoring protocols and selection guidance for primary stormwater treatment measures / Dr Tim Fletcher Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures / Dr Tim Fletcher Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher Predicting performance of bio-filters / Dr Ana Deletic |

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|-----------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gold Coast City Council | Large | Grant collaboration | <p>EMSS software</p> <ul style="list-style-type: none"> Used EMSS to support catchment planning for several local waterways / Programs 1 and 7 Researchers <p>Urban Stormwater Quality</p> <ul style="list-style-type: none"> 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 |
| Goulburn Broken Catchment Management Authority | Large | Project collaborator | <p>River Restoration</p> <ul style="list-style-type: none"> Restoration ecology in the Granite Creeks, Victoria / Assoc Prof Ian Rutherford Catchment assessment techniques to help determine priorities for river restoration / Dr Scott Wilkinson To experimentally evaluate the effectiveness of riparian zone restoration in the streams of the Murray-Darling Basin / Brett Anderson |
| Goulburn-Murray Water | Large | Core participant | <p>Sustainable water allocation</p> <ul style="list-style-type: none"> Hydrologic and economic modelling for water allocation; validated and tested WRAM for Goulburn-Broken catchment / Dr Bofu Yu <p>Communication and Adoption</p> <ul style="list-style-type: none"> Modelling and managing land-use impacts in and around water storages in northern Victoria / Pat Feehan |
| Gutteridge Haskins and Davey | Large | Consultant user | <p>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</p> <ul style="list-style-type: none"> Application in Brisbane – Park Hill Village, Brisbane / Program 4 Researchers |
| Land and Water Australia (LWRRDC) | SME | Grant collaboration, contract research | <p>Predicting catchment behaviour</p> <ul style="list-style-type: none"> Development of a catchment contaminant cycle for stakeholder use / Dr Rob Vertessy <p>Land-use impacts on rivers</p> <ul style="list-style-type: none"> Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang <p>Sustainable water allocation</p> <ul style="list-style-type: none"> Enhancement of the water market reform process: A socio-economic analysis of guidelines and procedures for trading in mature water markets (Project No:[GRU25]) / Dr John Tisdell <p>River Restoration</p> <ul style="list-style-type: none"> Riparian land management: Concepts, floods and erosion / Assoc Prof Ian Rutherford Catchment assessment techniques to help determine priorities for river restoration / Dr Scott Wilkinson Quantifying health in ephemeral rivers / Dr Justin Costelloe |
| Melbourne Enterprises International | SME | Consultancy | <p>Flow events methodology (FEM)</p> <ul style="list-style-type: none"> Dr Mike Stewardson led project through Melbourne Enterprises International to apply methodology to the Loddon River for the North Central CMA. |

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|-----------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Melbourne Water | Large | Core participant, grant collaboration | <p>Motivate Program</p> <ul style="list-style-type: none"> The Motivate Program was applied to contract between Bureau of Meteorology and Melbourne Water to determine time-area rainfall for one in five year storm / Program 5 Researchers <p>Draft Stormwater Quality Monitoring Protocol</p> <ul style="list-style-type: none"> Melbourne Water and Brisbane City Council have also adopted protocol for stormwater monitoring programs / Program 4 Researchers <p>Water Sensitive Urban Design (WSUD)</p> <ul style="list-style-type: none"> Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD) / Assoc Prof Tony Wong <p>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</p> <ul style="list-style-type: none"> Guidelines for MUSIC developed / Program 4 Researchers <p>Urban Stormwater Quality</p> <ul style="list-style-type: none"> Monitoring protocols and selection guidance for primary stormwater treatment measures / Dr Tim Fletcher Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures / Dr Tim Fletcher Development of integrated stormwater models / John Coleman Predicting urban stormwater quality, treatment and impacts / Dr Tim Fletcher Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher Development of novel integrated stormwater treatment and re-use systems / Dr Ana Deletic <p>Communication and Adoption</p> <ul style="list-style-type: none"> Modelling river water quality in the Yarra catchment / Graham Rooney |
| Murray-Darling Basin Commission | SME | Core participant, contract research | <p>MDBC report</p> <ul style="list-style-type: none"> CRC Report to MDBC has highlighted strategic impact of afforestation on water yield in Murray-Darling Basin / Program 2 Researchers <p>Flow events methodology</p> <ul style="list-style-type: none"> Report on Evaluation of Method (FEM) / Program 6 Researchers Final report to MDBC 'Evaluating the Effectiveness of Habitat Reconstruction' / Program 6 Researchers <p>Land-use impacts on rivers</p> <ul style="list-style-type: none"> Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang Basin-wide mapping of sediment and nutrient exports in dryland regions / Dr Chris Moran Integrated assessment of the effects of land-use changes on water yield and salt loads / Dr Lu Zhang Predicting salt movement in catchments / Dr Mark Littleboy |

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Murray-Darling Basin Commission (continued) | | | River Restoration <ul style="list-style-type: none"> To experimentally evaluate the effectiveness of riparian zone restoration in the streams of the Murray Darling Basin / Brett Anderson Predicting Catchment Behaviour <ul style="list-style-type: none"> Victorian Bushfire Recovery Program yield and water quality research / Prof Rodger Grayson |
| Murrumbidgee Catchment Management Board | SME | Activity by core participant DNR | SedNet and EMSS <ul style="list-style-type: none"> Project to demonstrate the relevance and applicability of models to assist in setting end-of-valley targets / Program 2 Researchers |
| National Institute for Water and Atmosphere, Wellington, New Zealand | SME | Research Affiliate | Climate variability <ul style="list-style-type: none"> The National Institute for Water and Atmosphere, Wellington, New Zealand, has successfully trialled S_Prog and is investigating its use as the nowcasting component of a flash flood warning system / Program 5 Researchers |
| Natural Heritage Trust, Dept of Agriculture, Fisheries and Forestry – Australia (AFFA) | Large | Grant collaboration | River restoration <ul style="list-style-type: none"> Research to improve the effectiveness of Australian fishway design / Assoc Prof Bob Keller |
| Natural Resources, and Mines, Qld | Large | Core participant | Sustainable water allocation <ul style="list-style-type: none"> Hydrologic and economic modelling for water allocation; validated and tested WRAM for Nogo-McKenzie / Dr Bofu Yu WRAM <ul style="list-style-type: none"> NRM, Qld has implemented an internal project to build and link IQQM and WRAM Models / Assoc Prof Bofu Yu River restoration <ul style="list-style-type: none"> Development of flow-ecological response models / Dr Nick Marsh Communication and Adoption <ul style="list-style-type: none"> Modelling river water quality in the Fitzroy catchment in partnership with regional strategy groups / Chris Carroll Enhancing stakeholder capacity in prioritising water quality management actions in southeast Queensland / Tony Weber |
| NSW EPA | Large | Consultancy user | Draft Stormwater Quality Monitoring Protocol <ul style="list-style-type: none"> NSW EPA adopted draft protocol and recommended procedure for monitoring stormwater treatment measures by NSW councils / Program 4 Researchers Urban Stormwater Quality <ul style="list-style-type: none"> Tools for evaluating the social and economic performance of stormwater management and Water Sensitive Urban Design / André Taylor |
| Pine Rivers Shire Council | SME | Consultancy | EMSS software <ul style="list-style-type: none"> 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 |

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|------------------------------------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Qld EPA | Large | Consultancy user, Project collaborator | <p>Predicting Catchment Behaviour</p> <ul style="list-style-type: none"> • General collaboration including application of EMSS to Qld EPA protocols for water quality targets / Prof Rodger Grayson <p>Urban Stormwater Quality</p> <ul style="list-style-type: none"> • Development of novel integrated stormwater treatment and re-use systems / Dr Ana Deletic |
| Sinclair Knight Merz | SME | Consultant user, Industry Affiliate | <p>Predicting Catchment Behaviour</p> <ul style="list-style-type: none"> • General collaboration including Catchment Modelling Toolkit / Prof Rodger Grayson <p>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</p> <ul style="list-style-type: none"> • Accredited by CRC as MUSIC trainer / Dr Tim Fletcher |
| South East Queensland Regional Water Quality Management Committee (SEQRWQMC) | SME | Consultancy-user | <p>SedNet – a model that predicts the sources and distribution of sediment through a river network</p> <ul style="list-style-type: none"> • The results of the SedNet application and validation in the Brisbane River catchment have formed the basis for targeting catchment works under the SEQRWMS – this modelling work has formed the basis of the agenda for Phase 4 of the strategy / Program 2 Researchers <p>EMSS software</p> <ul style="list-style-type: none"> • Development of an environmental management support system (EMSS) for catchments in south east Queensland / Dr Rob Vertessy <p>Predicting catchment behaviour</p> <ul style="list-style-type: none"> • Modelling and estimating sediment and nutrient loads in south east Queensland catchments – Phase 1 / Assoc Prof Francis Chiew <p>Land-use impacts on rivers</p> <ul style="list-style-type: none"> • SEQRWMS, Stage 3, Project Sediment and Nutrient Sourcing / Dr Jon Olley |
| South East Queensland Water Corporation | Large | Consultancy-user | <p>EMSS Software</p> <ul style="list-style-type: none"> • 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 <p>Sustainable water allocation</p> <ul style="list-style-type: none"> • The valuation of the water quality ecosystem service of the mid-Brisbane River / Dr John Tisdell |
| State Water, an arm of NRM, QLD | Large | Core participant | <p>Fitzroy catchment survey results</p> <ul style="list-style-type: none"> • State Water, an arm of NRM, QLD, used the results 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 |
| Sustainable Water Resources Research Centre, Korea | SME | Research Affiliate, International collaboration | <p>Predicting catchment behaviour</p> <ul style="list-style-type: none"> • General collaboration, including Catchment Modelling Toolkit / Dr Rob Vertessy, Geoff Podger |

| Research User (Industry and other organisations) | Organisation size (Small and medium sized enterprises, large firms) | Basis of interaction (Core participant, consultancy, contract research, grant collaboration) | CRC activity, product or service involved/ Principal researchers |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| UK Met Office | Large | International collaboration | Radar forecasting <ul style="list-style-type: none"> UK Met Office requested an MOU with BoM to apply the radar forecasting technology in the UK / Dr Alan Seed |
| University of New South Wales | Large | Research Affiliate | Climate Variability <ul style="list-style-type: none"> Collaboration on stochastic rainfall data / Program 5 Researchers |
| Urban and Regional Land Corporation (Vic Urban) | SME | User – grant collaboration | Water Sensitive Urban Design <ul style="list-style-type: none"> Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD) / Assoc Prof Tony Wong |
| Water and Rivers Commission (WA) (succeeded by Department of Environment, WA) | SME | Consultancy-user | Tarsier software environment <ul style="list-style-type: none"> 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 |
| Water Corporation of Western Australia | Large | Collaborative project | CRC Forge Software <ul style="list-style-type: none"> Application of extreme rainfall analysis software developed from initial CRC / Erwin Weinmann |
| WBM | SME | Consultancy, Industry Affiliate | EMSS software <ul style="list-style-type: none"> EMSS (Tarsier) has been delivered and being used by CRC project teams and WBM / Program 1 Researchers 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 Model for Urban Stormwater Improvement Conceptualisation (MUSIC) <ul style="list-style-type: none"> Brisbane and Melbourne offices – Lenworth Lake Development, Brisbane; Forrest Lake, Brisbane; Geelong Stormwater Management Plan, Victoria; Craigieburn Bypass Water Sensitive Road Design, Victoria / Program 4 Researchers Accredited by CRC as MUSIC trainer / Dr Tim Fletcher |

Contract Research Activity

CRC Associated/Additional Projects, External Funding and Direct CRC Contract Research/Consulting

| CRC Project No. | 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 |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------------------------------------|---------------------------|------------------------------|
| 1.3 | Development of an environmental management support system (EMSS) for catchments in south east Queensland/ Dr Rob Vertessy | Brisbane catchment | 263 | 151 | 112 | 43% |
| 1.4 | Modelling and estimating sediment and nutrient loads in south east Queensland catchments – Phase 1/ Dr Francis Chiew | Brisbane catchment | 72 | 54 | 18 | 25% |
| 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 catchment | 222 | 125 | 97 | 44% |
| 1.11 | Development of a catchment contaminant cycle for stakeholder use / Dr Rob Vertessy | Brisbane and Murrumbidgee catchments | 702 | 400 | 106 | 15% |
| 1.14 | Victorian Bushfire Recovery Program: Catchment yield and water quality research/ Prof Rodger Grayson | Goulburn-Broken catchment, Murrumbidgee catchment | 750 | 500 | 250 | 33% |
| 2.6 | Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang | Goulburn-Broken catchment, Murrumbidgee catchment | 812 | 150 | 500 | 62% |
| 2.7 | Eucalypts and water: Managing forest plantations in China and Australia for sustained productivity and environmental benefits / Dr Jim Morris | Goulburn- Broken Catchment | 1,621 | 821 | 300 | 19% |
| 2.10 | SEQRWQMS, Stage 3, Project SS: Sediment and Nutrient Sourcing / Dr Jon Olley | Brisbane River catchment | 397 | 277 | 120 | 30% |
| 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% |
| 2.15 | Integrated assessment of the effects of landuse 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% |
| 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 catchment | 1,945 | 415 | 141 | 7% |
| 2.26 | Adding the 'Contributor' Module to the Toolkit SedNet Module / Dr Scott Wilkinson | SedNet is being used in all Development Project catchments and users are requesting this capability be added. | 25 | 18 | 7 | 28% |
| 2.27 | Predicting Nutrient Sources and Transport for Regional Planning in the GBR Catchments / Dr Jon Olley | Includes Fitzroy focus catchment and other catchments draining to the Great Barrier Reef | 316 | 30 | 10 | 3% |
| 3.4 | Enhancement of the water market reform process: A socio-economic analysis of guidelines and procedures for trading in mature water markets (Project No: [GRU25]) / Dr John Tisdell | Murrumbidgee catchment | 833 | 208 | 625 | 75% |

| FUNDING AGENCY INPUT FOR: | | | | | | | Cumulative Funding agency input | start/ finish date | Project Parties involved | CRCPrincipal External Funding Agency |
|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| 99/00 \$000s | 00/01 \$000s | 01/02 \$000s | 02/03 \$000s | 03/04 \$000s | 04/05 \$000s | | | | | |
| 0 | 110 | 41 | 0 | 0 | 0 | 151 | May 00 / Aug 01 | CSIRO, Univ Melb, Monash Univ, BCC | South East Queensland Regional Water Quality Management Committee (SEQRWQMC) | |
| 0 | 54 | 0 | 0 | 0 | 0 | 54 | May 00 / Jan 01 | CSIRO, Univ Melb, Monash, BCC | South East Queensland Regional Water Quality Management Committee (SEQRWQMC) | |
| 0 | 0 | 125 | 0 | 0 | 0 | 125 | May 01 / Jun 02 | CSIRO, NRM, BCC | Pine Rivers Shire Council; South East Queensland Water Corporation; WBM Oceanics, Consultants | |
| 0 | 0 | 0 | 107 | 141 | 152 | 400 | Dec 02 / Jun 05 | CSIRO, Monash | Land and Water Australia | |
| 0 | 0 | 0 | 0 | 50 | 400 | 450 | Jan 04 / Oct 05 | Univ Melb, CSIRO Land and Water, Forest Science Centre DSE, G-MWater, MDBC | Department of Sustainability and Environment, Victoria | |
| 0 | 71 | 79 | 0 | 0 | 0 | 150 | Jul 00 / Jun 02 | CSIRO, DNRE, DNR NSW, Univ Melb | Land and Water Resources Research and Development Corporation (LWRRDC) | |
| 223 | 205 | 195 | 198 | 0 | 0 | 821 | Jul 99 / Jun 03 | Centre for Forest Tree Technology DSE, Univ Melb Dept of Forestry, CSIRO | Australian Centre for International Agricultural Research (ACIAR) | |
| 223 | 54 | 0 | 0 | 0 | 0 | 277 | Aug 99 / Jun 01 | CSIRO, NRM | South East Queensland Regional Water Quality Management Committee (SEQRWQMC) | |
| 24 | 109 | 229 | 130 | 0 | 0 | 492 | Mar 00 / Mar 03 | CSIRO, Univ Melb, Monash Univ, MDBC | Murray-Darling Basin Commission (MDBC) Strategic Investigations and Education Program | |
| 0 | 0 | 283 | 188 | 282 | 0 | 753 | Feb 01 / Oct 03 | NRE Vic, DNR NSW, CSIRO Land and Water | Murray-Darling Basin Commission (MDBC) Strategic Investigations and Education Program | |
| 0 | 0 | 0 | 81 | 126 | 140 | 347 | Apr 03 / Mar 06 | CSIRO, [links with DNR NSW] | Chinese Academy of Sciences – Institute of Soils and Water Conservation; Australian Centre for International Agricultural Research (ACIAR) | |
| 0 | 0 | 0 | 0 | 0 | 18 | 18 | Nov 04 / Dec 04 | Univ Melb, CSIRO | Queensland Environment Protection Agency | |
| 0 | 0 | 0 | 0 | 0 | 15 | 15 | Feb 05 / Sep 05 | CSIRO, NRM | James Cook Univ, Queensland Environment Protection Agency | |
| 0 | 60 | 72 | 76 | 0 | 0 | 208 | Jul 00 / May 03 | Griffith Univ, DNR NSW, Monash Univ | Land and Water Resources Research and Development Corporation (LWRRDC) | |

COMMERCIALISATION, UTILISATION AND APPLICATION OF RESEARCH – PROGRAM 7 continued...

| CRC Project No. | 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 |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------------------------------------|---------------------------|------------------------------|
| 3.10 | The valuation of the water quality ecosystem service of the mid-Brisbane River / Dr John Tisdell | Brisbane catchment | 40 | 30 | 10 | 25% |
| 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% |
| 4.3 | Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD)/ Dr Tony Wong | Yarra catchment | 106 | 100 | 6 | 6% |
| 4.4 | Monitoring protocols and selection guidance for primary stormwater treatment measures/ Dr Tim Fletcher | Yarra catchment | 220 | 200 | 20 | 9% |
| 4.5 | Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures / Dr Tim Fletcher | Yarra catchment | 120 | 100 | 20 | 17% |
| 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% |
| 4.11 | Stormwater quality prediction – predicting stormwater quality from land surface and short duration climate / Dr Tim Fletcher | Brisbane, Yarra | 713 | 511 | 284 | 40% |
| 4.13 | Development of novel integrated stormwater treatment and re-use systems / Dr Ana Deletic | Brisbane, Yarra | 450 | 140 | 86 | 19% |
| 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% |
| 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% |
| 6.14 | Quantifying health in ephemeral rivers / Dr Justin Costelloe & Fran Sheldon (CRCFE) | Field sites required by LWA to be located in South Aust | 885 | 113 | 210 | 24% |
| 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% |
| Totals | | | 15,765 | 6,948 | 4,108 | |

Associate/Additional Projects External Funding Agency Input total (\$000s)

CRC Direct Contract Research/Consulting Income total (\$000s)

Other Projected Direct income:

Project 2.21[2C]

Project 6.14

Total Contract Research/Consulting total (\$000s)

Commonwealth Agreement Contract Research totals (\$000s)

Notes

- Actuals for 99/2000 to 2004/05 as reported in Profit and Loss Account.
- Income processed through CRC direct financial reporting for 2004/05.

| FUNDING AGENCY INPUT FOR: | | | | | | | Cumulative Funding agency input | start/ finish date | Project Parties involved | CRC/Principal External Funding Agency |
|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------|------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------|
| 99/00 \$000s | 00/01 \$000s | 01/02 \$000s | 02/03 \$000s | 03/04 \$000s | 04/05 \$000s | | | | | |
| 0 | 0 | 0 | 0 | 30 | 0 | 30 | June 03 / Aug 03 | BCC, Griffith Univ | South East Queensland Water Corporation | |
| 0 | 0 | 0 | 0 | 67 | 66 | 133 | Mar 03 / Jul 04 | Griffith Univ, DPI Vic, Univ Melb | NAP [DPI Vic] | |
| 0 | 0 | 90 | 0 | 0 | 0 | 90 | Sep 01 / Jun 02 | Melbourne Water, Monash Univ | Melbourne Water, Urban and Regional Land Corporation | |
| 0 | 0 | 200 | 170 | 0 | 0 | 370 | Sep 01 / Jul 03 | Melbourne Water, Monash Univ | Environment Protection Authority Victoria | |
| 0 | 0 | 100 | 0 | 0 | 0 | 100 | Sep 01 / Jul 02 | Melbourne Water, Monash Univ | Environment Protection Authority Victoria | |
| 0 | 0 | 0 | 0 | 165 | 0 | 165 | Jul 03 / Jul 05 | BCC, Melbourne Water, Monash Univ | Environment Protection Authority Victoria | |
| 0 | 0 | 0 | 0 | 205 | 204 | 409 | Jul 03 / Jul 05 | BCC, Melbourne Water, Monash Univ | Environment Protection Authority Victoria | |
| 0 | 0 | 0 | 0 | 0 | 70 | 70 | Aug 04 / Aug 06 | Monash Univ, CSIRO | | |
| 18 | 134 | 210 | 0 | 0 | 0 | 362 | May 00 / Jun 02 | Monash Univ, Univ of Melbourne | Natural Heritage Trust, Dept of Agriculture, Fisheries and Forestry – Aust.(AFFA) | |
| 0 | 0 | 81 | 196 | 159 | 64 | 500 | July 01 / Jun 05 | Univ of Melbourne, CSIRO, [Interest expressed by Melb Water, Brisbane CC, NRM Qld | Land and Water Australia (LWRRDC) | |
| | | | | Note 2 | Note 2 | Note 2 | Mar 03 / Feb 05 | Univ of Melbourne, Monash Univ | Land and Water Australia (LWRRDC) | |
| 0 | 0 | 0 | 0 | 137 | 27 | 164 | Oct 03 / Dec 05 | Univ of Melbourne, Monash Univ, Murray Darling Basin Commission | Murray-Darling Basin Commission (MDBC) | |
| 488 | 797 | 1,705 | 1,146 | 1,362 | 1,156 | 6,654 | | | | |

| | | | | | | | |
|------------|------------|--------------|--------------|--------------|--------------|-------------|----------|
| 488 | 797 | 1,705 | 1,146 | 1,362 | 1,156 | 6,654 | |
| 32 | 152 | 30 | 125 | 64 | 61 | 464 | [Note 1] |
| | | | 100 | 200 | 150 | 450 | |
| | | | 9 | 21 | 26 | 56 | |
| 520 | 949 | 1,735 | 1,380 | 1,647 | 1,393 | 7624 | |
| 300 | 700 | 1000 | 1400 | 1800 | 2300 | 7500 | |

Milestones Program 7

| Milestone | Progress |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Years 3, 4 and 5 | |
| Preparation completed (Year 3) for the communication of research outcomes to targeted end-users. Individual program and project C and A strategies commenced | Preparation/planning for delivery completed by all Programs. First round project delivery completed. Stage 1 (major) of Toolkit web site development completed and resources now focussed on CRC website and consolidation of round one project outcomes for industry use. Catchment Modelling School 2004 highly successful. |
| Communication and adoption activities measured by independent consultants (Years 3 and 5) | Year 5 communication review completed with very positive outcomes. |
| 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 communications 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 Years 2 and 4. Resources were redirected to the establishment of Development Projects in the Focus Catchments. |
| Level of commitment to contract research is on target set in Strategic Plan. | External project funding represents 120% of the target to June 2004. Projects include South East Queensland Regional Water Quality Management Strategy Projects 1.3, 1.4, 1.7, 2.10; Land and Water Australia Projects 2.6, 3.2; Natural Heritage Trust/Agriculture, Fisheries and Forestry - Australia Project 6.8; Murray-Darling Basin Commission Projs 2.13, 2.15,6.15; ACIAR Projects 2.7, 2.24; URLC/Melb Water Proj 4.3; EPA Vic Projs 4.4, 4.5, 4.10, 4.11; DSE 1.13 |
| Years 6 and 7 | |
| High level of commitment to the Program by Project staff and Industry Parties to deliver Outputs and Outcomes required by each project's communication and adoption strategy. | Extremely high level of support by research teams to deliver products through the Toolkit (new products/versions launched since last Board include WRAM, and SedNet). The Toolkit now has 4000 registered members. |
| Best practice communication and adoption workshop convened to assess and implement recommendations from independent review (Year 6) | Best Practice workshop not considered priority after very thorough and positive review by external market research group. Resources utilised instead to support Toolkit and training programs. |
| Review strategies for communication to ensure end-users and stakeholders are implementing CRC research Outputs and Outcomes in an effective and iterative process. | Review of the effectiveness of CRC communications demonstrated very positive results with adoption and impact of CRC research very high. Existing strategies maintained to ensure delivery of targets by June 2005. |
| Level of commitment to contract research is on target set in Strategic Plan | External project funding represents 102% of the target to June 2005. |

Program 8

Education and Training

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.

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. 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



David Perry, Program Leader, Education and Training



Postgraduate poster displays, Annual Workshop, June 2005

Program highlights 2004-2005

- As also noted under Program 7, a major highlight of the CRC's Education and Training Program for this year was the Catchment Modelling School 2005. 48 catchment modelling and related workshops were held with 428 participants attending 576 workshop places in two locations – Brisbane and Sydney.
- Sara Lloyd was named the 2004 Young Water Scientist of the Year. The award, worth \$2500 is given annually by the CRC Water Forum, an alliance of the five water-focused Australian cooperative research centres. This is a great recognition of Sara's research into Water Sensitive Urban Design (WSUD) techniques, which has investigated key aspects of WSUD, its effectiveness, life cycle costs and community acceptance.
- Post-graduates have had the opportunity this year to give presentations on their research work to the Board over the last 12 months
- The CRC published two booklets in its new Model Choice Series. This series is designed to assist industry professionals who are commissioning or involved with catchment modelling to better understand how the tools developed by the CRC can help them. So far, two publications have been produced 'General approaches to modelling and practical issues of model choice' and 'Water quality model – sediment and nutrients'. The publications are available at www.toolkit.net.au/modelchoice.
- The CRC had an active program of Vacation Studentships over the summer of 2004-2005. Vacation Studentships were awarded to the following scholars who assisted with research at the university nodes:
 - Monash University – David Flower and David McCarthy;
 - The University of Melbourne – Keirnan Fowler and Emily Payne.



CRC Postgraduates – past and present - at Annual Workshop, June 2005

Catchment Modelling School 2005

The momentum and success of the 2004 Catchment Modelling School was continued again this year with 576 workshop places and 30 topics over 48 modelling software workshops at the School 2005.

The Catchment Modelling School 05 was held in two locations – in Brisbane from 30 June 8 July at the Nathan Campus of Griffith University and in Sydney from 14-22 July at the Darlington Campus of the University of Sydney.

Modelling and applying quantitative analysis tools are now an integral component of land and water management in Australia. In the last two years, there have been major advances in modelling and the range and extent of tools available.

A number of initiatives that require science-based, defensible objectives and priorities have driven the use of modelling. These range from the high level broad-scale of the National Water Initiative and the COAG reforms to the more practical needs of local catchment managers.

Initiated and organised by the CRC for Catchment Hydrology, the Catchment Modelling Schools are now recognised as the best opportunity to learn the latest techniques and applications. They are becoming a must for industry professionals.

The School 2005 brought together Australia's broad modelling community – model users, developers and those who commission models or who need to interpret the output from modelling exercises. The Catchment Modelling Schools demonstrate how the CRC is clearly focussed on 'delivering capability' to resource managers.

The School 2005 included sessions on major industry models such as MUSIC, IQQM, HEC-RAS and SedNet, plus introductory and advanced sessions on the new integrated modelling platform, E2.

All sessions involved 'hands-on' experience with the software with excellent supporting material. There is little doubt that workshops provide an outstanding opportunity for sharing experiences and learning from each other.

Feedback

Comments from participants included:

'Well structured, good coverage of topic'

'Experienced and knowledgeable presenters, balance between tutorial based learning and presentations was good, trouble shooting was accessible.'



Above top left: Catchment Modelling School 2005 workshop session, Sydney

Above top right: Joel Rahman, presenting at Catchment Modelling School 2005, Sydney

Above left: André Taylor instructing at Catchment Modelling School 2005, Sydney

Above right: Break from session, Catchment Modelling School 2005, Brisbane

POSTGRADUATES - CRC CORE PROJECTS 2004-2005

| Name | University | Type of post-graduate 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 A. (UM) on catchment-scale flood characteristics (Program 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) | GUPRAø | Nitrogen, phosphorus and carbon removal processes in stormwater wetlands (4) |
| Dominic Blackham | Melbourne | PhD | I.D. Rutherford (UM) M. J. Stewardson (UM) | MIRS~ | 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) |
| Alice Brown (nee 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) |
| Tim Capon | Griffith | PhD | J Tisdell (Griffith) A. Arthington (Griffith) | GUPRAø | 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) | GUPRAø | Integration between catchment biophysical models and economic models for the management of nonpoint source pollution (3) |
| Matthew Francey | Monash | MEngSc | T. Fletcher (Monash) A. Deletic (Monash) H. Duncan (Melbourne Water) | 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) A. Curtis (Charles Sturt Univ) R.B. Grayson (UM) | IPRSøø, MIRS~ | Organisational decision making – priority setting in stream rehabilitation (6) |
| Janice Green | Monash | PhD | P.E. Weinmann (Monash) R. Nathan (Sinclair Knight Merz) | APAIA | Estimation of extreme rainfall risk (D3) |
| Marnie Griffith | Monash | PhD | G. Codner (Monash) S. Schreider (RMIT) I. Wills (Monash) | MDS* | Irrigated agriculture and the COAG reforms under uncertainty (3) |
| Courtney Henderson | Griffith | PhD | M. Greenway (Griffith) I. Phillips (Griffith) | GUPRAø with CRC top-up | Assessing the effect of vegetation in biofiltration devices for nutrient pollution removal from stormwater (4.2) |
| Subhadra Jha | Melbourne | PhD | R. Grayson (UM) I.D. Rutherford (UM) | IPRSøø, MIRS~ | Modelling stream bank erosion at basin scale (6.6) |
| Dean Judd | Monash | PhD | R.J. Keller (Monash) I.D. Rutherford (UM) J. Tilleard (Moroka) | MDS*, MUGS†† | How a river anabranch forms: a process study on the Riverine Plain of South East Australia (6) |
| 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) |
| David Newton | Griffith | PhD | G.A. Jenkins (Griffith) I. Phillips (Griffith) B. Yu (Griffith) | GUPRAø | 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.M. Malano (UM) | APA# | An investigation of the potential economic benefits of seasonal climate forecasts for irrigators (5) |
| Gregory Summerell | Melbourne (3) | PhD | R.B. Grayson (UM) N.K. Tuteja (DNR) G. Walker (CSIRO) | NSW salinity strategy funds / Department of Natural Resources / and CRC | Understanding the processes of salt movement from the landscape to the stream (2) |

POSTGRADUATES - CRC CORE PROJECTS 2004-2005 (continued)

| Name | University | Type of post-graduate enrolment (PhD, MEngSc etc) | Supervisor and Associate Supervisors | Funding source(s) ARC/CRC/Uni/etc | Topic (Related CRC Program/Project) |
|----------------------------|------------|---------------------------------------------------|--------------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Geoff Taylor | Monash | PhD | T.H.F. Wong (EcoEng) 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) |
| Margot Turner (nee Biggin) | Monash (1) | PhD | G. Codner (Monash) S. Schreider (RMIT) M.J. Stewardson (UM) | MDS* | Evaluating the impact of water allocations on natural hydraulic habitat conditions (3) and (6) |
| Geoff Vietz | Melbourne | PhD | M.J. Stewardson (UM) B. Finlayson (UM) I.D. Rutherford (UM) | UMSPS† with CRC top-up | Understanding the relationships between river hydrodynamics and channel morphology (6B) |
| Clayton White | Griffith | PhD | J. Fien (Griffith) R. Rickson (Griffith) | GUPRAø | 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 | Environmental floods for Victorian regulated rivers (6.7) |
| Asif Zaman | Melbourne | PhD | H.M. Malano (UM) B. Davidson (UM) | Northcote Trust (UK) and CRC | Estimating regional impacts of temporary water trading through integrated hydro-economic modelling (3) |
| Elisa Zavadil (nee Howes) | Melbourne | PhD | M.J. Stewardson (UM) A. Ladson (Monash) I.D. Rutherford (UM) | UMSPS†, MRS## | The nature of in-stream change at tributary junctions and implications for river research and management (6) |

POSTGRADUATES - CRC ADDITIONAL/ASSOCIATED PROJECTS 2004-2005

| Name | University | Type of post-graduate enrolment (PhD, MEngSc etc) | Supervisor and Associate Supervisors | Funding source(s) ARC/CRC/Uni/etc | Topic (Related CRC Program/Project) |
|---------------------|------------|---------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------|----------------------------------------------------------------------------------------|
| Dale Browne | Monash | PhD | A. Deletic (Monash) T. Fletcher (Monash) G. Mudd (Monash) N.K. Tuteja (DNR) | MDS* | 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*/ James McNeill scholarship | Stormwater treatment for re-use (4) |
| 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) | MDS* | Modelling the performance of a series of surface flow stormwater treatment systems (4) |
| Nilmini Siriwardene | Monash | PhD | A. Deletic (Monash) T. Fletcher (Monash) | MDS* | Predicting the clogging of stormwater infiltration systems (4) |
| Stephen Wealands | Melbourne | PhD | R. Grayson (UM) J. Walker (UM) | APA | Comparing spatial patterns for hydrological models (1) |

- † University of Melbourne Special Postgraduate Studentship supported by CRC
 †† Monash University Graduate Scholarship
 * Monash University Department Scholarship supported by CRC
 ** Melbourne University Postgraduate Scholarship
 # Australian Postgraduate Award
 ## Melbourne Research Scholarship
 ~ Melbourne International Research Scholarship (fee remission)
 øø International Postgraduate Research Scholarship
 Δ Australian Postgraduate Award Industry
 ΔΔ Monash Graduate Scholarship
 ø Griffith University Postgraduate Research Award (ENS Faculty)
 (1) Also located at University of Melbourne
 (2) Also located at CSIRO, Canberra
 (3) Also located at DNR, Wagga Wagga



Above left: Dr Greg Summerell and supervisor, Prof Rodger Grayson
 Above right: Dr Justin Costelloe, Dr Teri Etchells with Prof Tom McMahon

TABLE C HIGHER DEGREES (RESEARCH) COMPLETED AND DESTINATION OF POSTGRADUATES 2004-2005

| Name | Degree, University | Supervisor(s) | Topic (Related CRC Program/Project) | Date Research Thesis Submitted/ Passed | Destination |
|-------------------|--------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------|---------------------------------------------------------|
| Pandora Hope | PhD, Melbourne | I. Simmonds (UM) | Shifts in Australia's circulation and rainfall source regions (5.3) | February 2005 | Climatologist – Bureau of Meteorology |
| Dean Judd | PhD, Monash | R.J. Keller (Monash) I.D. Rutherford (UM) J. Tilleard (Moroka) | How a river anabranch forms: a process study on the Riverine Plain of South East Australia (6) | May 2005 | Researcher – Monash University |
| Gregory Summerell | PhD, Melbourne | R.B. Grayson (UM) N.K. Tuteja (DNR) G. Walker (CSIRO) | Understanding the processes of salt movement from the landscape to the stream (2) | August 2004 | Dept of Natural Resources, NSW |
| Debbie Woods | MSc, Melbourne | I.D. Rutherford (UM) M.J. Stewardson (UM) | Environmental Floods for Victorian Regulated Rivers (6.7) | August 2004/ February 2005 | Water Sector Group, Dept Sustainability and Environment |

Milestones Program 8

| Milestones | Progress |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Years 3, 4 and 5 | |
| Regular program of short courses and workshops for all workshop places) stakeholders operating. | Catchment Modelling School delivered 31 workshops (508 places during 9-20 February 2004. Very positive feedback and industry response. On-line registration website at www.toolkit.net.au/training established |
| 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 <i>New milestone as approved by Commonwealth, 16 July 2003.</i> | 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 |
| Action plan to meet the requirements identified in the needs analysis | Implementation of action plan complete - the CRC has training provided and brokered education and training activities to meet the needs of CRC postgraduates, researchers and stakeholders. Ongoing education and training activities include 'People Skills' workshop for CRC postgraduates during March 2004 quarter. |
| Provide education and training workshops for CRC researchers to assist them with the delivery of products to end-users <i>Replacement milestone as approved by Commonwealth, 16 July 2003.</i> | Program 8 staff delivered a series of education and training workshops to Program teams during 2003. |
| Development of an education and training framework for a consistent and informed approach to education and training across the CRC, including development of education and training approaches or templates for use by CRC researchers <i>Replacement milestone as approved by Commonwealth, 16 July 2003.</i> | 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. |
| Years 6 and 7 | |
| Evaluation and redevelopment of program of short courses, training and postgraduate coursework | Product Manager (PM) workshops held 28 July 2004 (Canberra) and 30 July (Melbourne). Workshop designed to support PMs in delivering high quality software through the Catchment Modelling Toolkit web site. Internal and external CRC staff participated. Analysis of evaluation forms from Catchment Modelling School undertaken as part of Communications review. Very positive result. Further information available on request. |
| Organisation, conduct and evaluation of Catchment Modelling School <i>Replacement milestone as approved by Commonwealth, July 2003.</i> | Mini School for Catchment Modelling Toolkit held following the Feb 2005 Hydrology and Water Resources Symposium. Four workshops with 65 participants in total. The Catchment Modelling Schools in Brisbane and Sydney during July 2005 were highly successful with 576 registrations for Brisbane and Sydney. 48 workshops were presented. |

Management and Operating

New appointments

Deputy Directors

Assoc Prof Francis Chiew
The University of Melbourne
(Succeeded Prof Tom McMahon from 1 January 2005)

Dr Ana Deletic
Monash University
(Succeeded Mr Erwin Weinmann from 1 July 2004)

Program Leader

Dr Robert Argent
The University of Melbourne
Joint Program Leader, Program 1:
Predicting Catchment Behaviour (from 1 October 2004)

Research and Supporting Staff

During the year a total of 152 staff were engaged in CRC activities from the various contributing Parties and at various time fractions. The total full-time equivalent of cash funded and in-kind contributed staff was 55, with 51 involved in research.

Postgraduates

Postgraduates active in CRC core programs and projects during 2004-2005 totalled 27.

A further seven 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 were located at:

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

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



Above top: Assoc Prof Francis Chiew, appointed CRC Deputy Director at The University of Melbourne

Above middle: Dr Ana Deletic, appointed CRC Deputy Director at Monash University

Above bottom: Dr Robert Argent, appointed Joint Program Leader, Predicting Catchment Behaviour

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 constituted a major element of the research sites and facilities available to the CRC. The Development Projects within these Focus Catchments built on the CRC resources that were available in these catchments.

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

Specified Personnel

Dr Robert Argent,
The University of Melbourne,
(Joint Program 1 Leader – Predicting Catchment Behaviour,
from 1 October 2004)

Assoc Prof Francis Chiew,
Department of Civil and Environmental Engineering,
The University of Melbourne (Centre Deputy Director from
1 January 2005, Program 5 Leader – Climate Variability)

Dr Ana Deletic,
Department of Civil Engineering, Monash University
(Centre Deputy Director from 1 July 2004)

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

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

Prof Tom McMahon,
Department of Civil and Environmental Engineering,
The University of Melbourne (Centre Deputy Director
to 31 December 2004)

Mr David Perry,
Monash University (Program 7 Leader – Communication
and Adoption, and Program 8 Leader – Education
and Training)

Mr Geoff Podger,
CSIRO, formerly Department of Natural Resources, NSW
(Joint Program 1 Leader – Predicting Catchment Behaviour)

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

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

Dr Peter Wallbrink,
CSIRO Land and Water (Centre Deputy Director and Program
2 Leader – Land-use Impacts on Rivers).

| Percentage Time | | |
|--------------------------|------------|------------|
| Researcher | Actual | Agreement |
| Dr Robert Argent | 100 | 80 |
| Assoc Prof Francis Chiew | 88 | 80 |
| Dr Ana Deletic | 59 | 45 |
| Dr Tim Fletcher | 100 | 100 |
| Prof Rodger Grayson | 100 | 100 |
| Prof Tom McMahon | 10 | 10 |
| Mr David Perry | 100 | 100 |
| Mr Geoff Podger | 38 | 50 |
| Dr Mike Stewardson | 100 | 100 |
| Dr Peter Wallbrink | 74 | 70 |
| Total percentage | 769 | 735 |

Public Presentations, Public Relations and Communications

Communication Activities

Land and water management issues are now firmly on the public agenda, so CRC staff continue to be asked regularly to communicate about the research work that the CRC is doing and its practical application.

Many people in the industry are watching closely the progress of the Development Projects in the five Focus Catchments. Staff from the Projects gave many presentations during 2004-2005 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.

Public presentations by CRC staff, the expanded website and the Catchment Modelling Toolkit, amount 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) is easy to navigate and received positive feedback in the communications review undertaken this year by consultants.

The website averages about 5500 different visitors per month from all across the world. About 30% of the visitors return to the web site twice or more each month (based on a monthly audit).

Newsletters

One of the key communication vehicles for the CRC is the *Catchword* newsletter. In 2004-2005, 11 issues were produced as usual.

By the end of June 2005, 1430 people subscribed to *Catchword* (683 received the newsletter by post; 747 by email). Interested people can request a subscription via the CRC website.

Catchment Modelling Toolkit

The web-based Catchment Modelling Toolkit has around 4000 registered users – an increase of more than 2000 from the year before. MUSIC has more than 950 registered users.

The Toolkit successfully facilitates efficient communication channels between researchers and the users/user communities through training, publications, information and individual response via on-line user support.

The Toolkit website was also surveyed as part of the Communications review. In the survey of 184 Toolkit members high levels of satisfaction with the existing website structure and performance were recorded.

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

A good way for the CRC to communicate its activities and views is through the media. The following table lists the articles and publications that CRC activities were featured in.

Public Presentations 2004 2005

| Date | Speaker (s) | Topic | Venue |
|-----------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| 14 July 2004 | Assoc Prof Brian Finlayson (Univ Melb) | Impacts of the Brigalow development scheme | Capricorn Conservation Council, Rockhampton, Qld. |
| 16 August 2004 | Prof Stuart Bunn ‡ (Griffith) | Restoring ecological processes and ecosystem health in Australian streams and rivers | 2nd International Symposium on Riverine Landscapes, Bredsel, Sweden |
| 22 October 2004 | Dr Patrick Lane and Dr Gary Sheridan (Univ Melb) | The hydrologic impact of the 2003 bushfires. | Bright, Vic. |
| 26 October 2004 | Geoff Vietz (Univ Melb) | Environmental flows | Wise Waterways, Beechworth, Vic |
| 9 November 2004 | Dr Patrick Lane and Dr Gary Sheridan (Univ Melb) | The hydrologic impact of the 2003 bushfires | Bairnsdale, Vic. |
| 10 March 2005 | Assoc Prof Margaret Greenway (Griffith) | Stormwater treatment trains: Wetland and pond systems | Urban stormwater information group – bi-monthly technical meeting |
| 6 April 2005 | Assoc Prof Margaret Greenway and Dr Graham Jenkins (Griffith) | The role of Wetlands: How can we obtain macrophyte establishment in stormwater wetlands? Water Sensitive Urban Design. Why are macrophytes important? | Royal Society of Landscape Architects, Brisbane |
| 12 April 2005 | Geoff Vietz (Univ Melb) | Environmental flows and channel morphology | Engineers Australia, Melbourne |

‡ CRC personnel also involved in CRC for Freshwater Ecology

Presentations or Briefings to Government, Industry, Research and other Organisations 2004-2005

| Date | Speaker (s) | Topic | Organisation/Venue |
|--------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 20 July 2004 | Dr Mark Littleboy (DNR) | Predicting salt movement in catchment | MDBC/ BSMC working group |
| 9 September 2004 | Dr Mike Stewardson (Univ Melb) | River restoration research in Australia | COST action 626 – European Aquatic Modelling Group |
| 21 September 2004 | Prof Stuart Bunn (Griffith) ‡ | River ecosystem health. | Environmental Engineering Society, Queensland. |
| 11 October 2004 | Dr Mike Stewardson (Univ Melb) | River restoration research in Australia | CEMAGREF, France |
| 20 November 2004 | Prof Stuart Bunn (Griffith) ‡ | Freshwater issues in South East Qld. | Citizens Senate, South East Queensland NRM Group at Queensland State Parliament |
| 23 November 2004 | Dr Mark Littleboy and various team members (DNR) | Presentations to MDBC Project Steering Committee | Canberra |
| 8 December 2004 | Matthew Bethune (DPI) | Groundwater management in Victoria's irrigation areas: Opportunity for an integrated approach? | MDBC BSMS Implementation Committee, DPI Tatura |
| 8 December 2004 | Dr Gregory Summerell (DNR) | Results from the Livingstone Creek Field site | Recharge validation DNR Team, Tamworth |
| 9-10 December 2004 | Brett Anderson (Univ Melb) | The riparian rehabilitation experiment: Evolution of a practical methodology | Goulburn-Broken CMA: Healthy Rivers, Healthy Communities Conference, Dookie Farm Management College |
| 25 January 2005 | Dr Tim McVicar and Dr Michael Schmidt (CSIRO) | Deriving eco-hydrologic information from long time series All-Australasian remote sensing: applications and current developments | CSIRO Land and Water Seminar |
| 10 March 2005 | Dr Mark Littleboy and various team members (DNR) | Presentations to MDBC Project Steering Committee | Melbourne |
| 11 March 2005 | Pat Feehan (G-M Water) | Tools to assist catchment management | Australian Water Association (AWA)/American Water Works Association (AWWA) Honolulu |
| 5 April 2005 | Dr Mark Littleboy (DNR) | Predicting salt movement in catchments | MDBC forum |
| 5 April 2005 | Matthew Stenson (CSIRO) | 2C: Science and Software Functionality | MDBC forum |
| 5 April 2005 | Dr Mark Littleboy (DNR) | Evaluation for NSW catchments | MDBC forum |
| 5 April 2005 | Dr Mark Silburn (NRM) | Evaluation for Hodgson Creek, Queensland | MDBC forum |
| 5 April 2005 | Dr Brendan Christie (DSE) | Evaluation for Victorian Catchments | MDBC forum |
| 20 April 2005 | Dr Andrew Western (Univ Melb) | Sediment sources in the Tarago Reservoir catchment. A summary of CRC for Catchment Hydrology projects | Productive Grazing Healthy Rivers Forum, DPI Ellinbank, Vic |
| 27 April 2005 | Dr Gregory Summerell (DNR) | The use of rising stage sampling bottles for water quality sampling | Water Quality officers forum for the Murray-Murrumbidgee Region. (Albury) |
| 18 May 2005 | Dr Mark Littleboy and various team members (DNR) | Presentations to MDBC Project Steering Committee | Canberra |
| 19 May 2005 | Dr Tim McVicar (CSIRO) | Remote sensing of moisture availability: time series analysis for drought assessment | NHT/BRS Report to Australian Water Availability Project Reference Meeting |

Presentations or Briefings to Government, Industry, Research and other Organisations 2004-2005 continued

| Date | Speaker (s) | Topic | Organisation/Venue |
|--------------|--------------------------------------------------------------|------------------------------------------------------------------------------|----------------------|
| 2 June 2005 | Dr Mark Littleboy (DNR) | 2CSalt Model | DWLBC, Adelaide |
| 20 June 2005 | Dr Mike Stewardson and Assoc Prof Ian Rutherford (Univ Melb) | River Restoration in Victoria | DSE, Vic |
| 28 June 2005 | Carolyn Young and Dr Natasha Herron (DNR) | Using SedNet to prioritise sediment management in the Murrumbidgee catchment | DNR, Queanbeyan, NSW |

CRC Seminars 2004-2005

| Date | Speaker (s) | Topic | Venue |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------|
| 3 November 2004 | Chris Carroll (NRM) | EMSS and SedNet Modelling capabilities | Mackay, Qld |
| 12 November 2004 | CRC for Catchment Hydrology – in conjunction with CRC for Freshwater Ecology, CRC Water Quality and Treatment, Land and Water Australia, and Murray-Darling Freshwater Research Centre | Research Programs, Issues of Water Quality, Nutrient and Sediment Sourcing and Modelling | DPI, Attwood, Victoria |
| 19 January 2005 | Chris Carroll (NRM) | CRC for Catchment Hydrology Modelling Tools | Mackay, Qld |
| 14-15 February 2005 | Dr Tim Fletcher and André Taylor (Monash) | New Zealand two-day workshop on MUSIC modelling and life-cycle costing. | Auckland Regional Council, Auckland, New Zealand. |
| 24 February 2005 | Dr Sri Srikanthan, Dr Andrew Frost (Bureau of Met) | SCL | University of Canberra |
| 8 July 2005 | Dr David Rassam (CSIRO), Daniel Pagendam, Dr Heather Hunter (NRM), Dr Christy Fellows (Griffith) | The riparian nitrogen model | Griffith University |
| 14 July 2005 | Prof Gary Jones (eWater CRC) | eWater CRC – Our research and delivery 2005 – 2012 | Catchment Modelling School, University of Sydney |
| 18 July 2005 | Dr Tim Fletcher (Monash) | Modelling tools for water resource management in urban areas | Catchment Modelling School, University of Sydney |
| 19 July 2005 | Dr Rob Argent (Univ Melb), Dr Natasha Herron (DNR), Tony Weber (WBM) | Sediment and nutrient modelling for catchment management | Catchment Modelling School, University of Sydney |
| 20 July 2005 | Assoc Prof Francis Chiew (Univ Melb) | Hydroclimatic variability and water resources management | Catchment Modelling School, University of Sydney |
| 21 July 2005 | Dr Mike Stewardson (Univ Melb), Dr Nick Marsh (QEPA) | River restoration in Australia | Catchment Modelling School, University of Sydney |

Other Seminars 2004-2005

| Date | Speaker (s) | Topic | Venue |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 10 September 2004 | Dr Lu Zhang (CSIRO) | Hydrologic responses to land use and climate changes in arid regions | Seminar presented at Xinjiang University, China |
| 11 September 2004 | Dr Lu Zhang (CSIRO) | Ecohydrology in water limited environment | Seminar presented at Xinjiang Normal University, China |
| 14 September 2004 | Dr Mark Littleboy and various team members (DNR) | Presentations to MDBC Project Steering Committee | Queanbeyan |
| 19 October 2004 | Dr Lu Zhang (CSIRO) | Distributed hydrologic modelling in the context of land use and climate change | Seminar presented at China Agricultural University, Beijing, China |
| 2 December 2004 | Dr Christy Fellows (Griffith) - co-authors Nerida Beard (Griffith), Dr David Rassam (CSIRO), Rob DeHayr, Dr Heather Hunter and Phil Bloesch (NRM) | Riparian zone denitrification in a perennial stream and an ephemeral tributary | Australian Society for Limnology Congress, Adelaide, South Australia |
| 2 December 2004 | Nerida Beard (Griffith) – co-authors Dr Christy Fellows (Griffith), Dr David Rassam (CSIRO), Rob DeHayr, Dr Heather Hunter, and Phil Bloesch (NRM) | Investigation of denitrification potentials of inundated riparian zone soils through time under varying organic carbon and nitrate regimes | Australian Society for Limnology Congress, Adelaide, South Australia |
| 10 December 2004 | Assoc Prof Francis Chiew (Univ Melb) | Hydroclimatic variability and water resources management | Civil and Environmental Engineering Seminar Series University of California, Berkeley, USA |
| 14 December 2004 | Dr Justin Costelloe (Univ Melb) | Field day for quantifying the health of ephemeral rivers project: Indicators of riparian vegetation health | Mt Lofty Ranges, South Australia |
| 15 December 2004 | Hugh Duncan (Melb Water) | Nitrogen in urban stormwater | Melbourne Water |

| Date | Speaker (s) | Topic | Venue |
|------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 19 January 2005 | Assoc Prof Margaret Greenway (Griffith) | The role of constructed wetlands in the treatment of secondary sewage effluent and urban stormwater in subtropical climates | South China Institute of Environmental Science, Guangzhou |
| 21 February 2005 | Dr Scott Wilkinson (CSIRO) | Modelling sediment budgets in Great Barrier Reef catchments | CNRME, Cairns |
| 9 March 2005 | Dr Lu Zhang (CSIRO) | Estimating seasonality impact on catchment-scale water balance using top-down approach | Conference presentation at Hydrology Days 2005, Fort Collins, Colorado State University, USA |
| 11 March 2005 | Dr Lu Zhang (CSIRO) | Hydrologic responses to land-use change | Seminar presented at University of Washington, Seattle, USA |
| 5 April 2005 | Matt Stenson (CSIRO) | CRC Project 2C – Model functionality | BSMS Salinity Modelling Forum - Canberra Club |
| 10 May 2005 | Dr Justin Costelloe (Univ Melb) | Field day for quantifying the health of ephemeral rivers project: Indicators of geomorphic health | Mt Lofty Ranges, South Australia |
| 17 May 2005 | Dr Mike Stewardson and Assoc Prof Ian Rutherford (Univ Melb) | River restoration in Victoria | Engineers Australia, Melbourne |
| 25 May 2005 | Dr Ana Deletic and Dr Grace Mitchell (Monash) | Stormwater reuse | Brisbane |
| 9 June 2005 | Dr Ana Deletic and Dr Grace Mitchell (Monash) | Integrated urban water management research at Monash | Auckland, New Zealand |

CRC Workshops/Fieldtrips 2004-2005

| Date | Speaker (s) | Topic | Venue |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------------|
| 28 July 2004 | Geoff Podger (DNR), Joel Rahman (CSIRO), Nick Murray (CSIRO), Jake MacMullin (CSIRO), David Perry (Monash), Susan Daly (Monash) | Catchment Modelling Toolkit Product Managers Workshop | CSIRO Land and Water, Canberra |
| 30 July 2004 | Dr Robert Argent (Univ Melb), Nick Murray (CSIRO), Jake MacMullin (CSIRO), Susan Daly (Monash) | Catchment Modelling Toolkit Product Managers Workshop | The University of Melbourne, Parkville |
| 26-28 August 2004 | Dr Tim Fletcher (Monash), Dr Ana Deletic (Monash), Dr Grace Mitchell (Monash), Dr Tony Ladson (Monash), André Taylor (Monash), Graham Rooney (Melb Water) | ISWR Urban Water workshop with international guest, Prof. Richard Ashley (Univ Sheffield, UK) | Monash University, Clayton |
| 15 September 2004 | Assoc Prof Margaret Greenway (Griffith) | Brisbane Node Workshop | Griffith University, Nathan |
| 16-17 September 2004 | Joel Rahman (CSIRO), Nick Murray (CSIRO) | Introduction to TIME | CSIRO Land and Water, Canberra |
| 28 September 2004 | Dr Nick Marsh (Griffith/QEPA), Ciaran Harman (Univ Melb) | River Analysis Program (RAP), Advanced Training | Griffith University, Nathan |
| 29-30 September 2004 | Dr Tony Wong (Ecological Engineering), Dr Rob Allison (Ecological Engineering) | MUSIC Version 2 Training | The University of Melbourne, Parkville |
| 5-6 October 2004 | Tony Weber, (WBM Brisbane), Damion Cavanagh, (WBM Brisbane) | MUSIC Version 2 Training | Brisbane |
| 23-24 November 2004 | E2 development team and members of Development Projects | E2/Development Projects Workshop | Canberra |
| 25 November 2004 | Cameron Dougall (NRM) | The use of the Fitzroy EMSS erosion 'hotspot map' to guide FBA priorities in Nogoia, Comet sub basins | Emerald, Qld |
| 26 November 2004 | Cameron Dougall (NRM) | The use of the Fitzroy EMSS erosion 'hotspot map' to guide FBA priorities in Lower Fitzroy sub basins | Rockhampton, Qld |
| 8 December 2004 | Cameron Dougall (NRM) | The use of the Fitzroy EMSS erosion 'hotspot map' to guide FBA priorities in Isaacs sub basin | Nebo, Qld |
| 8-9 December 2004 | John Constandopoulos (SKM), Eleanor McKeogh (SKM) | MUSIC Training Version 2 | Sydney |
| 13 January 2005 | Scott Stevens (NRM) | The use of the Fitzroy EMSS erosion 'hotspot map' to guide FBA priorities in Dawson sub basin | Biloela, Qld |
| 27 - 28 January 2005 | Chris Carroll (NRM) | TIME version SedNet to guide WQ target setting. | NRM, Cairns, Qld |

CRC Workshops/Fieldtrips 2004-2005 continued

| Date | Speaker (s) | Topic | Venue |
|-----------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 21-25 February 2005 | Chris Carroll (NRM) Dr Scott Wilkinson (CSIRO) | Workshop to build TIME version SedNet for GBR catchments. | NRM Cairns, Qld |
| 24 February 2005 | Assoc Prof Francis Chiew (Univ Melb), Dr Sri Srikanthan (BoM) | Stochastic Climate Data Generation | University of Canberra (in conjunction with Hydrology and Water Resources Symposium) |
| 24-25 February 2005 | Dr Robert Argent (Univ Melb), Prof Rodger Grayson (Univ Melb) | Introduction to Catchment Modelling and E2 | University of Canberra (in conjunction with Hydrology and Water Resources Symposium) |
| 24-25 February 2005 | Dr Scott Wilkinson (CSIRO) | SedNet – Sediment and Nutrient Budgets for River Networks | University of Canberra (in conjunction with Hydrology and Water Resources Symposium) |
| 24-25 February 2005 | Alice Brown (CSIRO) Jean-Michel Perraud (CSIRO) Rob O'Neill (DNR) | Rainfall Runoff Library (RRL) Training Workshop | University of Canberra (in conjunction with Hydrology and Water Resources Symposium) |
| 7 March 2005 | Cameron Dougall (NRM) | EMSS to help set WQ Targets Mackenzie sub-basin group. | Dingo, Qld |
| 14-16 March 2005 | Program Leaders, Focus Catchment Coordinators, Executive | CRC for Catchment Hydrology Program Leaders, Focus Catchment Coordinators, Executive Workshop | Woodend, Vic |
| 9 May 2005 | André Taylor (Monash) Dr Tim Fletcher (Monash) | MUSIC V3 Upgrade Workshop | ICT, The University of Melbourne, Carlton |
| 11-12 May 2005 | Carolyn Young, Dr Natasha Herron (DNR) | SedNet workshop for DNR Murray-Murrumbidgee region staff | DNR, Queanbeyan, NSW |
| 23 June 2005 | Barry James (DSE) Tony Sheedy (SKM) Erwin Weinmann (Monash) Rukman Wimalasuriya (DPI) | Modelling the reallocation of water: WRAM-REALM Workshop | Victoria University Footscray |
| 30 June 2005 | Dr Robert Argent, Prof Rodger Grayson (Univ Melb) | An introduction to catchment modelling | Catchment Modelling School, Griffith Univ, Brisbane |
| 30 June 2005 | Assoc Prof Bob Keller (Monash) | CHUTE and RIPRAP – Hydraulic design of rock protection for the stabilisation of stream beds and banks | Catchment Modelling School, Griffith Univ, Brisbane |
| 30 June – 1 July 2005 | Joel Rahman, Nick Murray (CSIRO) | Model development using The Invisible Modelling Environment (TIME) | Catchment Modelling School, Griffith Univ, Brisbane |
| 30 June – 1 July 2005 | Geoff Podger, Jean-Michel Perraud (CSIRO) | Rainfall Runoff Library (RRL) and Forest Cover Flow Change Tool (FCFC) | Catchment Modelling School, Griffith Univ, Brisbane |
| 30 June – 1 July 2005 | Dr Scott Wilkinson, Harold Hotham, Yun Chen (CSIRO) | SedNet – Sediment budgets for river networks | Catchment Modelling School, Griffith Univ, Brisbane |
| 1 July 2005 | Chris Ryan (SMEC) | CatchmentSIM: Terrain analysis and hydrologic assessment | Catchment Modelling School, Griffith Univ, Brisbane |
| 4 July 2005 | Assoc Prof Bob Keller (Monash) | Basic flow profile modelling using HEC-RAS | Catchment Modelling School, Griffith Univ, Brisbane |
| 4 July 2005 | Dr Barry Croke (ANU) | Utilising the IHACRES Rainfall-Runoff Model | Catchment Modelling School, Griffith Univ, Brisbane |
| 5 July 2005 | Assoc Prof Bob Keller (Monash) | Advanced flow profile modelling using HEC-RAS | Catchment Modelling School, Griffith Univ, Brisbane |
| 4-5 July 2005 | Joel Rahman, Geoff Davis, Nick Murray (CSIRO) | Advanced model development using The Invisible Modelling Environment (TIME) | Catchment Modelling School, Griffith Univ, Brisbane |
| 4-5 July 2005 | Geoff Podger (CSIRO) | Modelling river basins using IQQM (Integrated Quantity and Quality Model) | Catchment Modelling School, Griffith Univ, Brisbane |
| 5 July 2005 | Assoc Prof Francis Chiew (Univ Melb) | Stochastic Climate Data Generation (SCL) | Catchment Modelling School, Griffith Univ, Brisbane |
| 4-5 July 2005 | Dr Robert Argent (Univ Melb), Jean-Michel Perraud (CSIRO), Prof Rodger Grayson (Univ Melb) | Whole-of-catchment modelling using E2 | Catchment Modelling School, Griffith Univ, Brisbane |
| 6 July 2005 | Assoc Prof Francis Chiew (Univ Melb) | Detecting trend in environmental time series data | Catchment Modelling School, Griffith Univ, Brisbane |
| 4-6 July 2005 | Tony Weber (WBM), André Taylor (Monash), Dr Graham Jenkins (Griffith) | MUSIC Version 3 training | Catchment Modelling School, Griffith Univ, Brisbane |
| 6-7 July 2005 | Dr Robert Argent, Prof Rodger Grayson (Univ Melb) | Advanced whole-of-catchment modelling using E2 | Catchment Modelling School, Griffith Univ, Brisbane |
| 6-7 July 2005 | Geoff Podger (CSIRO) | Modelling river basin management using IQQM (Integrated Quantity and Quality Model) | Catchment Modelling School, Griffith Univ, Brisbane |
| 7 July 2005 | Tony Weber (WBM), André Taylor (Monash), Dr Graham Jenkins (Griffith) | MUSIC Version 3 upgrade training | Catchment Modelling School, Griffith Univ, Brisbane |
| 7 July 2005 | Assoc Prof Francis Chiew (Univ Melb) | Seasonal hydroclimate forecasting and the NSF software | Catchment Modelling School, Griffith Univ, Brisbane |

| Date | Speaker (s) | Topic | Venue |
|-----------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| 8 July 2005 | Geoff Podger (CSIRO), Dr Robert Argent (Univ Melb), Prof Rodger Grayson (Univ Melb) | Advanced catchment modelling – Techniques for modellers | Catchment Modelling School, Griffith Univ, Brisbane |
| 7-8 July 2005 | Dr Grace Mitchell (Monash) | Aquacycle – A daily urban water balance model | Catchment Modelling School, Griffith Univ, Brisbane |
| 8 July 2005 | Dr David Rassam (CSIRO), Daniel Pagendam (NRM) | The riparian nitrogen model (RNM) – A Tool for targeted riparian restoration in catchments | Catchment Modelling School, Griffith Univ, Brisbane |
| 8 July 2005 | Assoc Prof Bofu Yu (Griffith) | Water ReAllocation Model (WRAM) | Catchment Modelling School, Griffith Univ, Brisbane |
| 14 July 2005 | Dr Robert Argent (Univ Melb), Prof Rodger Grayson (Univ Melb) | An introduction to catchment modelling | Catchment Modelling School, Univ Sydney |
| 14 July 2005 | Dr Narendra Tuteja, Dr Jai Vaze, Geoffrey Beale, Jin Teng (all DNR) | Modelling pasture and crop growth dynamics, recharge and water balance in the unsaturated zone using the CLASS pasture and crop growth models. | Catchment Modelling School, Univ Sydney |
| 15 July 2005 | Chris Ryan (SMEC) | CatchmentSIM: terrain analysis and hydrologic assessment | Catchment Modelling School, Univ Sydney |
| 14-15 July 2005 | Joel Rahman, Nick Murray (CSIRO) | Model development using the Invisible Modelling Environment (TIME) | Catchment Modelling School, Univ Sydney |
| 15 July 2005 | Dr Narendra Tuteja, Dr Jai Vaze, Geoffrey Beale, Jin Teng (all DNR) | Modelling recharge and water balance in the unsaturated zone using CLASS unsaturated moisture movement model. | Catchment Modelling School, Univ Sydney |
| 14-15 July 2005 | Geoff Podger, Jean-Michel Perraud (CSIRO) | Rainfall Runoff Library (RRL) and Forest Cover Flow Change Tool (FCFC) | Catchment Modelling School, Univ Sydney |
| 14-15 July 2005 | Dr Scott Wilkinson, Harold Hotham, Yun Chen (CSIRO) | SedNet – Sediment budgets for river networks | Catchment Modelling School, Univ Sydney |
| 18 July 2005 | Assoc Prof Bob Keller (Monash) | Basic flow profile modelling using HEC-RAS | Catchment Modelling School, Univ Sydney |
| 18 July 2005 | Dr Barry Croke (ANU) | Utilising the IHACRES Rainfall-Runoff Model | Catchment Modelling School, Univ Sydney |
| 19 July 2005 | Assoc Prof Bob Keller (Monash) | Advanced flow profile modelling using HEC-RAS | Catchment Modelling School, Univ Sydney |
| 18-19 July 2005 | Joel Rahman, Nick Murray (CSIRO) | Advanced model development using The Invisible Modelling Environment (TIME) | Catchment Modelling School, Univ Sydney |
| 18-19 July 2005 | Geoff Podger (CSIRO), Tahir Hameed | Modelling river basins using IQQM (Integrated Quantity and Quality Model) | Catchment Modelling School, Univ Sydney |
| 18-19 July 2005 | Dr Robert Argent (Univ Melb), Jean-Michel Perraud (CSIRO), Prof Rodger Grayson (Univ Melb) | Whole-of-catchment modelling using E2 | Catchment Modelling School, Univ Sydney |
| 20 July 2005 | Sue Cuddy (CSIRO), Dr Lachlan Newham (ANU) | CatchMODS and ICMS | Catchment Modelling School, Univ Sydney |
| 20 July 2005 | Assoc Prof Francis Chiew (Univ Melb) | Detecting trend in environmental time series data | Catchment Modelling School, Univ Sydney |
| 20 July 2005 | Dr Mark Littleboy (DNR), Matt Stenson (CSIRO) | Land-Use impacts on dryland salinity (2CSalt) | Catchment Modelling School, Univ Sydney |
| 18-20 July 2005 | Dr Tim Fletcher (Monash), Hugh Duncan (Melb Water), André Taylor (Monash) | MUSIC Version 3 Training | Catchment Modelling School, Univ Sydney |
| 20 July 2005 | Dr Mike Stewardson (Univ Melb), Dr Nick Marsh (QEPA) | Using the Hydraulic Analysis Module of the River Analysis Package (RAP) | Catchment Modelling School, Univ Sydney |
| 20-21 July 2005 | Dr Robert Argent (Univ Melb), Prof Rodger Grayson (Univ Melb) | Advanced whole-of-catchment modelling using E2 | Catchment Modelling School, Univ Sydney |
| 20-21 July 2005 | Geoff Podger (CSIRO), Tahir Hameed (DNR) | Modelling river basin management using IQQM (Integrated Quantity and Quality Model) | Catchment Modelling School, Univ Sydney |
| 21 July 2005 | Dr Tim Fletcher (Monash), Hugh Duncan (Melb Water), André Taylor (Monash) | MUSIC Version 3 Upgrade Training | Catchment Modelling School, Univ Sydney |
| 21 July 2005 | Assoc Prof Francis Chiew (Univ Melb) | Seasonal hydroclimate forecasting and the NSFM software | Catchment Modelling School, Univ Sydney |
| 21 July 2005 | Dr Mike Stewardson (Univ Melb), Dr Nick Marsh (QEPA) | Using the Time Series Analysis and Rules Based Module of the River Analysis Package (RAP) | Catchment Modelling School, Univ Sydney |
| 22 July 2005 | Geoff Podger (CSIRO), Dr Robert Argent (Univ Melb), Prof Rodger Grayson (Univ Melb) | Advanced catchment modelling – techniques for modellers | Catchment Modelling School, Univ Sydney |
| 21-22 July 2005 | Dr Grace Mitchell (Monash) | Aquacycle – A daily urban water balance model | Catchment Modelling School, Univ Sydney |

CRC MEDIA REFERENCES 2004-2005

| Date (Page) | Medium | Title / Subject | CRC Representative /Aspect |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| 22 July 2004 | ABC Radio National Bush Telegraph Program | Climate Change and Australian Farming | Discussion by Assoc Prof Francis Chiew |
| July 2004 (4) | Australian R&D Review, Hallmark Editions | People and Positions / Prof Rodger Grayson's Appointment as the Director of the Cooperative Research Centre for Catchment Hydrology | Professor Rodger Grayson |
| Issue 120 July-August 2004 (32) | Ecos Magazine, CSIRO Publishing | Underground Nitrogen Busting is Crucial / Report on the first steps to understanding subsurface riparian zone processes in an Australian context\ | Dr Heather Hunter |
| August 2005 Issue 5 (2) | The Centre for Education and Research in Environmental Strategies (CERES) Urban Water Conservation Demonstration and Research Facility (Brunswick, Victoria) | CERES Bio-retention System / Work by CRC team in design and operation of the bio-retentionsystem | MUSIC Team, Program 4 |
| 11 August 2004 (4) | The Weekly Times, News Limited | Burnt-out Catchment Poses Threat to Irrigators/Comments by Prof Rodger Grayson and Dr Rob Vertessy on bushfire impacts | Prof Rodger Grayson, Dr Rob Vertessy |
| 18 August 2004 (3) | Lakes Post, James Yeates & Sons Pty Ltd | Aim to Improve Water Management / Appointment of Prof Rodger Grayson as Director, CRC for Catchment Hydrology | Prof Rodger Grayson |
| August 2004 (24) | Engineers Australia, Engineers Media | People / Prof Rodger Grayson appointed as Director of the Cooperative Research Centre for Catchment Hydrology | Prof Rodger Grayson |
| October 2004 (5) | Land and Water News | Call for Further Work on Water Farming / Review of CRC Technical Report 04/6: 'Water Farms' | Laura Richardson, Dr Peter Hairsine, and Dr Tim Ellis |
| October 2004 (6) | Land and Water News | Assessment of River Restoration Studied / Review of CRC Technical Report 04/11: 'Evaluating the effectiveness of habitat reconstruction in rivers' | Program 6 |
| 18 February 2005 (774 3LO) | ABC Radio | Stormwater as a Resource | Interview with Dr Tim Fletcher, Program 4 |
| April 2005 No. 4 | CRC Irrigation Futures INFLO: E-newsletter for staff and members of the CRC Irrigation Futures | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |
| April 2005 | Watershed, CRC for Freshwater Ecology | Catchment Modelling School, CRC for Catchment Hydrology / Promotion of 2005 Catchment Modelling School | David Perry |
| April 2005 | Watershed, CRC for Freshwater Ecology | SideStream: Business trip to South Korea / Note on Australian water group visit to South Korean National Water Management Authority (KOWACO) and the Sustainable Water Resources Research Centre (SWRRC) | Geoff Podger, Program 1 |
| May 2005 | QLDmark AILA Newsletter for QLD and Region (Australian Institute of Landscape Architects) | CRC for Catchment Hydrology / Promotion of 2005 Catchment Modelling School | David Perry |
| May 2005 | Flotsam and Jetsam: Coastal CRC Newsletter | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |
| May 2005 | No. 5 BACKWASH, Email Newsletter of The Irrigation Association of Australia | Catchment Modelling Schools, July / Promotion of 2005 Catchment Modelling School | David Perry |
| 17 May 2005 | ABC Radio (Tasmania) | Water Sensitive Urban Design | Interview with Dr Tim Fletcher |
| May 2005 | Stormwater Industry Newsletter (Qld and NSW) | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |
| May 2005 | Engineers Australia, NSW Water Branch | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |
| May 2005 | CSIRO Website | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |
| May 2005 | CSIRO Land and Water Website | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |
| May 2005 | clearwater, Supporting Sustainable Urban Water Management | Catchment Modelling School / Promotion of 2005 Catchment Modelling School | David Perry |

Grants and Awards

Awards

Prof Rodger Grayson

Prof Rodger Grayson, Director, CRC for Catchment Hydrology, was awarded a Biennial Medal of the Modelling and Simulation Society of Australia and New Zealand (MSSANZ) in the 2005 MSSANZ Awards. The award recognised Prof Grayson's work in the modelling of natural systems.

Prof John Langford AM

Prof John Langford, Chairman, CRC for Catchment Hydrology Governing Board, was awarded Member (AM) in the General Division, Order of Australia, in the Queens Birthday 2005 Honours: 'For service to water resource management, particularly through organisations that regulate and research water supply, quality and usage.'

Dr Sara Lloyd

On 3 September 2004 Sara Lloyd, a young Australian scientist with Melbourne Water and a CRC for Catchment Hydrology postgraduate, won the Young Water Scientist of the Year Award.

The award, worth \$2500, is given annually by the CRC Water Forum, an alliance of the five water-focussed Australian Cooperative Research Centres.

Sara Lloyd's studies promote water sensitive urban design - a recent development for managing urban stormwater and rainwater runoff that should cost the community around 25% less than conventional treatments. Her work was supported by the CRC for Catchment Hydrology.

The CRC Water Forum runs the award to highlight the excellence of postgraduate students associated with the Australian cooperative research centres program and the five water CRCs in particular.

Sara's PhD thesis from Monash University was entitled: 'Exploring impediments and opportunities of sustainable stormwater management schemes'. Sara was supervised by Dr Tony Wong.

Prof Russell Mein AM

Former Director, Deputy Director, and Program Leader, CRC for Catchment Hydrology, was awarded Member (AM) in the General Division, Order of Australia, in the Queens Birthday 2005 Honours: 'For service to science in the field of flood hydrology and urban water resources and for contributions to research, teaching and professional practice.'



Dr Sara Lloyd, Young Water Scientist of the Year Award winner 2004 with Prof Ian Rae, Chair of Judging panel and fellow award finalists David Moore, Dale McNeil, Para K. Parameshwaran, and Ross Johnston.

CRC MUSIC Team

The CRC for Catchment Hydrology's MUSIC team was awarded an "honourable mention" in the 2004 B-HERT (Business Higher Education Round Table) awards for Outstanding Achievement in Collaboration in Research and Development, and Education and Training. The awards were announced in Sydney on 18 November 2004 and Dr Tony Wong received the certificate on behalf of the CRC.

Assoc Prof Ian Rutherford, Dr Mike Stewardson, and Dr Tony Ladson

Assoc Prof Ian Rutherford and Dr Mike Stewardson, both with The University of Melbourne, and Dr Tony Ladson, Monash University, won the Institution of Engineers Australia 2005 GN Alexander Medal for the best hydrology and/or water resources article in an Australian Hydrology journal over the last two years.

The award winning paper was: "Evaluating stream rehabilitation projects: reasons not to, and approaches if you have to". It was published in the Australian Journal of Water Resources 8(1): 57-68.

André Taylor

André Taylor, Monash University researcher, received a Merit Award on behalf of the CRC for Catchment Hydrology for the CRC's entry in the Victorian Stormwater Industry Association's 'Stormwater Excellence Awards 2004' in the 'research' category. The award was in relation to work on non-structural measures for urban stormwater quality improvement in connection with CRC Program 4: Urban Stormwater Quality

Dr Lu Zhang

Dr Zhang, CSIRO Land and Water, received an Award on appointment as an Overseas Assessor by the Chinese Academy of Sciences, December 2005.

Overseas Assessors are nominated by peers and reviewed by members of the Academy as part of the appointment process. Following appointment, Overseas Assessors are eligible to provide assessment tasks for the Academy including Academy grant applications, and supervision of Academy-related research projects.



Prof John Langford AM and Prof Russell Mein AM.

Grants

| No | Name of Researcher(s) Awarded the Grant | Researcher's Organisation | Title of project for which Grant is awarded / (and relationship to the CRCs research Programs/Projects) | Source of Grant | Period of the Award | Amount of the Grant \$000's |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------|
| 1 | Dr Ana Deletic and Dr Tim Fletcher | Monash University | Using WSUD for integrated stormwater treatment and re-use (Complements and builds on CRC Program 4: Urban Stormwater Quality) | Victorian Stormwater Action Program | July 2003- July 2005 | 56 |
| 2 | Dr Ana Deletic and Dr Tim Fletcher | Monash University | Integrated stormwater treatment and re-use systems - inventory of Australian and international practice (Complements and builds on CRC Program 4: Urban Stormwater Quality) | NSW EPA | July 2003- December 2003 | 45 |
| 3 | Dr Ana Deletic, Dr Tim Fletcher, Dr Rebeka Brown, Dr Grace Mitchell, Assoc Prof Raphael Grzebieta, Assoc Prof Jenny Read, Dr Ron Beckett and Dr Gavin Mudd; Dr Peter Breen, Mr Malcolm Eadie, and Dr Tony Wong | Monash University Ecological Engineering | Facility for Advancing Water Biofiltration (Complements and builds on CRC Program 4: Urban Stormwater Quality) | Science, Technology and Innovation Initiative, Department of Innovation, Industry and Regional Development, Victoria | July 2005- June 2008 | 1,460 |
| 4 | Dr Tim Fletcher and Dr Ana Deletic | Monash University | Australian Water Conservation and Reuse Research Program (Complements and builds on CRC Program 4: Urban Stormwater Quality) | CSIRO Land and Water | July 2003- December 2003 | 15 |
| 5 | Dr Tim Fletcher and Dr Ana Deletic | Monash University | Data Requirements for Integrated Urban Water Management UNESCO's IHP VI project (Complements and builds on CRC Program 4: Urban Stormwater Quality) | UNESCO | 2004-2006 | 10 |
| 6 | Dr Tim Fletcher and Dr Ana Deletic | Monash University | Modelling heavy metal concentrations in urban stormwater: new methods for assessing risks and uncertainties (Complements and builds on CRC Program 4: Urban Stormwater Quality) | Faculty of Engineering, Small Grant Scheme-2005 | January 2005- December 2005 | 15 |
| 7 | Dr Patrick Lane and Dr Gary Sheridan | The University of Melbourne / Department of Sustainability and Environment | Dynamics of sediment and nutrient fluxes from burnt forested catchments. (Complements and builds on CRC Program 2: Land-use Impacts on Rivers) | Land and Water Australia | 2004-2007 | 275 |
| 8 | Dr Tim McVicar, Dr Mike Raupach, Dr David Jones and David Barrett | CSIRO Land and Water / CSIRO Earth Observation Centre / Bureau of Meteorology / Bureau Rural Sciences | Australian Water Availability Project (Complements and builds on CRC Program 1: Predicting Catchment Behaviour; Program 2: Land-use Impacts on Rivers; and Program 5: Climate Variability) | Natural Heritage Trust | July 2004 - June 2005 | 600,000 |
| 9 | Dr Andrew Western and Assoc Prof Francis Chiew | The University of Melbourne | Daily hydrological and erosion modelling utilising sub-daily rainfall intensity distributions (Complements and builds on CRC Program 5: Climate Variability) | ARC Discovery | 2005-2007 | 270 |
| 10 | Dr Andrew Western and Dr Justin Costelloe | The University of Melbourne | Groundwater recharge processes and water use of arid rivers and riparian zones. (Complements and builds on CRC Program 2: Land-use Impacts on Rivers) | The University of Melbourne – CSIRO Collaborative Scheme | 2005-2006 | 34 |
| 11 | Dr Lu Zhang and Dr Roger Jones | CSIRO Land and Water / CSIRO Marine and Atmospheric Research | Estimating the impact of climate change and revegetation on catchment water and salt balances in Murray-Darling Basin (Complements and builds on CRC Program 2: Land-use Impacts on Rivers) | Australian Greenhouse Office | April 2004- October 2005 | 158 |

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- Abal, E.G., Dennison, W.C. and Bunn, S.E. (In press) Setting. In: Abal, E.G., Bunn, S.E. and Dennison, W.C. Healthy Waterways, Healthy Catchments: Making the connection in south east Queensland. Moreton Bay Waterways and Catchment Partnership, Brisbane Queensland. pp 35-68. ‡
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- Bunn, S. and Cullen, P. (2004) Water quality and aquatic ecosystem health in the Lake Eyre Basin. In Scientific Advisory Panel Information Papers 2004. Lake Eyre Basin Ministerial Forum. Australian Government. pp. 31-34. ‡
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† CRC personnel also involved in CRC for Coastal Zone, Waterway and Estuary Management and/or CRC for Sustainable Tourism

‡ CRC personnel also involved in CRC for Freshwater Ecology

GLOSSARY

| | | | |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Acquacycle | Urban water balance computer model | Macaque | Computer model for forest hydrology applications in large catchments |
| AEAM | Adaptive Environmental Assessment Modelling | MDBC | Murray-Darling Basin Commission |
| AFFA | Agriculture, Fisheries and Forestry – Australia (Commonwealth Department) | MELS | A design spreadsheet for minimum energy loss structures |
| BCC | Brisbane City Council | MUSIC | Model for Urban Stormwater Improvement Conceptualisation – CRC computer software methodology |
| BC2C | Biological capacity to change – software model for catchment land and water analysis | Mwater | A water market experimental methodology to evaluate alternative water trading rules and procedures in mature water markets |
| BoM | Bureau of Meteorology | NHT | Natural Heritage Trust (Commonwealth Government) |
| BRS | Bureau of Rural Sciences | NLWRA | National Land and Water Resources Audit (Commonwealth Government, funded by NHT) |
| CCDSM | Catchment Categorisation for Dryland Salinity Management project | NRM | Natural Resources and Mines, Qld |
| CHUTE | Computer program for hydraulic design of rock chute for stream rehabilitation | NWP | Numerical Weather Prediction |
| CLASS-CGM | A crop growth model | RAP | River Analysis Package, software to combine hydraulic models, visualisations and analysis of time series with aquatic ecology/habitat requirements |
| CLASS-PGM | A pasture growth model | RIPRAP | A design tool for riprap in streams |
| CLASS-U3M-1D | A 1-dimensional Unsaturated Moisture Movement Model | R&D | Research and development |
| CatchmentSIM | A hydrological 3D GIS application | REALM | Computer model for predicting catchment water balance |
| COAG | Council of Australian Governments | RRL | Rainfall Runoff Library, a catchment modelling tool containing several rainfall runoff models |
| CRC | Cooperative Research Centre | SCL | The Stochastic Climate Library |
| CRC-Forge | Computer software methodology for extreme rainfall analysis | SEQRWQMS | South East Queensland Regional Water Quality Management Strategy |
| DNR | Department of Natural Resources, NSW (formerly Department of Infrastructure, Planning and Natural Resources, NSW) | SHPA | A data set of soil hydrological properties of Australia |
| DSE | Department of Sustainability and Environment, Vic | S_PROG | Model for nowcasting (forecasting rainfall one to two hours in advance) |
| DSS | Decision Support System | TAG | Technical Advisory Group (expert panel for CRC projects) |
| E2 | Software for whole-of-catchment modelling | TARSIER | A framework for building and linking catchment hydrology models |
| EMSS | Environmental Management Support System | TIME | The Invisible Modelling Environment, a framework for building and linking catchment hydrology models being used by the CRC Catchment Modelling Toolkit Project |
| ET | Evapotranspiration | TOPOG | Computer model developed for forest hydrology applications in small or experimental catchments |
| FCC | Focus Catchment Coordinator | TREND | Statistical tests for detecting trend/change and randomness in time series hydrological data |
| GEWEX | Global Energy and Water Experiment (a component of the World Climate Research Program) | WRAM | Water Re-Allocation Model, an economic optimisation model to simulate water demand and trading |
| ICMS | Interactive Component Modelling System (formerly Integrated Catchment Management System) | WSUD | Water Sensitive Urban Design |
| IHACRES | A catchment-scale rainfall-streamflow modelling method | | |
| IQQM | Integrated Quantity and Quality Monitoring - water allocation software methodology and model | | |
| L&WA | Land and Water Australia (formerly Land and Water Resources Research and Development Corporation) (Commonwealth R&D Corporation) | | |
| LEMSS | Local-Scale Environmental Management Support System | | |
| LIZA | A data set of landcover types for the intensive use zone of Australia | | |
| LUOS | Land Use Options Simulator, software model for land use including salinity aspects | | |

Performance Indicators

Objectives of the Centre

| Nature of Indicator | Performance Indicator | 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 |
|---------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | Economic benefit to Centre | Adding value to intellectual capital at least equal to CRC Commonwealth funding | Building Centre 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 underway. Research projects (17 core projects) underway. |
| | | Additional income (contract research) of \$10.1 m over life of Centre | Budget provision | Additional contract income in year | Cumulative income | Research Contracts with AFFA, LWRDRC, MDBC, 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, LWRDRC, MDBC, 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] |
| | 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 underway. Seminars and dissemination of reports, videos continuing, |
| | | | Potential economic benefit assessed | | | 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. |
| | 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 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 |
| | Economic benefit -- other | Public benefit from positive environmental impact | Public good potential identified | Completed assessments of public good potential benefit for projects | Public good benefit achieved | Public good potential outlined in Business Plan Assessments of public good and other economic benefits to follow project completions | Public good potential outlined in Business Plan Assessments of public good and other economic benefits to follow project completions |
| Input | Total resources | \$67.7m total resources Total leverage > 4.1 vs Commonwealth cash | Agreement | Actually committed | Cumulative resources | Parties/Grant Total Agreement commitment of \$57.6m. \$6.1 m committed to 30 June 2000. | Parties/Grant Total Agreement commitment of \$57.6m. \$11.8 m committed by Parties to 30 June 2001. |
| | Cash resources | \$33.6m cash resources Cash 49% of total resources | Agreement | Actually committed | Cumulative resources | Total Agreement cash budget of \$33.6m. \$3.3m cash committed to 30 June 2000. | Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2001 |
| Process | 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 continuing. Reporting format upgraded. | Monthly Project finance reporting continuing. Quarterly Project reporting continuing. |
| Outputs | Centre Publications transferring research outcomes & technology to industry | 50 Centre reports | Number 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 (800 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. |
| | 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 |
| | Industry Workshops | 20 Workshops | Number planned | Number each year | Total number completed | 7 CRC workshops since July 99 | 14 CRC Workshops/field tours given |

Quality and Relevance of the Research Program

| | | | | | | | |
|---------|-----------------------------------------|--------------------------------|---------------------------------------|-----------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | 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. Project review panels established. 14 Project review panels held to June 2001 covering all projects. Independent science review included in project review panel tasks. |
| | | Demonstrated user satisfaction | User input to planned projects | | | 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 |

| Report of Activities and Achievements for 01/02 | Report of Activities and Achievements for 02/03 | Report of Activities and Achievements for 03/04 | Report of Activities and Achievements for 04/05 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19 collaborative core research projects and 11 major contract research projects with two completed. Research Contracts with AFFA, LWA, SEQRWQMS, MDBC, 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] | 34 collaborative core research projects including 15 new projects and 13 major contract research projects 9 core research projects completed. Research Contracts with ACIAR, AFFA, LWA, MDBC, SEQRWQMS, EPA. Contract income \$1.27m for 2002/03 of total \$4.47m in contracts to date. [Includes \$0.34m from direct CRC contract/consulting work] | 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. Research Contracts including ACIAR, AFFA, LWA, MDBC, 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] | 22 remaining collaborative core research projects including 15 second round projects; and 16 major contract research projects (\$0.15m funding and above). 5 Development projects (1 completed). 21 core research projects completed. Research Contracts including ACIAR, AFFA, LWA, MDBC, EPAVic. Contract income \$1.39m for 2004/5 of total \$7.62m in contracts to date. [Includes \$0.97m to date from direct CRC contract/consulting work] |
| IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing, Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions. | IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing, Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions. | IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, continuing, Access to Catchment Modelling Toolkit and involvement in Development Projects also benefits core participants. Overall indicative economic benefits highlighted in Business Plan and in application for successor CRC, eWater CRC. | IP access: Communication and Adoption Program. Seminars and dissemination of reports. Access to Catchment Modelling Toolkit and involvement in Development Projects also benefits core participants. Overall indicative economic benefits highlighted in Business Plan and in application for successor CRC, eWater CRC. |
| 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. | Overall indicative economic benefits highlighted in Business Plan and in application for successor CRC, eWater CRC. |
| Public good potential outlined in Business Plan Assessments of public good and other economic benefits to follow project completions | Public good potential outlined in Business Plan Assessments of public good and other economic benefits to follow project completions | Public good potential outlined in Business Plan Aspects of economic benefits assessed as part of economic benefit outlined in application for successor CRC, eWater CRC | Public good potential outlined in Business Plan Aspects of economic benefits assessed as part of economic benefit outlined in application for successor CRC, eWater CRC |
| Parties/Grant Total Agreement commitment of \$57.6m. \$18.0m committed by Parties to 30 June 2002. Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2002. Cumulative \$10.5m Grant/Parties. | Parties/Grant Total Agreement commitment of \$57.6m. \$24.1m committed by Parties to 30 June 2003. Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2003. Cumulative \$14.2m Grant/Parties. | Parties/Grant Total Agreement commitment of \$57.6m. \$31.3m committed by Parties to 30 June 2004. Total Agreement cash budget of \$33.6m. \$3.9m Grant/Parties cash committed in year to 30 June 2004. Cumulative \$18.1m Grant/Parties. | Parties/Grant Total Agreement (7 years) commitment of \$57.6m. \$39.5m committed by Parties to 30 June 2005, termination date. Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2005. Cumulative \$21.7m Grant/Parties. |
| 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. |
| 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. | 18 Technical Reports, one industry report and 11 other CRC reports published. Email notification and database established with 850 recipients. 10 issues of monthly newsletter issued (683 in hard copy, 747 emailed – includes Website posting). Approx 5500 visits to CRC website per month with over 1700 visiting more than twice per month. Over 4000 visits per month to Catchment Modelling Toolkit website. |
| 31 CRC Technical Seminars presented | 8 CRC Technical Seminars presented | 19 CRC Technical Seminars presented | 11 CRC Technical Seminars presented |
| 18 CRC Workshops/field tours given | 30 CRC Workshops/field tours/short courses given | 42 CRC Workshops/field tours/short courses given | 73 CRC Workshops/field tours/short courses given |
| 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. | Technical Advisory Groups involved in developing projects. Global review held in two stages in year to June 2004 with very positive outcomes. |
| 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. | User satisfaction with Catchment Modelling Toolkit assessed in part with supportive feedback on Catchment Modelling School 2005. |

Performance Indicators continued...

Quality and Relevance of the Research Program (cont...)

| Nature of Indicator | Performance Indicator | 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 |
|---------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input | Research program resources | \$46m total cash and in-kind resources on research program | Strategic plan | Actually committed | Cumulative resources | \$3.5m research expenditure (cash and in-kind) for 99/2000 | \$5.2m research expenditure (cash and in-kind) for 2000/01 Cumulative total \$8.7m |
| Process | 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. |
| | 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 . Project review panels established for projects. Independent science review included in project review panel tasks | Research users strongly represented in project formulation stages and Technical Advisory Groups and Communication and Adoption Plans. Project review panels held for all core projects. Independent science review included in project review panel tasks |
| Outputs | External publications | 100 publications in refereed journals 100 papers in international conferences 100 papers in national conferences | Number planned | Number of publications submitted | Total number published | Over 40 refereed papers submitted 99/2000. 16 international conference papers submitted 99/2000 41 Australian conference papers submitted 99/2000 | 69 refereed papers published/accepted in 2000/01. 24 international conference papers accepted/published 2000/01 37 Australian conference papers in 2000/01 |

Strategy for Utilisation and Application of Research Outputs

| | | | | | | | |
|---------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | Development of approaches to improve land and water management and adoption by end-users | Demonstration of approaches to improve land and water management in Centre's 5 focus catchments | Communication and adoption activities planned | Communication and adoption activities completed | Demonstrated adoption of Centre research outcomes and approaches by end-users in focus catchments | Communication and Adoption planning framework developed for new Programs. Pilot undertaken with industry users for Urban Stormwater Quality Program. Continuing activity with take-up of CRC products by users for Urban Hydrology, Predictive tools, Flood hydrology. | Communication and Adoption planning framework adopted for Programs. Continuing activity with take-up of CRC products by users for all programs. |
| Input | Resources devoted to communication and adoption program | Minimum \$13m cash and in-kind on communication and adoption program | Strategic plan – Commercialisation and adoption strategy | Actually committed | 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 Cumulative total \$3.7m |
| | User core participant resources | \$21m core user participant resources Core user participant resources 32% of total resources | Agreement | Actually committed | 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 50% of total contributions by core users, 2000/01. |
| Process | 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. | Number of meetings held by program leaders and site coordinators with stakeholders on communication and adoption | 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 Feb 2000. Workshop early April 2000 for Program Leaders and Focus Catchment Coordinators. | Workshops held October 2000 and early April 2001 for Program Leaders and Focus Catchment Coordinators. |
| Outputs | 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 | Number each year | 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, 5 Videos and 5 Working Documents issued since July 99. 2 Field Tours held since July 99, 5 Workshops 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'. Cumulative totals: 2 Website upgrades 5 Industry Seminars 33 Technical Seminars 3 Industry Reports 26 Technical Reports 3 Field Tours 18 Workshops 20 Industry/trade articles |

| Report of Activities and Achievements for 01/02 | Report of Activities and Achievements for 02/03 | Report of Activities and Achievements for 03/04 | Report of Activities and Achievements for 04/05 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| \$5.8m research expenditure (cash and in-kind) for 2001/02 Cumulative total \$14.5m | \$5.5m research expenditure (cash and in-kind) for 2002/03 Cumulative total \$20.0m | \$5.1m research expenditure (cash and in-kind) for 2003/04 Cumulative total \$25.1m | \$5.9m research expenditure (cash and in-kind) for 2004/05 Cumulative total \$31.0m |
| 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. |
| 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. | Research users strongly represented in project formulation stages, Technical Advisory Groups and Communication and Adoption Plans. Independent Global Review held for core projects. |
| 33 refereed papers published/accepted in 2001/02. | 66 refereed papers published/accepted in 2002/03. | 30 refereed papers published/accepted in 2003/04. | 75 refereed papers published/accepted in 2004/05. |
| 35 international conference papers accepted/published in 2001/02 | 51 international conference papers accepted/published in 2002/03 | 21 international conference papers accepted/published in 2003/04 | 61 international conference papers accepted/published in 2004/05 |
| 96 Australian conference papers in 2001/02 | 41 Australian conference papers in 2002/03. | 56 Australian conference papers in 2003/04 | 88 Australian conference papers in 2004/05 |
| 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. |
| Continuing activity with take-up of CRC products by users for all Programs. | Five Development Projects established in CRC Focus Catchments. Continuing activity with take-up of CRC products by users for all Programs | Five Development Projects continuing in CRC Focus Catchments. Continuing activity with take-up of CRC products by users for all Programs, particularly through Catchment Modelling Toolkit. | Five Development Projects in CRC Focus Catchments Take-up of CRC products by users for all Programs, particularly through Catchment Modelling Toolkit and with training |
| 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. | Total \$3.4m cash and in-kind expenditure for 2004/05 on Communication and Adoption Program. |
| Cumulative total \$6.8m | Cumulative total \$9.6m | Cumulative total \$13.1m | Cumulative total \$16.5m |
| Total \$21.8m committed by core user Parties in Agreement. | Total \$21.8m committed by core user Parties in Agreement. | Total \$21.8m committed by core user Parties in Agreement. | Total \$21.8m committed by core user Parties in Agreement. |
| Contributions of \$3.8m in 2001/02. | Contributions of \$3.3m in 2002/03. | Contributions of \$4.5m in 2003/04. | Contributions of \$4.0m in 2004/05. |
| Cumulative total of \$9.3m. | Cumulative total of \$12.6m. | Cumulative total of \$17.1 m. | Cumulative total of \$21.2 m. |
| 57% of total contributions by core users, 2001/02. | 54% of total contributions by core users, 2002/03. | 63% of total contributions by core users, 2003/04. | 48% of total contributions by core users, 2004/05. |
| Workshops held October 2001, January 2002 and April 2002 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. | Catchment Modelling Toolkit workshop/mini-school, February 2005. Major software products and approaches presented at Catchment Modelling School 2005, June/July 2005. Program Leaders and Focus Catchment Coordinators Workshop held March 2005 and CRC Annual Workshop for all participants also held June 2005. Research and technology, including postgraduate projects, presented. |
| Monthly newsletter continuing: copies to 1400 subscribers (surveyed need) and available on CRC website. | Monthly newsletter continuing: copies to 1320 subscribers (surveyed need) and available on CRC website. | Monthly newsletter continuing: copies to 1490 subscribers and available on CRC website. | Monthly newsletter continuing: copies to 1430 subscribers and available on CRC website. |
| 30 Technical seminars. 10 Technical Reports, 1 Manual, 3 Field Tours, 18 CRC workshops held, 6 industry articles. | 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. | 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. | 11 Technical seminars. 18 Technical Reports, 1 Industry Report, 0 Short Courses [training courses], 0 Field tour, 73 CRC workshops held, 0 major website upgrades, 4 industry articles. |
| Cumulative totals: 2 Website upgrades 5 Industry Seminars 63 Technical Seminars 3 Industry Reports 36 Technical Reports 6 Field Tours 36 Workshops 26 Industry/trade articles | Cumulative totals: 2 Website upgrades 5 Industry Seminars 71 Technical Seminars 4 Industry Reports 47 Technical Reports 3 short courses 6 Field Tours 63 Workshops 30 Industry/trade 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 | Cumulative totals: 6 Website upgrades 5 Industry Seminars 102 Technical Seminars 5 Industry Reports 80 Technical Reports 5 short courses 7 Field Tours 175 Workshops 34 Industry/trade articles |

Performance Indicators continued...

Collaboration Arrangements

| Nature of Indicator | Performance Indicator | 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 |
|---------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | Cooperation in research within Australian and overseas and more efficient use of resources | Twenty collaborative arrangements | 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); NIWA(NZ); close collaboration with University of Texas and Univ Nth Carolina, USA. |
| Input | Research providers contributed resources | \$19.5m total cash and in-kind | Agreement | Actually committed | Cumulative resources | \$2.6m committed by Research providers to 99/2000. | \$3.1m committed by Research providers in 2000/01. \$5.7m Cumulative |
| | Research providers FTEs in-kind | 11.4 FTE in-kind | Agreement | Actually committed | Cumulative resources | 10.6 FTE for 99/2000 Increased level expected for later years. | 12.7 FTE for 2000/01 23.3 FTE Cumulative |
| Process | Collaboration between researchers | All projects to involve two or more Parties Participants workshop each year | Average number of Parties proposed per agreement Workshop planned for year | Average number for projects initiated within year Number attending | Average cumulative number of Parties per project Total number of participant workshops held and cumulative attendance | Average of 5 Parties for 11 Agreements signed February 2000. Workshop held 4-6 April 2000 (Mt Buffalo) 68 attended | Average of 4.4 Parties for 11 Agreements signed February 2000 to June 2001. Workshop held 3-5 April 2001 (Cobram-Barooga) 93 attended 161 Cumulative |
| | Collaboration between researchers and research users | University and non-University supervisors for 75% of postgraduate students | Percentage planned Number planned for year | Percentage for students starting in year | 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 |
| | International collaboration Associate membership program | Centre researchers involved in 3 international collaborations per year 75% of postgraduate students to present at one international conference | Number planned for year | Number of collaborations in year Number attended in year | Cumulative number of international collaborations Cumulative number | 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 Presentations in 99/2000 by 5 postgraduates at Intl confs: Haupt, Hoang, Jordan, McJannet, Wilkinson. | 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 Presentations in 2000/01 by 2 postgraduates at Intl confs: Lloyd, Wilkinson. 7 Cumulative. |
| Process | Secondments of industry staff to research providers | 5 Associates (by Year 4) | Number planned in year | Number of Number joined in year | Total number | SA Water joined. State Forests of NSW renewed. | SA Water continuing involvement. State Forests of NSW renewed. |
| Outputs | | 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 Seker (Goulburn-Murray Water), B James (DNRE) at Monash Univ. Cumulative 6 (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 Siriwardena 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. |
| | Collaborative publications (Centre researchers and authors from other organisations) | 100 collaborative publications | Number planned in year | Number published in year | Total number Number employed | 10 refereed journal papers and 12 conference papers – all with external collaborators | 14 refereed journal papers and 12 conference papers – all with external collaborators |

Education and Training

| | | | | | | | |
|----------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------|-----------------------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | Training and equipping postgraduate students as future leaders in research & management | All postgraduates employed | Students trained in job skills | Employment of graduating students | % employed in user or related industry | 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. |
| | Education benefit – postgraduate | 50% of postgraduate students employed in user or related industry | | | | Postgraduates*: Feikema, Haupt, Jordan, Richards, Siriwardhena, Somes with user industry. Davis, Herron, McJannet, Scanlon, and Stewardson with research providers *Submitted theses in 99/2000 | Postgraduates*: Hoang, Lewis, Sabaratnam, Tilleard with user industry. Roberts with research providers. *Submitted theses in 2000/01 |

| Report of Activities and Achievements for 01/02 | Report of Activities and Achievements for 02/03 | Report of Activities and Achievements for 03/04 | Report of Activities and Achievements for 04/05 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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; close collaboration with University of Natal, 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 Pusan, Korea; Met Office UK; NIWA NZ; iCAM ANU; Univ California, Berk; Univ Newcastle, NSW; | WBM, Earth Tech, Ecological Engineering, SKM, participated as Industry Affiliates. Sustainable Water Resources Research Centre, Korea participated as Research Affiliates. Close collaboration with University of Natal,SA; Univ of Pusan, Korea; Met Office UK; NIWA NZ; iCAM ANU; Univ California, Berk; Univ Newcastle, NSW; |
| \$3.0m committed by Research providers in 2001/02. \$8.7m Cumulative | \$2.8m committed by Research providers in 2002/03. \$11.5m Cumulative | \$2.6m committed by Research providers in 2003/04. \$14.1m Cumulative | \$4.5m committed by Research providers in 2004/05. \$18.6m 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 | 13.6 FTE for 2004/05 72.1 FTE Cumulative |
| 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. | Average of 4.1 Parties for 41 Core Project Agreements signed to June 2005. |
| Workshop held 16-18 April 2002 (Ballarat) 96 attended 257 Cumulative | Workshop held 8-10 April 2003 (Yanco, NSW) 92 attended 349 Cumulative | Annual Workshop held 15-18 March 2004 (Yarra Valley, Dixons Creek, Vic) 100 attended 449 Cumulative | Annual Workshop held 14-16 June 2005 (Marysville, Vic) 120 attended 569 Cumulative |
| 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 | 30% of postgraduates have both university and non-university supervisors |
| 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 Catalonia, Spain; Met Office UK), 5.2 (Univ of Natal), 6.7 (CEMAGREF, France). 12 in total listed | Collaborative arrangements developed for projects including Projects 1.1, 1.09 (HTW, Saarlandes, Germany; California State Univ), 1.2 (Univ of Vienna); 2.2, 2.20 (C. Univ of Leuven), 2.7 (China Eucalypt Centre, Leizhou Forest Bureau), 2.19 (USDA); 4.08 (Chalmers Univ Sweden); 5.1, 5.05 (NIWA NZ, Catalan Tech Univ Spain ; Univ Connecticut; Met Office UK), 5.2, 5.06 (Univ of Natal; Massey Univ, NZ), 6.2 (Univ Agric Vienna). 15 in total listed | Collaborative arrangements developed including Program 1 (California State Univ; Pusan National University, Korea; SWRRC, 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; SWRRC, Korea; Univ of Vienna); Program 2 (Chinese Agricultural University, Beijing, China; Institute of Soils and Water Conservation, China); Program 4 (Chalmers Univ Sweden; INSA, France; Landcare Research, NZ; Univ of Sheffield, UK); Program 5 (McGill Univ, Canada; Massey Univ, NZ; Met Office UK; Univ California, Berkeley; Univ of KwaZulu-Natal, South Africa); Program 6 (CEMAGREF, France) 15 in total listed, 63 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. | Presentations in 2004/05 by postgraduate M Bayley at Intl conf: 16 cumulative |
| WA Water Corporation continuing involvement as Associate. | WA Water Corporation continuing involvement as Associate. | WA Water Corporation continuing involvement as Associate. | WA Water Corporation involvement as Associate concluded June 2005. |
| H Duncan (Melb Water) and J Green (DLWC) at Monash Univ. Cumulative 8 (part) secondments | H Duncan (Melb Water) and M Francey (Melb Water) (part-time) at Monash; G Podger and M Littleboy (DNR) part-time at CSIRO. Cumulative 12 (part) secondments | H Duncan (Melb Water) and M Francey (Melb Water) (part-time) at Monash; G Podger and M Littleboy (DNR) part-time at CSIRO. Cumulative 16 (part) secondments | H Duncan (Melb Water) and M Francey (Melb Water) (part-time) at Monash; G Podger and M Littleboy (DNR) part-time at CSIRO. Cumulative 20 (part) secondments |
| | J-M Perraud (CSIRO) part-time at DIPNR offices in Parramatta, NSW Cumulative 4 (part) secondments | T Fletcher (Monash) part-time at Brisbane City Council, Qld. Cumulative 5 (part) secondments | Cumulative 5 (part) secondments |
| 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 | 30 refereed journal papers and 45 conference papers – all with external collaborators Cumulative 210 collaborative publications |
| 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. | Interaction with industry provided in Annual workshop. |
| Postgraduates*: Akeroyd, Bailey, Linton, Vaze with user industry, Bartley, Marsh, Motha, Petheram, Thomas, Wilkinson with research providers. *Submitted theses in 2001/02 | Postgraduates*: White, Woods with user industry, Barton, McKergow with research providers. *Submitted theses in 2002/03 | Postgraduates*: Alankarage, Lloyd, Muthukumaran with user industry. Brown, Etechells, Gooch, Kandel, Koletelo, Thomsen with research providers. *Submitted theses in 2003/04 | Postgraduates*: Hope, Summerell, and Woods with user industry. Judd with research providers. *Submitted theses in 2004/05 |

Performance Indicators continued...

Education and Training (cont...)

| Nature of Indicator | Performance Indicator | 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 |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|--------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | Increase in knowledge and skill base available for land and water management in Australia: Education benefit - other | Short courses attended by 500 industry persons | 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); Setting 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 (40); Hydrology and hydraulics for floodplain managers – Flood level estimation, Oct 2000(35); Regional hydrologic modelling, Oct 2000 (24); 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 |
| Input | Education and training Program resources | \$6.1m cash and in-kind resources | Strategic plan | Actually committed | Cumulative resources used | \$0.53m for 99/2000 | \$1.05m for 2000/01 \$1.58m Cumulative |
| Process | Industry training | All students to undergo industry induction | Planning of induction | Number of students inducted in year | Cumulative number inducted | Induction program to be planned | Industry placements program being developed (S. Lloyd with Melbourne Water on specific project) |
| Outputs | PhD program | 12 full scholarships 12 top-up scholarships | Number planned | Number in year | Cumulative number Awarded | Two rounds of scholarships advertised. Lloyd, Muthukumaran, Anderson, Ghali awarded scholarships and/or top-ups from first round. | Five rounds of scholarships advertised [Aug,Sept, Oct, Nov 2000; Mar/April 2001], Best, Etchells, Gooch, Grudzinski, Lymburner, Newton, Ramchurn, Thomsen, White C. awarded scholarships and/or top-ups . |

Management Structure and Arrangements

| | | | | | | | |
|----------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome | Continuity of long term research effort | Satisfaction of Parties | Survey of Parties satisfaction | Annual Party survey results | Cumulative results | Survey to be planned. | Survey to be planned. (CRC Parties included in Communications survey in 2000/01) |
| Input | Total cash and in-kind resources in general administration program | \$2m cash and in-kind | Strategic plan | Actually committed | Cumulative resources | \$0.54m total expenditure 99/2000. | \$0.35m total expenditure 2000/01. Cumulative total \$0.89m |
| Process | Governing Board | Representatives for each Party Majority of user and independent members on Governing Board | Chair and number of members | Number of meetings held in year | 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) |
| | Occupational Health and Safety | Incident and accident free workplaces | OH&S training. Risk identification and assessment procedures | OH&S to be part of project meetings and reviews | 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 |
| | Project management skills | All program/ project leaders to attend one course | Selection and planning of Project Management/leadership training for Program/projects | Number of project leaders attending training courses in year | 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. |
| Outputs | Financial management | Programs and projects within budget | Program budgeting for year ahead and three years | Budget versus actual performance within year | Cumulative income and expenditure budget performance | 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. |
| | Monthly, quarterly and Annual report on time | Completion by required dates each year | Preparation of reports | Timeliness within year | Cumulative performance | Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time. | Parties provided monthly cash reporting. Quarterly in-kind reports submitted in time. |

| Report of Activities and Achievements for 01/02 | Report of Activities and Achievements for 02/03 | Report of Activities and Achievements for 03/04 | Report of Activities and Achievements for 04/05 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Over 440 attended courses/ workshops on: Fitzroy AEAM, Building the shell for AEAM process, Aug 2001(15); Stochastic data – risks in water resources management, Sept 2001(23); Fitzroy AEAM, Understanding Fitzroy catchment, Sept 2001 (25); Design flood flow estimation, Sept 2001 (28); Application of MUSIC, Oct 2002 (5); EMSS Training, Oct 2001(35); ICMS Training, Oct 2001 (12); Climate Variability Research, Oct 2001 (40); MUSIC users, Oct 2001 (12); Modelling Toolkit concepts and activities, Nov 2001 (23); Water experiment trials, Jan 2002 (12); ICMS, Feb 2002 (10); Water experiment trials, Feb 2002 (12); We all use water, Feb 2002 (15); Field investigation, river rehabilitation design, Mar 2002 (6); Field demonstration, stream restoration, Mar 2002 (50); We all use water, Mar 2002 (17); Project management, Apr 2002 (17); We all use water, May 2002 (15); Fitzroy AEAM stakeholders, May 2002 (30); WSUD field tour, June 2002(40).</p> <p>1138 Cumulative</p> | <p>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); SIMHYD 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).</p> <p>1778 Cumulative</p> | <p>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, 1Mar 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)</p> <p>2483 Cumulative</p> | <p>Total 985 attended courses/workshops on: Catchment Modelling Toolkit Product Managers, ACT, 28 July 2004 (12); Catchment Modelling Toolkit Product Managers, Vic, 30 July 2004 (6); ISWR Urban Water, 26-28 August 2004 (25); Brisbane Node Workshop, 15 September 2004 (20); Introduction to TIME, 16-17 September 2004 (12); River Analysis Program (RAP) Advanced Training, 28 September 2004 (17); MUSIC Version 2 Training, Vic, 29-30 September 2004 (18); MUSIC Version 2 Training, Qld, 5-6 October 2004 (18); E2/ Development Projects Workshop, 23-24 November 2004 (25); Use of Fitzroy EMSS erosion 'hotspot map', Emerald, 25 November 2004 (12); Use of Fitzroy EMSS erosion 'hotspot map', Rockhampton, 26 November 2004 (15); Use of Fitzroy EMSS erosion 'hotspot map', Nebo, 8 December 2004 (10); MUSIC Training Version 2, 8-9 December 2004 (30); Use of Fitzroy EMSS erosion 'hotspot map', Biloela, 13 January 2005 (16); TIME version SedNet to guide WQ target setting, 27-28 January 2005 (20); TIME version - 21-25 February 2005 (20); Stochastic Climate Data Generation, 24 February 2005 (6); Introduction to Catchment Modelling and E2, 24-25 February 2005 (36); SedNet – Sediment and Nutrient Budgets for River Networks, 24-25 February 2005 (9); Rainfall Runoff Library (RRL) Training Workshop, 24-25 February 2005 (4); EMSS to help set WQ Targets Mackenzie sub-basin group, 7 March 2005 (15); CRC for Catchment Hydrology Program Leaders, Focus Catchment Coordinators, Executive, 14-16 March 2005 (20); MUSIC V3 Upgrade Workshop, 9 May 2005 (30); SedNet workshop, 11-12 May 2005 (4); Modelling the Reallocation of Water: WRAM-REALM, 23 June 2005 (9); Catchment Modelling School, Brisbane, Sydney, 30 June-22 July 2005, 48 workshops (576).</p> <p>3468 Cumulative</p> |
| \$1.09m for 2001/02 \$2.67m Cumulative | \$1.20m for 2002/03 \$3.87m Cumulative | \$1.25m for 2003/04 \$5.12m Cumulative | \$1.74m for 2004/05 \$6.86m Cumulative |
| Industry placements program being developed | Industry placements program commenced. (S. Johnson at Melbourne Water) | Industry placements program on hold. | Industry placements program on hold. |
| <p>One round of scholarships advertised [Oct 2001] Biggin, Griffith, Henderson, Johnson, Judd, Potter, Taylor, Woods awarded scholarships and/or top-ups.</p> <p>21 Cumulative total scholarships/top-ups.</p> | <p>One round of scholarships advertised [Oct 2002] Bayley, Borg, Capon, Clowes, Francey, Howes, Rebgetz, Vietz, Zaman awarded scholarships, industry support, and/or top-ups.</p> <p>30 Cumulative total scholarships/top-ups /industry support.</p> | <p>No further scholarships sought as projects move into final stages.</p> <p>30 Cumulative total scholarships /top-ups/industry support.</p> | <p>No further scholarships sought as projects in final stages.</p> <p>30 Cumulative total scholarships/ top-ups/industry support.</p> |
| Board reviewed its performance in 2001/02. Parties' further survey to be planned. | Parties confirmed support and involvement with new round of 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. | Parties confirmed support and involvement with: Active support and in-kind resources for Development Projects; Extension of Development Projects by 3 Industry Parties; Commitment by all existing Parties to successor CRC application. |
| \$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 | \$0.33m total expenditure 2004/05. Cumulative total \$2.49m |
| 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) |
| 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/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/ training attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers |
| 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. | Program/Project leaders funded to attend training courses where appropriate. |
| Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2002 Board (22 projects) | Program budgeting: Program budgeting for initial projects on three-year basis. Program budget for new round of three-year projects (22 projects) approved Nov 2002, and May 2003 Board | Program budgeting: Program budgeting included in planning for next two years as part of budget approved June 2004. | Program budgeting: Program budgeting included in planning for next two years as part of budget approved June 2004. |
| Project Budget performance: 12 projects under cash budget for 2001/02. Total cash 95% of budget. | Project Budget performance: 20 projects under cash budget for 2002/03. Total cash 96% of budget. | Project Budget performance: 18 projects under cash budget for 2003/04. Total cash 100% of budget. | Project Budget performance: 16 projects under cash budget for 2004/05. Total cash 101% of budget. |
| 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. |

IN-KIND CONTRIBUTIONS FROM PARTIES (DOLLARS IN \$'000's)

TABLE 1 (a)

| PARTICIPANT | 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 | 04/05 YEAR 6 Actual | 04/05 YEAR 6 Agr'mt | CUMULATIVE TOTAL TO DATE Actual Agr'mt | | 05/06 YEAR 7 Budget Agr'mt | | GRAND TOTAL Total Agr'mt 7 Yrs 7 Yrs | | Diff 7 Yrs |
|-------------------------------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|----------------------------------------------|--------------|----------------------------------|------------|--------------------------------------------|--------------|---------------|
| Brisbane City Council | | | | | | | | | | | | | | |
| Salaries | 147 | 11 | 12 | 34 | 46 | 47 | 28 | 297 | 168 | 28 | 28 | 325 | 196 | 129 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 263 | 359 | 364 | 376 | 403 | 403 | 372 | 2,168 | 2,232 | 372 | 372 | 2,540 | 2,604 | (64) |
| TOTAL | 410 | 370 | 376 | 410 | 449 | 450 | 400 | 2,465 | 2,400 | 400 | 400 | 2,865 | 2,800 | 65 |
| Bureau of Meteorology | | | | | | | | | | | | | | |
| Salaries | 80 | 189 | 142 | 124 | 135 | 219 | 137 | 889 | 822 | 137 | 137 | 1,026 | 959 | 67 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 160 | 358 | 293 | 268 | 282 | 402 | 284 | 1,763 | 1,704 | 284 | 284 | 2,047 | 1,988 | 59 |
| TOTAL | 240 | 547 | 435 | 392 | 417 | 621 | 421 | 2,652 | 2,526 | 421 | 421 | 3,073 | 2,947 | 126 |
| CSIRO Land and Water | | | | | | | | | | | | | | |
| Salaries | 417 | 451 | 470 | 381 | 273 | 802 | 423 | 2,794 | 2,538 | 423 | 423 | 3,217 | 2,961 | 256 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 552 | 598 | 623 | 505 | 361 | 1,252 | 561 | 3,891 | 3,366 | 561 | 561 | 4,452 | 3,927 | 525 |
| TOTAL | 969 | 1,049 | 1,093 | 886 | 634 | 2,054 | 984 | 6,685 | 5,904 | 984 | 984 | 7,669 | 6,888 | 781 |
| Department of Natural Resources NSW | | | | | | | | | | | | | | |
| Salaries | 107 | 77 | 167 | 159 | 505 | 318 | 151 | 1,333 | 906 | 151 | 151 | 1,484 | 1,057 | 427 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 74 | 58 | 112 | 107 | 314 | 202 | 102 | 867 | 612 | 102 | 102 | 969 | 714 | 255 |
| TOTAL | 181 | 135 | 279 | 266 | 819 | 520 | 253 | 2,200 | 1,518 | 253 | 253 | 2,453 | 1,771 | 682 |
| Department of Natural Resources and Mines Qld. | | | | | | | | | | | | | | |
| Salaries | 110 | 94 | 447 | 249 | 306 | 271 | 180 | 1,477 | 1,080 | 180 | 180 | 1,657 | 1,260 | 397 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 189 | 216 | 727 | 439 | 522 | 472 | 338 | 2,565 | 2,028 | 338 | 338 | 2,903 | 2,366 | 537 |
| TOTAL | 299 | 310 | 1,174 | 688 | 828 | 743 | 518 | 4,042 | 3,108 | 518 | 518 | 4,560 | 3,626 | 934 |

IN-KIND CONTRIBUTIONS FROM PARTIES (DOLLARS IN \$'000's)

TABLE 1 (b)

| PARTICIPANT | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 04/05 | CUMULATIVE | | 05/06 | | GRAND TOTAL | | Diff 7 Yrs |
|-----------------------------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------------|-------------------------|--------------|--------------|----------------|-----------------|---------------|
| | YEAR 1 Actual | YEAR 2 Actual | YEAR 3 Actual | YEAR 4 Actual | YEAR 5 Actual | YEAR 6 Actual | YEAR 6 Agr'mt | TOTAL TO DATE Actual | TOTAL TO DATE Agr'mt | Budget | Agr'mt | Total 7 Yrs | Agr'mt 7 Yrs | |
| Department of Sustainability and Environment, Vic. | | | | | | | | | | | | | | |
| Salaries | 75 | 318 | 194 | 158 | 202 | 199 | 187 | 1,146 | 1,122 | 187 | 187 | 1,333 | 1,309 | 24 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 122 | 356 | 236 | 202 | 231 | 242 | 230 | 1,389 | 1,380 | 230 | 230 | 1,619 | 1,610 | 9 |
| TOTAL | 197 | 674 | 430 | 360 | 433 | 441 | 417 | 2,535 | 2,502 | 417 | 417 | 2,952 | 2,919 | 33 |
| Griffith University | | | | | | | | | | | | | | |
| Salaries | 200 | 237 | 255 | 246 | 233 | 257 | 231 | 1,428 | 1,379 | 231 | 231 | 1,659 | 1,610 | 49 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 214 | 344 | 317 | 308 | 295 | 320 | 292 | 1,798 | 1,745 | 292 | 292 | 2,090 | 2,037 | 53 |
| TOTAL | 414 | 581 | 572 | 554 | 528 | 577 | 523 | 3,226 | 3,124 | 523 | 523 | 3,749 | 3,647 | 102 |
| Melbourne Water | | | | | | | | | | | | | | |
| Salaries | 69 | 93 | 100 | 106 | 155 | 109 | 76 | 632 | 456 | 76 | 76 | 708 | 532 | 176 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 93 | 236 | 244 | 250 | 286 | 253 | 226 | 1,362 | 1,356 | 226 | 226 | 1,588 | 1,582 | 6 |
| TOTAL | 162 | 329 | 344 | 356 | 441 | 362 | 302 | 1,994 | 1,812 | 302 | 302 | 2,296 | 2,114 | 182 |
| Monash University | | | | | | | | | | | | | | |
| Salaries | 334 | 257 | 292 | 250 | 258 | 337 | 270 | 1,728 | 1,620 | 270 | 270 | 1,998 | 1,890 | 108 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 384 | 305 | 340 | 298 | 306 | 388 | 318 | 2,021 | 1,908 | 318 | 318 | 2,339 | 2,226 | 113 |
| TOTAL | 718 | 562 | 632 | 548 | 564 | 725 | 588 | 3,749 | 3,528 | 588 | 588 | 4,337 | 4,116 | 221 |
| Goulburn-Murray Water | | | | | | | | | | | | | | |
| Salaries | 18 | 16 | 23 | 22 | 101 | 56 | 11 | 236 | 121 | 11 | 11 | 247 | 132 | 115 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 52 | 50 | 59 | 48 | 152 | 83 | 24 | 444 | 290 | 24 | 24 | 468 | 314 | 154 |
| TOTAL | 70 | 66 | 82 | 70 | 253 | 139 | 35 | 680 | 411 | 35 | 35 | 715 | 446 | 269 |
| The University of Melbourne | | | | | | | | | | | | | | |
| Salaries | 112 | 306 | 184 | 234 | 265 | 294 | 200 | 1,395 | 1,200 | 200 | 200 | 1,595 | 1,400 | 195 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 116 | 316 | 190 | 241 | 273 | 302 | 206 | 1,438 | 1,236 | 206 | 206 | 1,644 | 1,442 | 202 |
| TOTAL | 228 | 622 | 374 | 475 | 538 | 596 | 406 | 2,833 | 2,436 | 406 | 406 | 3,239 | 2,842 | 397 |
| TOTAL IN-KIND CONTRIBUTIONS | | | | | | | | | | | | | | |
| Salaries | 1,669 | 2,049 | 2,286 | 1,963 | 2,479 | 2,909 | 1,894 | 13,355 | 11,412 | 1,894 | 1,894 | 15,249 | 13,306 | 1,943 |
| Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other | 2,219 | 3,196 | 3,505 | 3,042 | 3,425 | 4,319 | 2,953 | 19,706 | 17,857 | 2,953 | 2,953 | 22,659 | 20,810 | 1,849 |
| GRAND TOTAL IN-KIND (T1) | 3,888 | 5,245 | 5,791 | 5,005 | 5,904 | 7,228 | 4,847 | 33,061 | 29,269 | 4,847 | 4,847 | 37,908 | 34,116 | 3,792 |

TABLE 2

| Participant | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 04/05 | CUMULATIVE | | 05/06 | | GRAND TOTAL | | Diff 7 Yrs |
|--------------------------------------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-------------------------|-------------------------|--------------|--------------|----------------|-----------------|----------------|
| | YEAR 1 Actual | YEAR 2 Actual | YEAR 3 Actual | YEAR 4 Actual | YEAR 5 Actual | YEAR 6 Actual | YEAR 6 Agr'mt | Total To Date Actual | Total To Date Agr'mt | Budget | Agr'mt | Total 7 Yrs | Agr'mt 7 Yrs | |
| Brisbane City Council | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 300 | 300 | 50 | 50 | 350 | 350 | - |
| Bureau of Meteorology | 50 | 50 | 50 | 50 | 150 | - | 50 | 350 | 350 | - | - | 350 | 350 | - |
| CSIRO Land and Water | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 600 | 600 | 100 | 100 | 700 | 700 | - |
| Dept. Natural Resources, NSW | 100 | 100 | 100 | 100 | 125 | 100 | 100 | 625 | 625 | 75 | 75 | 700 | 700 | - |
| Dept. Natural Resources and Mines Qld. | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 600 | 600 | 100 | 100 | 700 | 700 | - |
| Dept. Sustainability and Environment, Vic. | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 600 | 600 | 100 | 100 | 700 | 700 | - |
| Griffith University | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 300 | 300 | 50 | 50 | 350 | 350 | - |
| Melbourne Water | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 300 | 300 | 50 | 50 | 350 | 350 | - |
| Monash University | 100 | 100 | 100 | 100 | 150 | 100 | 100 | 650 | 650 | 50 | 50 | 700 | 700 | - |
| Murray-Darling Basin Commission | 50 | 50 | 50 | 50 | 100 | 50 | 50 | 350 | 350 | - | - | 350 | 350 | - |
| Goulburn-Murray Water | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 900 | 900 | 150 | 150 | 1,050 | 1,050 | - |
| Southern Rural Water | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 180 | 180 | 30 | 30 | 210 | 210 | - |
| Wimmera Mallee Water | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 360 | 360 | 60 | 60 | 420 | 420 | - |
| The University of Melbourne | 50 | 50 | 50 | 50 | 75 | 50 | 50 | 325 | 325 | 25 | 25 | 350 | 350 | - |
| TOTAL CASH FROM PARTICIPANTS | 1,040 | 1,040 | 1,040 | 1,040 | 1,290 | 990 | 1,040 | 6,440 | 6,440 | 840 | 840 | 7,280 | 7,280 | - |
| OTHER CASH | | | | | | | | | | | | | | |
| Non-participants | 78 | 83 | 30 | - | - | - | - | 191 | - | - | - | 191 | - | 191 |
| External Grants | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Contract Research (See Note B below) | 32 | 152 | 30 | 125 | 284 | 116 | 2,300 | 739 | 7,500 | 2,600 | 2,600 | 3,339 | 10,100 | (6,761) |
| Commercialisation | 61 | - | 118 | 176 | 247 | 230 | - | 832 | - | - | - | 832 | - | 832 |
| Education | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Interest | 66 | 118 | 105 | 68 | 41 | 41 | - | 439 | - | - | - | 439 | - | 439 |
| TOTAL OTHER CASH | 237 | 353 | 283 | 369 | 572 | 387 | 2,300 | 2,201 | 7,500 | 2,600 | 2,600 | 4,801 | 10,100 | (5,299) |
| CRC GRANT | 2,242 | 2,600 | 2,600 | 2,600 | 2,600 | 2,600 | 2,600 | 15,242 | 15,242 | 1,000 | 1,000 | 16,242 | 16,242 | - |
| TOTAL CRC CASH CONTRIBUTION (T2) | 3,519 | 3,993 | 3,923 | 4,009 | 4,462 | 3,977 | 5,940 | 23,883 | 29,182 | 4,440 | 4,440 | 28,323 | 33,622 | (5,299) |
| Cash From Previous Year | 527 | 1,775 | 2,118 | 1,388 | 528 | 543 | - | - | - | - | - | - | - | - |
| Less | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Unspent Balance | 1,775 | 2,118 | 1,388 | 528 | 543 | 337 | - | - | - | - | - | - | - | - |
| TOTAL CASH EXPENDITURE (T3) | 2,271 | 3,650 | 4,653 | 4,869 | 4,447 | 4,183 | 5,940 | 24,073 | 29,182 | 4,440 | 4,440 | 28,513 | 33,622 | (5,109) |
| ALLOCATION OF CASH EXPENDITURE BETWEEN HEADS OF EXPENDITURE | | | | | | | | | | | | | | |
| Salaries | 1,232 | 2,067 | 2,349 | 2,424 | 2,308 | 2,395 | 3,165 | 12,775 | 15,547 | 2,366 | 2,366 | 15,141 | 17,913 | (2,772) |
| Capital | - | - | - | 27 | - | - | - | 27 | - | - | - | 27 | - | 27 |
| Other | 1,039 | 1,583 | 2,304 | 2,418 | 2,139 | 1,788 | 2,775 | 11,271 | 13,635 | 2,074 | 2,074 | 13,345 | 15,709 | (2,364) |
| TOTAL CASH EXPENDITURE (T3) | 2,271 | 3,650 | 4,653 | 4,869 | 4,447 | 4,183 | 5,940 | 24,073 | 29,182 | 4,440 | 4,440 | 28,513 | 33,622 | (5,109) |

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".

SUMMARY OF RESOURCES APPLIED TO ACTIVITIES OF CENTRE (Dollars in \$,000)

TABLE 3

| | 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 | 04/05 YEAR 6 Actual | 04/05 YEAR 6 Agrmt | CUMULATIVE TOTAL TO DATE Actual Agrmt | | 05/06 YEAR 7 Budget Agrmt | | GRAND TOTAL Total Agrmt Diff 7 Yrs 7 Yrs 7 Yrs | | |
|------------------------------------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|---------------------------------------------|--------|---------------------------------|-------|------------------------------------------------------|--------|---------|
| Grand Total Inkind Table 1 (T1) | 3,888 | 5,245 | 5,791 | 5,005 | 5,904 | 7,228 | 4,847 | 33,061 | 29,269 | 4,847 | 4,847 | 37,908 | 34,116 | 3,792 |
| Grand Total Cash Table 2 (T3) | 2,271 | 3,650 | 4,653 | 4,869 | 4,447 | 4,183 | 5,940 | 24,073 | 29,182 | 4,440 | 4,440 | 28,513 | 33,622 | (5,109) |
| TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE (T1+T3) | 6,159 | 8,895 | 10,444 | 9,874 | 10,351 | 11,411 | 10,787 | 57,134 | 58,451 | 9,287 | 9,287 | 66,421 | 67,738 | (1,317) |

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 | 5,304 | 5,059 | 26,130 | 26,959 | 4,260 | 4,260 | 30,390 | 31,219 | (829) |
| 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 | 6,107 | 5,728 | 30,977 | 31,492 | 5,027 | 5,027 | 36,004 | 36,519 | (515) |
| GRAND TOTALS (T1+T3) | 6,159 | 8,895 | 10,444 | 9,874 | 10,351 | 11,411 | 10,787 | 57,134 | 58,451 | 9,287 | 9,287 | 66,421 | 67,738 | (1,317) |

ALLOCATION OF RESOURCES BETWEEN CATEGORIES OF ACTIVITIES (DOLLARS IN \$,000)

Table 4

| PROGRAM | RESOURCE USAGE | | | |
|----------------------------------|----------------------|---------------|-----------------------------------|-----------------------------------|
| | \$ Cash ¹ | \$ In-kind | Contributed Staff ² | Cash Funded Staff ² |
| Research | 1,949 | 3,955 | 23.24 | 19.73 |
| Education | 550 | 1,187 | 0.12 | 0.70 |
| External Communication | 1,128 | 1,438 | 4.58 | 3.18 |
| Commercialisation/Tech. Transfer | 259 | 615 | 1.14 | 0.80 |
| Administration | 297 | 33 | 0.07 | 1.85 |
| TOTAL | 4,183 (T3) | 7,228 (T1) | 29.15 | 26.26 |

- (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.

CRC FOR CATCHMENT HYDROLOGY


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 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 inkind 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 2005 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 Agreement.
6. Intellectual Property in all Contract Material is vested as provided in the 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 *2nd* day of September 2005



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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 2005

Scope

We have reviewed the financial information of the Cooperative Research Centre for Catchment Hydrology ("CRC") for the financial year ended 30 June 2005 as set out on pages 1 to 7. 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

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Member of
Deloitte Touche Tohmatsu

Deloitte.

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.

Unqualified Statement

Based on our review, which is not an audit, 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 2005 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


David Maddock
Partner
Chartered Accountants

Melbourne, 2nd September 2005

FINANCIAL STATEMENTS 2004-2005

STATEMENT OF FINANCIAL PERFORMANCE FOR THE YEAR ENDED 30 JUNE 2005

| | NOTE | 2005 \$ | 2004 \$ |
|--------------------------------------------------------------------------------------------------------|------|--------------|--------------|
| Revenue From Ordinary Activities | | | |
| Commonwealth Grant | | 2,600,000 | 2,600,000 |
| Interest | | 39,969 | 45,984 |
| Other | | 378,774 | 707,247 |
| | | 3,018,743 | 3,353,231 |
| Expenses From Ordinary Activities | | | |
| Salary and Related Expenses of Researchers | | (3,057,186) | (3,021,262) |
| Operating Expenses of Researchers | | (1,213,112) | (1,390,309) |
| Inkind Research Expenses | | (7,228,544) | (5,904,013) |
| | | (11,498,842) | (10,315,584) |
| Loss From Ordinary Activities Before Income Tax Expense | | (8,480,099) | (6,962,353) |
| Income Tax Expense | | - | - |
| Net Loss | 6 | (8,480,099) | (6,962,353) |
| Total Changes in Equity Other Than Those Resulting From Transactions with Participants as Participants | | (8,480,099) | (6,962,353) |

Notes to the financial statements are included on pages 2 to 4

STATEMENT OF FINANCIAL POSITION AS AT 30 JUNE 2005

| | NOTE | 2005 \$ | 2004 \$ |
|--------------------------------|------|--------------|--------------|
| Current Assets | | | |
| Cash Assets | 3(a) | 337,193 | 543,198 |
| Receivables | 4 | 514,725 | 215,112 |
| TOTAL CURRENT ASSETS | | 851,918 | 758,310 |
| TOTAL ASSETS | | 851,918 | 758,310 |
| Current Liabilities | | | |
| Payables | 5 | 53,575 | 13 |
| Income in Advance | 5 | 301,602 | - |
| Party Contributions in Advance | 5 | 175,000 | 50,000 |
| TOTAL CURRENT LIABILITIES | | 530,177 | 50,013 |
| TOTAL LIABILITIES | | 530,177 | 50,013 |
| NET ASSETS | | 321,741 | 708,297 |
| RESEARCHERS' FUNDS | | | |
| Contributions by Parties | 2 | 39,854,279 | 31,760,735 |
| Accumulated losses | 6 | (39,532,538) | (31,052,438) |
| | | 321,741 | 708,297 |

Notes to the financial statements are included on pages 2 to 4

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 30 JUNE 2005

| | NOTE | 2005 \$ | 2004 \$ |
|----------------------------------------------|------|-------------|-------------|
| Cash Flows From Operating Activities: | | | |
| Receipts from the Commonwealth Government | | 2,600,000 | 2,600,000 |
| Interest Received | | 40,553 | 47,373 |
| Other Income | | 345,821 | 679,553 |
| Payments for Research | | (4,182,379) | (4,389,685) |
| Net Cash Used in Operating Activities | 3(b) | (1,196,005) | (1,062,759) |
| Cash Flows From Financing Activities: | | | |
| Cash Contributions by Parties | | 990,000 | 890,000 |
| Net Cash Provided by Financing Activities | | 990,000 | 890,000 |
| NET DECREASE IN CASH HELD | | (206,005) | (172,759) |
| CASH AT THE BEGINNING OF THE FINANCIAL YEAR | | 543,198 | 715,957 |
| CASH AT THE END OF THE FINANCIAL YEAR | 3(a) | 337,193 | 543,198 |

Notes to the financial statements are included on pages 2 to 4

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.

(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 Inkind 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 payables or receivables.

(g) Receivables

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

NOTE 2. CONTRIBUTIONS BY PARTIES (Excluding advance contributions)

| | 2005 \$ | 2004 \$ |
|----------------------------------------------------|------------|------------|
| Cash | | |
| Brisbane City Council | 50,000 | 50,000 |
| Bureau of Meteorology | - | 100,000 |
| CSIRO Land and Water | 100,000 | 100,000 |
| Department of Natural Resources, NSW | 100,000 | 125,000 |
| Department of Natural Resources and Mines Qld. | 100,000 | 100,000 |
| Department of Sustainability and Environment, Vic. | 100,000 | 100,000 |
| Griffith University | 50,000 | 50,000 |
| Melbourne Water Corporation | 50,000 | 50,000 |
| Monash University | 50,000 | 150,000 |
| Murray-Darling Basin Commission | - | 100,000 |
| Goulburn-Murray Rural Water Authority | 150,000 | 150,000 |
| Gippsland & Southern Rural Water Authority | 30,000 | 30,000 |
| Grampians Wimmera-Mallee Water | 60,000 | 60,000 |
| The University of Melbourne | 25,000 | 75,000 |
| | 865,000 | 1,240,000 |
| Inkind | | |
| Brisbane City Council | 450,112 | 448,453 |
| Bureau of Meteorology | 621,145 | 417,316 |
| CSIRO Land and Water | 2,054,463 | 634,316 |
| Department of Natural Resources, NSW | 519,779 | 819,187 |
| Department of Natural Resources and Mines Qld. | 743,381 | 828,573 |
| Department of Sustainability and Environment, Vic. | 440,850 | 432,721 |
| Griffith University | 577,294 | 527,890 |
| Melbourne Water Corporation | 361,967 | 440,887 |
| Monash University | 725,081 | 563,603 |
| Murray-Darling Basin Commission | - | - |
| Goulburn-Murray Rural Water Authority | 138,492 | 253,167 |
| Gippsland & Southern Rural Water Authority | - | - |
| Grampians Wimmera-Mallee Water | - | - |
| The University of Melbourne | 595,980 | 537,900 |
| | 7,228,544 | 5,904,013 |
| Total Cash And Inkind Contributions | | |
| Brisbane City Council | 500,112 | 498,453 |
| Bureau of Meteorology | 621,145 | 517,316 |
| CSIRO Land and Water | 2,154,463 | 734,316 |
| Department of Natural Resources, NSW | 619,779 | 944,187 |
| Department of Natural Resources and Mines, Qld. | 843,381 | 928,573 |
| Department of Sustainability and Environment, Vic. | 540,850 | 532,721 |
| Griffith University | 627,294 | 577,890 |
| Melbourne Water Corporation | 411,967 | 490,887 |
| Monash University | 775,081 | 713,603 |
| Murray-Darling Basin Commission | - | 100,000 |
| Goulburn-Murray Rural Water Authority | 288,492 | 403,167 |
| Gippsland & Southern Rural Water Authority | 30,000 | 30,000 |
| Grampians Wimmera-Mallee Water | 60,000 | 60,000 |
| The University of Melbourne | 620,980 | 612,900 |
| | 8,093,544 | 7,144,013 |
| Opening balance Party Contributions | 31,760,736 | 24,616,723 |
| Contributions this year, cash and inkind | 8,093,544 | 7,144,013 |
| Closing balance Party contributions | 39,854,280 | 31,760,736 |

NOTE 3: NOTES TO THE STATEMENT OF CASH FLOWS

| | 2005 \$ | 2004 \$ |
|--|------------|------------|
|--|------------|------------|

(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 | 337,193 | 543,198 |
|-------------|---------|---------|

(b) Reconciliation Of Loss From Ordinary Activities After Related Income Tax Expense To Net Cash Flows From Operating Activities

| | | |
|------------------------------------------------------------------------|-------------|-------------|
| Loss from Ordinary Activities after related income tax. | (8,480,099) | (6,962,353) |
| Non cash flow items in Loss from Ordinary Activities after income tax: | | |
| In-Kind expenditure | 7,228,544 | 5,904,013 |
| Changes in assets and liabilities: | | |
| Increase / (Decrease) in Payables | 301,600 | (22,217) |
| (Increase) / Decrease in Receivables | (246,050) | 17,798 |
| Net cash used in Operating Activities | (1,196,005) | (1,062,759) |

NOTE 4: Receivables

| | | |
|--------------------------------------|---------|---------|
| Interest Receivable | 4,228 | 4,813 |
| Other Receivables | 510,497 | 175,942 |
| Goods & Service Tax (GST) Receivable | - | 34,357 |
| | 514,725 | 215,112 |

NOTE 5: Payables

| | | |
|---------------------------------------|---------|--------|
| Income in Advance | 301,602 | - |
| Advance Contributions by Participants | 175,000 | 50,000 |
| Goods & Service Tax (GST) Payable | 53,563 | - |
| Other Payables | 12 | 13 |
| | 530,177 | 50,013 |

The Income in Advance relates to fees from participants in the Catchment Modelling Schools which took place in July 2005.

NOTE 6: Accumulated Losses

| | | |
|--------------------------------------------|--------------|--------------|
| Balance at beginning of the financial year | (31,052,438) | (24,090,085) |
| Net Loss | (8,480,099) | (6,962,353) |
| Balance at end of the financial year. | (39,532,537) | (31,052,438) |

CRC FOR CATCHMENT HYDROLOGY

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 2nd day of September 2005

Deloitte.

Deloitte Touche Tohmatsu
A.B.N. 74 490 121 060

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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 2005 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.

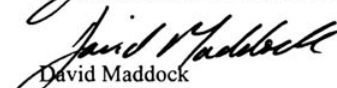
Our review has been conducted in accordance with Australian Auditing Standards applicable to review engagements. A review is limited primarily to inquiries of CRC personnel and analytical procedures applied to the financial data. These procedures do not provide all the evidence that would be required 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 2005 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



David Maddock
Partner
Chartered Accountants

Melbourne  September 2005

Liability Limited by the Accountants Scheme, approved under the Professional Standards Act 1994 (NSW).

Member of
Deloitte Touche Tohmatsu

APPENDIX – Staff Resources 2004-2005

Research Staff - Contributed as In-kind Resources (100% = 1 person year)

| Name | Main Activity | Total % Time | % Spent on Research Program (R) Subprograms | | | | | | | Total On Research | % Spent On Education Program (8)/(E) | % Spent On Commercialisation Program (7)/(C) | % Spent On Administration Program (9)/(A) |
|----------------------------------------------|---------------|--------------|---------------------------------------------|------------|----------|-----------|------------|----------|----------|-------------------|--------------------------------------|----------------------------------------------|-------------------------------------------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 10 | | | | |
| Brisbane City Council | | | | | | | | | | | | | |
| Allen, R | R | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 0 | 0 |
| Armitage, R | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Chandler, S | R | 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 7 | 0 | 0 |
| Chapman, B | R | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Folan, A | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Herklots, A | R | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Manners, B | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Mogg, M | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Peljo, L | R | 15 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 5 | 0 | 0 |
| Prandolini, K | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Rahimullah, M | R | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 |
| Ryan, C | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Simi, A | R | 13 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 13 | 0 | 0 | 0 |
| Stephenson, D | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Weber, T | R | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| Total | | 108 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | 34 | 0 | 74 | 0 |
| Bureau of Meteorology | | | | | | | | | | | | | |
| Ebert, E | R | 8 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 |
| James, J | R | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Manton, M | R | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 |
| Mills, G | R | 8 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 |
| Seed, A | R | 63 | 0 | 0 | 0 | 0 | 63 | 0 | 0 | 63 | 0 | 0 | 0 |
| Srikanthan, S | R | 108 | 0 | 0 | 0 | 0 | 105 | 0 | 0 | 105 | 3 | 0 | 0 |
| Stewart, B | C | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| Total | | 196 | 0 | 0 | 0 | 0 | 189 | 0 | 0 | 189 | 0 | 7 | 0 |
| CSIRO Land and Water | | | | | | | | | | | | | |
| Chen, Y | R | 6 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 6 | 0 | 0 | 0 |
| Christen, E | R | 20 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| Coleman, J | R | 68 | 29 | 0 | 0 | 39 | 0 | 0 | 0 | 68 | 0 | 0 | 0 |
| Cuddy, S | R | 27 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 |
| Dawes, W | R | 11 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |
| Gilfedder, M | R | 12 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| Hornbuckle, J | R | 26 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 0 |
| Hotham, H | R | 7 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| Li, T | R | 28 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 0 | 0 |
| McVicar, T | R | 35 | 0 | 35 | 0 | 0 | 0 | 0 | 0 | 35 | 0 | 0 | 0 |
| Murray, N | R | 38 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 |
| Perraud, J-M | R | 6 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 |
| Prosser, I | R | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Rahman, J | R | 44 | 43 | 1 | 0 | 0 | 0 | 0 | 0 | 44 | 0 | 0 | 0 |
| Rassam, D | R | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| Rutherford, K | R | 18 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 |
| Seaton, S | R | 31 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 |
| Stenson, M | R | 25 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| Tao, L | R | 54 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 54 | 0 | 0 | 0 |
| Walker, G | R | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Wallbrink, P | R | 65 | 0 | 47 | 0 | 0 | 0 | 0 | 0 | 47 | 6 | 6 | 6 |
| Wilkinson, S | R | 22 | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 0 | 0 |
| Zhang, L | R | 36 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 0 |
| Total | | 593 | 194 | 335 | 0 | 39 | 0 | 7 | 0 | 575 | 6 | 6 | 6 |
| Department of Natural Resources, NSW. | | | | | | | | | | | | | |
| Geeves, G | R | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 |
| Herron, N | C | 42 | 4 | 25 | 0 | 0 | 0 | 0 | 0 | 29 | 13 | 0 | 0 |
| Littleboy, M | R | 55 | 0 | 55 | 0 | 0 | 0 | 0 | 0 | 55 | 0 | 0 | 0 |
| Nandakumar, N | R | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Podger, G | R | 24 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 |
| Salbe, I | R | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Summerell, G | C | 14 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 |
| Teng, J | R | 55 | 0 | 48 | 0 | 0 | 0 | 0 | 0 | 48 | 7 | 0 | 0 |
| Tuteja, N | R | 31 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 |
| Vaze, J | R | 74 | 0 | 65 | 0 | 0 | 0 | 0 | 0 | 65 | 9 | 0 | 0 |
| Young, C | R | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 |
| Zierholz, C | R | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 |
| Total | | 367 | 28 | 238 | 1 | 0 | 0 | 0 | 0 | 267 | 0 | 100 | 0 |

Appendix – Staff Resources 2004-2005 (cont...)

Research Staff - Contributed as In-kind Resources (100% = 1 person year)

| Name | Main Activity | Total % Time | % Spent on Research Program (R) Subprograms | | | | | | | Total On Research | % Spent On Education Program (8)/(E) | % Spent On Commercialisation Program (7)/(C) | % Spent On Administration Program (9)/(A) |
|-----------------------------------------------------------|---------------|--------------|---------------------------------------------|------------|-----------|------------|----------|----------|----------|-------------------|--------------------------------------|----------------------------------------------|-------------------------------------------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 10 | | | | |
| Department of Natural Resources and Mines, QLD | | | | | | | | | | | | | |
| Amour, J | R | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 |
| Bloesch, P | R | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| Carroll, C | C | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 0 |
| Cogle, L | R | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| Freebairn, D | R | 21 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 0 |
| Hately, L | R | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 52 | 0 |
| Hunter, H | R | 29 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 0 |
| Irvine, S | R | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Masters, B | C | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 |
| Millar, G | R | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 |
| Owens, J | R | 32 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 0 |
| Park-Weir, W | R | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Rhode, K | R | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 |
| Ruffini, J | C | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Sallaway, M | C | 18 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 17 | 0 |
| Searle, R | R | 65 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 57 | 0 |
| Silburn, M | C | 31 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 |
| Weber, T | R | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Total | | 364 | 0 | 132 | 6 | 0 | 0 | 0 | 0 | 138 | 0 | 226 | 0 |
| Department of Sustainability and Environment, Vic. | | | | | | | | | | | | | |
| Bethune, M | R | 24 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 |
| Beverly, C | R | 38 | 0 | 38 | 0 | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 |
| Christy, C | R | 43 | 0 | 43 | 0 | 0 | 0 | 0 | 0 | 43 | 0 | 0 | 0 |
| Duke, C | R | 52 | 0 | 0 | 52 | 0 | 0 | 0 | 0 | 52 | 0 | 0 | 0 |
| Duncan, R | R | 29 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 0 |
| Eigenraam, M | R | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Eigenraam, R | R | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Feikema, P | R | 41 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 0 | 0 | 0 |
| James, B | R | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Kesari, K | R | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Lane, P | R | 23 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 |
| Morris, J | R | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Sheridan, G | R | 15 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 |
| Wimalasuriya, R | R | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| Total | | 277 | 79 | 135 | 63 | 0 | 0 | 0 | 0 | 277 | 0 | 0 | 0 |
| Goulburn-Murray Water | | | | | | | | | | | | | |
| Feehan, P | C | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| Flowers, G | C | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Huggins, C | C | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Kellock, L | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Papworth, S | C | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 |
| Seker, M | C | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Smith, G | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | 90 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 88 | 0 |
| Griffith University | | | | | | | | | | | | | |
| Bunn, S | R | 8 | 0 | 3 | 0 | 0 | 0 | 5 | 0 | 8 | 0 | 0 | 0 |
| Fellows, C | R | 16 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 |
| Greenaway, M | R | 29 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 29 | 0 | 0 | 0 |
| Hughes, J | A | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Jenkins, G | R | 17 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 17 | 0 | 0 | 0 |
| Phillips, I | R | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Rickson, R | C | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 |
| Thomlinson, R | R | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Tisdell, J | R | 62 | 0 | 7 | 46 | 0 | 0 | 1 | 0 | 54 | 5 | 3 | 0 |
| Yu, B | R | 41 | 0 | 0 | 41 | 0 | 0 | 0 | 0 | 41 | 0 | 0 | 0 |
| Total | | 196 | 0 | 26 | 87 | 56 | 0 | 6 | 0 | 175 | 5 | 15 | 1 |
| Melbourne Water | | | | | | | | | | | | | |
| Duncan, H | R | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| Francey, M | R | 23 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 23 | 0 | 0 | 0 |
| Hughes, C | C | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Rooney, G | C | 8 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 5 | 0 |
| Total | | 151 | 0 | 0 | 0 | 126 | 0 | 0 | 0 | 126 | 0 | 25 | 0 |

| Name | Main Activity | Total % Time | % Spent on Research Program (R) Subprograms | | | | | | | Total On Research | % Spent On Education Program (8)/(E) | % Spent On Commercialisation Program (7)/(C) | % Spent On Administration Program (9)/(A) |
|--------------------------|---------------|--------------|---------------------------------------------|----------|-----------|------------|----------|-----------|----------|-------------------|--------------------------------------|----------------------------------------------|-------------------------------------------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 10 | | | | |
| Monash University | | | | | | | | | | | | | |
| Codner, G | R | 26 | 4 | 0 | 2 | 20 | 0 | 0 | 0 | 26 | 0 | 0 | 0 |
| Deletic, A | R | 59 | 10 | 0 | 0 | 49 | 0 | 0 | 0 | 59 | 0 | 0 | 0 |
| Fletcher, T | R | 72 | 0 | 0 | 0 | 70 | 0 | 0 | 0 | 70 | 0 | 2 | 0 |
| Grove, J | R | 39 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 39 | 0 | 0 | 0 |
| Keller, R | R | 9 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 6 | 0 | 3 | 0 |
| Ladson, A | R | 37 | 0 | 0 | 0 | 15 | 4 | 18 | 0 | 37 | 0 | 0 | 0 |
| Mitchell, G | R | 47 | 0 | 0 | 0 | 47 | 0 | 0 | 0 | 47 | 0 | 0 | 0 |
| Mudd, G | R | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Weinmann, E | R | 21 | 0 | 0 | 15 | 0 | 0 | 0 | 2 | 17 | 0 | 4 | 0 |
| Wong, T | C | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Wootton, R | R | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Total | | 319 | 14 | 0 | 17 | 249 | 4 | 22 | 4 | 310 | 0 | 9 | 0 |

The University of Melbourne

| | | | | | | | | | | | | | |
|----------------|---|------------|-----------|----------|-----------|-----------|------------|-----------|----------|------------|----------|-----------|----------|
| Argent, R | R | 18 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 3 | 0 |
| Chiew, F | R | 47 | 0 | 0 | 0 | 6 | 27 | 0 | 0 | 33 | 0 | 14 | 0 |
| Downes, B | R | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 |
| Finlayson, B | R | 12 | 0 | 0 | 0 | 3 | 0 | 9 | 0 | 12 | 0 | 0 | 0 |
| Malano, H | R | 23 | 0 | 0 | 22 | 0 | 0 | 0 | 0 | 22 | 0 | 1 | 0 |
| McMahon, T | R | 6 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 4 | 0 | 2 | 0 |
| Peel, M | R | 20 | 8 | 0 | 0 | 0 | 12 | 0 | 0 | 20 | 0 | 0 | 0 |
| Pegram, G | R | 9 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 0 |
| Rutherford, I | R | 21 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 18 | 1 | 2 | 0 |
| Simmonds, I | R | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 |
| Siriwardena, L | R | 61 | 0 | 0 | 0 | 12 | 49 | 0 | 0 | 61 | 0 | 0 | 0 |
| Western, A | R | 32 | 4 | 3 | 0 | 0 | 18 | 7 | 0 | 32 | 0 | 0 | 0 |
| Total | | 254 | 27 | 6 | 22 | 21 | 110 | 45 | 0 | 231 | 1 | 22 | 0 |

STAFF – CRC FUNDED RESOURCES

| Name | Employing Organisation | Main Activity | Total % of Time | % Spent on Research Program (R) Subprogram | | | | | | | Total on | % Spent on Education Program 8/(E) | % Spent on Commercialisation Program 7/(C) | % Spent on Administration Program 9/(A) |
|---------------|------------------------|---------------|-----------------|--------------------------------------------|----|----|----|-----|----|----|----------|------------------------------------|--------------------------------------------|-----------------------------------------|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 10 | | | | |
| Draper, C | Bureau of Met | R | 8 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 |
| Frost, A | Bureau of Met | R | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| Austin, J | CSIRO | R | 7 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| Bridgart, R | CSIRO | R | 45 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 0 |
| Carrol, J | CSIRO | R | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| Chen, Y | CSIRO | R | 39 | 0 | 39 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 0 |
| Christen, E | CSIRO | R | 11 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |
| Coleman, J | CSIRO | R | 36 | 0 | 0 | 0 | 36 | 0 | 0 | 0 | 36 | 0 | 0 | 0 |
| Cuddy, S | CSIRO | R | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 |
| Davis, G | CSIRO | R | 63 | 54 | 9 | 0 | 0 | 0 | 0 | 0 | 63 | 0 | 0 | 0 |
| Dawes, W | CSIRO | R | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| DeRose, R | CSIRO | R | 62 | 0 | 0 | 0 | 0 | 0 | 62 | 0 | 62 | 0 | 0 | 0 |
| Ellis, T | CSIRO | R | 8 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 |
| Gee, S | CSIRO | C | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| Gilfedder, M | CSIRO | R | 12 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| Hornbuckle, J | CSIRO | R | 37 | 0 | 37 | 0 | 0 | 0 | 0 | 0 | 37 | 0 | 0 | 0 |
| Hotham, H | CSIRO | R | 34 | 3 | 27 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 4 | 0 |
| Khan, S | CSIRO | R | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Leicht, F | CSIRO | R | 27 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 |
| Lu, H | CSIRO | R | 16 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 |
| MacMullin, J | CSIRO | C | 81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 56 | 0 |
| Miller, T | CSIRO | R | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Murray, N | CSIRO | R | 48 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 0 | 0 | 0 |
| Perraud, J-M | CSIRO | R | 47 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 0 | 0 | 0 |
| Podger, G | CSIRO | R | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Rahman, J | CSIRO | R | 27 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 |
| Rassam, D | CSIRO | R | 36 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 0 |
| Read, A | CSIRO | R | 6 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 |
| Seaton, S | CSIRO | R | 56 | 37 | 19 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 0 |
| Stenson, M | CSIRO | R | 23 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 |
| Wallbrink, P | CSIRO | C | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 |
| Zhang, L | CSIRO | R | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Podger, G | DNR, NSW | R | 12 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| Owens, J | DNRM, Qld | R | 50 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 |
| Paul, L | DNRM, Qld | R | 33 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 |
| Reading, L | DNRM, Qld | R | 57 | 0 | 57 | 0 | 0 | 0 | 0 | 0 | 57 | 0 | 0 | 0 |
| Alder, L | Griffith Univ. | R | 42 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 42 | 0 | 0 | 0 |
| Beard, N | Griffith Univ. | R | 18 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 |
| Clements, S | Griffith Univ. | R | 6 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 |
| Conway, C | Griffith Univ. | R | 17 | 0 | 10 | 7 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 |
| Crooks, J | Griffith Univ. | R | 63 | 0 | 25 | 38 | 0 | 0 | 0 | 0 | 63 | 0 | 0 | 0 |
| English, C | Griffith Univ. | R | 35 | 0 | 5 | 30 | 0 | 0 | 0 | 0 | 35 | 0 | 0 | 0 |
| Lindberg, D | Griffith Univ. | R | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |

STAFF – CRC FUNDED RESOURCES continued...

| Name | Employing Organisation | Main Activity | Total % of Time | % Spent on Research Program (R) | | | | | | | Total on | % Spent on Education Program 8/(E) | % Spent on Commercialisation Program 7/(C) | % Spent on Administration Program 9/(A) |
|---------------|------------------------|---------------|-----------------|---------------------------------|------------|------------|------------|------------|------------|----------|--------------|------------------------------------|--------------------------------------------|-----------------------------------------|
| | | | | Subprogram 1 | 2 | 3 | 4 | 5 | 6 | 10 | | | | |
| Mahardika, H | Griffith Univ. | R | 25 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| Markwell, K | Griffith Univ. | R | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Marsh, N | Griffith Univ. | R | 42 | 0 | 0 | 0 | 0 | 0 | 42 | 0 | 42 | 0 | 0 | 0 |
| Murphy, B | Griffith Univ. | R | 26 | 0 | 0 | 26 | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 0 |
| Newton, D | Griffith Univ. | R | 4 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 4 | 0 | 0 | 0 |
| Polson, C | Griffith Univ. | R | 43 | 0 | 0 | 0 | 43 | 0 | 0 | 0 | 43 | 0 | 0 | 0 |
| Pudmenzky, C | Griffith Univ. | R | 6 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 |
| Stewart, B | Griffith Univ. | R | 6 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 6 | 0 | 0 | 0 |
| Strong, C | Griffith Univ. | R | 17 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 |
| Tisdell, J | Griffith Univ. | R | 38 | 0 | 5 | 33 | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 |
| Yu, B | Griffith Univ. | R | 16 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 |
| Duong, H L | Mon. Univ. | R | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Fletcher, T | Mon. Univ. | R | 28 | 0 | 0 | 0 | 28 | 0 | 0 | 0 | 28 | 0 | 0 | 0 |
| Padgham, M | Mon. Univ. | R | 25 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| Perry, D | Mon. Univ. | C | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 90 | 0 | 0 |
| Poelsma, P | Mon. Univ. | R | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| Argent, R | Univ. Melb. | R | 82 | 78 | 0 | 0 | 0 | 0 | 0 | 0 | 78 | 1 | 1 | 2 |
| Chiew, F | Univ. Melb. | R | 41 | 0 | 0 | 0 | 0 | 39 | 2 | 0 | 41 | 0 | 0 | 0 |
| Costelloe, J | Univ. Melb. | R | 45 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 45 | 0 | 0 | 0 |
| Fowler, K | Univ. Melb. | R | 17 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 |
| Grayson, R | Univ. Melb. | C | 100 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 20 | 45 | 20 |
| Harman, C | Univ. Melb. | R | 33 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 33 | 0 | 0 | 0 |
| Marsh, J | Univ. Melb. | R | 21 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 21 | 0 | 0 | 0 |
| McMahon, T | Univ. Melb. | R | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| Payne, E | Univ. Melb. | R | 25 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 25 | 0 | 0 | 0 |
| Stewardson, M | Univ. Melb. | R | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 |
| Tan, K S | Univ. Melb. | R | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 |
| Western, A | Univ. Melb. | R | 21 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 21 | 0 | 0 | 0 |
| Zhou, S | Univ. Melb. | R | 68 | 0 | 0 | 0 | 0 | 68 | 0 | 0 | 68 | 0 | 0 | 0 |
| TOTAL | | | 2,266 | 391 | 509 | 250 | 238 | 292 | 293 | 0 | 1,973 | 65 | 204 | 24 |

SUMMARY OF CONTRIBUTIONS IN PERSON YEARS (100% = 1 person year)

| | Total Equiv. 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 | 29.15 | 3.42 | 8.72 | 1.98 | 5.25 | 3.03 | 0.80 | 0.04 | 23.24 | 0.12 | 5.72 | 0.07 |
| TOTAL FUNDED BY CRC | 22.66 | 3.91 | 5.09 | 2.50 | 2.38 | 2.92 | 2.93 | 0.00 | 19.73 | 0.65 | 2.04 | 0.24 |
| GRAND TOTAL | 51.81 | 7.33 | 13.81 | 4.48 | 7.63 | 5.95 | 3.73 | 0.04 | 42.97 | 0.77 | 7.76 | 0.31 |
| Proportion of total professional staff resources in each activity | 100 | 14 | 26 | 9 | 14 | 12 | 7 | 0 | 82 | 2 | 15 | 1 |

SUPPORT STAFF (100% = 1 PERSON YEAR)

(1) Contributed

| Organisation | Number of Staff Person Years |
|-----------------------------|------------------------------|
| CSIRO | 0.00 |
| Griffith University | 0.00 |
| Monash University | 0.00 |
| The University of Melbourne | 0.00 |
| TOTAL | 0.00 |

(2) CRC Funded

| Organisation | Number of Staff Person Years |
|-----------------------------|------------------------------|
| CSIRO | 0.35 |
| Griffith University | 0.00 |
| Monash University | 3.25 |
| The University of Melbourne | 0.00 |
| TOTAL | 3.60 |



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 – 10 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 2004-2005 in Bold)
(Completed Projects in light)*



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 Natural Resources, NSW
- Department of Sustainability and Environment, VIC
- Goulburn-Murray Water
- Grampians Wimmera Mallee Water
- 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



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under the Australian
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Successor Organisation
In September 2005 the CRC for
Catchment Hydrology will cease.
Its successor is the eWater CRC.

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Telephone + 61 2 6201 5168
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www.ewatercrc.com.au