National Centre for
Groundwater Research and Training

Annual Report 2009

National Centre for Groundwater Research and Training

National Centre for Groundwater Research and Training

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Annual Report 2009

National Centre for Groundwater Research and Training

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Directors Report

The National Centre for Groundwater Research and Training (NCGRT) was born on June 10, 2009, out of a national desire to undertake major reforms in groundwater research and training in Australia. We all know too well the major significance of groundwater to this country and its vital role in water supply for agriculture, industry and in some cases even domestic water supply and the way in which groundwater sustains vital environmental flows to ecosystems. This joint venture between the Australian Research Council and the National Water Commission is one of the most significant investments in groundwater research and training in Australia's history.

Our aim is to create, develop and grow an enduring groundwater institution of national and international standing. The Centre will build capacity in groundwater knowledge and tackle the shortage of skilled groundwater scientists and managers in Australia and is an important centrepiece of the $105M National Groundwater Action Plan (GAP). We will conduct nationally and internationally significant and relevant research that is needed to improve groundwater understanding and management and will train honours and postgraduate students in advanced hydrogeological sciences, as well as the vital social, economic, legal and decision support frameworks that critically underpin water policy and management.

Hon Penny Wong Opening the Centre on 22 Jan 2009

The Centre is extremely fortunate to have 24 Chief Investigators, 5 Partner Investigators and 5 NCGRT Investigators, who are among the leading Australian scientists and academics working in groundwater and related areas. These come from our strong consortium of 12 University partners and 8 industry partners in the Centre. We have a truly national line-up of scientists, academics and industry partners.

Our first 6 months has been largely devoted to laying firm foundations on which to build the Centre and to key components of the establishment process. The Centre Executive Team is now in place and the Centre is very fortunate to have a group of bright, talented and hard working individuals, with wide and varied backgrounds and expertise, working to support it. I am also very fortunate to have a group of excellent Program Leaders who work closely with me on all aspects of Centre management, and in particular on our research and training agenda.

Together with the Program Leaders and our Chief Investigators, the Centre has been actively defining and refining an exciting and relevant research agenda – working across broad areas including innovative characterisation of aquifers and aquitards, complex modelling and hydrodynamics, surface water – groundwater interactions, groundwater-vegetation-atmospheric interactions, and integrating socioeconomics, policy and decision support into our groundwater analyses. These areas are designed to align with both key national priority areas reflected in, for example, the National Groundwater Assessment Initiative and National Water Initiative, as well as the clear international trend that groundwater hydrology in the 21st century will be a rich and vibrant blend of interdisciplinary sciences associated with core groundwater interacting seamlessly with vital biophysical (e.g., surface water, climate sciences, ecologyl) and socioeconomic and human interfaces as part of an integrated, whole of system approach to understanding and managing water in the water cycle. A number of distinguished international scholars will visit the Centre this year as part of our Centre International Visiting Scholars program.

The Centre has been working hard to fill some 58 positions for postdoctoral fellows, PhD students and Honours students in our first intake for 2010. Our focus has been on attracting the best national and international research talent to Centre in order to develop the next generation of groundwater professionals who will play a key role in ensuring that Australia's groundwater resources are managed in an integrated and sustainable manner. Our first recruitment drive was very successful and attracted in excess of 400 applications from students nationally and internationally. We have successfully begun to fill key positions in the Centre and students and postdoctoral fellows have commenced their studies and positions.

We have also established strong governance structures and decision making groups that advice the Centre. Our centre Program Leaders continue to work hard and provide major high level leadership across a large range of Centre matters.

Our Centre Advisory Board is a multiskilled group of very senior individuals who provide me and the Centre with high level, strategic and prudent advice on all of our operations and the Board has had three very successful meetings to date.

Our International Scientific Advisory Committee is comprised of truly renowned scientists in groundwater and broader water resources management and had its first successful meeting in Australia in early February this year to provide advice on Centre operations, international benchmarking of our research programs and significant feedback on research strategy and technical matters pertaining to it.

The Centre aims to establish strong national and international networks and linkages and to establish and develop strong, collaborative relationships with research, education, industry and government sectors. The Centre will continue to consult and work closely with the national groundwater industry on projects that are of key importance to groundwater in Australia.

The Centre's highly successful short course program is poised for another strong year of professional training for the groundwater industry in 2010 with a strong line up of short courses, including the new National Groundwater Field Methods School which has been designed to be the "sister school" to the theory-lecture based National Groundwater School. The Centre has recognised the urgent need for improved training in field methods.

Our Industry Liaison Committee plays a vital role in direction setting for the Centre and in informing the business we do, including direction setting for the National Groundwater Short Course program. We believe that it is absolutely critical that the groundwater industry and wider stakeholders have continued and varied opportunities to provide input into the Centre and to engage closely with us in our activities on all levels. To that end, it our vision that the Centre will have world class priority setting processes that allow us to make clear, transparent and well-informed decisions about the work we will do and will not do that are supported by solid rationale and justification for decision making. Wide consultation and stakeholder input and communication will be an ongoing and critical component of Centre priority setting processes and I welcome your comments and feedback at all times. Importantly, the Centre has almost completed its Strategic Plan and this will be available very shortly for feedback and comment.

In addition to an initial investment of $30million from the Commonwealth Government, and an additional $10million from Centre University and industry partners, the Centre has been successful in obtaining a further $15 million from the Commonwealth Government's Super Science Funding to establish high level groundwater monitoring and investigation infrastructure in the nation. This investment aligns with the Centre's capacity building strategy and a focussed number of highly instrumented field sites will provide outstanding facilities and opportunities for Centre staff and students, and the wider Australian hydrologic community, to undertake world-class projects that enhance our ability to understand the often very complex groundwater systems. This instrumentation will offer a much higher level of spatial and temporal data resolution in groundwater systems than has been typical in many large water resource assessments. Super Science sites will be located around the nation. We have already selected sites at Wellington (NSW), Ti Tree (NT), Willunga Basin (SA) and Namoi (NSW) and hope to make our final site selections in 2010.

The first 6 months of the Centre's life has been committed to establishing solid foundations from which to grow. The Centre is now poised for major national and international capacity building, training and research on an unprecedented scale. The NCGRT is an outstanding opportunity for students and researchers from Australia and other countries around the world who work in many disciplines, not just those already involved in groundwater.

I would like to thank all of the Centre staff, students, our University and Industry partners, for their ongoing support and commitment to making this Centre a success. I look forward to working with the Australian groundwater community in the coming years to secure the sustainable management of Australia's precious groundwater resources.

Craig T. Simmons
Director
National Centre for Groundwater Research and Training

Our Role and Functions

The National Centre for Groundwater Research and Training was established in June 2009 to support novel, innovative and cross-disciplinary research training in the field of groundwater. The Centre's activities will enhance and underpin the Commonwealth Government's National Water Initiative.

The Centre is jointly funded by the Australian Research Council (ARC) and the National Water Commission (NWC) under the Special Research Initiatives Scheme.

The Centre is administered by Flinders University with research nodes based at University of New South Wales, the Australian National University and The University of Queensland.

Our Partners

The Centre is proud to have the following partners:

Universities

Flinders University
Charles Sturt University
James Cook University
Latrobe University
Monash University
Queensland University of Technology (QUT)
The Australian National University (ANU)
The University of New South Wales (UNSW)
The University of Queensland (UQ)
The University of Western Australia (UWA)
University of South Australia (UniSA)
University of Technology Sydney (UTS)

Government Departments and Organisations

Commonwealth Scientific and Industrial Research Organisation
Geoscience Australia
NSW Department of Primary Industries
NSW Science Leveraging Fund
SA Department of Water, Land and Biodiversity Conservation

Industry Partners

Aquaterra Consulting Pty Ltd
SA Water
Sinclair Knight Merz (SKM) Consulting Pty Ltd
United Water International

NCGRT Overview

Aims

The National Centre for Groundwater Research and Training aims to establish and operate a national centre of excellence in groundwater research and training to enhance Australia's future environmental, economic, social and cultural wellbeing.

Goals

Research

- Undertake highly innovative and relevant research in groundwater and related fields with a scale and focus leading to outstanding national and international collaboration and recognition.
- Establish explicit links to the National Water Initiative.

Building Capacity in Australia's groundwater profession

- Attract and retain researchers of high international standing from within Australia and overseas, as well as the most promising research students.
- Provide high quality postgraduate and post-doctoral training environments for the next generation of professionals and researchers.
- Offer Australian researchers and groundwater professionals access to world-class infrastructure, training, equipment and key research information and technologies.
- Provide high quality non-research and professional training programs.

Linkages

- Provide an effective resource for the groundwater sector by establishing and developing strong, collaborative relationships with the research, education, industry and government sectors and serving as a point of interaction among these sectors.
- Establish and develop international networks and linkages.

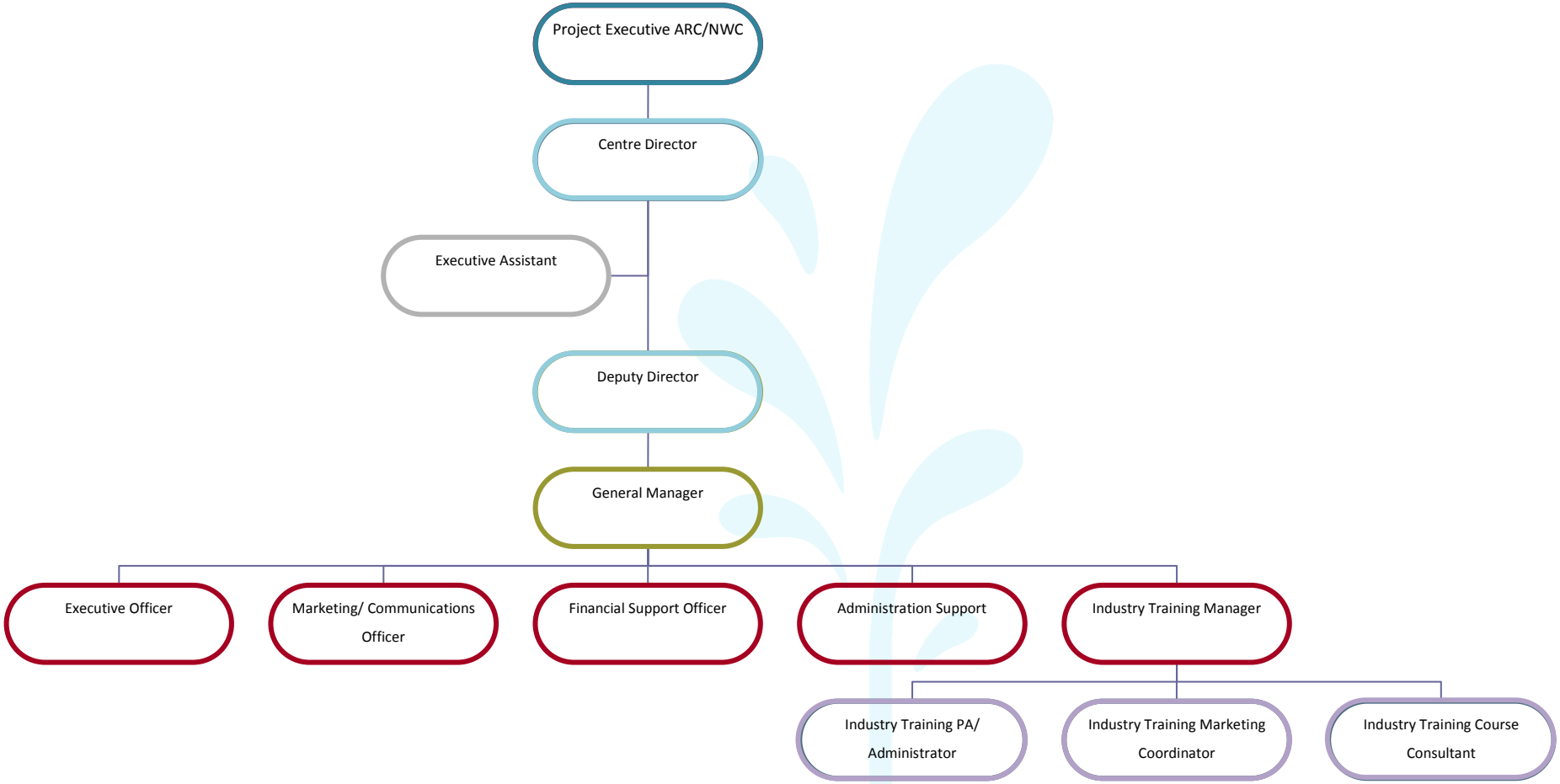
Outreach

- Communicate, utilising a range of methods/mediums, the science undertaken in the Centre to the general public.

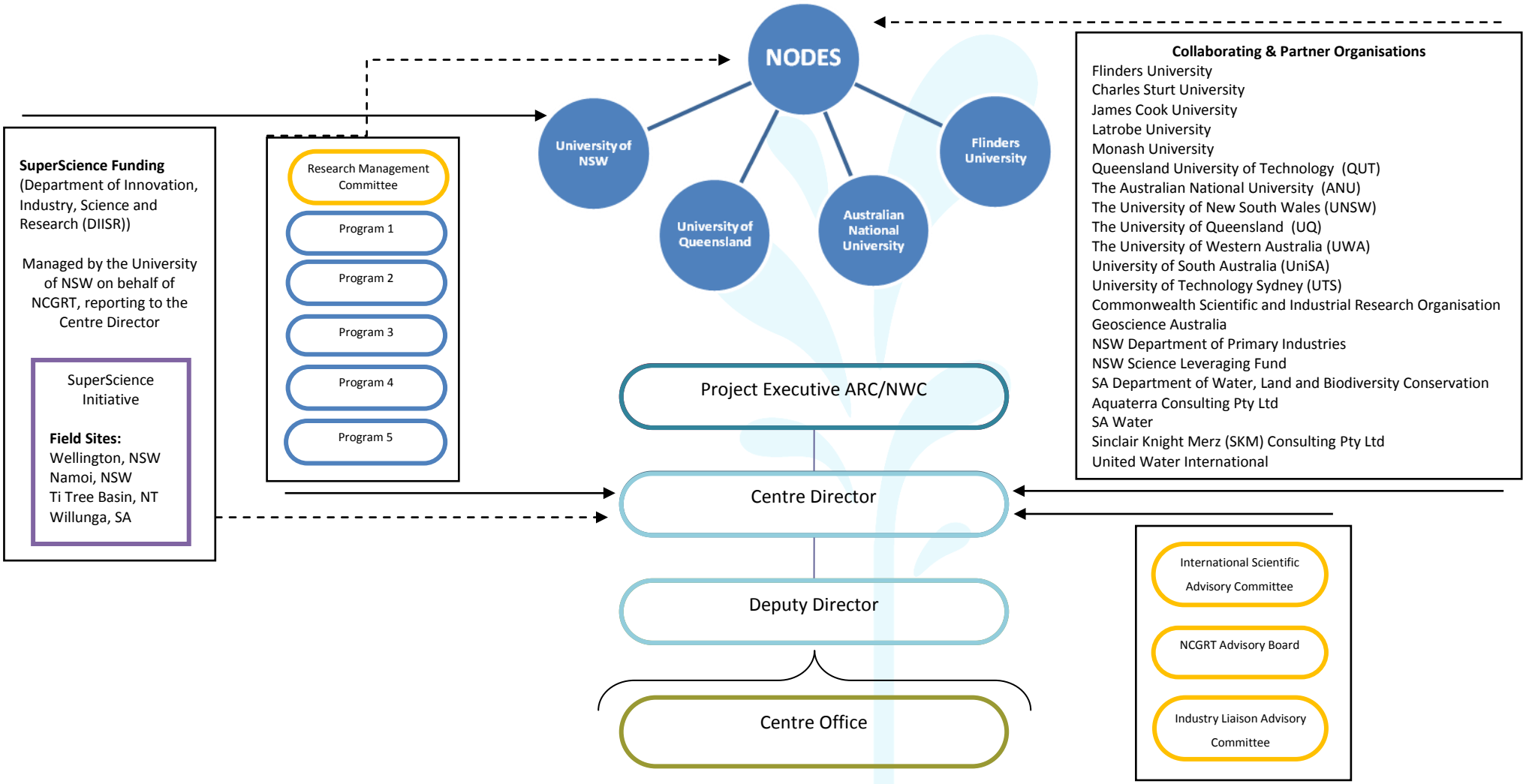
Governance

- Strategically manage and direct the Centre, including reporting and financial administration.

Centre Office Structure



Centre Governance and Collaborating Structure



Introducing Our People

The Centre Management and Administration Team

Professor Craig T. Simmons

Director

Mr Trevor Pillar

Industry Training Manager

Professor Peter Cook

Deputy Director

Mrs Glenys Flight

Industry Training PA/ Administrator

Ms Ann-Maree O'Connor

Executive Officer

Ms Lauren Moore

Industry Training Marketing Coordinator

Mrs Margaret Rafferty

Personal Assistant

Mr Joel Voortman

Industry Training Course Consultant

Mrs Megan Spyker

Executive Assistant

Mrs Sue Zammit

Finance Officer

Miss Zoe Smith

Administrative Officer

The Centre's General Manager, Kay Brown, and Executive Officer, Joanne Barbaro were appointed in December 2009 and will join the team early in the New Year.

Program Leaders

Program 1: Innovative Characterisation of Aquifers and Aquitards

Program Leader: Professor Ian Acworth, University of New South Wales

Program 2: Hydrodynamics and Modelling of Complex Groundwater Systems

Program Leader: Professor Craig Simmons, Flinders University

Program 3: Surface Water – Groundwater Interactions

Program Leader: Professor Peter Cook, Commonwealth Scientific and Industrial Research Organisation and Flinders University

Program 4: Groundwater-Vegetation-Atmosphere Interactions GVI)

Program Leader: Professor David Lockington, University of Queensland

Program 5: Integrating Socioeconomics, Policy and Decision Support

Program Leader: Professor Anthony (Tony) Jakeman, The Australian National University

Biographical information on all our Program Leaders is located at Appendix A

Chief and Partner Investigators

Professor Ian Acworth, UNSW

Dr Martin Andersen, UNSW

Dr Ross Brodie, GA

Professor Ian Cartwright, Monash

Professor Peter Cook, CSIRO/Flinders

Ms Jane Coram, GA

Associate Professor Malcom Cox, QUT

Dr Barry Croke, ANU

Professor Alan Curtis, CSU

Dr Edoardo Daly, Monash

Professor Derek Eamus, UTS

Associate Professor Alex Gardner UWA

Dr Massimo Gasparon, UQ

Dr Huade Guan, Flinders

Professor Neil Gunningham, ANU

Dr Glenn Harrington, CSIRO/Flinders

Associate Professor Bryce Kelly, UNSW

Dr Marc LeBlanc, JCU

Professor Ling Li, UQ

Professor David Lockington, UQ

Dr Andrew Love, Flinders University

Associate Professor Catherine Lovelock, UQ

Dr Matthew McCabe, UNSW

Professor Jennifer McKay, UniSA

Dr David Mitchell, NSW DPI

Professor David Pannell, UWA

Dr Carmel Pollino, ANU

Professor Craig Simmons, Flinders

Dr Wendy Timms, UNSW

Associate Professor John Webb, La Trobe

Dr Adrian Werner, Flinders University

Biographical information on all of our Chief and Partner Investigators is located at Appendix B

Our Post Doctoral Fellows, PhD's and Honours Students

Student recruitment is a key foundation and core activity for the Centre. The Centre received over 400 applications through its inaugural recruitment process from students within Australia and abroad. Through a detailed evaluation and selection process, the Centre selected its first recruits for 2010. The following table identifies the post doctoral fellows, PhDs and Honours students who accepted positions with the Centre as at 31 December 2009:

STUDENT NAME	PROGRAM 1	PROGRAM 2	PROGRAM 3	PROGRAM 4	PROGRAM 5
HONOURS					
Ms Katie Le Avery	X				
Mr Ed Kearney	X				
Ms Kathryn Ludowici	X				
Ms Malinda McDonell	X				
Mr Luke Filmer		X			
Mr Chris Turnadge		X			
Mr Tariq Laattoe		X			
Mr Dylan Irvine		X			
Mr Matthew Knowling		X			
Ms Julie Guerin			X		
Miss Alison Kaczmarek			X		
Ms Amanda Trejis			X		
Mr Leighton Randell				X	
Mr Carl Zimmerman					X
Miss Alice Drummond					X
PhD					
Mr Adam King	X				
Mr Douglas Anderson		X			
Miss Danica Jakovovic		X			
Mr Yuequing Xie		X			
Mr Carlos Ordens		X			
Ms Jessica Liggett		X			
Mr Ty Watson		X			
Mr James McCallum		X			
Ms Tricia Williams		X			
Miss Louise Anders			X		
Miss Sarah Bourke			X		
Miss Saskia Noorduijn			X		
Mr Nicholaas Unland			X		
Mr Chani Welch			X		
Ms Nadia Santini				X	

Mrs Sepideh Zolfagher				X	
Mr Parikshit Verma				X	
Mr Zhijuan Deng				X	
Mr Josh Dean				X	
Miss Cecilia Azcurra	X			X	
Miss Rebecca Higgins	X			X	
Ms Rachel Blakers					X
Mr Joseph Guillaume					X
Miss Madeleine Hartley					X
Ms Elena Bendi					X
Ms Alison Wilson					X
Ms Emily Barbour					X
POSTDOCS					
Mr Jeremy Stalker	X				
Dr Leonardo David Donald		X			
Dr Behzad Ataie-Ashtiani		X			
Dr George Kourakos		X			
Dr Lieke van Roosmalen		X			
Dr Jordi Batle-Agullar			X		
Mr Adrien Guyot				X	
Dr Cate McInnis-Ng				X	
Dr Hoori Ajam				X	
Ms Sondoss El Sawah					X
Mr James Skurray					X
Dr Michael Mitchell					X
Dr Darren Sinclair					X

In 2010 the Centre carried out a “stocktake” to evaluate where student and postdoctoral targets have and/or have not been met (refer to the Building Capacity section on page 21 for the recruitment targets per program). Where targets had not been met, individual research nodes to undertake highly targeted advertising to fill any gaps that may exist. This will involve highly targeted recruitment drives throughout the February-March 2010 period. The 2011 recruitment drive will commence in mid-2010.

Achievements, Highlights and Activities Report

This section of the report outlines our objectives for the first six months of our operation.

Research

Our key objectives in 2009 were to:

- Define the Centre's key areas of research focus, having consulted our key stakeholders regarding current knowledge gaps and future research needs;
- Convene a Research Management Committee to develop the Centre's Research Plan and the strategy for recruiting the staff and students who would play the critical role in delivering it;
- Identify and develop the systems and processes necessary to support the delivery of integrated, inter-disciplinary work; and
- Convene an international panel of groundwater experts to review the quality of our proposed research programs; and whether we had sufficient resources and ambition.

Defining knowledge gaps and research needs

The Centre was not created in a research vacuum. At the date of the Centre's launch in June 2009 there was already a consistent view across the policy, science, and industry communities that Australia's critical groundwater research gaps were in the areas of:

- Surface water — groundwater interactions and connectivity;
- Groundwater dependent ecosystems;
- Groundwater — vegetation interactions;
- Aquifer storage and recovery/managed aquifer recharge;
- The impacts of climate change/variability on the nature of groundwater across Australia;
- Impacts of forestry management on groundwater systems; and
- Groundwater management and jurisdictional issues, including issues impacting on Indigenous communities and their country.

It is no coincidence that these gaps resonate with the NGAI priority investments areas which are:

- Harmonisation of groundwater definitions and standards and improved governance and management practices;

- Northern Australia Groundwater Stocktake;
- National assessment of sites suitable for managed aquifer recharge and recovery;
- Vulnerability of groundwater dependent ecosystems;
- Investigation of groundwater-surface water inter-connectivity;
- Strategic aquifer characterisation to quantify sustainable yields;
- National review of groundwater potential for deep fresh, saline and brackish waters; and
- Managing risks to groundwater quality.

Against this background the Centre's key challenge was to translate the intelligence that had been gathered to date into a coherent and integrated research program. The Centre has achieved this by:

Appointing its Research Management Committee (RMC)

This Committee is responsible for coordinating all research and research-training activities of the Centre. In particular it:

- provides advice and support to the Centre Director on broad issues including research capacity building, linkage, Super Science funds and outreach;
- provides direction on the recruitment strategies and processes, and coordination of the selection of personnel;
- monitors Research Program performance, and develops strategies to address risks and maximize opportunities;
- identifies new research and training opportunities for the Centre;
- develops guidelines, protocols and policies to enable the Centre to manage research related matters such as IP, publications, research data management, and dissemination of research outcomes;
- develops research incentive schemes including awards and prizes, and travel and internship opportunities; and
- coordinates the Centre's International Visiting Scholars Program.

The RMC is comprised of our Research Program Leaders. In addition to coordinating program deliver, Program Leaders have the specific portfolio responsibilities outlined below:

RESEARCH PROGRAM	PROGRAM LEADER	RESEARCH MANAGEMENT COMMITTEE PORTFOLIO ROLE
1	Prof. Ian Acworth (UNSW)	Super Science funding coordinator
2	Prof. Craig Simmons (FUSA) **(Chair)**	Centre Director
3	Prof. Peter Cook (FUSA/CSIRO)	Centre Deputy Director; Industry liaison, communications and outreach
4	Prof. David Lockington (UQ)	Research training coordinator
5	Prof. Tony Jakeman (ANU)	Data management coordinator

The RMC members played a critical role in helping develop the Centre and have been meeting formally as the RMC since June 2009.

Defining our research programs

The RMC has developed five Research Programs which focus on developing core groundwater science and understanding its associated economic, environmental and social interfaces. (All five programs have been discussed in some detail above). We have also developed a detailed Research Plan which describes the detailed operational description of each program and sub-program.

Undertaking a National Tour to confirm end-user needs

The Centre Director and Deputy Director completed an extensive National Tour of key stakeholders to assess their research needs, and to identify potential collaboration opportunities. This process played an important role in promoting awareness of the Centre and building the relationships that will be critical to our long term success.

Recruitment

The Centre has also recruited a team of 34 world-class research Investigators which includes 24 Chief Investigators (CIs); 5 Partner Investigators (PIs); and 5 NCGRT Investigators (researchers whose time allocation to the Centre is 10% or less of their total work). This makes the Centre one of the strongest groupings of groundwater investigators anywhere in the world.

We have also finalised our Scholarships Framework and developed a range of scholarship awards which will assist the Centre in its efforts to attract researchers of high international standing as well as the most promising research students.

Delivering effective research project management

We have commenced work on developing the systems that will be required to manage and measure research performance in a transparent, consistent and timely manner. This work includes the development of our data management strategy and ongoing discussions with our Partners and Collaborating Organisations regarding the optimal intellectual property arrangements that must be put in place.

We have also started work on defining the Centre's ideal research culture, the type of environment that we want to provide our staff and students, and the processes and the leadership behaviours that will be necessary to support it.

Work on priority setting processes has commenced

We have started work on developing the priority setting processes that will enable the Centre to systematically review the quality of its research and training activities, and give it the flexibility to respond to new challenges and opportunities as they arise.

International Scientific and Advisory Committee (ISAC) Appointed

We were pleased to secure the agreement of four eminent international groundwater scientists to serve on the Centre's International Scientific and Advisory Committee (ISAC).

The Committee will help review and evaluate the Centre's research and training programs, and help benchmark performance. The Committee members will also provide us with access to rich international networks which will help us identify potential collaboration and partnership opportunities.

The ISAC Committee members are:

MEMBERS	ORGANISATIONS
Emertius Professor Ghislain de Marsily	University of Paris VI, France
Dr Leonard Konikow	U.S. Geological Survey, USA
Professor Daniel Loucks	Cornell University, USA
Professor Edward Sudicky	University of Waterloo, Canada
Professor Craig Simmons **(Chair)**	Centre Director

Building Capacity

Our key objective in 2009 was to start translating the Centre's vision into reality by commencing its recruitment drive for Postdoctoral, PhD and Honours students. Preparations for the recruitment campaign, including the

finalisation of our Recruitment Plan, commenced almost immediately after the Centre's launch in June 2009. We are pleased to report that our marketing and communication campaign produced 400 applications for the vacancies that were available during the first recruitment round.

Many of the recruitment interviews and referee checks were still being conducted at the date of this report. However the following table outlines our recruitment targets as at 31 December 2009.

		Program 1	Program 2	Program 3	Program 4	Program 5
Post Docs	Target	5	4	5	4	6
PhDs	Target	4	4	4	4	4
Honours	Target	3	2	3	3	3

The Centre's recruitment processes are ongoing and we have initiated a stocktake to identify critical gaps and determine the process for addressing them. Our priority in 2010 is to fill the remaining gaps through targeted recruitment processes at each research node.

Linkages

Our priority over the last six months has been to develop a Stakeholder Engagement and Communication Strategy. This process is well advanced, and our stakeholder mapping work has helped us identify the stakeholders who will help us drive and support change in the areas of groundwater research and training. This has provided strong foundations for the more detailed work that we will be undertaking in 2010 on our knowledge transfer strategy.

Our other key successes in 2009 were:

- securing $15 million funding from the SuperScience Initiative funded by the Department of Innovation, Industry, Science and Research. The Centre will use this funding to establish high level groundwater monitoring and investigation infrastructure throughout Australia;
- securing $989,000 from the New South Wales State Government Science Leverage Fund to enhance the Centre's research programs and support the dissemination of our research results through a New South Wales Government portal;
- securing $900,000 from partners in South Australia (including the South Australian Department of Water, Land and Biodiversity Conservation, SA Water, United Water and Sinclair Knight Merz) for research investments in South Australia, including the development of the Super Science site; and

- initiating discussions with the Danish Hydraulic Institute (DHI) to enable Centre staff and students to work with DHIs world leading hydrology and groundwater research team who produce some of the modeling software that will be used by the Centre.

In addition to this we have developed an International Visiting Scholars Program and Distinguished Guest Lecture series. However the dividends from this work will not accrue until 2010. We have also pressed ahead with our plans to have a major presence in the International Association of Hydrogeologists (IAH) Congress that will be in Perth in 2013. We also hope to have a solid presence at the fourth Australasian Hydrogeology Research Conference in 2011.

The Centre has also continued to have discussions with eWater CRC in relation to the National Hydrologic Modeling strategy, and the Bureau of Meteorology in relation to the development of the Centre's data management strategies.

Industry Liaison Advisory Committee (ILAC)

We have established an Industry Liaison Advisory Committee (ILAC) to provide a mechanism to enable the broad range of professionals engaged in the groundwater industry to have open and regular communication with the Centre. Developing strong relationships between the research, training and industry communities is one of the Centre's key aims. The ILAC Committee will play an important role in reviewing and refining our research and training activities. It will also help us identify the tools and opportunities necessary to facilitate effective knowledge transfer from (and indeed between) the research base and industry.

The Committee's terms of reference have been developed and its members are as follows:

MEMBER	ORGANISATION
Dr Phil Commander **(Chair)**	President, Australian Chapter, International Association of Hydrogeologists
Mr Blair Douglas	BhpBilliton Resource Planning
Mr Andrew Kelly	Groundwater Users and Managers (GUMS); North Burdekin Water Board
Mr Kym Good	Adelaide and Mount Lofty Ranges NRM Board
Mr Ian Lancaster	Natural Resources, Environment, The Arts and Sport, NT
Ms Jennifer Fraser	Department of sustainability and Environment, Victoria
Mr Michael Williams	NSW Office of Water
Mr Tony McLeod	Murray Darling Basin Authority
Dr John Waterhouse	Consulting: Golder Associates
Mr Peter Hyde	National Water Commission (Commonwealth Observer)

Outreach

The 2009 priorities for our Outreach program were to:

- arrange the Centre's official launch;
- develop the Centre website and supporting content;
- develop posters, brochures and newsletters; and
- establish a marketing and communications plan.

We are pleased to report that we completed all of these items. We have also initiated discussions with the Primary Industry Centre for Science and Education with a view to developing groundwater training and outreach activities in high schools throughout Australia. We are continuing to work with the organisers of the Tall Poppy Campaign to try and promote recognition of Australia's outstanding groundwater scientists and encourage younger generations to undertake further studies and careers in the area.

Our only minor disappointment related to the fact that we were unable to appoint a Marketing and Communications Manager. However we are confident of making an appointment in early 2010.

Management and Governance

As is inevitable with any new start up organisation our key focus during 2009 has been on:

- Developing and executing our 2009 Business Plan;
- Commencing work on 2010-2014 Strategic Plan so that the Centre has a clear vision, purpose and direction;
- Building our management team;
- Appointing members to our Advisory Board and other technical and advisory committees so they could become operational;
- Completing the transfer of the former Centre for Groundwater Studies business operation into the Centre; and
- Commencing work on the Centre's strategic priority setting processes.

Our recruitment process has been successful with appointment of the Centre's Deputy Director, General Manager and Executive Officer all being completed. We have appointed members to our Advisory Board namely:

MEMBER	ORGANISATION
Dr Tom Hatton **(Chair)**	Director, Water for a Healthy Country Flagship, CSIRO
Mr Ken Matthews	CEO, National Water Commission & GTAC member
Prof Suzanne O'Reilly	Director, ARC National Key Centre for Geochemical Evolution and Metallogeny of Continents (GEMOC)
Prof Carl Schiesser	Director, ARC Centre of Excellence for Free Radical Chemistry and Biotechnology
Mr John Ruprecht	Director, Water Resources Management Department of Water WA
Mr Neil Power	Chair, National Groundwater Working Group & Group Manager, Resource Knowledge & Science, SA Dept Water, Land & Biodiversity Conservation
Dr John Radcliffe	Former National Water Commissioner & Former Groundwater Sponsoring Commissioner
Mr Garry Smith	Formerly of Goulburn-Murray Water; Advisory Board of E-water CRC; current Director, DG Consulting Pty Ltd
Dr Eileen Doyle	Chair, Port Waratah Coal Services, Hunter Valley Research Foundation; Director, One Steel, Hunter Medical Research Institute, State Super Financial Services, Ross Human Directions Ltd, Steel & Tube Ltd, New Zealand; member of the CSIRO Board; Conjoint Professor, Graduate School of Business, University of Newcastle.

The Advisory Board will provide strategic advice to the Centre Director on a broad range of issues including its research, training, partnership and public awareness activities. The Board held its first meeting in August 2009 which was an important milestone for the Centre. A second Board meeting was held in November 2009.

As noted above, we have also made appointments to Research Management Committee, Industry Liaison and Advisory Committee, and International Scientific and Advisory Committee. All committees have agreed terms of reference. The Research Management Committee has been operational since June 2009. The remaining Committees will convene their first meetings in the first quarter of 2010.

The inaugural meeting of our Advisory Board. In attendance: Mr Neil Power, Mr John Ruprecht; Dr Tom Hatton (Chair), Professor Craig Simmons. Seated: Mr Ken Matthews, Mr Garry Smith, Professor Carl Schiesser

We have devoted a significant amount of time to identifying the internal policies and systems that are necessary to support high-quality, evidence-based decision making. This scoping work is a crucial part of building a sustainable and responsive Centre. Now that the Centre management team is in place we will make significant progress in the management and governance areas in 2010. One area of Key focus in 2010 will be finalizing the centre's strategic priority setting processes following consultation with our Key Stakeholders.

We have also completed the wind up of the Centre for Groundwater Studies operation and were pleased to welcome their four highly experienced industry training professionals into our team.

Board and Committees: June –December 2009

	MEETINGS (number)	NUMBER OF MEMBERS	EXTERNAL MEBMERS
Advisory Board	2	9	Yes
Research Management Committee	Fortnightly	5	No
Senior Centre Management Team	Weekly	4	Yes

Super Science

Work on the Super Science project is progressing well and a number of research sites have been assessed against a comprehensive suite of selection criteria. At this point, four field research sites have been chosen namely: Namoi (NSW), Ti Tree (NT), Willunga (SA), and Wellington (NSW). The Centre hopes to finalise the selection of a fifth field site by June 2010.

Centrifuge

Progress on finalising the arrangements for the design and installation of the centrifuge have taken slightly longer than expected. Although the delay is disappointing, it has not had a material impact on research activities. We expect the contract for the supply of the centrifuge will be executed at the beginning of 2010, with work on the construction of the centrifuge laboratory commencing mid-year. We are also in the process of recruiting a specialist centrifuge engineer and hope the successful candidate will start work with us early in 2010.

Overview of Research Programs

For the first time researchers and professionals from many disciplines are pooling their expertise in five major research programs to unlock the secrets of Australia's sub surface water systems. These programs reflect extensive consultations with state governments and industry: those who manage our water and the technologies and systems that are required to deliver it to users.

Groundwater is often called the forgotten resource. Despite the fact that groundwater accounts for over 30 per cent of Australia's water consumption, we simply do not know enough about this vital water resource, and how to manage it. With severe droughts and climate change placing extreme pressure on existing water supplies, there is an urgent need to expand this knowledge base.

The NCGRT will coordinate the efforts of nearly 200 Australian and international researchers – many of whom are internationally recognised as leaders in their fields. Using the latest technology and infrastructure, our researchers are pioneering new hydrogeological research methods to investigate pressing questions relating to aquifers and aquitards; water flows in complex subterranean systems; and the largely unexplored link between surface water and groundwater.

NCGRT research teams are studying groundwater-dependent ecosystems and the potential impact of climate change, while legal and policy experts are examining the highly complex area of socio-economics, policy-making and management.

Through its major training and capacity building program, the NCGRT will deliver an understanding of our groundwater systems that will be critical for Australia's future water security.
Our Research Programs explore the key questions from the basic understanding of groundwater origins and processes, through groundwater interactions with surface water, vegetation, and the environment, to the decisions we are taking about the management of this resource.

Program 1: Innovative Characterisation of Aquifers and Aquitards

Program Leader: Professor R Ian Acworth (University of New South Wales)

International Visiting Scholars:	Prof. Clayton Deutsch (University of Alberta)
	Prof. Philippe Renard (University of Neuchâtel)
	Prof. Jim Hendry (University of Saskatchewan)
	Prof. Dieke Postma (Technical University Denmark)
	Prof. John M Sharp, Jnr. (University of Texas)

Key Investigators:	CI Acworth	CI Timms	CI Kelly
	CI Andersen	CI Baker	CI McCabe
	PI Cook	CI Cox	PI Brodie/PI Mitchell

Groundwater management decisions usually rely on models that are based upon very simple conceptual representations of subsurface processes. Normally, a severe or complete lack of data is acknowledged and a general conceptual model is applied. It is now widely accepted that this level of conceptualisation can be grossly misleading (Poeter, 2005).

Future advances in understanding groundwater systems will rely heavily on an increased ability to measure subsurface parameters at increasing spatiotemporal resolution. Lachassagne (2005) identified major inadequacies in available hydrogeologic conceptualisation and field measurement methodologies that this program is directed at overcoming.

Sub-program 1A: Linking Geological and Hydrogeological Processes

Regional hydrogeologic data such as hydraulic head and conductivity data are typically of low density. Building conceptual 3D geological models of aquifers therefore requires interpolation of data and the combination of hard data (data collected from bores) with soft data (geophysical surveys). This is best achieved with computer based interactive 3D geological models where multiple data sets can be stored, accessed and visualised. A particular problem encountered in building these models is that, while the current interpolation algorithms for estimating values at non-sampled locations honour the geostatistical properties of the data (Renard, 2007), if naively applied, they can lead to serious misinterpretation of the hydrogeology (palaeo river channels running up hill, for example). This research will focus on how to blend geostatistical methods with geological rules.

Sub-program 1B: Characterising Aquitards

Lack of knowledge of the moisture content, storage, hydraulic conductivity and water quality of the many aquitards that overlie critical groundwater acquifers in Australia is a major threat to groundwater resource security. Aquitards surround many aquifers and because they have a comparatively high storage capacity, they will control the hydraulics of aquifers in the long term (Remenda, 2001).

Over very long time scales, diffusional losses mean that they also play a vital role in aquifer water quality. Neuzil (2003) stressed the importance of understanding the hydromechanical coupling within these systems and McMahon (2001) illustrated the importance of the mixing zone between aquifers and aquitards. Neuzil also noted that time constraints are a major problem in testing many of the physical properties of aquitards using field techniques such as drawdown tests. The timescale problem will be overcome through the use of a large, high-speed centrifuge from which permeability and characteristic moisture curves of drill core samples can be derived.

This sophisticated equipment also allows the extraction of water samples for chemical analysis and will be a unique resource in Australia. The program will characterise both the hydraulics and chemistry (major anions, cations, stable isotopes, ^{36}Cl) of low permeability strata with the view to better estimating the potential impact of water derived from these strata on groundwater quality and regional-scale aquifer dynamics. Various hydraulic, chemical and geophysical methods (e.g. microgravity methods for measuring subtle changes in water content of geologic materials) will be utilised and compared. Major advances in hydrochemistry will require techniques that allow better representative samples to be obtained (Glynn and Plummer, 2005) and this program directly addresses this urgent need.

Sub-program 1C: Heat as a groundwater tracer

Heat carried by groundwater serves as a tracer to identify groundwater-surface water interaction, flow through fractures, and flow patterns in groundwater basins (Anderson, 2005). Renewed interest in using heat as a groundwater tracer has emerged, largely a result of improved temperature sensors and relatively inexpensive data loggers, as well as improved numerical codes for simulating coupled groundwater flow and heat transport.

One of the most powerful uses of temperature data is in constraining groundwater model calibration. Anderson (2005) noted that additional studies of joint inversion of head and temperature data in a variety of hydrogeological settings are urgently needed to determine the general applicability and limitations of the method. Field measurements of heat will be conducted in both aquifer settings (e.g. regional-scale basin analysis, fractured rock settings) and at vital groundwater-environmental interfaces (e.g. in streams and coastal environments). The output from this research will enhance our theoretical understanding of heat transport processes and provide constraint to the modelling undertaken in other research studies such as in Subprogram 2C.

Sub-program 1D: Characterising Fractured Rock Aquifer Systems using hydraulic, hydrochemical and geophysical tools

While relatively robust procedures are available to characterise aquifers comprising primary porosity only (e.g., sandy aquifers), the characterisation of the spatial heterogeneity of fractured rock aquifers remains a significant problem (Cook, 2003; Krasny and Sharp, 2007). Gh. de Marsily (2005) identified the development of improved procedures for characterising fractured-rock systems as an important priority in a recent review of the subject. At present we do not know if there is a correlation between fracturing and depth, or fracturing and rock type, or if there is a correlation between the distribution of fractures observed at the surface and the hydraulically significant fractures at depth. Similarly, is there a correlation between the measured hydraulic conductivity and other physical factors such as lithology, alteration of the host rock, or topographic setting? Is there a correlation between fracture density determined from geophysical and lithologic mapping in boreholes and measured hydraulic conductivity? Is there a preferred orientation to the conductive fractures?

This research will focus on the development and use of hydraulic, hydrochemical (major ions, environmental tracers and isotopes) and geophysical (heat, down-hole geophysics) tools to investigate fractured rock systems at field sites on or close to the Wellington site. Major and minor ion concentrations and stable and radiogenic isotopes from both water and aquifer matrix samples will be established. Cores will be taken from the fractured rock aquifer and tested in the centrifuge. Both worldwide and in Australia, significant water resources are contained in fractured rock aquifers and the appropriate management of these resources is not possible without an adequate understanding of the aquifer characteristics. The project will improve our understanding of groundwater movement and water quality in fractured rock aquifers that vitally underpins fractured rock aquifer management.

Program 2: Hydrodynamics and Modelling of Complex Groundwater Systems

Program Leader: Professor Craig Simmons, Flinders University

Deputy Leader: Dr Adrian Werner, Flinders University

International Visiting Scholars:	Prof. Rene Therrien (University of Laval, Quebec)
	Dr Clifford Voss (US Geological Survey)
	Prof. Mary P. Anderson (University of Wisconsin, Madison)
	Prof. Wolfgang Kinzelbach (ETH, Zurich)
	Prof. Scott Tyler (University of Nevada)

Key Investigators:	CI Simmons	CI Werner	PI Cook
	CI Lockington	CI Li	CI Kelly

Numerical models form a vital and increasingly important component of modern quantitative hydrogeology; they are both a fundamental way of investigating complex groundwater hydrodynamics and an invaluable tool in the formulation of research questions and hypotheses. It is widely understood that as the sophistication of hydrogeologic conceptual models evolves major research challenges will be encountered on at least two levels: (a) the conceptual understanding of the inherent physics, chemistry and groundwater dynamics associated with these problems, and (b) the incorporation and simulation of increasingly complex groundwater processes in the numerical simulators used to understand them. A number of significant complex groundwater processes will be examined in this program using modelling as the investigative tool.

Sub-program 2A: Uncertainty in groundwater flow estimation

Estimating groundwater flow rates in heterogeneous aquifers remains a critical challenge for modern quantitative hydrogeology. Commonly-used approaches rely on hydraulic methods (e.g. pump tests) as a basis for using Darcy's Law, or environmental tracers (e.g. CFC's, ^{14}C and ^{3}H) for estimating groundwater age. Previous studies have assessed uncertainty separately in these approaches (de Marsily, 2005). This Sub-program is, however, the first systematic and unified theoretical assessment of the two approaches.

Hydraulic and tracer approaches will be simulated in a heterogeneous system. Both heterogeneous sedimentary aquifers with appropriate geostatistical properties (mean, standard deviation, correlation length scales) and fractured rock aquifers with appropriate discrete fracture properties derived from statistical distributions (fracture length, aperture, separation, connectedness) will be considered. The Sub-program is cutting-edge in that it will attack the fundamental research questions (i) how uncertainty in flow rate estimation is linked to degree and structure of heterogeneity, and (ii) which method will have the lowest uncertainty in a particular system. Quantifying uncertainty in groundwater flow estimation is a very significant unresolved problem in groundwater hydrology.

Sub-program 2B: Heterogeneity in groundwater fluids and geologic structures

In certain hydrogeologic situations, groundwater fluid properties (such as density and viscosity) vary because of changes in solute concentration, temperature and pressure of the groundwater. These spatiotemporal variations in groundwater fluid properties can have critical consequences for groundwater flow and solute transport. Previous studies (Simmons, 2005) have identified that the prediction of dense plume migration rates and pathways is extremely complex and in heterogeneous geologic systems is currently not possible.

This work will test the hypothesis that 'microscopic indicators' of dense plume migration (e.g. number of unstable fingers) may not be amenable to prediction but that 'macroscopic indicators' (e.g. salt flux rates or centre of mass) may be. We contend that an equivalent homogeneous but anisotropic system coupled with macroscopic indicators can be used to provide reliable predictions for dense plume migration in certain heterogeneous systems. We use numerical models and a combined geostatistical-Monte Carlo framework to explore this hypothesis. This Sub-program will provide new fundamental understanding about upscaling groundwater processes in systems where both heterogeneous groundwater fluids and heterogeneous geologic structures control groundwater flow and solute transport processes.

Sub-program 2C: Highly transient, spatially-distributed surface water–groundwater interaction

Models of surface–groundwater interaction commonly assume steady state conditions in time and homogeneity of river bed conductance in space. These conditions are rarely true in real hydrogeologic systems. Surface water systems are often highly dynamic and they are spatially-distributed features in the landscape. In addition, riverbed conductance, a vital control on surface water – groundwater interaction, is known to vary by 6-7 orders of magnitude (Calver, 2001). Current modelling approaches for surface water-groundwater interaction usually require surface water features to be specified *a priori* as simple boundary conditions that are fixed in space and time. In ephemeral systems, however, the presence of surface water bodies is highly time dependent. The generation and persistence of surface water features will be a function of geologic, geomorphologic and climatic controls. There is a complex but poorly understood interplay between surface water and groundwater processes that lead to the spatially–distributed formation, and transient persistence, of surface water features and hence surface water – groundwater interactions. These processes are extremely oversimplified in current modelling approaches.

This Sub-program will utilise powerful numerical models to simulate the evolution and dissipation of highly dynamic and spatially–distributed surface water features and hence surface water –groundwater interactions. We will employ state of the art fully-coupled models such as HydroGeoSphere (Therrien et al., 2005) to simulate three dimensional explicit surface flow, vadose zone, and groundwater flow processes. Models will be constrained using hydraulic and tracer data, including heat. This advanced form of highly coupled, explicit, surface water – groundwater interaction modelling is one of the most fundamental next advances required for computational simulation in this field of hydrogeology.

Sub-program 2D: Simplicity versus complexity in groundwater modelling

This Sub-program is driven by an urgent need to build better practical, complex, regional groundwater models that can be used with greater confidence in solving water management questions. It is founded on the well-accepted premise that hydrogeology is *model rich* and *data poor*. The predictive value of groundwater models is often recognised to be poor, in large part due to our inherent inability to characterise critical hydrogeologic parameters

at the requisite spatial and temporal scales and form the appropriate conceptual models (Bredehoeft, 2005). Model calibration is also highly sensitive to recharge rates and hydraulic conductivities. If both are ill-constrained, a calibrated model may be of little, if any, predictive value.

This research will develop techniques and methods to significantly improve the predictive value of models. The spatiotemporal pattern of evapotranspiration and recharge may be reliably estimated by upscaling point ground-based measurements using both airborne and spaceborne remote sensing data. Spatially distributed hydraulic conductivity and geologic data from 3D geological models developed in Program 1 will also form a vital basis for improved groundwater flow simulation. Examples of the use of spatially distributed data in hydraulic modelling (Becker, 2006; Brunner et al, 2007) have highlighted major challenges in calibration, parameter uncertainty, optimisation and methods for interpolating/ extrapolating point data in 3D. These challenges will be addressed in this Sub-program. We will also conduct urgently required rigorous quantitative assessments of model parsimony as well as quantifying the trade-offs between model complexity, predictive ability and data acquisition costs. These relationships are rarely, if ever, quantified but are urgently required if we are to maximise the power and usefulness of groundwater modelling.

Program 3: Surface Water - Groundwater Interactions

Program Leader: Professor Peter Cook, CSIRO/Flinders

International Visiting Scholars:	Dr Judson Harvey (US Geological Survey)
	Dr Randall Hunt (US Geological Survey)
	Prof. John Selker (Oregon State University)
	Prof. Alicia Wilson (Florida State University)

Key Investigators:	PI Cook	PI Lamontagne	CI Lockington
	CI Simmons	CI Cartwright	CI Gasparon
	CI Acworth		

The interconnectivity of surface water and groundwater is often not fully recognised or accounted for by water managers, and this can lead to double accounting and double allocation of resources. This problem is compounded by a lack of widely available infrastructure for monitoring surface water–groundwater connections. Scientifically, because they are at the interface between surface water and groundwater hydrology, surface water–groundwater interactions still

pose major research challenges. Understanding the spatial and temporal dynamics of surface water–groundwater interaction processes is a major research area (Sophocleous 2002).

This research program will quantify fluxes and constrain biogeochemical processes and will provide important links to important groundwater dependent ecosystems; these are key gaps in current understanding and matters of critical international scientific interest. Attempts will be made to develop integrated concepts for the ecological assessment of connected surface water and groundwater. Importantly, through ecological and biogeochemical characterisation, this program will aim to determine whether ecological communities can be used to measure or indicate groundwater-surface water interactions.

Sub-program 3A: Groundwater recharge from losing streams

There are no accepted field methods for distinguishing between connected and disconnected streams, and currently-used theoretical criteria for assessment are now recognised to be in error (Brunner et al., 2009). Developing robust theoretical criteria to predict river connectivity remains a challenge. Field-based assessments of disconnected streams, and their transient nature, are absent in current literature since they lack a robust theoretical basis. An ability to make this distinction is vital for groundwater management, as groundwater pumping will only deplete streamflow if streams are hydraulically connected to the groundwater.

This Sub-program will develop new theoretical criteria and urgently needed field methodologies (hydraulic, heat/thermal and hydrochemical) for assessing disconnection states between groundwater and losing streams. The rate of surface water loss will be measured using river flow gauging, and relationships between loss rate and surface water and groundwater levels will be explored using both modelling and hydraulic, chemical and tracer approaches. Improved methods for estimating connectivity and river losses are particularly needed in arid and semi-arid regions where ephemeral losing streams form a major recharge mechanism. The transient nature of these processes is a major challenge that will be overcome by sampling for both hydraulics and chemistry at high spatial and temporal resolution.

Sub-program 3B: Groundwater discharge to gaining streams

Chemical baseflow separation methods typically suggest that 30-70% of the streamflow peak that follows a rainfall event is attributable to groundwater baseflow. This contradicts hydraulic analyses, which suggest a large timelag between an increase in groundwater recharge resulting from the rainfall event and the corresponding increase in discharge to the stream (Kirchner, 2003). This paradox remains an important but unresolved scientific problem in the area of surface water–groundwater interaction.

This Sub-program will investigate this paradox by conducting baseflow separation during storm events with a number of different tracers. These will include a combination of chloride and ^{2}H and ^{18}O, which are traditionally used for chemical baseflow separation, and novel tracers such as ^{222}Rn, He, and $^{3}H/^{3}He$, which allow groundwater residence times to be determined. This combination of tracers will allow for the critically needed differentiation between native groundwater and bank return flow, and allow mixing processes within the near-stream environment to be assessed. Groundwater levels during the stormflow event will also be measured in transects of nested piezometers, allowing directions of flow at different levels in the groundwater system to be monitored throughout the event.

This will lead to a better understanding of the hydraulic and chemical exchange processes that occur during stormflow events, and also the ability of chemical methods to accurately partition storm hydrographs. These issues also apply to lake and wetland systems, which have received relatively little study, and where hydraulic and tracer approaches yield different fluxes (Hunt et al., 1996).

Sub-program 3C: River – Hyporheic exchanges

While river–hyporheic exchanges are known to be important regulators of subsurface biochemical transformations, the manner in which these processes vary spatially and temporally requires further research. In particular, understanding the extent to which hyporheic processes are influenced by groundwater inputs remains a key challenge.

This Sub-program will refine our understanding of the vital controls on hyporheic exchange processes in order to further understand the links between net groundwater exchange with a river and the more transient hyporheic exchange process. It will examine water residence times in hyporheic and near-stream environments, and the relationships between residence time and biogeochemical processes. These have important impacts on water quality (e.g., nutrient loading) and ecological activity along river-groundwater exchange zones. Residence time will be estimated using artificial tracers (timescale of hours), and environmental tracers ^{222}Rn (days), and $^{3}H/^{3}He$ (months to years). Hydraulic gradients will be measured with mini-piezometers, so that residence times can be linked to zones of up-welling and downwelling groundwater, and measurement will also be made of key geochemical parameters (e.g. dissolved oxygen, organic matter content). The outcome will be an improved understanding of how river–hyporheic exchanges vary across riverine environments, and the relationship between river–hyporheic exchanges and large scale variations in groundwater inflow or outflow rate.

Sub-program 3D: Groundwater interaction with estuarine rivers, lakes and wetlands

Australia's extensive coastline, including a large number of islands, gives rise to an enormous range of tropical to sub-Antarctic terrestrial and shallow water conditions and habitats, which in turn are home to complex and sensitive ecosystems of rich biodiversity, and subject to major development and climate change impacts. Tidal

forcing, chemical and density contrasts between seawater and terrestrial groundwater and complex hydrogeology characterise the hydrology of these systems.

This Sub-program will significantly advance the fundamental quantitative understanding of the groundwater dynamics, biogeochemistry and ecology of estuarine rivers, lakes and wetlands. The results of this program are critical to global understanding and management of these vital and threatened ecological and hydrological systems. The composition and distribution of biota in benthic and riparian zones in estuaries are sensitive to salinity distributions as well as the magnitude, chemistry and spatial distribution of discharging groundwater. Recent studies have also shown that wetland and lake water balances may be used to link hydrogeological processes with ecological effects. Estuarine systems provide breeding and life cycle habitats for a wide range of important, sensitive biota (e.g. crustaceans, fish, mangroves, and seagrasses). Preliminary field and modelling investigations have identified new riparian-hyporheic circulation patterns that vitally affect ecological functioning (Werner and Lockington, 2006).

Despite the importance of groundwater and nutrient fluxes for these complex environments, the dynamics of these processes in coastal environments are poorly understood and unable to be reliably quantified. Major knowledge gaps relate to: (1) the effect of tidal, variable salinity estuary and lake hydrodynamics on groundwater discharge and estuarine water recirculation; (2) the consequences of the hydrodynamics and exchange on residence times and groundwater biogeochemical processes; and (3) the ability to properly model and quantify these complex processes and implications for ecosystem functioning. This research will advance our knowledge of the hydrological, ecological and biogeochemical functioning of estuarine systems using field, laboratory and surface water-groundwater modelling approaches.

Program 4: Groundwater-Vegetation-Atmosphere Interactions (GVI)

Program Leader: Professor David Lockington, UQ

International Visiting Scholars: Prof John Selker. Bioresource Engineering, Oregon State University
Prof Steve Gorelick, Earth Sciences, Stanford University
Prof Yves Parlange, Biological and Environmental Engineering, Cornell University

Key Investigators:

CI Lockington	CI Guan	PI Cook
CI Daly	CI McCabe	
CI Eamus	CI Webb	

The groundwater balance is determined by rates of recharge and discharge and estimates of these are required at a range of spatial and temporal scales. Although there have been advances in methods for estimating recharge, many issues relating to the underlying processes as well as its spatial and temporal extrapolation require resolution. Vegetation plays a critical role either directly through discharge, where it abstracts water from the watertable or capillary fringe, or indirectly by mediating recharge.

Apart from the obvious implications for groundwater management, this control on recharge has important ramifications for proposed plantation-based strategies for climate change mitigation: we don't yet have a clear understanding of the trade-off between carbon sequestration and the associated reduction in groundwater recharge and dependent stream and river flow. In fact, how climate change will modify the functional attributes of vegetation related to its water use is also poorly understood. While groundwater use by vegetation has been observed at a number of sites, scaling measurements from individual trees to regional scale catchments in order to estimate the water balance and the impact of watertable drawdown on groundwater-dependent vegetation are largely unexplored. Modelling GVI also remains a challenge, particularly its representation in groundwater hydrological models used in water resource management.

Research in this program will address these and other critical gaps in knowledge. Field work will be undertaken at a number of sites across Australia.

Sub-program 4A: Regional groundwater discharge through evapotranspiration

A key source of uncertainty in efforts to monitor the movement of water through the hydrological cycle is characterizing the moisture flux between the groundwater and surface-atmosphere interface. Groundwater loss to evapotranspiration (through direct soil evaporation plus plant transpiration) accounts for the major component of the moisture flux into the atmosphere, particularly under water-limited conditions. While soil moisture storage might be depleted due to lack of incident precipitation, dynamic root systems may have access to groundwater sources, assisting in vegetation survival during prolonged dry periods. Deep lysimeter measurements under crops, indicate that groundwater evapotranspiration can account for more than 16% of total evapotranspiration. For forested stands this would be expected to be even greater.

This Sub-program will examine controls on groundwater discharge via evapotranspiration by developing quantitative relationships between discharge rate, vegetation and soil type, water table depth and other key variables using a multi-scale monitoring and modelling program that includes: 1) sapflow devices to determine

volumes of individual tree water use; 2) isotopic techniques to discriminate between plant transpiration and direct soil evaporation (Farquhar et al., 2007); 3) eddy-covariance techniques for larger scale evapotranspiration measurement (Su et al, 2005); and 4) remote sensing-based approaches to extrapolate field-based measurements to catchment and regional scales (McCabe and Wood, 2006). These estimates will be compared with independent measurements of diurnal fluctuations in groundwater and soil moisture levels and modelled fluxes to form a fundamental basis for upscaling (McCabe et al., 2008).

Sub-program 4B: Impact of watertable decline on groundwater dependent vegetation (GDV)

GDV uses groundwater when it is within reach, via roots accessing groundwater at depth or through groundwater discharge to the surface followed by plant uptake (Eamus and Froend 2006). Understanding how vegetation responds to a decline in the watertable remains a significant research challenge.

This Sub-program will compare and contrast key vegetation attributes (root depth, basal area, leaf area index, rates of water use, pre-dawn and midday water potential, turgor loss point and vulnerability of xylem to cavitation) at sites of contrasting climate, soil type, vegetation structure, and depth to groundwater. Stable isotope analyses of groundwater, soil water and xylem water and root distribution data will be used to quantify the contribution of groundwater to annual water budgets of each GDV. Long-term meteorological data will be used to examine inter-annual variability in the potential for vegetation groundwater use. These data will be used, in conjunction with Soil-Vegetation-Atmosphere (SVAT) models, to develop rules governing the impact of declining watertable on Australian GDV.

Sub-program 4C: Effect of climate change on GVI and groundwater recharge and discharge

The relationship between recharge and discharge and climate forcing requires rigorous and more detailed scientific investigation. It is clear that climate change will not only alter rainfall and temperature, but also the functional attributes of vegetation (leaf area index, stomatal conductance, standing basal area, hydraulic architecture of the vegetation) that govern rates of water use (Eamus and Palmer 2007). Rainfall through much of Australia is episodic, and recharge is likely to be more sensitive to changes in the frequency and intensity of rainfall events than to changes in mean annual rainfall. While some site specific assessments have been conducted, a generalised understanding of fundamental processes has not been developed. An unstated assumption is that recharge will reduce under future climates but we do not know that this is the case and it has not formally been demonstrated in the scientific literature. This is, however, critical, and the state of current knowledge is extremely poor.

This Sub-program will employ and develop SVAT models to determine the sensitivity of recharge to changes in important climate variables. To be accurate, these models must combine highly mechanistic descriptions of plant

growth, carbon fixation and water use, with climatic models that predict changes in rainfall frequency and intensity, and potential evaporation. An important part of model calibration is examining the extent to which models are able to predict modern day spatial and temporal variations in recharge and discharge.

Program 5: Integrating Socioeconomics, Policy and Decision Support

Program Leader: Professor Anthony (Tony) Jakeman, ANU

International Visiting Scholars: Prof. George M. Hornberger (University of Virginia, USA)
Prof. Martin van Ittersum (Wageningen University, The Netherlands)
Prof. Hoshin Gupta (University of Arizona).

Key Investigators:			
	CI Jakeman	CI Croke	CI Pannell
	CI Curtis	CI Gunningham	CI Gardner
	CI McKay	CI Newham	CI Pollino

The National Water Initiative aims to optimize economic, social and environmental outcomes through a nationally compatible market, regulatory and planning-based system of surface and groundwater management. There are several requirements to develop practical, long-term strategies that will achieve this goal such as critical integration of a whole-of-water cycle approach with socio-economic issues and engaging with the community in a way that increases the depth of understanding of water issues, builds trust, increases adoption of better practices, clarifies tradeoffs and ensures transparency in decision making.

The other four programs will be linked strongly with this program to largely provide the new biophysical science and modelling required to ensure a whole-of-water cycle approach. The decision support, policy and socioeconomic frameworks will include consider ecological determinants and constraints. The framing of any groundwater management problem with experts and interest groups clarifies the knowledge (e.g. flux attributes, boundaries and scales) required as input for integration with the socioeconomic aspects, and vice-versa.

Flagship case studies will be used to focus this program's projects and to link with other programs so that the way to provide decision support to a management problem is better understood and delivered. One will be an inland

case study of an over-allocated groundwater system with cross-border jurisdictional issues (the Lower South East of South Australia that will address the socioeconomic and environmental issue of sustainable aquifer yield.

The various Sub-programs will: identify the appropriate interest groups; frame the issues with them; co-develop a representation of the drivers, interactions and outcomes; and develop integrated models and methods (including the biophysical ones with the other programs) that allow the characterization of quantitative and qualitative tradeoffs. In both cases, the research will be encapsulated in a decision support system (DSS) that will assimilate targeted knowledge from the other biophysical programs. Cutting edge research issues are defined in the Sub-programs below.

Sub-program 5A: Integrated Assessment Modelling and Decision Support

Constructing and considering the consequences of alternative problems and policy options is fundamental for processes of policy formulation. Formal computer-based decision support tools can provide a means of structuring and exploring problems, and of generating qualitative and quantitative information for analysing and characterising decision options.

The aim of this Sub-program is to represent, accrue and share socioeconomic and biophysical knowledge that will elucidate improved outcomes for groundwater and groundwater-connected systems. It will use the 'discipline' of Integrated Assessment (IA) (Giupponi et al., 2006) encompassing: the biophysically-connected system components; the socioeconomic components of policy, other drivers, governance constraints and impacts; and interest groups. It will involve three main modelling approaches to represent the interactions and processes in order to understand, estimate and communicate impacts. These approaches range from those that are more qualitative such as Decision Trees to quantitative approaches such as Bayesian Networks and Coupled Complex Models. Each has strengths and weaknesses for particular uses (Jakeman et al., 2007). The overall challenge here is to exploit the growing body of experience-based know-how the DSS community is accumulating to inform design and development practices. One of the key elements to this integration is plausible scenario construction (Liu et al., in press) to help assess vulnerability, risk and uncertainty to a range of influences which will form a vital basis for research in this program.

Sub-program 5B: Farmers of the Future: How will they farm groundwater?

Agricultural and rural communities are undergoing profound technical, structural and demographic changes. These changes have different implications for specific farm sectors and regions, and individual communities and farm families – with impacts that are variable in nature (creating costs and opportunities) and magnitude. Strategic investment in improved groundwater management requires a strong understanding of the adoptability patterns and socioeconomic implications for rural industries of new technology or management systems. Consideration

must be given to the extent to which proposed changes to groundwater management are consistent with the long-term personal and farm business plans of landholders. Methods and databases for socioeconomic profiling of adopters are essential.

This Sub-program will build on the current understanding and knowledge base and will integrate it with spatially and temporally referenced hydrologic and agronomic data. In consort with the other Sub-programs, it will develop and evaluate policy instruments that seek to engage landholders and establish long-term commitment to sustainable groundwater-relevant natural resource management (NRM) practices.

Sub-program 5C: Policy, Institutional, Law and Governance issues

The principal instrument proposed by the NWI for communities defining the sustainable use of groundwater is the statutory water plan. Plans are a foundation stone for an efficient water market and the vehicle for settling trade-offs between competing outcomes for water systems, securing ecological and resource security outcomes, addressing over allocation and assigning risks of changes in allocations.

This Sub-program will focus on the governance issues relating to the groundwater and surface water planning process and content, including the design of the institutions and the implementation and review of plans. It will explore the design of water plans as a water governance tool and make law reform suggestions. It will address issues including the design of local consultative and managerial committees and irrigation co-ops and the duties of water agencies (i.e. to research environmental and socio-economic issues in preparing and implementing plans and to identify and provide for surface-groundwater interaction and sustainable groundwater extraction, consult in preparing and implementing plans); determine the applicability of the concepts of consumptive pools and share-based access entitlements to groundwater resources; and articulate appropriate management concepts for the injection and storage of water in aquifers.

Sub-program 5D: Vulnerability, Risk, Sensitivity and Uncertainty Issues in Integrated Management of Groundwater

Methods for assessing groundwater vulnerability, risk and uncertainty of predicted outcomes of options for managing groundwater and surface water-groundwater connected systems will be examined in this Sub-program. The crux of model-aided decision-making is to determine whether one alternative is superior to another, by comparison of model outputs for the scenarios being considered. The outputs from integrated models are often highly uncertain, and a key question is how these different types of uncertainties are incorporated in model-aided approaches, with scenario and sensitivity analysis being the two most common (Brouwer and Hofkes, in press).

This Sub-program will focus on how to characterise and reduce uncertainty at all stages of groundwater decision-making and how to assess the sensitivity of the outputs of different types of integrated models to variation in the

scenarios, inputs, parameters and process descriptions. The main output from this Sub-program will be innovative assessment methods to guide modellers towards the simplest adequate integrated model and to establish how reliably that model can aid groundwater management decisions. Most importantly, it will assess what additional knowledge could inform the management decision options, and by how much and at what cost.

Financial Performance

Our major objective in 2009 was to establish the financial management and reporting systems necessary to:

- enable all income and expenditure related to the Centre to be identified in its accounts;
- ensure that Commonwealth Government funding is only used for the specific purposes outlined in the Funding Agreement;
- disburse Year 1 funding to the Centre's partners, and to receive Year 1 cash contributions from all contributing partners.

At the date of this report the Centre's financial systems were fully operational. The Centre's audited Financial Statements are located at Appendix C. The key issues arising from these statements are that:

- contributions of collaborating and partners organizations were lower than forecast. This reflected some minor problems synchronizing the Centre's budgetary systems (which are based on a calendar year) with the financial year systems used by a number of our collaborators and partners;
- expenditure patterns were lower than expected because collaborating organizations were strongly focused on student recruitment during August – November 2009. Now that the first round of recruitment has been completed expenditure patterns are expected to be closer to budget forecasts in 2010.

Appendix A – Program Leader Biographies

Professor Ian Acworth

Director, University of New South Wales Connected Waters and Gary Johnston Chair of Water Management.

Super Science Coordinator, National Centre for Groundwater Research and Training

Professor Ian Acworth is a leading developer of new geophysical techniques for groundwater investigation. He has a strong track record of industry-driven research during 35 years as a hydrogeologist in universities and working in South America, Europe, the Middle East, Africa and Australia. His early work resulted in new electrical imaging field techniques that have evolved to become a standard application.

Professor Acworth has also been responsible for many other technology developments. He shares a patent on an electrical image method for resolving problems in dryland salinity and coastal intrusion of sea water, and he recently took out a patent involving the 3D monitoring of deep drainage beneath irrigated crops.

He has carried out extensive investigation into aquitards and the hydromechanical coupling evident in such systems. His interests cover many areas of practical hydrogeology, including hydrochemical and geophysical techniques.

These have been applied to the study of surface water groundwater process investigation and extensive work in coastal zones resulting in well-cited publications and several PhD completions.

Professor Acworth has a long-held interest in the origins of dryland salinity and recently published work that considers the influence of climate change on this process.

During his career Professor Acworth has published well over 100 scientific articles and has been chief investigator on grants totalling nearly $4 million.

He is the Australia and Pacific Vice-President of the International Association of Hydrogeologists and has served on the National Groundwater Committee advising the Federal Government.

Professor Acworth will play a major leadership role in the Training Advisory Committee of the NCGRT, including the development of a new National Groundwater Field Training School Short Course.

Professor Craig Simmons

Professor of Hydrogeology, Flinders University

Director, National Centre for Groundwater Research and Training

One of Australia's foremost groundwater academics, Professor Craig Simmons has been a significant contributor to global advances in the science of hydrogeology for many years. He is Professor of Hydrogeology at Flinders University, and a leading international authority in hydrogeology. In particular, he is a recognised expert in variable-density groundwater flow phenomena, research that has taken him to leading groundwater institutions around the world.

He has a particular interest in groundwater systems where fluid density and groundwater flow are strongly affected by concentrations of solute, such as in salt lakes or highly saline coastal environments, or by temperature, such as the deep hot geothermal fluids found in the Gulf of Mexico.

During his highly successful career Professor Simmons has been a chief investigator on various large national and international projects and has published more than 180 scientific articles. Among his many scientific contributions, Professor Simmons has significantly advanced our understanding of the ability and limitations of numerical computer models to solve variable density flow problems, applied theoretical developments in variable density flow to many practical groundwater problems, was involved in the pioneering team which first detected free convection phenomena in a field based groundwater system, has developed innovative laboratory equipment for the visualisation of dense plume migration, and has contributed major theoretical advances on how geologic heterogeneity controls dense plume migration.

Professor Simmons has also conducted internationally recognised research in the fields of surface water - groundwater interaction, fractured rock hydrogeology, aquifer storage and recovery, and groundwater flow and solute transport modelling.

In 2006 Professor Simmons joined six other pre-eminent hydrogeologists to write a position paper on the state of groundwater research, training and management, which has been a catalyst for major groundwater reform in Australia. He is a member of the National Water Commission's Groundwater Technical Advisory Committee, which advises on high-level groundwater direction setting and investment strategies in Australia.

Professor Simmons' research and academic excellence have been recognised by a number of awards including the BankSA Travel Award, The Miss Amy Forwood Travel Award and the Young Tall Poppy Science Award for outstanding contributions to science. In 2005 Professor Simmons was formally acknowledged by SA Great and the

South Australian Government as one of the Top 50 Inspirational Young South Australians who make a positive impact in our community.

In 2002, Professor Simmons' recognised ability as an outstanding communicator of science was publicly and nationally acknowledged when he won the prestigious national Australian Award for University Teaching, the highest form of recognition for teaching excellence in Australia. In 2002, Professor Simmons was named the Distinguished Oliver Lecturer by the University of Texas at Austin in recognition of his distinguished contribution to international hydrologic research. In 2007, he received the American Geophysical Union (AGU) 2007 Editors' Citation for Excellence in Refereeing for Water Resources Research.

Professor Simmons has served as an Editor and Associate Editor for numerous major international journals. He currently serves as an Associate Editor on the Editorial Boards of prestigious international scientific journals including *Journal of Hydrology* and *Ground Water* and has also served previously as an Associate Editor for *Hydrogeology Journal*, *Ground Water* and *Water Resources Research*. Upon invitation in 2005 by the International Association of Hydrogeologists (IAH), Professor Simmons served a three year term as Managing Editor of their official international scientific journal, *Hydrogeology Journal*, a high-profiled and influential role requiring scientific vision and distinguished leadership.

Professor Peter Cook

Senior Principal Research Scientist, CSIRO Land and Water; Professorial Status at Flinders University

Deputy Director, National Centre for Groundwater Research and Training

Professor Peter Cook is a world-leading groundwater scientist who specialises in the areas of hydrology, ecohydrology, isotope hydrology and unsaturated zone flow.

His work is recognised globally and he is the National Ground Water Association Darcy Lecturer for 2009. This is one of the highest honours that can be given to a groundwater scientist and he is the first non–Northern American resident to be chosen for the role.

A key research focus for Professor Cook has been the use of environmental tracers to quantify groundwater flow rates and the integration of tracer and hydraulic methods.

Specific projects have included estimation of aquifer recharge, quantification of groundwater discharge to streams and wetlands, and assessment of groundwater dependent ecosystems.

Professor Cook was a member of the National Groundwater Committee between 2002 and 2007 and has been a member of the Victorian Government's Technical Audit Panel for water resources since its inception in 2002.

In 2003, he was commissioned by the United States National Research Council to review the deliberations of its Committee on Hydrologic Sciences involving the interaction between groundwater and surface water resources.

During the mid-1990s, Professor Cook was at the forefront of the development of chlorofluorocarbons as a groundwater dating tool. He has also developed isotopic and artificial tracer methods that permit estimation of aquifer recharge rates and groundwater flow velocities in highly heterogeneous fractured rock environments.

His research has also involved close collaboration with plant physiologists to assess the likely impacts of groundwater extraction on ecosystems.

Professor Cook has co-written books on environmental tracers and ecohydrology and has been the associate editor of leading international journals.

Professor Tony Jakeman

Professor, Fenner School of Environment and Society and Director of the Integrated Catchment Assessment and Management Centre, Australian National University

For the past 30 years Professor Anthony (Tony) Jakeman has been at the forefront of international research in environmental modelling methods and practice.

His work in hydrology is extensive and includes new models of rainfall-runoff processes, surface-groundwater interactions, aquifer saline intrusion, two-dimensional groundwater flow and in-stream water quality.

Professor Jakeman's research interests also include extensive involvement in professional activities outside his home university.

He is president of the Modelling and Simulation Society of Australia and New Zealand and was the Foundation President of the International Environmental Modelling and Software Society.

As Director of the iCAM Centre, Professor Jakeman leads a team of researchers with strong disciplinary backgrounds in areas such as surface and subsurface hydrology, economics, ecology, soil science, computer science, mathematics and physics.

He routinely undertakes joint research projects with the CSIRO, government agencies and other organisations and has a particular passion for research training.

Professor Jakeman's work is distinctive in that it attempts to combine formulations of key processes and drivers in statistically rigorous ways. He pioneered the development of the IHACRES dynamic water balance model which has been applied worldwide to hundreds of catchments in most hydroclimatologies.

Since 1997, Professor Jakeman has been an international leader in the interdisciplinary field of integrated assessment with an emphasis on quantifying environmental and socioeconomic trade-offs in large catchments to aid decision-making.

His research is widely published and he is editor-in-chief of the Elsevier journal, *Environmental Modelling and Software*.

Professor David Lockington

Head, Department of Environmental Engineering and Director of the Centre for Water Studies, University of Queensland

Professor David Lockington's expertise in vadose zone and coastal groundwater hydrology is recognised internationally.

He is a specialist in the quantitative analysis of catchment and groundwater hydrology through mathematical modelling, including both chemical and biological processes.

His work is widely published and has been recognised through his appointment as an associate editor of two of the most prestigious international hydrology journals.

While Professor Lockington's research activity covers a broad range of topics, over the past decade he has been concentrating on quantitative groundwater dynamics at the land-ocean interface (LOI).

In the 1990s he helped establish the effect of tidal dynamics on basic seawater intrusion as well as identifying their generation of an upper circulation cell. The presence of this upper cell has become the focus of significant international research activity due to its implications for fluid residence times and biogeochemical processes.

Professor Lockington has now extended this work to investigate other critical interactions as well as quantifying the hydrology and groundwater dynamics in important island systems.

He is also continuing with the research fundamentals of water and chemical transport in the vadose zone, particularly those associated with infiltration and recharge.

The governing equations are very nonlinear and difficult to solve. Professor Lockington has principally worked on developing knowledge of the basic structure of these equations and their underlying solutions using analytical approaches.

His recent contributions to vadose zone hydrology include assessing the role of hysteresis in aquifer properties in tidal water table capillary fringe dynamics and salinisation, as well as tidal marsh processes.

Appendix B – Chief and Partner Investigator Biographies

Chief Investigators

Martin Andersen

Senior Lecturer, Faculty of Engineering, University of New South Wales

Dr Martin Andersen brings high-level research experience to the Centre, particularly in the area of groundwater quality problems and applied hydro-geochemistry.

He has broad experience in field methods related to groundwater hydrology, connected waters, geophysics, modelling and applied hydrology investigation technologies.

Dr Andersen has worked extensively in Europe, including several EU research projects at the Technical University of Denmark involving the natural baseline quality in European aquifers and the impact of nutrient contaminated groundwater on coastal areas.

Several years teaching in groundwater geochemistry at the Technical University of Denmark has given Dr Andersen extensive knowledge of most aspects of the state of the art code for hydro-geochemical modelling.

His current research work is interdisciplinary in scope in the areas of aqueous geochemistry, modelling of reactive solute transport processes in aquifers, surface water interactions and problems related to the quantity and quality of groundwater resources.

In his role at the Centre Dr Andersen will be a Chief Investigator on sub-programs involving heat as a groundwater tracer, the integration of hydrochemical and hydrogeological methods for analysing regional groundwater flow, and groundwater recharge from losing streams.

Ross Brodie

Senior Hydrogeologist, Geoscience Australia

A hydrogeologist in Australian Government scientific agencies for nearly 20 years.
Dr Ross Brodie has provided high-level technical advice on numerous groundwater issues. His work includes scientific investigations of Murray-Darling Basin salinity, groundwater dynamics under irrigation areas, seawater

intrusion, fractured rock systems, catchment water balances, groundwater-dependent ecosystems, coastal acid sulfate soils and integrated water management.

Recent research has focused on testing and advancing various methods of evaluating groundwater discharge to streams and wetlands and he is also interested in combining different approaches to the geological characterisation of aquifers for conceptual and numerical models.

Dr Brodie will be a partner investigator for the Centre, focusing on activities in the Innovative Characterisation of Aquifers and Aquitards program.

This aligns with Geoscience Australia's interest in developing geological understandings of groundwater systems, and involves advances in 3D geological modelling, geophysical and remote sensing approaches and evaluation of hydraulic properties.

Ian Cartwright

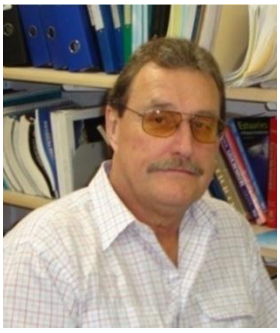
Head, School of Geosciences, Monash University

A successful hard rock geologist, Professor Ian Cartwright has changed research direction in recent years to focus on hydrogeological systems and environmental change.

He has quickly made a mark with a vibrant research program that has received funding from competitive grant schemes and government agencies. An associate editor of the international *Hydrogeology Journal*, Professor Cartwright oversees the running of the Environmental Stable Isotope Facility at Monash University which consistently produces high-quality data and world-class research.

Most of his current research integrates major and trace element geochemistry, stable and radiogenic isotopes, and numerical and chemical models to better understand solutes, pathways of groundwater flow and water-rock-gas interactions.

Professor Cartwright will be closely involved in several of the Centre's research themes, specifically in the integration of geochemical techniques such as stable isotopes, radiogenic isotopes and major ion geochemistry with other areas including numerical modelling and physical hydrogeology.



Malcolm Cox

Associate Professor, School of Natural Resource Sciences and Water Initiative of the Institute for Sustainable Resources, Queensland University of Technology

Associate Professor Malcolm Cox has established a strong groundwater research and training presence in Queensland and forged collaborative links with many state government agencies, industry and local governments. He has extensive international research experience in groundwater studies covering a wide range of geological and climatic settings, including geothermal and volcanic systems.

His main focus is in hydrogeology and environmental geochemistry with particular interests in the occurrence and migration of groundwater, the geological and geochemical character of aquifer materials, water-rock interaction and aqueous geochemistry.

As co-chief investigator in the Centre's program on aquifer characterisation, he intends using his broad groundwater experience and expertise in hydrogeochemistry and geothermal systems in the development of 3D models in areas such as the Great Artesian Basin.

Such an application will have substantial overlap with modelling of possible CO2 sequestration and hydrocarbon occurrence, and lead to a better understanding of the long-term integrity of the basin's complex system.

Associate Professor Cox is on the drafting team for National Climate Change Adaptation Research Plan for Water.

Barry Croke

Senior Lecturer, Department of Mathematics and the Fenner School for Environment and Society, Australian National University

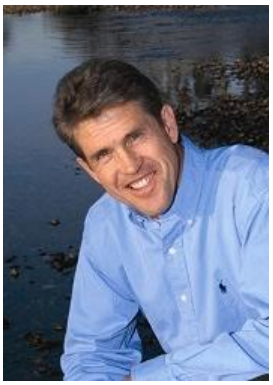
An international leader in the prediction of flow at ungauged sites, Dr Barry Croke is leading the Centre's sub-program to test the integrated management of groundwater.

The aim is to reduce uncertainty at all stages of groundwater decision-making by examining key issues such as vulnerability, risk, sensitivity and uncertainty.

With a broad background in modelling environmental systems, Dr Croke is highly qualified for the task. His research interests are mainly focused on developing models for prediction of streamflow and water quality and applying them to manage water resources.

His expertise includes estimation of surface energy budgets and evaporation rates, modelling water quantity and quality, and examining surface water and groundwater interactions.

Dr Croke is the co-founder of the Top-Down Modelling Working Group, an international group of hydrologists actively engaged in the Prediction in Ungauged Basins.



Allan Curtis

Professor of Integrated Environmental Management, Charles Sturt University

Research by Professor Allan Curtis into landcare is the largest and most comprehensive body of work of its kind in any developed economy.

He has been at the forefront of international efforts to assess and sustain the contribution of local organisations to natural resource management for many years. He will be applying his extensive research background in the social dimensions of catchment management in his role with the Centre.

Professor Curtis has been appointed to lead the social research components of the centre and will contribute to integrated projects as required. Some of his recent research includes exploring adaptive management, triple bottom line reporting, preparing socio-economic profiles of catchment communities and assessments of the socio-economic impact of changes in land use and resource access.

He has also gained international prominence through his work on integrating social and economic data with biophysical data to improve decision-making for regional catchment management authorities in Australia. Professor Curtis is currently one of the leading researchers examining adoption of new technologies in agriculture and conservation.

Edoardo Daly

Lecturer, Department of Civil Engineering, Monash University

Dr Edoardo Daly is joining the Centre's research team looking into the relationship between groundwater, the atmosphere and different ecosystems.

The program will draw on his expertise in soil-moisture dynamics and water balance, eco-hydrology and the impact of soil-atmosphere interactions.

Dr Daly has a particular interest in developing tools to develop a better understanding of the links between climate, and hydrologic and biogeochemical cycles.

Since joining Monash University in 2008 as a lecturer in civil engineering, he has also been working on stormwater biofiltration and bioretention systems and their relationship with the surrounding urban environment. Dr Daly has also undertaken research at the Duke and Princeton universities in the US and tutored undergraduate classes in hydraulic engineering in Italy.

Derek Eamus

Professor of Environmental Sciences, University of Technology Sydney

A specialist in ecohydrology, Professor Derek Eamus has been chosen to lead the Centre's sub-program investigating interactions between groundwater, vegetation and climate.

Since 1984 Professor Eamus has developed a keen interest in modelling the rate of water use by different ecosystems, particularly savanna and riparian vegetation, temperate woodlands and arid-zone.

He is a senior research fellow of Land and Water Australia and has also run several vegetation-climate change research projects, including the first Australian in-ground CO2 enrichment tree project. He is chief investigator on the Hawkesbury Forest experiment to quantify the impact of CO2 enrichment on vegetation water use and groundwater recharge.

Professor Eamus has published more than 150 research and review papers and co-authored *Ecohydrology: vegetation function, water and resource management* published by the CSIRO.
In addition to his role as a sub-program lead for the Centre, Professor Eamus will also provide advice for researchers involved in vegetation water use and groundwater availability across all programs.

Alex Gardner

Associate Professor, Law School, University of Western Australia

A specialist in water resources law, Associate Professor Alex Gardner will be using his expertise to help the Centre in the important area of statutory water management planning to achieve the sustainable use of groundwater.

Associate Professor Gardner is one of Australia's leading academic natural resources and environmental lawyers and has an environmental law practice that focuses on water resource issues.

He is the lead author of the recently publised *Water Resources Law*, LexisNexis Butterworths, July 2009. He has been a consultant to community groups, government agencies and industry in Western Australia and was a member of the Advisory Council to the Environmental Protection Authority of Western Australia.

Since 2005 Professor Gardner has served as a senior sessional member of the State Administrative Tribunal and also advised WA's State Department of Water on the reform of water resources legislation. He will be a chief investigator with Professor Neil Gunningham and Professor Jennifer MacKay on the Centre's sub-program looking at policy, institutional, law and governance issues.

They will investigate various legal issues involving groundwater, including ways to achieve ecological and resource security, overallocation and overused systems, and assigning risks for changes in allocations. The project will also address questions of governance relating to planning.

Massimo Gasparon

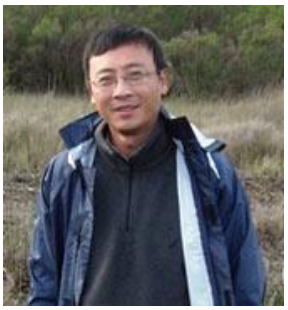
Associate Professor in Geochemistry and Director of Earth Sciences, University of Queensland

Dr Massimo Gasparon has worked extensively with researchers and environmental managers in Australia and overseas on projects involving the pathway of metals in the environment.

Since 1995 he has led research projects in environmental geochemistry in the Australian Antarctic Territory and in 2007 headed an environmental monitoring program on the impact of intercontinental flights on the ecosystem. He is a member of the International Mine Water Association and works with the Queensland Department of Mines and Energy on the assessment of surface and groundwater contamination at mine sites.

In his role with the Centre, Dr Gasparon will try to resolve hydrological problems in a range of environments, particularly in the land-ocean interface. His understanding of geological processes and water-rock geochemistry, and familiarity with widely used geochemical modelling software, will help complement the classic engineering approach to groundwater research.

A thorough understanding of water-rock-sediment interaction and geochemistry is an extremely powerful tool in hydrogeological and environmental investigations.



Huade Guan

Lecturer in hydrology, School of Chemistry, Physics and Earth Sciences, Flinders University

Dr Huade Guan has a multidisciplinary background and works in close collaboration with scientists across Australia and in the US, China, Taiwan and India on his broad research interests.

His main focus is water resource and environmental issues related to hydrometeorological and hydrological processes occurring from the land and atmosphere interface and in the groundwater table.
Recently he has been collaborating with other scientists on the spatial distribution of rain-originated environmental tracers in coastal areas.

This research is providing tools for studying water movement in the groundwater-vegetation-atmosphere system and relates to Dr Guan's work for the Centre. His expertise in this field includes characterising atmospheric forcing and vegetation response using geostatistical and remote sensing techniques, and soil hydrological modelling.

Dr Guan is experienced in vegetation remote sensing and using topography to study plant life response to climatic conditions. This will be useful for the Centre's research into the connection between groundwater and vegetation and the likely impact of climate change.

Neil Gunningham

Professor, Fenner School of Environment and Society and Regulatory Institutions Network, Australian National University

Pioneering work in law and society as an interdisciplinary social scientist has resulted in Professor Neil Gunningham making significant contributions in the research fields of environmental law, regulation and governance.

Various national and international government agencies have commissioned him to undertake high-level policy research and consultancies. In recent years these have included the United Nations Environment Program, OECD, US Environment Protection Agency and the US Multi-State Working Group on the Environment.

Professor Gunningham's most substantial contributions have been in the interdisciplinary research fields of safety, health and environmental law, regulation and policy. His achievements include work on the theory of regulatory design and efforts to directly influence regulatory policy.

In his role at the Centre Professor Gunningham will be chief investigator on a sub-program exploring policy, institutional, law and governance issues. The project is focusing on the application of statutory water management planning to achieve the sustainable use of groundwater. Professor Gunningham has extensive experience in researching and advising about water resources planning and policy instruments for water resources management, and routinely works with agencies and managers on such issues

Glenn Harrington

Senior Research Scientist, CSIRO Land and Water

Dr Glenn Harrington has been actively involved in various research and groundwater management programs for federal and state government agencies.

As a senior research scientist and hydrogeology team leader for CSIRO Land and Water, he has been the leader of several large-scale projects involving multiple stakeholders. A key focus has been research in the Great Artesian Basin, the Northern Territory's Daly River and Western Australia's Fitzroy River.

Prior to joining CSIRO, Dr Harrington worked on groundwater assessments and water allocation planning for the South Australian Government and was involved in hydrogeology research in Canada.

He also has considerable teaching experience in groundwater studies in Vietnam, Canada and with Flinders University in Adelaide.

His specific scientific interests include surface water and groundwater interaction, groundwater and hydrochemical modelling, arid zone hydrology and aquitard hydrogeology. Dr Harrington will be applying his expertise in supporting the Centre's program on Surface Water and Groundwater Interactions.

Bryce Kelly

Associate Professor, School of Biological Earth and Environmental Sciences, University of New South Wales

A specialist in 3D geological computer models and geostatistics, Associate Professor Bryce Kelly is researching ways to quantify uncertainty of current hydrogeological data.

He has been appointed lead of the Centre's program on 3D Geological Modelling of Aquifers to help improve our understanding of hydrogeological processes and the accuracy of aquifer mapping.
Associate Professor Kelly was part of the software development team that created the EarthVision geostatistics package and wrote an associated course that has been presented worldwide.

Recently he established Australia's first 3D geological modelling course with a focus on hydrogeological models to improve mapping of groundwater resources. His research is focused on how to integrate all disparate earth science data relating to the hydrogeology of catchments into 3D geological models.

The outcome will be improved insights into complex issues such as recharge pathways, groundwater contributions to river baseflow, the impact of irrigation extraction, water quality and the impact of climatic variability on groundwater resources.

Sébastien Lamontage

Senior Research Scientist, CSIRO Land and Water

Over the past decade Dr Sébastien Lamontagne has been involved in several large collaborative research projects involving groundwater and surface water interactions.

He was the leader for the groundwater component of the Adelaide Coastal Waters Study and was one of the leaders of a national initiative to investigate the impacts of climate change and environmental flows on the Murray-Darling Estuary.

His recent research achievements include the development of a new method using radon to measure hyporheic exchange in streams. He was also involved in understanding the links between wetland salinisation and the development of inland acid sulfate soils in the Murray-Darling Basin.

The current focus of Dr Lamontagne's work is on the use of environmental tracers to study groundwater and surface water interactions and the impact that these processes have on wetlands and other surface water ecosystems.

He is a project leader within the Centre's program on Surface Water-Groundwater Interactions and will use his expertise to examine processes in streams, rivers, lakes and coastal zones.

Ling Li

Chair, Environmental Engineering, University of Queensland

A world leading researcher on coastal groundwater, Professor Ling Li's work has provided a key theoretical base for studying the dynamics of shallow aquifers and interactions with coastal water.

His principal research interests lie in mathematical modelling of complex environmental systems with a current focus on the processes at the ocean-land interface.

He has contributed to the development of many emerging concepts and research directions in the area of coastal groundwater, including a theoretical model of submarine groundwater discharge that assists our understanding of contaminants in coastal aquifers.

During his career Professor Li has published over 110 research papers, including 80 articles mostly in top international journals. He is a member of the editorial board of *Advances in Water Resources* and an associate editor of *Hydrogeology Journal*.

Professor Li will be supporting the Centre's program on groundwater dynamics at the land-ocean interface. He will help link research with his related work on contaminant transport in coastal aquifers currently being undertaken in Europe and China through his role as visiting professor at the University of Edinburgh and Hohai University.

Matthew McCabe

Senior Lecturer, School of Civil and Environmental Engineering and Climate Change Research Centre, University of New South Wales

A leading expert in hydrological remote sensing, Dr Matthew McCabe has extensive international research experience including work with NASA.

Dr McCabe's overriding research interest is in observation and modelling of the Earth's coupled energy and water cycles. He is respected in diverse areas of Earth observation and is recognised for his research involving multi-scale and multi-satellite observation and modelling.

His achievements include publishing the first validated soil moisture results from the NASA-AMSR-E satellite and undertaking the first detailed scale analysis of evapotranspiration prediction from remote sensing.

He also recently developed a new technique for monitoring ice-sheet melting in Greenland, providing an advanced observational capacity for climate predictions.

His most recent contribution is the development of a conceptual framework to assess remote observations based on their hydrological consistency, advancing the field of water and energy cycle analysis and application using remote sensing data.

Dr McCabe's expertise in evapotranspiration estimation will be used in the Centre's program on Groundwater-Vegetation-Atmosphere Interactions. He has extensive experience in diverse field scale hydrological measurement, running field campaigns and commissioning scientific equipment for hydrometeorological measurements.

Jennifer McKay

Director, Centre for Comparative Water Policies and Laws, University of South Australia

With a PhD in geography and a degree in law, Professor Jennifer McKay has become a key adviser on international water policy development.

She has a strong understanding of both the structure and mechanics of natural systems in surface and groundwater, combined with an international legal and policy perspective on water ownership and management. This specialist and complementary expertise has been applied through research projects involving more than 60 publications.

Professor McKay has contributed to water management policy frameworks of Federal and State Governments, international legal organisations and international water policy development bodies.
She was awarded the Fulbright Senior Fellowship for 2008-2009 which placed her in direct contact with world-class researchers concerned with groundwater ownership, allocation and policy frameworks.

Her key interests involve law and policy designed to achieve ecologically sustainable development. She has designed a framework for research which blends socio legal methods with a distinct law reform emphasis. Professor McKay will be co-leader of the Centre's sub-program on policy, institutional, law and governance issues.

David Mitchell

Technical Specialist Salinity Management, Orange Agricultural Institute, Department of Primary Industries, New South Wales

A specialist in salinity management, Dr David Mitchell has been involved in one of the first comprehensive and scientifically credible studies in Australia to validate models of how water and salt move under a range of common landuses.

As leader of the statewide National Action Plan research project Key Sites, he is studying the effect of landuse and climate on eight small upland dryland catchments in New South Wales. The research is challenging much of the commonly held conceptual understanding of hydrology processes that are used as the basis for investment of public funds and natural resource policy development.

Dr Mitchell has a PhD in surface hydrology and spent several years researching aspects of water balance science. Among his achievements is the development of a framework to measure water balances over a series of nested spatial scales. He will be a principal investigator in the Centre's sub-program involving the integration of hydrochemical and hyrogeological methods for analysing regional groundwater flow.

David Pannell

Professor, School of Agricultural and Resource Economics, University of Western Australia, Australian Research Council Federation Fellow

One of Australia's leading experts on groundwater-driven dryland salinity, Professor David Pannell has been a prominent advocate of policies that better reflect the needs of the scientific, economic and social communities.

His influential research activities have included work on bio-economic modelling, economic and policy aspects of natural resource management and farmer adoption of new practices.

In 2004 he became the first social scientist to win the W.E. Wood prize for his research into salinity, a national award across all research disciplines.

Professor Pannell's research is characterised by a high degree of collaboration internationally and with other research disciplines to tackle the economics of natural resource issues. His integrated analysis of dryland salinity has been highly influential and he was the main modeller for the early development of the MIDAS whole-farm bioeconomic models.

Professor Pannell leads a team which recently (August 2009) was awarded a prestigious Eureka Prize for Excellence in Research by an Interdisciplinary Team. The award was won for the team's INFER Project: the Investment Framework for Environmental Resources, which is a tool for developing and prioritising projects to address environmental issues such as water quality, biodiversity, environmental pests and land degradation. It aims to achieve the most valuable outcomes with the available resources.
Professor Pannell will play a leading role in the Centre's sub-programs relating to integrated water management and decision support.

Carmel Pollino

Research Fellow, Integrated Catchment Assessment and Management Centre (iCAM), Fenner School of Environment and Society, Australian National University

Dr Carmel Pollino is a specialist in the development of risk and integrated assessment for natural resource management and conservation. Her work focuses on the conceptual framing of complex socio-economic-biophysical problems, their conversion into quantitative and qualitative models and evaluation of associated tradeoffs with relevant interest groups.

She has performed risk assessment and Bayesian modelling for government and industry in Australia and overseas. As a researcher with the Commonwealth Environmental Research Facility Landscape Logic, Dr Pollino has been responsible for conceptualising and modelling water management issues, integrating information from physical and social science programs and developing tools to support natural resource management.

Her experience in developing risk assessment processes and risk analysis methods has been demonstrated in industries such as mining and irrigation and specific issues concerning environmental flow and contaminants.

As a chief investigator with the Centre, she will be contributing to all the sub-programs in the Integrating Socioeconomics, Policy and Decision Support program.

Wendy Timms

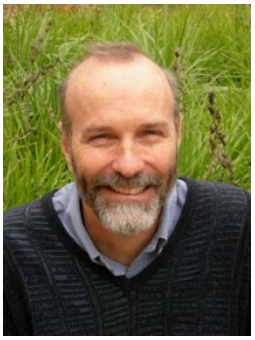
Senior Engineer-Scientist, Water Research Laboratory, School of Civil and Environmental Engineering, University of New South Wales

Dr Wendy Timms has gained considerable attention for her research on aquitards in groundwater systems of the Murray-Darling Basin and in North America. Her research has targeted key unknowns that are critical to achieving sustainable groundwater development and water quality protection.

Through her membership of the International Association of Hydrogeologists she has actively sought to raise awareness of groundwater issues and provide ongoing development opportunities for groundwater professionals and students.

Since heading the groundwater business unit at the Water Research Laboratory since 2003, Dr Timms has worked closely with industry and government. Her specialist research interests are in clay aquitards, accelerated gravity permeameter techniques and hydrochemical and isotopic techniques for tracing leakage.

Dr Timms will use this expertise as lead of the Centre's sub-program on characterising aquifers and aquitards



John Webb

Head of Environmental Geoscience, La Trobe University

During a long history of groundwater research in Victoria, Associate Professor John Webb has been involved in numerous joint projects with researchers and groundwater managers.
Through his work he has forged strong links between his research and the people who benefit most from the outcomes. His research interests span the fields of groundwater hydrochemistry and hydrology, particularly focusing on the causes of dryland salinity and appropriate remediation strategies. He has also been concentrating on the interrelationships between geology, groundwater and salinity from the catchment to the paddock scale. A developing focus has been the role of vegetation and climate in dryland salinity, and the potential impacts of changes in these factors.

With his broad expertise in the fields of hydrogeological and hydrogeochemical techniques, Dr Webb will be closely involved in the Centre's research into Groundwater-Vegetation-Atmosphere Interactions.
The Centre will draw on his expertise involving the impacts of vegetation and climate on groundwater levels and quality using new technology and new modelling methods at a variety of scales.

Adrian Werner

Associate Professor in Groundwater Hydrogeology, School of Chemistry, Physics and Earth Sciences, Flinders University

With his extensive background in groundwater hydrology research, Associate Professor Adrian Werner has been appointed chief investigator for two important Centre sub-programs. Drawing on his experience in coastal groundwater investigations, he will lead projects involving complex coastal systems and their modelling.

Associate Professor Werner has considerable expertise in the development of field monitoring campaigns, investigations into coastal processes and the development of complex models.
His work includes leading regional-scale groundwater models in Queensland and most recently the Southern Eyre Peninsula hydrogeology project in South Australia.

Associate Professor Werner's background in modelling complex systems includes research into groundwater and soil hydrology, and seawater intrusion. He has a specific interest in process averaging and up-scaling, and the challenges of developing meaningful models of regional-scale systems.

An associate editor of the prestigious Journal of Hydrology, Associate Professor Werner's research is recognised internationally. He is a member of the eWater CRC, representing the Queensland Government in the sub-program on surface water-groundwater interaction.

NCGRT Investigators

Jane Coram

Senior Hydrogeologist, Geospatial and Earth Monitoring Division, Geoscience Australia

Jane Coram has provided high-level technical advice on groundwater issues, including dryland salinity, groundwater sustainability and wetlands management, to Federal and State government agencies and regional catchment managers.

Her work has involved the integrated use of hydrologic, hydrochemical and remotely sensed information, to understand groundwater dynamics in relation to near-surface, ecological systems and deeper aquifer dynamics.

She has also been actively involved in the development of multidisciplinary, regional assessments of the role of groundwater processes in wetlands dynamics, dryland salinity and groundwater sustainability.

As a Partner Investigator with the Centre Ms Coram will focus on three sub-programs under the Innovative Characterisation of Aquifers and Aquitards program – linking geological and hydrogeological processes, characterising aquitards and heat as a groundwater tracer.

This research is aligned with her work for Geoscience Australia in developing geological understandings of groundwater systems using advances in 3D modelling, geophysical and remote sensing, and evaluation of hydraulic properties.

Marc LeBlanc

Senior Lecturer, School of Earth and Environmental Sciences, James Cook University

Dr Marc LeBlanc will apply his expertise in tropical hydrological sciences to support the Centre's research program into surface water and groundwater interactions.

The tropical environments of Australia are unique in their rapid groundwater dynamics. Dr LeBlanc is particularly interested in the spatial and temporal variability in tropical groundwater resources.
Representing a group of scientists working in the field of tropical hydrogeology and hydrological sciences at Queensland's James Cook University, he will provide key input into the NCGRT sub-program on groundwater recharge from losing streams.

Dr LeBlanc believes an improvement in our current understanding of the hydrogeological processes and groundwater issues in the wet and dry tropics is crucial for Australia. His research interests are focused on developing innovative applications of remote sensing and GIS to advance water resources assessment and management in Australia and overseas.

Using satellite data and hydrological modelling, Dr LeBlanc is currently working on a range of tropical water resources issues.

Andrew Love

Researcher, School of Chemistry, Physics and Earth Sciences, Flinders University

An experienced hydrogeologist, Dr Love has expertise in various different fields of relevance to the Centre's research program.

His expertise covers surface-water groundwater interactions, fractured rock aquifers, large groundwater system analyses and aquifer characterisation.

Before joining Flinders University as a researcher, Dr Love was a principal hydrogeologist with the South Australian Department of Water, Land and Biodiversity Conservation.
He has contributed to several books and written various journal papers on his research into complex groundwater interactions.

As a result of Dr Love's broad experience, he will provide advice on a number of NCGRT research initiatives, with particular interest in the Aquifer Characterisation Program. He will have direct involvement in three sub-programs – linking geological and hydrogeological processes, characterising aquitards and research into highly transient, spatially-distributed surface water-groundwater interaction.

Catherine Lovelock

Associate Professor, Centre for Marine Studies and School of Integrative Biology, University of Queensland

Associate Professor Lovelock's expertise is in the fields of plant ecology and global change biology. As a Centre investigator she will work collaboratively on groundwater interaction with estuarine rivers, lakes and wetlands. Her research will examine how

groundwater influences a range of ecological processes, focusing particularly on the stability of intertidal vegetation, such as mangrove and saltmarsh, with changing climate and rises in sea level.

Early in her career Associate Professor Lovelock made important contributions in understanding the role of light in structuring mangrove, tropical rainforest and coral reef algal communities. She also uncovered the importance of nutrient availability in determining species interactions in mangrove forests.

Through her research in global change biology, Associate Professor Lovelock discovered the remarkable tolerance of Antarctic mosses to fluctuating temperatures. Her most recent contributions in this area are focused on improving understanding of carbon cycling in soils in both terrestrial and mangrove environments, and in assessing vulnerability of intertidal habitats to climate change and sea level rise.

Appendix C – Independent Audit Report and Audited Financial Statements

For the year ended 31 December 2009

Messenger Zerner

INDEPENDENT AUDIT REPORT
TO THE AUSTRALIAN RESEARCH COUNCIL
FOR NATIONAL CENTRE FOR GROUNDWATER RESEARCH AND TRAINING

REPORT ON THE FINANCIAL REPORT

We have audited the accompanying financial report, being a special purpose financial report of National Centre for Groundwater Research and Training, which comprises the Statement of Financial Position as at 31 December 2009, and the Income Statement, a Summary of Significant Accounting Policies, other explanatory notes and the Financial Statements Certification.

University's Responsibility for the Financial Report

Flinders University of South Australia as the Administering Organisation is responsible for the preparation and fair presentation of the financial report and have determined that the accounting policies described in Note 1 to the financial statements, which form part of the financial report, are consistent with the financial reporting requirements of the Australian Research Council Act 2001 (ARC Act 2001). The University's responsibilities also include establishing and maintaining internal control relevant to the preparation and fair presentation of the financial report that is free from material misstatement, whether due to fraud or error; selecting and applying appropriate accounting policies; and making accounting estimates that are reasonable in the circumstances.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. No opinion is expressed as to whether the accounting policies used, as described in Note 1, are appropriate to meet the needs of the Australian Research Council. We conducted our audit in accordance with Australian Auditing Standards. These Auditing Standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial report in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the internal controls. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the University, as well as evaluating the overall presentation of the financial report.

MESSENGER ZERNER PTY LTD as agent for MESSENGER ZERNER SERVICES ABN 81 562 766 308
DIRECTORS • M K ZERNER • W G DARTNALL • S P GRAETZ • CHARTERED ACCOUNTANTS
157 GRENFELL STREET ADELAIDE SA 5000 TELEPHONE (08) 8223 1468 FACSIMILE (08) 8232 1753
www.messengerzerner.com.au

The financial report has been prepared for distribution to Australian Research Council for the purpose of fulfilling the Universities' financial reporting requirements under the ARC Act 2001. We disclaim any assumption of responsibility for any reliance on this report or on the financial report to which it relates to any person other than the Australian Research Council, or for any purpose other than that for which it was prepared.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Independence

In conducting our audit, we have complied with the independence requirements of Australian professional ethical pronouncements.

AUDITORS OPINION

In our opinion, the financial report and the accounts and money held by the Administering Organisation, or paid to or received by the Administering Organisation are held and dealt with in accordance with the ARC Act 2001, and the terms and conditions of the funding agreement and the current applicable Australian Accounting Standards as shown in Note 1 to the financial statements.

W. Dartnall
.....
W G DARTNALL
Adelaide

Messenger Zerner
.....
MESSENGER ZERNER PTY LTD
Chartered Accountants

Dated 31 day of March 2010

National Centre for Groundwater Research and Training

Flinders University of South Australia

Annual Financial Statements

For the year ended 31 December 2009

Contents

National Centre for
Groundwater Research and Training
sustaining a vital water resource

www.flinders.edu.au/ncgrt

Income Statement for the year ended 31 December 2009

	Notes	2009 $
Revenue		
Australian Government		
Australian Research Council	2 , 6	2,986,875
Administering Organisation		
Flinders University of SA	3 , 4	145,833
Collaborating Organisations		
Other Australian Universities	3 , 4	1,003,372
Partner Organisations		
SA State Government Departments	3 , 4	150,000
NSW State Government Departments	3 , 4	989,000
Non-government industry	3 , 4	60,000
Total cash revenue		5,335,080
In kind contributions		
Administering Organisation - Flinders University of SA	4	475,182
Collaborating Organisations - Other Australian Universities	4	918,817
Partner Organisations	4	6,210
Total in kind contributions		1,400,209
Total cash revenue and in kind contributions		**6,735,289**
Expenses		
Cash	5	
Research operations		152,998
Centre management activities		382,394
Total cash expenses		535,392
In kind	5	
Research operations		925,027
Centre management activities		475,182
Total in kind expenses		1,400,209
Total cash and in kind expenses		**1,935,601**
Operating result for the year		**4,799,688**

The above Income Statement should be read in conjunction with the accompanying notes.

MZ.

Statement of Financial Position as at 31 December 2009

	2009
	$
ASSETS	
Current Assets	
Cash and cash equivalents	4,474,388
Receivables	325,300
Total Current Assets	4,799,688
Total Assets	**4,799,688**
LIABILITIES	
Total Liabilities	-
Net Assets	**4,799,688**
EQUITY	
Retained surplus	4,799,688
Total Equity	**4,799,688**

The above Statement of Financial Position should be read in conjunction with the accompanying notes.

MZ.

Statement of Cash Flows for the year ended 31 December 2009

	Notes	**2009**
		$
Cash flows from operating activities		
Australian Government ARC Grants received	2	2,986,875
Administering Organisation (Flinders University) contributions received	4	145,833
Collaborating Organisations (other universities) contributions received	4	678,072
Partner Organisations (Industry) contributions received	4	60,000
Partner Organisation (SA State Government) contributions received	4	150,000
Partner Organisation (NSW State Government) contributions received	4	989,000
Payments to suppliers and employees	5	(535,392)
Net cash provided by operating activities		**4,474,388**
Cash flows from investing activities		
Payments for property, plant and equipment		-
Net cash outflow used in investing activities		**-**
Cash flows from financing activities		
Proceeds from borrowings		-
Net cash provided by financing activities		**-**
Net increase/ (decrease) in cash and cash equivalents		**4,474,388**
Cash and cash equivalents at beginning of the year		-
Cash and cash equivalents at the end of the year		**4,474,388**

The above Statement of Cash Flows should be read in conjunction with the accompanying notes.

M2.

Note 1 Summary of significant accounting policies

The significant policies that have been adopted in the preparation of this financial report are:

(a) Basis of preparation

The National Centre for Groundwater Research and Training (NCGRT) is not a reporting entity. This financial report is a **special purpose financial report** that has been produced for the sole purpose of complying with the agreement between Flinders University and Commonwealth of Australia as represented by the Australian Research Council (ARC). It has been prepared for distribution to the Commonwealth of Australia and the Partner and Collaborating Organisations and must not be used for any other purpose. It has been prepared in accordance with the following applicable Australian Accounting Standards:

AASB 101	Presentation of Financial Statements	AASB 118	Revenue
AASB 107	Statement of Cash Flows	AASB 1004	Contributions
AASB 108	Accounting Policies, Changes in Accounting Estimates and Errors	AASB 1031	Materiality
AASB 110	Events after the Reporting Period		

The financial report has been prepared on the accrual basis of accounting as defined in AASB 101: Presentation of Financial Statements, using the historical cost convention and the going concern assumption. Except where stated, it does not take into account changing money values or current valuations of non-current assets.

(b) Reporting entity

Flinders University is the Administering Organisation for the National Centre for Groundwater Research and Training (NCGRT) and forms part of the University Reporting Entity. Accordingly all financial transactions conducted by Flinders University are recorded in the University's General Ledger and results are reflected and incorporated in the University's 2009 financial statements.

(c) Consolidated initiative reporting

The NCGRT initiative includes sub-agreements between Flinders University and nineteen Collaborating and Partner organisations. Part of the Commonwealth Government funding received through ARC is distributed to Collaborating and Partner Organisations, who also contribute specified amounts to the NCGRT initiative, conduct work for the initiative, and incur related expenses. This report consolidates all the financial transactions relating to the NCGRT by all relevant parties.

(d) Contribution recognition

The funds received from the ARC/National Water Commission and the Collaborating and Partner Organisations are considered to be non-reciprocal in nature and accordingly the principles of AASB 1004 Contributions are applied. Any expenditure of these funds will be brought to account in the reporting period in which it is incurred.

(e) In kind contributions

The Administering Organisation and some of the Collaborating and Partner Organisations, make in kind contributions to the NCGRT that are recognised in the Income Statement at fair value according to AASB 9, and are based on estimates of internal resources applied by the organisations.

(f) Plant and equipment assets

In accordance with Flinders University policy, any assets over $10,000 are capitalised. Plant and equipment is valued at historical cost less accumulated depreciation, and recorded in the University's asset register.

(g) Intangible assets

Expenditure on research activities, undertaken with the prospect of obtaining new scientific or technical knowledge and understanding, is recognised in the Income Statement as an expense when it is incurred.

(h) Employee entitlements

Personnel engaged in the NCGRT initiative are employees of the Administering, Collaborating or Partner Organisation. Each organisation is separately responsible for the provision of long service and annual leave estimated to be payable to employees on the basis of statutory and contractual requirements in accordance with AASB 119 *"Employee Benefits"*. Accordingly no recogition of these liabilities is included in this report.

(i) Taxation

The NCGRT initiative is administered by Flinders University whose activities are exempt from income tax. NCGRT expenditure is subject to Fringe Benefits Tax (FBT) and Payroll Tax where applicable.

Funds received by the NCGRT from the Commonwealth are an appropriation and are therefore exempt from the Goods and Services Tax (GST). Distributions of Commonwealth funding to other government related entities as specified in the funding agreement will also be classified as appropriations and exempt from GST (final treatment pending outcome of an ATO private ruling submitted January 2010). All other receipts and payments are subject to GST where applicable.

(j) Comparative figures

NCGRT commenced operations in June 2009, consequently there are no prior period comparative figures.

M2.

Note 2 ARC funds revenue and distribution

	Notes	2009 $
ARC Revenue		
ARC Funds received by Administering Organisation, Flinders University	6	2,986,875
Total ARC revenue		2,986,875
Distribution of ARC Funds to Collaborating Organisations		
Australian National University		-
Charles Sturt University		60,370
James Cook University		-
La Trobe University		23,855
Monash University		-
Queensland University of Technology		-
University of NSW		-
University of Queensland		-
University of South Australia		60,370
University of Technology Sydney		-
University of Western Australia		-
Total ARC funds distributed		144,595
Total ARC Funds retained by Administering Organisation, Flinders University as at 31 December 2009	6	2,842,280

Note 3 Non-ARC funds revenue and distribution

Non-ARC Revenue	
Cash Contributions from Administering, Collaborating and Partner Organisations	2,348,205
Total Non-ARC revenue	2,348,205
Distribution of Non-ARC Funds to Collaborating Organisations	
Australian National University	-
Charles Sturt University	7,521
James Cook University	-
La Trobe University	3,760
Monash University	-
Queensland University of Technology	-
University of NSW *	1,070,541
University of Queensland	51,458
University of South Australia	7,521
University of Technology Sydney	-
University of Western Australia	-
Total Non-ARC funds distributed	1,140,801
Total Non-ARC Funds retained by Administering Organisation, Flinders University as at 31 December 2009	1,207,404

* University of NSW received $989,000 of this funding for the NCGRT initiative directly from the NSW Government.

M2.

Note 4 Administering, Collaborating and Partner Organisation Contributions

	Cash contributions $	In kind contributions $	2009 Total Contributions $
Administering Organisation			
Flinders University of South Australia	145,833	475,182	621,015
Total administering organisation	145,833	475,182	621,015
Collaborating Organisations			
Australian National University	126,562	144,849	271,411
Charles Sturt University	54,844	30,815	85,659
James Cook University	40,000	-	40,000
La Trobe University	25,300	-	25,300
Monash University	75,000	60,751	135,751
Queensland University of Technology	50,000	13,750	63,750
University of NSW	295,312	333,313	628,625
University of Queensland	160,000	186,225	346,225
University of South Australia	36,354	41,112	77,466
University of Technology Sydney	75,000	8,232	83,232
University of Western Australia	65,000	99,771	164,771
Total collaborating organisations	1,003,372	918,817	1,922,189
Partner Organisations			
Aquaterra	-	-	-
CSIRO	-	6,210	6,210
Geoscience Australia	-	-	-
NSW Department of Primary Industries *	989,000	-	989,000
SA Department of Water, Land & Biodiversity Conservation	100,000	-	100,000
SA Water	50,000	-	50,000
Sinclair Knight Merz	10,000	-	10,000
United Water	50,000	-	50,000
Total partner organisations	1,199,000	6,210	1,205,210
Total collaborating and partner organisation contributions	**2,348,205**	**1,400,209**	**3,748,414**

* NSW DPI paid the $989,000 for the NCGRT initiative directly to University of NSW.

M2.

Note 5 Expense - cash and in kind

	Administering Organisation $	Collaborating Organisations $	2009 Total Expenses $
Cash expense			
Research operations			
Salaries and on-costs	-	95,529	95,529
Teaching Relief	-	3,080	3,080
Non-capitalised equipment	-	19,857	19,857
Maintenance	-	2,777	2,777
Workshops and Seminars	-	1,214	1,214
PostDoc Travel	-	656	656
CI/PI Travel	-	6,980	6,980
Conference/Workshop Travel	-	14,799	14,799
Site or Project Expenditure	-	1,718	1,718
Other Admin expenditure	-	6,388	6,388
Total research operations cash expense	**-**	**152,998**	**152,998**
Centre management activities			
Salaries and on-costs	175,698	-	175,698
Staff Recruitment	28,972	-	28,972
Travel, conferences, workshops, entertainment	20,756	-	20,756
Consultancy fees	61,930	-	61,930
Marketing and business development	50,376	-	50,376
General administration	42,414	-	42,414
Printing and publishing	2,249	-	2,249
Total centre management activities cash expenses	**382,394**	**-**	**382,394**
Total cash expense	**382,394**	**152,998**	**535,392**
In kind expense			
Salaries and on-costs	258,096	543,363	801,459
Office space and overheads	217,086	381,664	598,750
Total in kind expense	**475,182**	**925,027**	**1,400,209**
Total cash and in kind expense	**857,576**	**1,078,025**	**1,935,601**

M2.

Note 6 Commitments

(a) Current commitments to redistribute ARC funds under legal agreements entered into by the Administering Organisation (AO) with Collaborating Organisations (CO), less invoiced amounts accrued by the AO, as at 31 December 2009.

	Notes	ARC Funds for redistribution	Less accrued 31Dec09	Commitment as at 31Dec09
		$	$	$
Collaborating organisation				
Australian National University		348,344	-	348,344
Charles Sturt University		60,370	60,370	-
Flinders University		1,056,159	-	1,056,159
James Cook University		44,557	-	44,557
La Trobe University		23,855	23,855	-
Monash University		137,060	-	137,060
Queensland University of Technology		26,361	-	26,361
University of New South Wales		702,441	-	702,441
University of Queensland		329,729	-	329,729
University of South Australia		60,370	60,370	-
University of Technology Sydney		137,259	-	137,259
University of Western Australia		60,370	-	60,370
Total commitments to redistribute ARC funds	2	**2,986,875**	**144,595**	**2,842,280**

(b) Current commitments to redistribute cash contributions under legal agreements entered into by the Administering Organisation (AO) with Collaborating Organisations (CO), less invoiced amounts accrued by the AO, at 31 December 2009.

	Notes	Cash contributions for redistribution	Less accrued 31Dec09	Commitment as at 31Dec09
		$	$	$
Collaborating organisation				
Australian National University		58,979	-	58,979
Charles Sturt University		7,521	7,521	-
Flinders University		155,563	-	155,563
James Cook University		3,760	-	3,760
La Trobe University		3,760	3,760	-
Monash University		15,042	-	15,042
Queensland University of Technology		63,745	-	63,745
University of New South Wales		81,541	81,541	-
University of Queensland		51,458	51,458	-
University of South Australia		7,521	7,521	-
University of Technology Sydney		15,042	-	15,042
University of Western Australia		7,521	-	7,521
Total commitments to redistribute cash contributions	3	**471,453**	**151,801**	**319,652**

Note 7 Events occurring after reporting date

There were no events that took place after reporting date that have a material impact on the financial statements of the NCGRT.

MZ.

National Centre for Groundwater Research and Training Financial Statements for the year ended 31 December 2009

To the best of our knowledge and belief, we certify the correctness of the attached Special Purpose Financial Report for the National Centre for Groundwater Research and Training for the 2009 reporting period, in accordance with the agreement between Flinders University of South Australia (the Administering Organisation) and the Commonwealth of Australia as represented by the Australian Research Council (ARC), the financial position of the National Centre for Groundwater Research and Training (NCGRT) as at 31 December 2009, the results of its operations and its cash flows for the year;

Craig T. Simmons

Professor Craig Simmons
Director, National Centre for Groundwater Research and Training 29 March 2010

Michael Barber

Professor Michael N Barber
Vice-Chancellor, Flinders University of South Australia 29 March 2010

Daniel Flaherty

Mr Daniel Flaherty CPA
Director Financial Services, Flinders University of South Australia 26 March 2010

MZ.

Appendix D – Measurement and Account of Performance against Milestones

The measurement and account for Performance against milestones is based on the five goals of the Centre set out in the Centre Business Plan 2009.

RESEARCH

The Centre's Research goals are to:

- undertake highly innovative and relevant research in groundwater and related fields with a scale and focus leading to outstanding national and international collaboration and recognition; and
- establish explicit links to the National Water Initiative.

ACTION	DUE DATE	STATUS	ACTUAL
Research Management Committee two day planning workshop	21-22 August	Completed on schedule	21-22/8/2009
National end-user research needs identification tour	30 September	Completed on schedule	September 2009
Preparation of research plans matrix and project management plans	September	Ongoing. Early drafts completed.	Dec 2010
Development of a Research data management strategy with the RMC	October	To be Completed behind schedule	By July 2010
Submission of final detailed research plans to respective Research Nodes & Partners	End of November	Completed by due date	Nov 2010
Briefing of ISAC Committee	November	Completed by due date Briefing documentation was sent to ISAC members in November 2009.	The ISAC Meeting was held on 8-11 February 2010.

BUILDING CAPACITY

The Centre's building capacity goals are to:

- attract and retain researchers of high international standing from within Australia and overseas, as well as the most promising research students;
- provide high quality postgraduate and post-doctoral training environments for the next generation of professionals and researchers;
- offer Australian researchers and groundwater professionals access to world-class infrastructure, training, equipment and key research information and technologies; and
- provide high quality non-research and professional training programs.

ACTION	DUE DATE	STATUS	ACTUAL
Trigger and implement all marketing strategies (National and International Postdoctoral, PhDs and Honours)	31st August	Completed behind schedule	January 2010
Schedule and promote short-courses for 2010	31st August	Completed by due date	31/8/2009
Screening of Postdoctoral, PhD and Honours resumes	Mid-September	Completed by due date	On-going process
Short-course integration and promotion and strategy to design new courses	October	Completed behind schedule	February 2010
International and National PhD applicants	October	Completed by due date	On-going process
National and International Honours applicants	October	Completed by due date	On-going process
Purchase of major equipment	31st December	Completed by due date	31/12/2009
First round of APA offers	December	Completed by due date	December 2009
Subsequent APA offers	January/February 2010	Completed by due date	February 2010
Final enrolment of students	31st March 2010	Completed by due date	31/3/2010

LINKAGES

The Centre's goals for linkages are to:

- provide an effective resource for the groundwater sector by establishing and developing strong, collaborative relationships with the research, education, industry and government sectors and serving as a point of interaction among these sectors; and
- establish and develop international networks and linkages.

ACTION	DUE DATE	STATUS	ACTUAL
National Tour	End of September	Completed by due date	30/9/2009
Industry briefings	Continuous through to 18 December	Completed by due date	On-going process

OUTREACH

The Centre goal for outreach is to communicate, utilising a range of methods/mediums, the science undertaken in the Centre to the general public.

ACTION	DUE DATE	STATUS	ACTUAL
Official NCGRT launch	Late October	Completed behind schedule	22/1/2010
Operational NCGRT website	31st August	Completed by due date	31/8/2009
Posters and brochures	End of September	To be completed behind Schedule	By July 2010
NCGRT newsletters	September and Mid-November	To be completed behind schedule	By July 2010
Establishment of marketing and communications plan	31st December	Completed by due date	22/12/2009

GOVERNANCE

The Centre's governance target is to ensure that the structure is fully implemented by the end of December 2009, with the fundamentals in place by the end of August 2009.

ACTION	DUE DATE	STATUS	ACTUAL
Director & Deputy Director formal appointments	End of August	Completed by due date Completed behind schedule	D: 30/8/2009 DD:
Legal wind-up of CGS	End of August	Completed by due date	June 2009
Advisory Board Centre briefing, TOR and Strategic Plan Meeting	31st August	Completed by due date	31/8/2009
Execution of financial sub-agreements (Flinders Partners)	1 September	Completed by due date	30/8/2009
ILAC Brief, TOR confirmation and Strategic meeting	15 September	To be completed behind schedule	17/3/2010
RMC annual 2010 action plan meeting	End of September	Completed by due date	September 2009
Human Resource and Financial Management system	End of September	To be completed behind schedule	July 2010
Finalisation of RMC 2010 action plan	Early October	To be completed behind schedule	2010
Recruit a Finance Officer and Executive Assistant	End of October	Completed behind schedule	FO:20/1/2010 EA: 30/6/2009
Recruit marketing/communications manager	End of October	Completed behind schedule	17/5/2010
Advisory Board Centre review meeting	Early November	To be completed behind schedule	2010
RMC face to face meeting	18 November	Completed by due date	23/11/2009
Appointment of General Manager	Mid-November	Completed by due date	30/11/2009
Submission of Strategic and Business Plan 2010	30 November	Completed by due date Revised BP and SP submitted to ARC on:	30/11/2009 BP: 26/2/2010 SP: 30/4/2010

Appendix E – Summary of Public Acknowledgements of Funding

DATE	DESCRIPTION	ORGANISATION
June 2009	Meeting with SAMLNRM Board	SAMBD NRM/ SAMLNRM
June 2009	SA Council Members visit to Faculty	SA Government
June 2009	Research Planning Meeting	Airborne Research Australia
June 2009	NCRIS Meeting	AuScope Melbourne University
July 2009	UNSW WRL 50th Event	UNSW
July 2009	NCGRT Meeting in Melbourne	Victoria Department of Sustainability and Environment
July 2009	Clever Green Conference	Flinders University
July 2009	NCGRT Meeting	DHI
July 2009	NCGRT Meeting with NRETAS	NRETAS, Darwin
Aug 2009	Meeting with NSW Government	NSW Government
Aug 2009	NCGRT Meeting	Water Industry Alliance
Aug 2009	Southern Adelaide Water Industry Forum Dinner	Southern Adelaide Water Industry Forum
Aug 2009	Super Science meeting	DIISR
Aug 2009	NCGRT Meeting	Department of Water, Land and Biodiversity Conservation
Sept 2009	FEFLOW Conference, Potsdam Germany	FEFLOW
Sept 2009	CGS Groundwater School presentation	Centre for Groundwater Studies
Sept 2009	NCGRT Meeting	CSIRO
Sept 2009	ASTR Workshop	SA Water
Sept 2009	NCGRT Meeting	PICSE
Sept 2009	NCGRT Research planning Meeting	Willunga Basin Water Company
Sept 2009	Presentation to the NSW Office of Water Project Steering Committee	NSW office of Water
Oct 2009	NCGRT Industry Meeting	Geoscience Australia

Oct 2009	NCGRT Meeting	PICSE
Oct 2009	Internode Business Luncheon	State and Federal Government
Oct 2009	Water Industry Alliance Presentation on NCGRT	Water Industry Alliance
Oct 2009	State Industry Partners Meeting	DWLBC/ SA WATER
Oct 2009	ARC Major Grants announcement and Expo, Parliament House, Canberra	ARC
Oct 2009	National Hydrological Modelling Strategy Meeting	CSIRO
Oct 2009	NSW Office of Water Teleconference	NSW office of Water
Nov 2009	Flinders Library Presentation	Flinders University
Nov 2009	State Industry Partners Meeting	DWLBC, SA Water
Nov 2009	Birdsall Dreiss Lectures - Chunmiao Zheng	Flinders University
Nov 2009	Superscience Meeting	SA Water
Nov 2009	Superscience Meeting	DWLBC
Nov 2009	Briefing on NCGRT	DWLBC
Nov 2009	Groundwater Action Plan Forum	National Water Commission
Dec 2009	PICSE Meeting on NCGRT	PICSE

Appendix F – Abbreviations

AC	Aquaterra Consulting Pty Ltd
ACT	Australian Capital Territory
ANU	Australian National University
AO	Administration Officer
ARC	Australian Research Council
BP	Business Planning
CI	Chief Investigator
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CGS	Centre for Groundwater Studies
CSU	Charles Sturt University
D	Director
DD	Deputy Director
DIISR	Department of Innovation, Industry, Science and Research
DWLBC	Department of Water, Land and Biodiversity Conservation
EA	Executive Assistant
EO	Executive Officer
FM	Finance Management
FO	Finance Officer
FU	Flinders University
GA	GeoScience Australia
GM	General Manager
GUMs	Groundwater Users and Managers
IAH	International Association of Hydrogoelogists
ILAC	Industry Liaison Advisory Committee
IP	Intellectual Property
ISAC	International Scientific Advisory Committee
JCU	James Cook University
KPIs	Key Performance Indicators
LA	Legal Advisory
LTU	LaTrobe University
MU	Monash University
NCGRT	National Centre for Groundwater Research and Training
NCGRTI	National Centre for Groundwater Research and Training Investigator other than CIs and PIs
NGAI	National Groundwater Assessment Initiative
NT	Northern Territory
NSW	New South Wales
NSWDPI	New South Wales Department of Primary Industries
NWC	National Water Commission
NWI	National Water Initiative
PI	Partner Investigator
PICSE	Primary Industry Centre for Science Education
PM	Project Management
QLD	Queensland
QUT	Queensland University of Technology
RMC	Research Management Committee
RN	Research Nodes
TAS	Tasmania
TOR	Terms of Reference
SA	South Australia
SAW	SA Water
SKM	Sinclair Knight Merz Consulting Pty Ltd
SLF	NSW Science Leveraging Fund
SP	Strategic Plan
UniSA	University of South Australia
UNSW	University of New South Wales
UQ	University of Queensland
UTS	University of Technology Sydney
UWA	University of Western Australia
UWI	United Water International
VIC	Victoria
WA	Western Australia