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knowledge for managing Australian landscapes

Knowledge needs for the Environmental Water Allocation R&D Program



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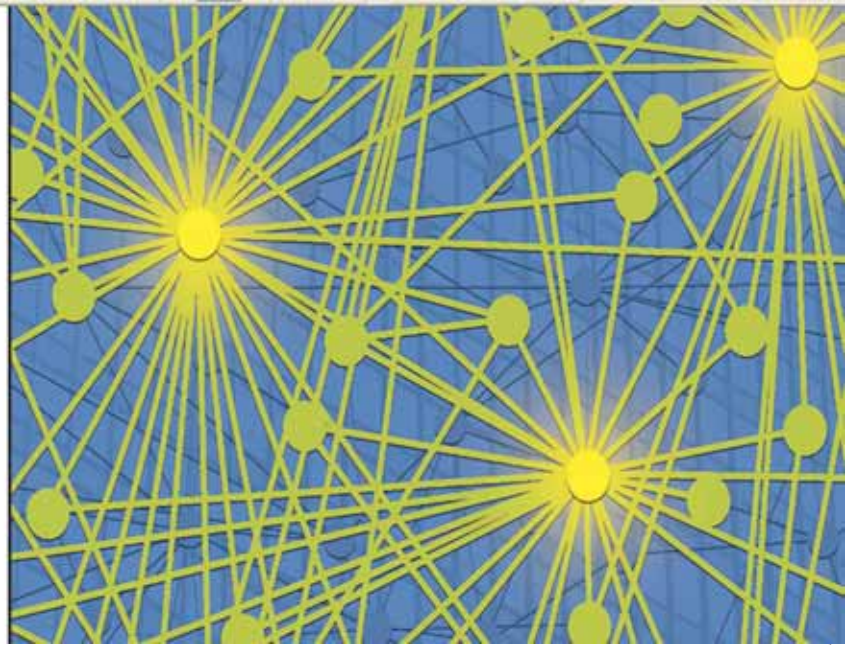
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Knowledge Needs EWA R&D Program



- Final Report
- 31 August 2007



Knowledge Needs: EWA R&D Program

- Final Report
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1. Introduction

Sinclair Knight Merz has undertaken a knowledge needs assessment of environmental water managers at national, state and regional levels.

This report and accompanying database identifies agencies and networks in Australian and state government agencies and regional organisations who are responsible for the development and implementation of environmental water allocation policies and plans, namely:

- Water sector policy makers at the federal level;
- Water sector policy makers and managers at state level; and
- Regional and state water managers in Natural Resource Management (NRM) organisations.

The report outlines:

- 1) Background and the case for a national dialogue
- 2) Roles and responsibilities of stakeholders involved in e-flow decision making and management
- 3) Knowledge gaps in e-flows science, policy and management
- 4) Knowledge needs of stakeholders
- 5) Current and future sources of information for each type of stakeholder
- 6) Recommendations and conclusions

2. Background: The case for a national dialogue

In spite of cross-jurisdictional initiatives such as The Living Murray, Australian water management has been largely the jurisdiction of individual states and territories. This means that to a large extent approaches to water allocation for consumptive and environmental use have evolved with limited cross-jurisdictional coordination.

A recent project, High Conservation Value Aquatic Ecosystems Project (SKM 2007) identified a number of beneficial outcomes from promotion of a national dialogue on environmental water allocation. These include:

- The creation of common language around environmental water allocation in order to promote a consistent approach and shared knowledge and co-operation between states and territories.
- The establishment and reporting of national targets and objectives for maintaining and enhancing aquatic ecosystems.
- The alignment of existing policies and programs to ensure that they are working towards the same goals of reduced risk of costly duplication and bureaucratic inefficiencies.
- Co-ordinated and integrated approach to managing national assets to ensure samples of different types of rivers and wetlands are protected. Improved management of trans-boundary assets, threats and resources.
- Consistent identification of high value environmental assets, monitoring and evaluation to enable comparisons between jurisdictions.
- Improved and transparent prioritisation of aquatic ecosystems for funding and research ensuring that limited resources are strategically targeted.
- Transferral of the benefits gained from a national approach to the management of terrestrial and marine areas through the determination of aquatic ecosystems with national significance.
- Improved capacity to meet commitments under the National Water Initiative, the Natural Heritage Trust's (NHT) Rivercare and Coastcare Programs, the Convention on Biological Diversity and the Ramsar Convention.

While there are compelling arguments supporting the development of a national dialogue it is important to be mindful of possible limitations and constraints. In the first instance, there is no value in 're-inventing the wheel' - where possible dialogue should work through existing networks. This will enable Land & Water Australia to utilise existing networks and relationships. Moreover, it will prevent busy stakeholders from being overwhelmed by the number of networks and information sources which they are a part of.

Secondly, it is critical that any dialogue is appropriately targeted- for example, regional water managers will have different knowledge needs to Australian government officials. Equally, issues for water management in the Northern Territory for example, where many rivers are close to pristine are very different to those faced in Victoria where over-allocation is a major issue.

3. Project Methodology

3.1 Who's who database of decision makers and managers

The first stage involved identifying who the key players are, what roles they are in and the networks that they belong to and engaging them through a variety of techniques in order to gain an insight into how they access and use knowledge.

The initial information on decision makers has been compiled into the accompanying 'Who's who in environmental water allocation' MS Excel database.

3.2 Consultation with decision makers

The second stage of the project involved consultation with key decision makers at the Federal, state and regional levels within each state in Australia.

An environmental water allocation survey was created online using the host 'Survey Monkey' to elicit the knowledge gaps and information products required by regional and state government policy makers and water managers across Australia in June 2007. Around 110 state and regional water managers were invited to respond over June and early July. The results of this survey are available in MS Excel spreadsheet format.

Phone interviews were conducted with Federal stakeholders, State policy makers and several regional stakeholders to attain in-depth insights.

Two focus groups of around 6 to 7 participants were held in Victoria and Queensland to enable Land & Water Australia (LWA) staff to develop relationships with stakeholders, and to generate discussion around knowledge gaps and delivery mechanisms.

3.3 Analysis of results

An analysis of the online survey results, interviews and focus groups was performed, and the key insights appear in sections 5, 6, and 7 in this report. The full analysis appears within a separate document entitled 'Full analysis of results' with each table and graph containing embedded MS Excel spreadsheets of data.

Figure 1.1 below shows the location and jurisdiction of survey respondents. A high number of respondents were from Western Australia (WA), Victoria and regional New South Wales (NSW). A smaller number of decision makers in South Australia (SA) the Northern Territory (NT) and Tasmania responded to the survey.

The final stage involved development of recommendations for LWA to move forward. The following sections present each of these three stages in greater detail.

Figure 1.1: The location and jurisdiction of survey participants

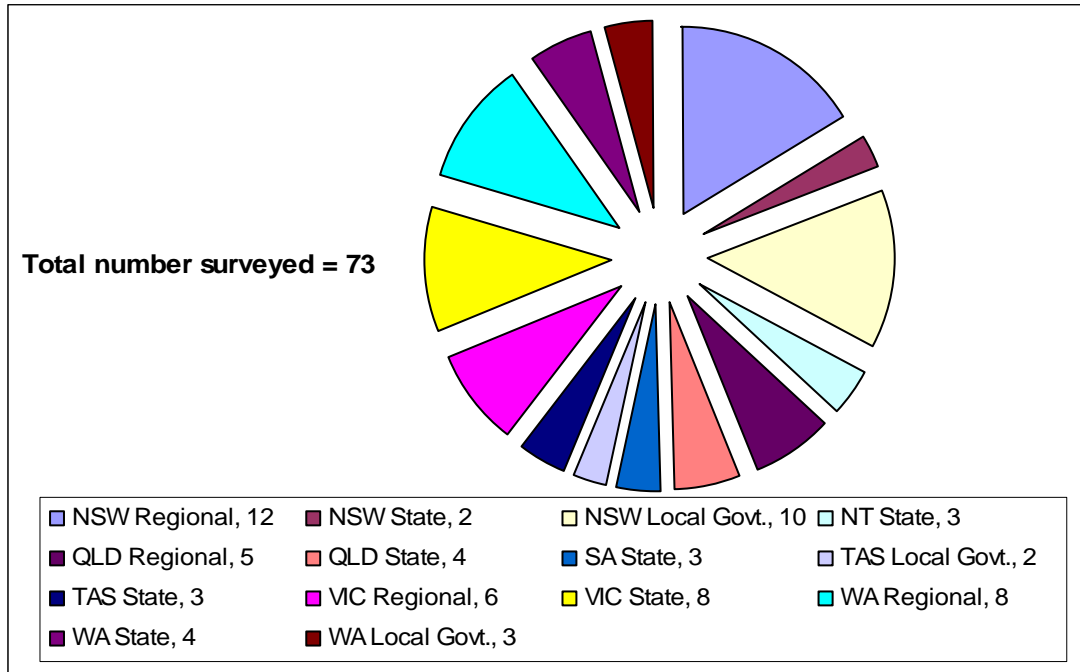
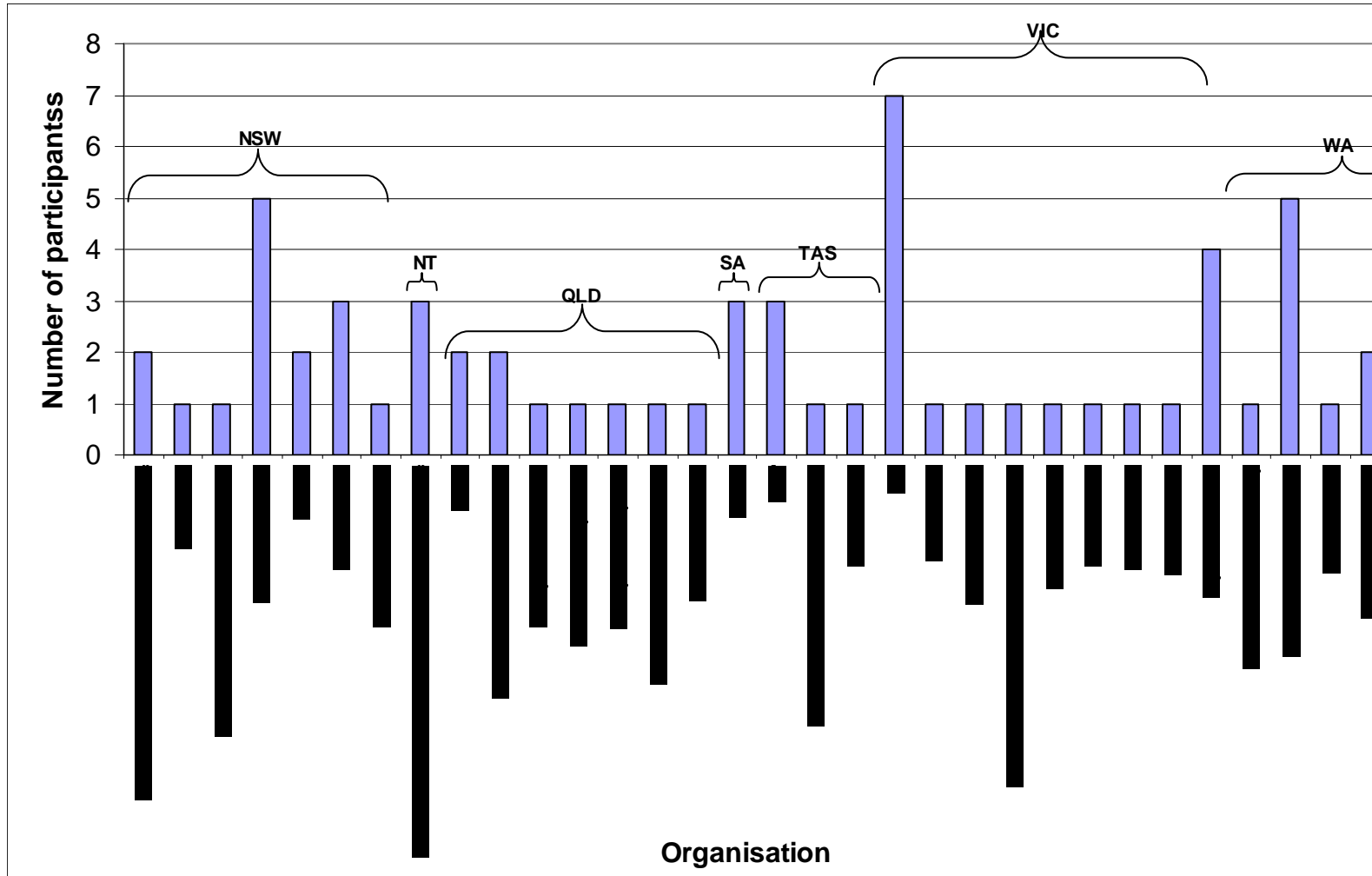


Figure 1.2 below shows the number of respondents by organisation within each state.

NSW, Victoria, Queensland and WA reaped responses from the widest range of organisations, while only the main state government departments responded from SA and Tasmania.

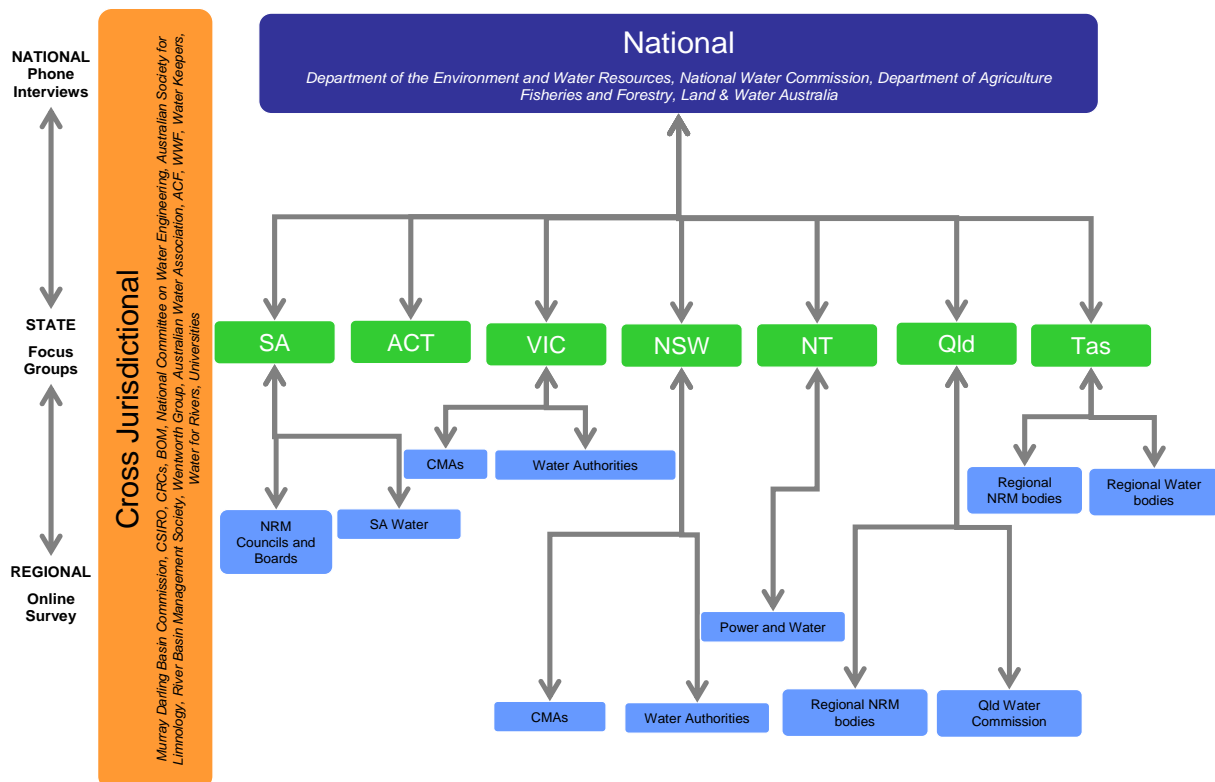
Only one respondent was from state government in Tasmania, and no state government respondents indicated an inclination to be interviewed or attend focus groups in this state. Hence, recommendations have not been made for state government policy organisations in Tasmania.

Figure 1.2: The number of survey respondents by State and Organisation



4. Roles and responsibilities of stakeholders

This section outlines the key bodies involved in environmental water management at a national, state and regional level and the agencies and networks which run across jurisdictions as set out in the diagram below. The specific roles and responsibilities of individual agencies and individual people involved in them are set out in the ‘who’s who’ directory which accompanies this background paper. *It is important to recognise that networks are dynamic and therefore the directory should be viewed as a work in progress rather than a definitive list.*



Environmental water crosses both the themes of water management and the environment. In some instances this is managed by single agencies and in others it is managed as two separate portfolios. For the sake of completeness, water supply management agencies have been included in this chapter as these organisations tend to be responsible for environmental water from an operational perspective (physical delivery of environmental flows etc.)

Finally, this chapter provides an over view of the existing networks in environmental water and the roles that they play.

4.1 Key environmental water managers

National

Until very recently, the Australian government has had no specific jurisdiction over the management of water resources or the environment (under the Commonwealth Constitution). This means that decisions about environmental water allocation have been primarily undertaken on a state and regional level. In spite of its limited powers in relation to water and the environment, the Australian government has a number of agencies established to provide strategic leadership and research direction to states and territories. These include: Department of the Environment and Water Resources, National Water Commission, Department of Agriculture, Fisheries and Forestry, Land & Water Australia, CSIRO, Bureau of Meteorology and Cooperative Research Centres (CRCs).

Recently, Federal level agencies have been particularly active in light of the current drought. This is evidenced by the recent creation of a national body responsible for the management of the Murray Darling Basin as a component of the National Plan for Water Security. Under the National Water Initiative an assessment of Australia's water resources was recently undertaken, the assessment documented the status of environmental water provisions across Australia. The preparation of this assessment involved ongoing input from state and territory agencies which are responsible for data collection and management of water resources. This provides a network of key people at a state level who are responsible for monitoring hydrologic, water use and ecological data.

Similarly, under the National Water Initiative, a high level strategic High Conservation Value Aquatic Ecosystems Task Group was established to oversee the development of a nationally consistent approach to the management of aquatic ecosystems. Again this is an existing network of key state representatives.

The Murray Darling Basin Commission is a cross-jurisdictional body which is responsible for promoting and co-ordinating effective planning and management for the equitable, efficient and sustainable use of water, land and other environmental resources of the Murray- Darling Basin. To this end it works with the relevant states to manage water allocation in the basin.

Australian Capital Territory

The Australian Capital Territory's (ACT) size means that its role in environmental water is limited. Key agencies at a state level include the Office of Sustainability and ACTEW Corporation. The ACTEW Corporation is responsible for the provision of energy, water and wastewater services in the ACT. The Office of Sustainability has an across government role, this includes responsibility for the implementation of Think Water, Act Water which is the ACT's strategy for sustainable water resource management, catchment management, water restrictions, cross border water issues, water pricing, assessment of future water supply options, the Murray Darling Basin Commission, Living Murray commitments and the National Water Initiative policy and implementation. As such it is the primary body for

decision making on water for the environment within the ACT. There are no regional bodies within the ACT and catchment management occurs largely through NSW's regional bodies.

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New South Wales

There are two government departments responsible for environmental water management in New South Wales. The first of these is the Department of Environment and Climate Change. This is a new agency formed on 27 April 2007. The new department brings together a range of conservation and natural resources science and programs, including environmental water recovery. The second of these is the Department of Water and Energy. Other government departments responsible for water/ environmental management include Department of Primary Industries and Department of Planning.

At an operational level, the key organisation responsible for water resource management in regional and rural NSW is the State Water Corporation who delivers bulk water to all authorised users including environmental users. Sydney Catchment Authority is the agency which oversees the management and protection of Sydney's water supply catchments. Sydney Water is responsible for the provision of drinking water to Sydney, Illawarra and the Blue Mountains.

At a regional level, catchment management authorities are responsible for catchment level planning for natural resources. CMA's have been relatively recently introduced in NSW and are responsible for the development of catchment action plans which set out priorities for natural resource management at a catchment scale.

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Northern Territory

The primary agency responsible for water for the environment in the Northern Territory is the Department of Natural Resources, Environment and the Arts (NRETA). NRETA is responsible for conserving the Territory's natural and cultural assets. This includes water and environmental protection. Other relevant agencies include the Department of Planning and

Infrastructure and the Department of Primary Industry, Fisheries and Mines. From a water supply perspective Power and Water is the NT’s provider of electricity, water and sewerage.

Water resources in the Northern Territory are not currently facing the over-allocation problems currently experienced in the southern states, for this reason regional/catchment scale management has not had a strong influence. Despite this, in an effort to avoid the water issues faced in the southern states, the Northern Territory Government is currently preparing regional water plans for areas which are ecologically significant.

A particular focus in the NT is indigenous protected areas through the ‘Healthy Country Healthy People’ program which aims to promote indigenous natural and cultural land management. This program assists indigenous people to work in natural resource management.

Finally, the Tropical Rivers and Coastal Knowledge (TRaCK) research hub is a major new research initiative that brings together multidisciplinary consortium to focus on the rivers and coasts between the tip of Cape York Peninsula and Broome. The TRaCK research program has been developed through close collaboration of researchers and key stakeholders.

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Queensland

The responsible agency for water allocation and management in Queensland is the Department of Natural Resources and Mines which is responsible for the sustainable use of the State’s natural resources and are the decision makers for environmental flows. Other relevant governmental agencies include the Department of Primary Industries and Fisheries and the Environmental Protection Agency. From an operational perspective, Queensland Water Commission is responsible for the provision of water in South East Queensland.

On a regional level, regional NRM bodies are responsible for protecting and managing natural resources in Queensland. This involves the development of regional plans. Local government is responsible for water supply and sewerage.

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South Australia

In South Australia, the Department of Water, Land and Biodiversity Conservation is the primary body for water resource allocation, licensing, research, monitoring and assessment. They are supported by the Department of Environment and Heritage which provides a lead role in the development of environmental policy. Other governmental agencies include the Department of Primary Industries and Resources and the Environment Protection Agency. From an operational perspective water supply is managed by SA water.

On a regional level, South Australia has recently introduced Natural Resource Management Boards across eight NRM regions. These Boards are responsible for regional level planning and policy such as Catchment Water Management Plans and the preparation of water allocation plans for prescribed water resources in their region. The water allocation plan must include ‘an assessment of the quality and quantity of water needed by the ecosystems that depend on the water resource and the times at which, or the periods during which, those ecosystems will need that water.’

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Tasmania

The primary state level body for environmental water management in Tasmania is the Department of Primary Industries and Water (DPIW). DPIW is responsible for managing the State’s natural resources. They have developed a new framework for determining environmental water requirements. At a state governmental level DPIW is supported by the Department of Tourism Arts and the Environment and the Department of Infrastructure, Energy and Resources. From an operational perspective the Rivers and Water Supply Commission is responsible for administering water districts. Water supply is managed by regional water agencies: Esk Water, Hobart Water and Cradle Coast Water.

There are three Regional Natural Resource Management Committees in Tasmania. The main role of these committees is to develop and implement a Natural Resource Management strategy for their region.

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Victoria

The Department of Sustainability and Environment (DSE) is the key agency for sustainable water and catchment management in Victoria. DSE is responsible for setting the policy framework and over-arching strategic direction for water in Victoria through the newly created Office for Water. This includes decisions about water allocation. Other relevant governmental agencies include the Department of Primary Industries, Parks Victoria and the Environment Protection Agency. From an operational perspective, water supply and management is overseen by regional Water Authorities, they are responsible for the physical delivery of environmental flows.

At a regional level, Victoria is divided into ten catchment regions and a Catchment Management Authority is established for each region. Catchment Management Authorities are responsible for setting regional priorities for natural resource management. The CMAs are involved in two relevant networks (1) waterways managers network; (2) environmental water reserve officer network, these groups get together regularly to discuss issues in water management.

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Jodie Brazell	Environmental Flows Policy Officer	jodie.brazell@dse.vic.gov.au
Phil Mitchell	Environmental Flows Policy Officer	phil.mitchell@dse.vic.gov.au
Melanie Carew	Environmental Flows Policy Officer	melanie.carew@dse.vic.gov.au
Department of Primary Industries		
Tarmo Raadik	Senior Scientist	(03) 9450 8600
Parks Victoria		
Environmental Protection Authority		
Lisa Dixon	Freshwater Ecology	03 6233 3800
Leon Metzeling	Catchment and Marine Studies	03 9628 5955 leon.metzeling@epa.vic.gov.au
Environment Victoria		
Juliet Le Feuvre	Healthy Rivers Community Campaigner	03 9341 8106

Western Australia

The Department of Water is responsible for water resource management in Western Australia. The Department oversees the strategic and operational aspects of water resource management including the collection and analysis of water resources information, issuing of licences, regulating water-use, protecting water quality and planning. Their role is complemented by the Department of Environment and Conservation, its key role is management of natural resources and as such they are responsible for managing the environmental values associated with water. Other relevant government agencies include the Department for Planning and Infrastructure and the Environmental Protection Authority. On an operational level the Water Corporation provides water supply and wastewater services.

There are six natural resource management regional groups in WA who are responsible for setting regional priorities in NRM. Natural resource management plans are prepared at both a

regional and sub-regional level. Sub-regional plans specifically define the environmental water requirements of a region.

Department of Water		
Contact	Role	Details
Dr Jane Latchford	Waterways and NRM	jane.latchford@water.wa.gov.au
Mark Pearcey		mark.pearcey@water.wa.gov.au
Vicki McAllister	Water Resource Leader	vicki.mcallister@water.wa.gov.au
Hazel Kural	Water Reform Manager	
Department of Environment & Conservation		
Fred Tromp	Director- Natural Resource Management	08 6467 5201
Michael Coote	Senior Environment Officer- Wetlands	08 9334 0479
Natalie Thorning	Co-ordinator- Wetlands Program	08 6467 5207
Melanie Strawbridge	Water Resources	08 6364 7409
Stuart Halse	Invertebrates	stuarth@calm.wa.gov.au
Conservation Commission		
General	Admin	(08) 9389 1766
Environmental Protection Authority		
General	Admin	http://www.epa.wa.gov.au
Department of Planning & Infrastructure		
General	Admin	133 677

4.2 Key environmental water networks

There are a number of existing networks in water resource management which span across the different jurisdictions. These fall generally within two categories:

- 7) **Lobby Groups-** these are groups which are lobbying for improved or changed management of the environmental. At the highest level this includes organisations like the Wentworth Group of Concerned Scientists which was convened to develop practical scientific and economic solutions for the better management of Australia's landscapes and fresh water resources. Other national/ international level organisations include Environment Defenders Office, Australian Conservation Foundation and World Wildlife Fund. On a state level organisations such as Environment Victoria act as a voice for the environment. Similarly, there are a large number of local/ grass roots organisations such as '*Friends of*' groups and community water-watch teams.
- 8) **Professional Groups-** these are groups of professionals who network in order to share ideas/ opportunities/ lessons learnt in their chosen field. Examples of these networks include the Australian Water Association, the National Committee for Water Engineering, the Australian Society for Limnology and the River Basin Management Society. These groups tend to be active in organising technical conferences, editing

technical journals, development of guidelines and preparation of position papers. The inertia of these groups depends largely on their membership.

Finally it is important to recognise the role of consultants in dispersing knowledge in environmental water management. Consultants frequently provide advice, assist in the preparation of policy and produce management plans for environmental water managers. This means that consultants provide an important bridge between researcher and on-ground decision makers.

4.3 Network affiliations as stated by survey respondents

Around three quarters of all respondents did not indicate that they were part of any networks. Those who do take part are members of a wide variety of different networks, as outlined in Table 1.

The key message is that those who are interested in environmental water are not part of any one single network and could quite possibly benefit from such a network providing accessible, concise, region specific information.

Table 1: Network affiliations of environmental water managers

NSW Regional	Contact Details
The Living Murray	P: (02) 62796100 E: thelivingmurray@mdbc.gov.au
Snowy River Rehabilitation Plan Steering Committee (Water for Rivers)	P: 02 6041 5467 mail@waterforrivers.org.au
Alpine River Keepers	Waterkeepers Stacey Bloomfield E: mail@waterforrivers.org.au
NT State government	
International Association of Hydrogeologists	Dino Parisotto (NSW Director) P: (02) 4234 0829 E: earthh2o@tpg.com.au W: http://www.iah.org.au/
Numerous conferences	N/A
Informal contacts through associations with TRaCK research consortium	W: www.lwa.gov.au
Qld Regional	
SEQ Water Quality Monitoring group	SEQ Water P: (07) 3229 3399
Fitzroy Basin Association	Nathan Johnston Regional Coordinator Water Quality

	P: 07 4999 2819 E: Nathan.Johnston@fba.org.au
Bureau of Rural Science in-stream community salinity monitoring program.	Margaret Allan E: margaret.allan@brs.gov.au
Qld State government	
Aquatic Ecosystems Task Group	Angela Robinson (DAFF) Project Officer- Water Accounting P: (02) 6272 4823
Australian Water Association	Chris Adam Asset Management Convenor E: cadam@ramafin.com.au
E-Water CRC**	Dr Nick Marsh nick.marsh@csiro.au
Informal network of researchers**	
Tasmanian State government	
Australian society of limnology	Professor Stuart Bunn Centre for Riverine Landscapes Griffith University P: 07 3875 7407 E: S.Bunn@griffith.edu.au
International Association of Hydrogeologists	Dino Parisotto (NSW Director) P: (02) 4234 0829 E: earthh2o@tpg.com.au W: http://www.iah.org.au/
Dorset NRM and NRM North (local government)	Jay Wilson (NRM Facilitator – Dorset Region) P: 03 6352 6537 Andrew Baldwin (NRM North) E: Andrew.Baldwin@launceston.tas.gov.au
Victoria Regional	
Environmental Water Reserve Officers network**	W: www.dse.vic.gov.au
Waterways Managers Forum	Rex Candy East Gippsland Waterways Manager P: 51 530 462 E: rcandy@egcma.com.au
Victorian Wetlands Network	W: http://bird.net.au/bird/index.php?title=Victorian_Wetlands_Network
Victoria State government	
Environmental Water Reserve Officers network**	W: www.dse.vic.gov.au

MDBC taskforces, Wetlands and Waterbirds Taskforce, Aquatic Ecosystems Task Group	Andy Close Hydrology P: 08 6279 0100
Inland river network	P: (02) 8270 9904 E: coordinator@irnsw.org.au W: www.irnsw.org.au/
Environment Victoria Network and Environmental flows email network	W: www.dse.vic.gov.au
International Rivers Network	W: www.irn.org
Australian society of limnology	Professor Stuart Bunn Centre for Riverine Landscapes Griffith University P: 07 3875 7407 E: S.Bunn@griffith.edu.au
WA Regional	
Port Mandurah Canal Waterways Advisory Group	E: council@mandurah.wa.gov.au
Peel-Harvey Catchment Council Committee	P: (08) 9550 4225 E: info@peel-harvey.org.au
SW Regional water sub strategy group	P: (08) 9550 4225 E: info@peel-harvey.org.au
Serpentine-Jarrahdale Landcare Centre	P: (08) 9526 0012 E: info@landcaresj.com.au W: www.landcaresj.com.au
WA State government	
Water planning committee's etc	W: http://portal.water.wa.gov.au/portal/page/portal/home
Internal Department of Water working groups	W: http://portal.water.wa.gov.au/portal/page/portal/home

** = specified frequently

5. Federal and state policy knowledge needs

This section presents the findings from a range of focus groups, face to face and telephone interviews with state and federal policy makers on their knowledge requirements relevant to environmental water allocation.

5.1 Federal policy makers knowledge needs

Federal government policy makers are still largely concerned with developing administrative frameworks (such as market based mechanisms) and water accounting, rather than the technical management of water resources in Australia. This gives rise to the need for different types of information as compared with state and regional policy makers and water managers.

The recent assessment of Australia's water resources documenting the status of environmental water provisions across Australia highlighted a central concern for federal policy makers: that there is lack of a standard approach to measuring, monitoring and describing information related to provisions for environmental water, and water resources more generally.

It is perceived that a range of data and information useful for decision making at the federal level often exists, but is not sufficiently shared amongst states and with federal policy makers to be incorporated in the most effective and timely manner. Efforts to overcome constraints to transferability, such as a consistent set of terms, are required to more accurately define attributes of water systems and associated environmental flows.

There is also a strong emphasis upon national water accounting at the federal level, with an associated focus upon volumes of available water and water storage facilities. The lack of information and understanding around groundwater / surface water interactions within states presents a significant impediment to consistent national accounting – and there is a concern that 'double counting' can occur where ground and surface water resources are considered independently. Queensland policy makers believe that water accounting at the federal level also overlooks the episodic nature of water related events in this state (see section 7 for more detail).

Currently, a Water Resources Observation Network project being conducted under the National Water Initiative is investigating ways to improve water data sharing across state boundaries through providing and trialling infrastructure. It is also facilitating the development of a range of consistent data collection and definitional protocols, including a consistent set of indicators to monitor and describe the attributes of environmental water.

5.2 State policy makers knowledge needs

5.2.1 New South Wales

Knowledge of e-flows in this state is generally perceived as lower than in other jurisdictions.

It is recommended that research in the areas in the table below be commissioned:

Knowledge gaps

Specific knowledge gaps include:

- Scientific results showing the benefits of environmental watering.
- Off - stream watering systems
- General information about environmental water - research, findings from past experiences, evidence of benefits achieved
- Information about equitable water usage.
- Information on the management of stakeholder conflict regarding location in catchment and water use (i.e. conflict over upstream landholders dams, water 'slowing' structures such as weirs etc)
- Better and more transparent modelling of riverine systems
- Farm level options for improving environmental water management and relative merits of each e.g. transferring to high flow extraction, improved on farm water
- storage options specific to catchment hydrology (not state wide policies)
- The impacts of legislation and the trade of environmental water

Types of information

Fact sheets, email updates and other readily available and easily accessible information is relied upon.

Delivery mechanisms

To provide NSW with valuable information, Land & Water Australia should focus on assisting to clarify governance issues and arrangements for managers, and practical solutions to stakeholder management issues around environmental water allocation. Farm level information and options in the form of fact sheets and brief summaries would be useful. Simple information in fact sheet and email update formats could be of use – and it is recommended that several small workshops be held to raise awareness in the regions of the importance of e-flows to decision making in natural resource management.

5.2.2 Northern Territory

The Northern Territory state government plays a role of interacting with committees and community groups and preparing Environmental Water Management Plans. Communicating the basis of decisions to communities around e-flows is an important role for state government. Preventing severe change is seen as a stronger focus than engaging in new initiatives at present.

Researchers are often considered to be of less practical help to policy makers where they provide data and information, but not opinion, on appropriate management.

Knowledge gaps

Specific knowledge gaps include:

- Quantitative ecosystem benefits from e-flows
- The impacts of intercepting early flows. The timing issues of flows would be important to understand
- Recessional flows from floodplain back into river. Much material returning to the river as both dissolved organics, sediments – and in-stream processes and impact on in-stream health
- The timing and duration of e-flows required to sustain ecosystem health
- Acid sulphate issues around drying out some wetlands for evaporative savings.

Sources of information

The Land & Water Australia TRaCK program is seen as useful for quantifying the ecosystem services that flow from environmental watering. The model is seen as a powerful model for storing and disseminating information and reducing transaction costs.

Consultant are often relied upon to provide clear direction, as researchers are seen to be cautious about proffering such advice due to uncertainty.

Types of information

More ‘broad brush’ information required at the strategic policy level, as identified by individual policy makers. Strong guidance is required around management decisions, and increased knowledge around which experts to consult about specific issues. A process of providing expert knowledge on these sorts of issue would be important.

Land & Water Australia could contribute significantly through synthesising that expert knowledge within a decision support system approach. Case studies could also be useful.

Delivery mechanisms

Northern Territory policy makers believe that good decision support systems have been developed, and yet they have not been well grasped or adopted by policy makers. Although more recently, some models on fire have received early uptake potentially caused by recent pressure on water policy development in the region.

5.2.3 Queensland

Queensland policy makers have a significant interest in e-flows and are well aware of the information gaps that impede current decision making. They perceive significant differences between the way that e-flows must be considered in Queensland as compared to Victoria and other southern states, primarily because of the highly seasonal nature of floods and flows in Queensland.

This difference gives rise to a more episodic or ‘rules based’ approach to water allocation, where timing and seasonal allocations are critical rather than a purely volumetric approach with a heavy emphasis upon water storages. Hence the predominant view is that the ways in which water in Queensland is considered in national accounting must take into account *when* water can be allocated as in addition to *how much*. An important implication is that research into e-flows from other jurisdictions is unlikely to be considered relevant to Queensland.

Queensland policy makers attend events and conferences regularly. A personal approach to information communication is favoured across both regional state jurisdictions.

Knowledge gaps

In particular, there is a perceived need for more extensive hydrological modelling. The information gaps included:

- Information and research in the Northern Tropics
- Identification of the key ecological assets (and associated indicators) that are to be protected through environmental water
- Link between hydrological regimes and ecological assets. Presently monitoring the effects of low flows
- Water dependent wetlands and estuarine requirements. Qld government is presently investing in monitoring.
- Information on the groundwater refugia that require protection, and what research is currently being conducted in this area
- The lifecycle, flow and water quality requirements of many species
- The ways in which diversions such as dams affect e-flows, and how these impact upon significant assets
- Groundwater – surface water interactions
- The nature and location of groundwater dependent ecosystems (e.g. wetlands)
- The ways in which ecosystem health frameworks being developed incorporate or interact with knowledge around e-flows
- Coastal groundwater and the impacts upon marine ecosystems and sea beds (requires modelling)
- Environmental risks of the impacts upon assets and ecology of changes to hydrology

Types of information

Groundwater and surface water hydrological modelling was perceived to be an important way to overcome information gaps. Policy makers require a framework for monitoring relevant information, in contrast to regional bodies who reported needing more trend and scorecard-type information.

Sources of information

The combined Commonwealth and state Wetlands Protection Program provides advice for directing investment. It would be valuable for LWA to establish a relationship with the program to identify relevant research areas.

Investment is currently being made to research ecological response models in relation to E-Water (DPI and DNRW). LWA could investigate the potential for playing a role in this research.

Queensland policy makers would also like to receive more information on the AWA framework for E-Water being developed.

Delivery mechanisms

State government policy makers would find freely and readily available web-based access to all relevant data and models. Creative commons licensing of software was also mentioned as a useful strategy for increasing access to knowledge. Spatial representations of the location and nature of the issues would be highly useful.

Email alerts similar to the Rangelands program email alerts would be useful. These are short and are distributed only when new research becomes available.

Research reports are also of use to Queensland decision makers, with the SEQ EHMP Technical Report being cited as a good example of a useful document. However, a forum for experts to come together to share ideas would be of most benefit, particularly in the development of plans. Conferences such as the River Symposium are seen as being important, although more for distributing rather than gaining information.

Policy makers saw a key opportunity for LWA to coordinate research activities related to e-flows across the nation through generating reviews that synthesised all existing knowledge and research across the various jurisdictions.

5.2.4 South Australia

The main issue for South Australian policy makers is the need to justify to stakeholders the rationale for environmental water allocation in the midst of competing uses. The information

required also needs to be appropriate for the strategic policy making environment, which is not conducive to incorporating large amounts of technical data.

Knowledge gaps

There are perceived to be both significant gaps in technical information, and in information relevant to decision making at the strategic policy level. Specific knowledge gaps include:

- Information that could assist in the quantification of the environmental benefits of watering, including for the sustainability and improvement of vegetation, terrestrial and aquatic animals and plants.
- Information upon EG nutrients and carbon cycling through system as a result of water flowing out into floodplains. Quantifying this information as carbon comes back into river systems after floods would be useful.
- Timing and duration of flow events and impacts of this upon environmental outcomes
- Frameworks for use in comparing benefits for other uses in order to justify trade offs for competing uses

Sources of information

South Australian policy makers often use in house or commissioned consultant to identify information for specific projects. Policy makers also look to the Murray Darling Fresh Water Research Centre and the E-Water CRC – yet mainly rely upon the knowledge of experts directly involved in projects, rather than seeking information products. It is this embodied knowledge that provides most benefit in a time-constrained environment.

South Australian decision makers are eagerly anticipating the results of the CSIRO Ecology Program. This issues-focussed and targeted program involves many research agencies, and inputs from a wide number of groups.

Types of information

While there is much information available upon the impacts of timing and flow events upon fish and bird breeding, it is mostly single species research. Such information on its own is not perceived to be useful at the strategic policy level.

Delivery mechanisms

Collation and synthesis of appropriate guidelines and integration of this into decision support systems would be highly useful.

5.2.5 Tasmania

There were insufficient responses to the survey by this category of policy maker to report meaningful results.

5.2.6 Victoria

Victorian policy makers believe that the information available to them lacks appropriate currency for making decisions around watering and management. While information exists as to the effects of low flows on ecosystem functioning in some cases, the benefits of specific environmental flow allocations is often lacking.

Presently, the uncertainties around environmental water allocation are giving rise to social concerns that require more robust clarification and communication. More current scientific information would assist communities to participate in the planning process, and to better understand and accept decisions that limit current options. Community perceptions of healthy aquatic ecosystems would benefit from better communication/engagement processes supported by sound science. Community consultation processes were seen as improving but is constrained by gaps in science.

Particular gaps include:

- Sufficiently accurate hydrological data to calculate stream flows, including the amount of water used for domestic and stock purposes, including dams and extractions from watercourses
- Empirical data to support environmental flow models to estuaries
- The impacts of land use upon water flows
- General understanding of the nature of a healthy, yet altered, ecological system
- Groundwater interactions and ecosystem functioning of unregulated rivers
- Drought and ecosystem capacities to cope with drought
- The impacts of climate change upon all systems, especially shallow ephemeral wetlands
- The specific, measured benefits and impacts of e-flows upon ecological processes
- Sub-lethal effects on species, especially for mobile species such as birds
- The ways in which limits in over-bank flows affect adjoining ecosystems both for the channel and the ecosystem supported by overbank flows

While some flexibility exists to allocate flows to the environment in regulated systems, unregulated systems are perceived to present greater uncertainties. Groundwater interactions are not well understood, particularly in unregulated systems.

The links between urban water and e-flows link is insufficiently considered at the political and policy level. Water accounting processes tend to separate stormwater and recycled water from the entire water budget.

Current sources of information

Policy makers tend to consult a select range of known information sources – in particular, individual experts in specific fields rather than organisations per se. It was acknowledged that the field of expertise is limited nationally.

It is significant that DSE mainly commissions its own research such as literature reviews upon specific topics and the requirements of specific species through bodies such as the Arthur Raligh Institute. There is perceived to be a strong relationship between individual scientists and managers in Victoria, yet policy makers perceived that insufficient networks and lack of a resource that ‘maps’ the network relating to e-flows impeded information flow. No single ‘centre of excellence’ exists to address or route queries. Such a centre would be useful for assimilating or identifying knowledge gaps and areas where knowledge is repeatedly sought.

Types of information required

Generally there is limited synthesis of information. Rather than research reports, Victorian policy makers believe they require a model that provides fairly accurate scenarios of consequences of various flow regimes / water use decisions, both as a communication tool for communities and for decision making. Bayesian models are being used in Victoria to support decision making.

In addition, a tool that better captures real flow events to make better decisions would be highly desirable.

Delivery mechanisms

A queryable database for decision making would be highly useful for Victorian decision makers.

5.2.7 Western Australia

The main decision making at a policy level in WA is around resource assessment and groundwater management, particularly within decision making around future land developments. The basis behind the decisions made by those responsible for releasing environmental flows in the regions is not well understood by those at the policy level.

Knowledge gaps

It is generally thought that less research of Western Australian rivers is being conducted than in eastern states. There is a lack of geomorphological information and geomorphologists generally in WA. Many of the relevant researchers and managers have been attracted to mines in the regions.

The impacts of reduced environmental flows due to development upon ecosystems are also not well understood. Policy makers are concerned that the ecological and hydrological impacts of developments are not adequately known. Specific knowledge gaps include:

- Knowledge of both ecology and hydrology in the North Perth Basin
- Geomorphological data and information in all jurisdictions
- Limited information is available in specific areas of the interface of groundwater and surface water dependent ecosystems
- The impacts of reduced irrigation pipe leakage upon the environment and in particular Environmental Water Reserves (EWRs) is not understood. The international experience of this would be helpful.
- Information specific to WA water systems is required – particularly as much larger volumes of water are being managed than in eastern states
- EWRs are not currently enforced for all rivers, and monitoring after releases is often not adequately performed.

Sources of information

There is a general lack of knowledge around who to gain information from. A general source of information to go to when making decisions would be useful.

The high level of staff turnover in government departments and research organisations is perceived to be contributing to both loss of knowledge and the breakdown of networks.

Types of information required

The River Landscapes research has been useful, although there have been insufficient Western Australian examples. Nevertheless, it is perceived that the program brought effective scientists together to review important issues. WA policy makers desire “good, renowned thinkers” to research issues specific to WA.

Delivery mechanisms

The training workshops conducted in WA have been well received, and were seen to be well targeted. In particular, experts such as Ian Rutherford were extremely well appreciated. More training workshops on specific areas would be appreciated – including lessons learned nationally and internationally. Online training courses with interactive, multimedia components are seen as valuable for WA policy makers.

A tiered and tailored system of information delivery would be appreciated. Technical research reports are required, but the results tailored for specific decision makers would be useful. For example, shorter, technical papers could be valuable for policy makers. Pamphlets that could be distributed to the community outlining the basis for decision making would also be useful.

The River Restoration Manual is perceived to highly useful. More units could be added to the existing manual where additional WA research is conducted.



Websites are used frequently, and provide valuable information about federal and state activities. Email updates often get lost in general email traffic – although short, sharp briefs on new research and information sources could be useful.

6. State and regional water manager knowledge needs

This section provides an analysis of the regional and state water managers' responses to both the online survey and the focus groups held in June 2007.

6.1 Overall summary of state and regional knowledge needs

Regional and state water managers have information and knowledge needs that differ from federal and state policy makers. Most are concerned with specific levels of e-flows released, and the local environmental benefits achieved for specific assets (in Victoria) or resource condition. This aligns with their role in regional catchment planning and management. This need is second only to improving their systemic understanding of environmental water, and its implications for ground water and surface water dependent ecosystems, interactions and allocation.

Overall, regional and state water managers tend to desire *regionally specific information products*, tailored to their specific management contexts. Most regional and state water managers are concerned with understanding the specific impacts of environmental watering, including the benefits of releasing particular flow regimes upon local species and water systems. They perceive that this requires raw monitoring data and the outputs from modelling in many cases, rather than reports covering the strategic aspects of e-water management.

Nevertheless, guidelines outlining best practice 'rules of thumb' under a variety of conditions (such as the River Restoration Manual) were considered highly useful, particularly where specific information was lacking. Trends reports that also explore the implications of climate change upon local resources and e-flow regimes are highly sought after.

Those with the highest level of knowledge of environmental water appeared to have the greatest need for primary research and information products that synthesise research upon regionally specific topics, where possible. In particular, Victorian, South Australian and Queensland water managers require the most technical depth, while New South Wales Western Australian respondents may be more responsive to succinct fact sheets and short synthesis reports on key regional considerations. Lessons learned and case studies of both successful and unsuccessful management experiences in their own and other regions are also important.

Regional water managers have a key role in land holder and community liaison, and require products that will assist them to easily and effectively communicate the impacts of e-flows upon the local environment – particularly where trade-offs between water users and uses must be made. Visual maps and spatial information is universally regarded as useful for both decision making and communication. Scorecards, trends reports and fact sheets are useful for this purpose.

Regional water managers tend to rely upon their respective state government departments universities for the majority of their information, particularly where monitoring and on-ground research projects are commissioned in the area. Projects that involve a range of research bodies, policy makers and regional water managers are considered to be highly informative and productive for networking, learning and information sharing.

Regional water managers are highly responsive to fact to face, practical training and contact, particularly around locally specific planning issues and programs. They tend to appreciate being personally consulted about research areas of interest, are engaged by relationship building and pragmatic management extension and training. Many are time poor, and already inundated with electronic emails and other communication. Face to face workshops and seminars are also highly important for networking and immediate use of information for pragmatic outcomes.

Networks tend to be reasonably strong in the regions, and formal networks meet regularly to explore planning issues around water management. It would be beneficial for Land and Water Australian to consider attending and presenting at pre-arranged meetings of existing networks to build relationships, to keep participants updated of new information, and to identify research areas of interest over time. This was particularly the case in Queensland.

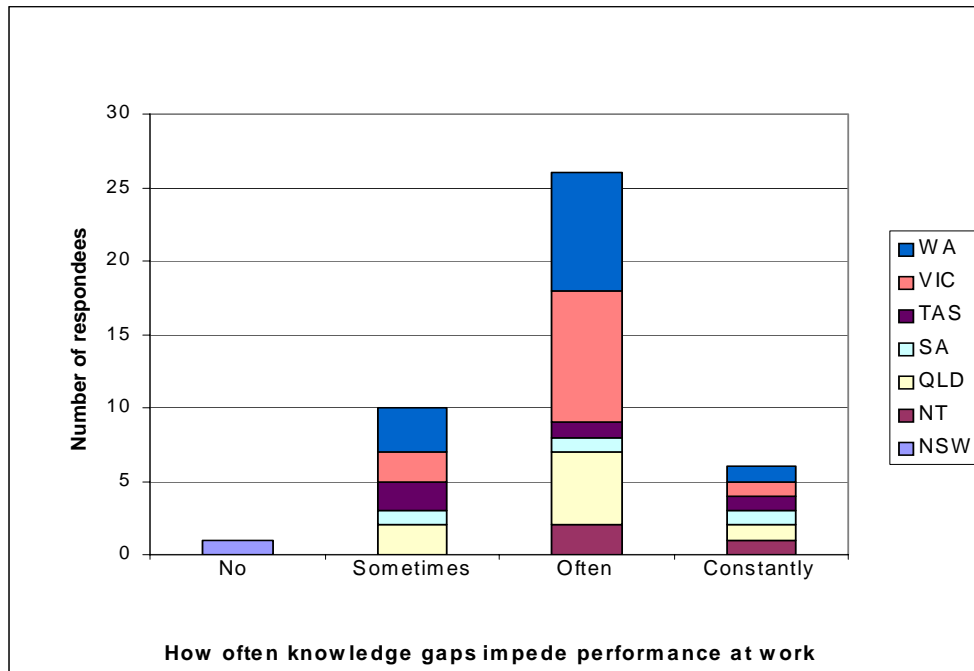
Despite the strength of networks, high staff turnover can mean that knowledge is often insufficiently stored and transferred within and between organisations. A 'who's' who' of environmental water experts nationally, regionally and at the state level and lists of key research within an easily accessible, web based database could be useful.

6.2 Analysis of online survey results

6.2.1 Environmental water knowledge & information gaps

Figure 5.1 below indicates that Victorian respondents have a most immediate need for more information about environmental water. NSW respondents reported no specific knowledge gaps.

Figure 5.1: Proportion of the time knowledge gaps impede work performance



Given that Victorians also reported having the highest level of knowledge about environmental water (and it makes up the highest proportion of their work), it may be concluded that decision makers in NSW are less far down the adoption pathway – and that less information is required at present.

NSW water managers may benefit from less technical information to assist in understanding what information might be important to consider, but it would not be a priority.

In fact, all other respondents with a professed *high* or *advanced* understanding of environmental water allocation found that ‘Often’ or ‘Constantly’ there were knowledge gaps. Only 3 respondents who professed a *high* or *advanced* understanding of environmental water allocation found that ‘Sometimes’ a lack of information about environmental water hindered them.

This correlation has significant implications for LWA’s research efforts in relation to the level of knowledge and knowledge need within each state.

6.2.2 Knowledge gaps for state water managers

The following areas for further research were reported by respondents in each jurisdiction.

6.2.2.1 Northern Territory

Ecosystem requirements for environmental water – benefits and impacts

- Quantification of level of impact on aquatic ecosystems resulting from change in low flow regimes in rivers of northern Australia
- Ecological impacts of changed flow regimes on ecology of tropical floodplains
- Techniques for managing uncertainties when water resource and ecosystem information is poor.
- Techniques for applying indigenous knowledge to environmental water allocation

Water use, institutional arrangements, management and administration processes

- Analysis of governance models and options

6.2.2.2 Queensland

While Victoria and other states are concerned with ‘volume-based’ water allocation issues, Queensland decision makers perceive that due to widespread seasonal and geographic variations in flow regimes in Queensland waterways, environmental water allocation decisions must be made according to a ‘rules-based’ framework.

That is, Queensland decision makers in particular will be resistant to national-level research that makes generalised volumetric recommendations and does not specify when and where allocations may be made. Specific knowledge gaps included:

- Predictions of the impacts of improved land use practices on ambient water quality over time.
- Flow models and landscape modelling generally
- Minimum volumes of water (spatially and temporally) that can be left in the rivers without major detrimental effects.

Ground water system and interactions

- Method to consider surface and groundwater interactions.
- Methods to deal with phase lag, climate change, and increasing demands on limited supply

6.2.2.3 South Australia

“There is a lot of general info but the problem is in relating this to a specific site or reach of a watercourse.”

Ecosystem requirements for environmental water – benefits and impacts

- Practical information about the impact of management actions on the integrity of the particular ecosystems and the objectives set for their management.
- A checklist that allows you to tick off whether a particular aspect is relevant to the resource unit in question. Not so much interested in academic research - although this is an important base for determining a practical cause-effect response
- More information on watering requirements of floodplains

Groundwater system and interactions

- Interaction between groundwater and surface water
- Investigation of flow measurement techniques in low velocity and low flow situations
- More information on groundwater and surface water interaction - as well the time step in some areas probably needs to be as small as hourly - especially if the only event connecting the flood plain and watercourse only occurs once every 2 years and lasts 1 to 2 hours
- Research on carbon and nutrient fixing and connectivity between floodplains and rivers

6.2.2.4 Tasmania

“Information is needed to inform confident decision making at the planning level, including how much water can we allocate in a system, what will the impacts be? As well as to inform allocation decisions at a local level, such as what will the impacts be if we allocate a certain volume of water at a particular location?”

Ecosystem requirements for environmental water – benefits and impacts

- Flow regimes required to protect threatened species, such as *Astacopsis gouldii*.
- Flows required to maintain the integrity of wetlands.
- Information to support understanding and prediction of the effects of the allocation of water for alternative uses on water-dependent ecosystems, relating to both surface water and groundwater.

Impacts of land use change upon catchment hydrology

- Adequate information on the impacts of land use change on catchment hydrology i.e. plantation development. (local government)
- Adequate, available and usable catchment hydrology modelling.

Ground water system and interactions

- More information on the outcomes of research into affects of changing groundwater levels on ecosystems

Models to support decision-making

- A sufficient level of knowledge at the appropriate scale and an understanding of the processes involved to be able to construct adequate conceptual and numerical models to be able to model various allocation scenarios.

6.2.2.5 Victoria

Ecosystem requirements for environmental water – benefits and impacts

- Water flow requirements of species/communities/ecosystems
- Links between flow and ecosystem health - in particular with the uncertainty of climate change
- Ecological implications of changed water regimes - models and predicted outcomes

- Decision support systems to assist in ecological asset prioritisation for water allocation
- Flow requirements for aquatic biota - eg minimum riffle depth to allow movement of various fish species, more information on the outcomes of research into affects of changing groundwater levels on ecosystems
- Critical flow needs and thresholds for ecosystems, including ‘tipping points’ (points of no return)

Future ecosystem and water resource pressures and their likely impacts upon flow regimes:

- Water availability under climate change scenarios
- Climate change, bush fires, farm dams, plantations and drought.
- Changes to links between flow and ecosystem health posed by the uncertainty of climate change

Ground water system and interactions

- Groundwater/surface water interactions - good general model and rules for decision-making
- Interaction of river flows with saline groundwater and saline pools, planning/scheduling flows whilst allowing for losses and travel times when combining releases into multiple streams.

Water use, institutional arrangements, management and administration processes

- Water use (by all water users - irrigation, commercial, domestic stock, private rights)
- Water trade in unregulated systems
- Information on the administration and management processes for environmental water, especially as it relates to regional delivery

6.2.2.6 Western Australia

Environmental water requirements

- More baseline information to set environmental water requirements in priority areas
- A consistent precautionary approach to setting EWR/EWP
- Methods to allow for climatic change in EWR work

Ground water system and interactions

- More information on groundwater dependent ecosystems and resource assessment

Water use, institutional arrangements, management and administration processes

- Ways to better connect research and information with decision making and policy at regional levels

6.2.3 Knowledge gaps for regional water managers

6.2.3.1 New South Wales

Ecosystem requirements for environmental water – benefits and impacts

- Scientific results showing the benefits of environmental watering.
- General information about environmental water - research, findings from past experiences, evidence of benefits achieved
- Information on off - stream watering systems

Maps / Models to support decision-making

- Better and more transparent modelling of riverine systems
- We have a world class flow response monitoring project in place with pre and post flow data

Water use, institutional arrangements, management and administration processes

- Information about equitable water usage (no governance here).
- Information on the management of stakeholder conflict regarding location in catchment and water use (i.e. conflict over upstream landholders dams, water 'slowing' structures such as weirs etc)
- Farm level options for improving environmental water management and relative merits of each e.g. transferring to high flow extraction, improved on farm water storage options specific to catchment hydrology (not state wide policies)
- The impacts of legislation and the trade of environmental water

6.2.3.2 Northern Territory

Ecosystem requirements for environmental water – benefits and impacts

- Quantification of level of impact on aquatic ecosystems resulting from change in low flow regimes in rivers of northern Australia
- Ecological impacts of changed flow regimes on ecology of tropical floodplains
- Techniques for managing uncertainties when water resource and ecosystem information is poor.
- Techniques for applying indigenous knowledge to environmental water allocation

Water use, institutional arrangements, management and administration processes

- Analysis of governance models and options

6.2.3.3 Queensland

Ecosystem requirements for environmental water – benefits and impacts

- Environmental flow requirements for tropical freshwater fish species
- Specific information about water resources and environmental flows in the Wet Tropics. E.g. WRP; ROP available for Barron catchment, but not for other catchments.
- Pathways of communication on studies and research need to be open to everyone not retained within organisations
- Wetland inundation

Maps / Models to support decision-making

- Better modelling of changes in flow regime for systems not under a water resource plan
- Regional Mapping of riffles and pools,

Groundwater system and interactions

- Local groundwater-surface water interactions
- Effects of mine site dewatering on groundwater aquifers
- Groundwater systems in sediments from the carbonaceous time period
- Effect of subsidence in river systems due to underground coal mining

Water use, institutional arrangements, management and administration processes

- Research on acceptable draw down limits of pools in dry times.

Communication strategies

- We are commencing data capture to plug some of the gaps in our management and information dissemination to our communities

6.2.3.4 South Australia

“There is a lot of general info but the problem is in relating this to a specific site or reach of a watercourse.”

Ecosystem requirements for environmental water – benefits and impacts

- Practical information about the impact of management actions on the integrity of the particular ecosystems and the objectives set for their management.
- A checklist that allows you to tick off whether a particular aspect is relevant to the resource unit in question. Not so much interested in academic research - although this is an important base for determining a practical cause-effect response
- More information on watering requirements of floodplains

Groundwater system and interactions

- Interaction between groundwater and surface water
- Investigation of flow measurement techniques in low velocity and low flow situations
- More information on groundwater and surface water interaction - as well the time step in some areas probably needs to be as small as hourly - especially if the only event connecting the flood plain and watercourse only occurs once every 2 years and lasts 1 to 2 hours
- Research on carbon and nutrient fixing and connectivity between floodplains and rivers

6.2.3.5 Tasmania

“Information is needed to inform confident decision making at the planning level, including how much water can we allocate in a system, what will the impacts be? As well as to inform allocation decisions at a local level, such as what will the impacts be if we allocate a certain volume of water at a particular location?”

Ecosystem requirements for environmental water – benefits and impacts

- Flow regimes required to protect threatened species, such as *Astacopsis gouldii*.
- Flows required to maintain the integrity of wetlands.
- Information to support understanding and prediction of the effects of the allocation of water for alternative uses on water-dependent ecosystems, relating to both surface water and groundwater.

Impacts of land use change upon catchment hydrology

- Adequate information on the impacts of land use change on catchment hydrology i.e. plantation development. (local government)
- Adequate, available and usable catchment hydrology modelling.

Ground water system and interactions

- More information on the outcomes of research into affects of changing groundwater levels on ecosystems

Models to support decision-making

- A sufficient level of knowledge at the appropriate scale and an understanding of the processes involved to be able to construct adequate conceptual and numerical models to be able to model various allocation scenarios.

6.2.3.6 Victoria*Ecosystem requirements for environmental water – benefits and impacts*

- Science underpinning environmental flow recommendations,
- Species specific flow requirements
- Interdependency of critical flow components
- Maximising ecological benefits from environmental water allocations
- Ecological response to different parts of flow regime,
- Defining ecological thresholds
- Aquatic species and their needs, best way to use water to achieve environmental gains
- Monitoring environmental flows to demonstrate benefits

Groundwater system and interactions

- Ground/surface water interactions
- Understanding impacts of groundwater management on river and water resources
- Groundwater dependent ecosystems

Water use, institutional arrangements, management and administration processes

- Water delivery planning and management for environmental flows
- Rigorous decision making processes to assist managers
- Improved understanding of CMAs role

- Effective monitoring programs that enable us to understand the effect e-flows have on overall River Health Resource condition targets.

Future ecosystem and water resource pressures and their likely impacts upon flow regimes:

- Future impacts of climate change on water availability
- Land use changes on water availability ie farm dams
- Effects of climate changes, estuarine flow needs, drought adaptations

6.2.3.7 Western Australia

Water use, institutional arrangements, management and administration processes

- Environmental flow releases from dams

Groundwater system and interactions

- Groundwater impacts

Maps / Models to support decision-making

- High spatial resolution terrain and bathymetric models.
- More information on impacts of water quality fluctuations.
- More detailed work on the relationship of vegetation/infiltration/interception to rainfall intensity and run-off

Future ecosystem and water resource pressures and their likely impacts upon flow regimes:

- Confidently predicting impact of change (especially increased development) - on ground and surface water resources.
- Understanding impacts of natural water quality fluctuations as opposed to human induced change

Water use, institutional arrangements, management and administration processes

- Riparian management and rehabilitation
- Storm Water management
- Greater recognition/adoption of guidance on Environmental Water Plans for Ramsar listed wetlands. Ramsar provides detailed guidance for statutory and strategic water planning. There is little mention of this guidance as having informed Australian policy making decisions.

Ecosystem requirements for environmental water – benefits and impacts

- More research into the environmental water requirements of wetlands in our catchment;
- More info on affects of reduced flows on ecosystem health following obstructions in waterways and effects of mining operations on ecosystem health i.e. revegetation drawing more surface water and lowering groundwater

6.2.4 Types of knowledge, information and/or data required

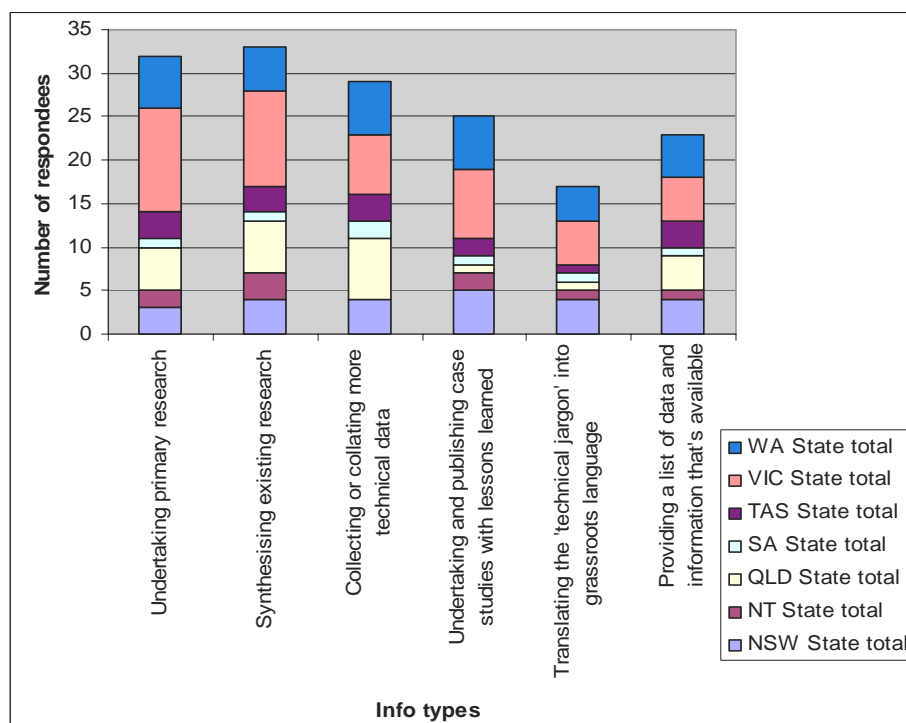
No one type of research is clearly required more than another, and Figure 6.1 below shows that all regions and states require most types of information reasonably uniformly. Victoria was most notably uniform in its desire for all types of information.

Two key messages are that respondents (particularly regional) desire *region-specific* information, and better collation of *existing data*. 77% of respondents indicated that synthesising *existing* research or providing lists of information that is *already available* (rather than undertaking new research) would successfully reduce information gaps.

Overall, there is also a high perceived need for more primary research and data collection, with 82% of respondents indicating that this is required to enable better performance.

It appears that Qld, Victoria and WA would benefit most from additional primary research by LWA. NT is also in need of both primary research and synthesis products, however our sample size was low for this state. There were too few Tasmanian respondents to provide a meaningful interpretation.

Figure 6.1: Types of information required



There did not seem to be a great need to translate the ‘technical jargon’ into grassroots language. Surprisingly, there is slightly less of a perceived need to undertake and publish case studies with lessons learned – but this desire is still significant, particularly in WA and NSW.

Additional observations include:

- State government in NSW desires more primary research as a priority
- State government in NT desires more synthesis products
- Regions and State government in QLD require collecting and collating more technical data, and Regional QLD also requires more primary research
- Both state and regional Victoria and state government in WA require both primary research and synthesis products equally highly.

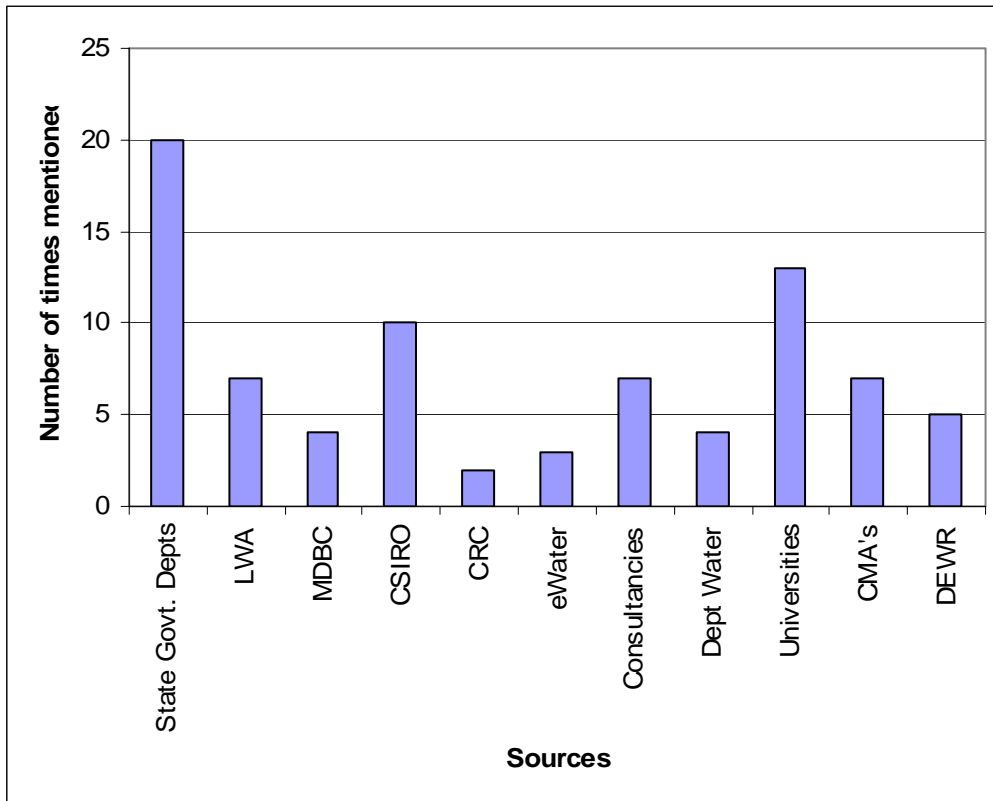
6.2.5 Suppliers/sources of information on environmental water

Figure 6.2 indicates the top 13 organisations used by respondents to provide information about environmental water. Regional water managers tend to rely upon their relative state government departments for information most heavily – in particular, DSE (Vic), EPA and DNRW (Qld). Both regional and state respondents use Universities as the next most significant information source. CSIRO was also frequently used, particularly by WA Regional and SA state government respondents. Consultants provide a high level of information to both state and regional water policy makers and managers in Victoria.

Land and Water Australia was relied upon most strongly by NT State, WA Regional and State, and to a lesser extent elsewhere around Australia. CMA's were also considered of value especially to NSW Regional areas, and consultancies to both State and Regional areas of VIC.

LWA could work more frequently with universities to commission and distribute research, given the amount of water managers and policy makers who rely upon them. State government departments are a key access point for the provision of information to many water managers.

Figure 6.2: Organisations used by respondents to access information



6.2.6 General delivery mechanisms for information on environmental water

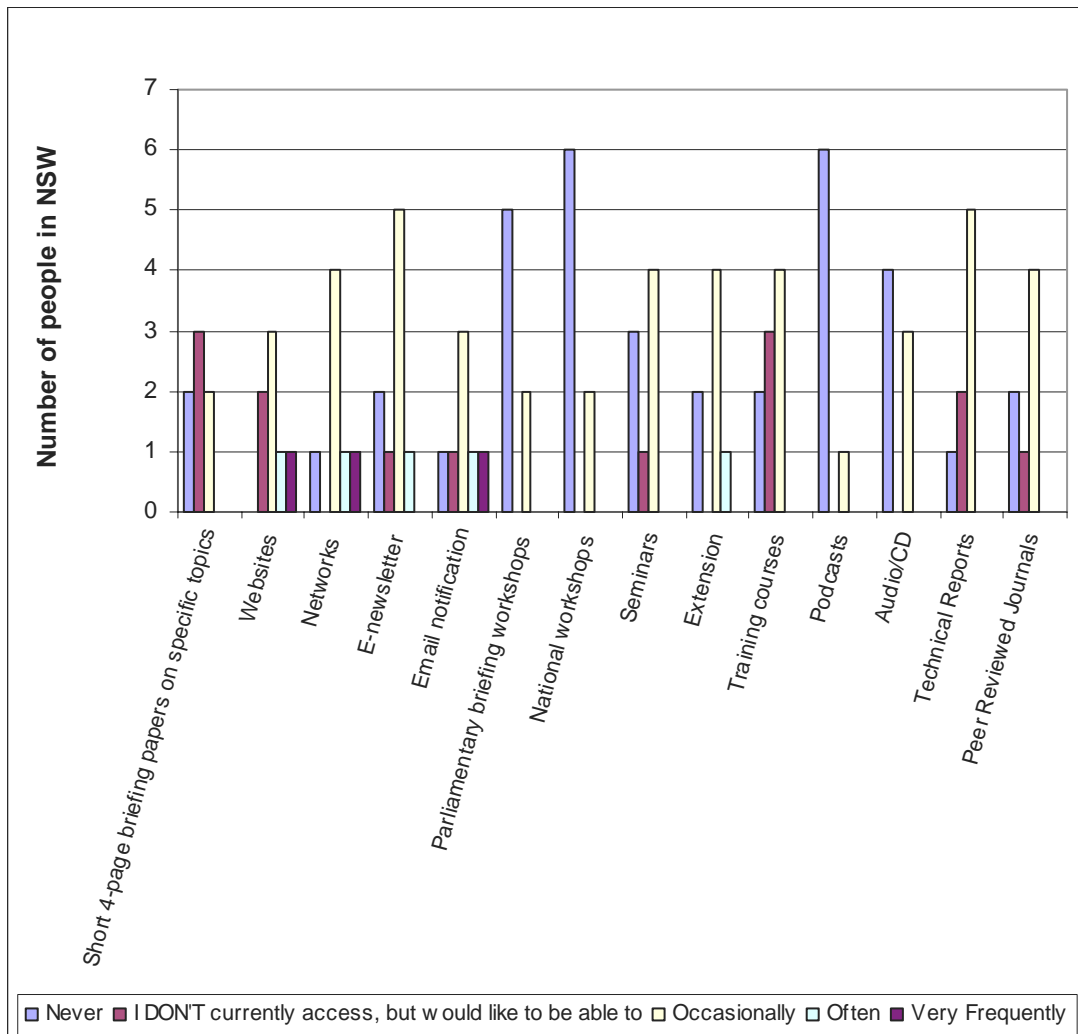
6.2.6.1 New South Wales

Regional NSW decision makers rely most heavily on *websites*, to provide them with information on environmental water, followed by *networks*, *email notification*, *extensions* and *e-newsletters*, then *seminars*, *technical reports* and *training courses*.

NSW respondents rely least upon *short 4 page briefing papers on specific topics*, *parliamentary briefing workshops*, and *podcasts*. However, *short 4-page briefing papers on specific topics* are the most desired form of information not currently accessed by regional NSW respondents.

The one state government respondent in NSW never relies upon *National workshops*, *seminars*, *training courses* or *podcasts*, and only occasionally uses other information types. Most NSW respondents only occasionally rely upon technical reports and journals.

Figure 6.3 Formats of information most frequently accessed in NSW



Where “Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3”;

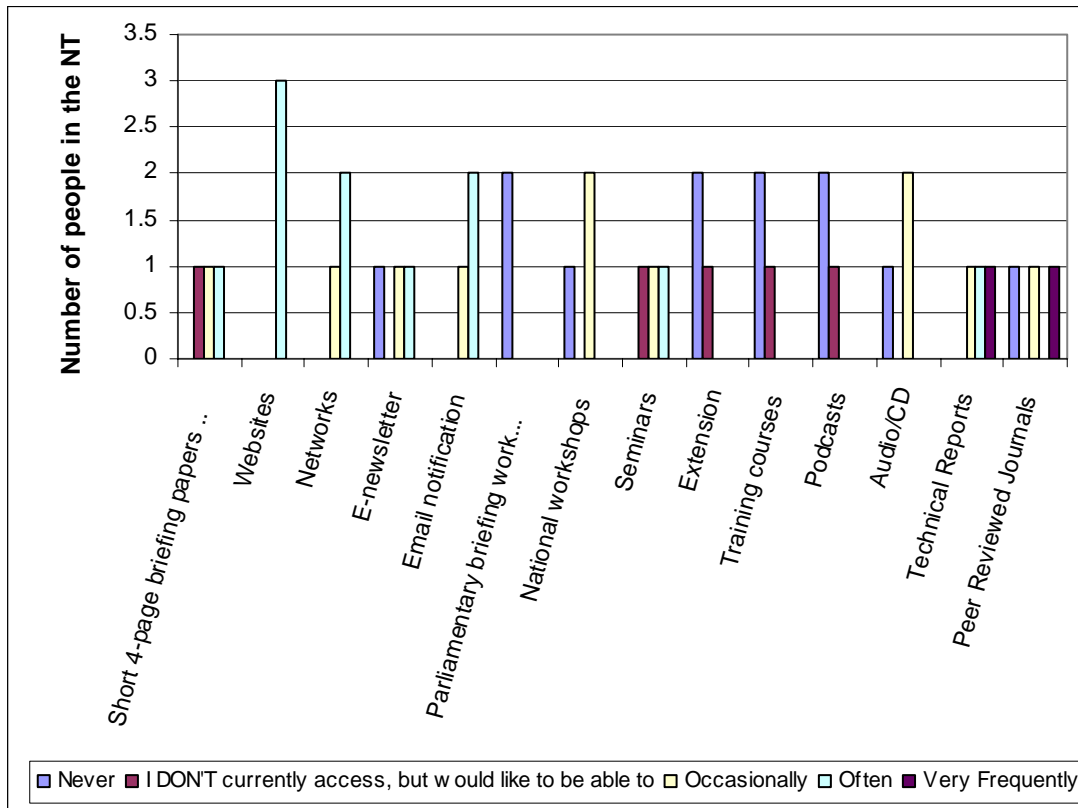
6.2.6.2 Northern Territory

Figure 6.4 indicates that NT state government respondents rely most frequently upon *websites* and *technical reports*, followed closely by *networks* and *email notification*, *peer reviewed journals* and *short 4 page briefing papers on specific topics*, *e-newsletters* and *seminars*.

Extension, *parliamentary briefing workshops*, *training courses* and *podcasts* were never used.

NT state government respondents do not access, but would like to access ‘*Short 4-page briefing papers on specific topics*’, ‘*Seminars*’, ‘*Extension*’, ‘*Training courses*’ and ‘*Podcasts*’.

Figure 6.4: Formats of information most frequently accessed in NT



Where “Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3”;

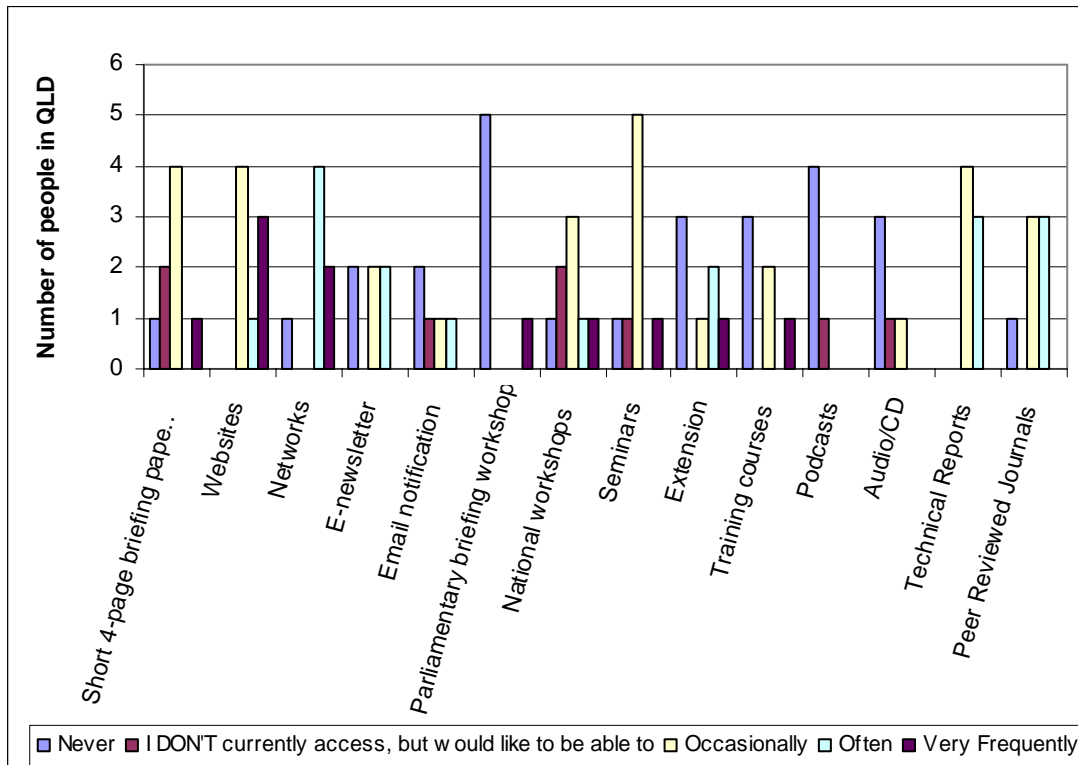
6.2.6.3 Queensland

Regional Qld decision makers rely most heavily on *networks*, followed by *websites*, then *extension* and *technical reports*, *short 4 page briefing papers on specific topics*, *national workshops* and *training courses* and then *peer reviewed journals*. *Podcasts* are never used.

Figure 6.5 indicates that of the QLD State government respondents, *websites* were again most commonly used, then *peer reviewed journals*, and *e-newsletters* and *technical reports*. *Parliamentary briefing workshops*, *training courses*, *podcasts*, and *audio/cd* were never used.

‘*Short 4-page briefing papers on specific topics*’ and ‘*National workshops*’ are the most sought after forms of information currently not accessed. ‘*Email notification*’, ‘*Seminars*’, ‘*Podcasts*’ and ‘*Audio/CD*’ were also noted as desired forms of information not currently accessed.

Figure 6.5: Formats of information most frequently accessed in Qld



Where “Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3”;

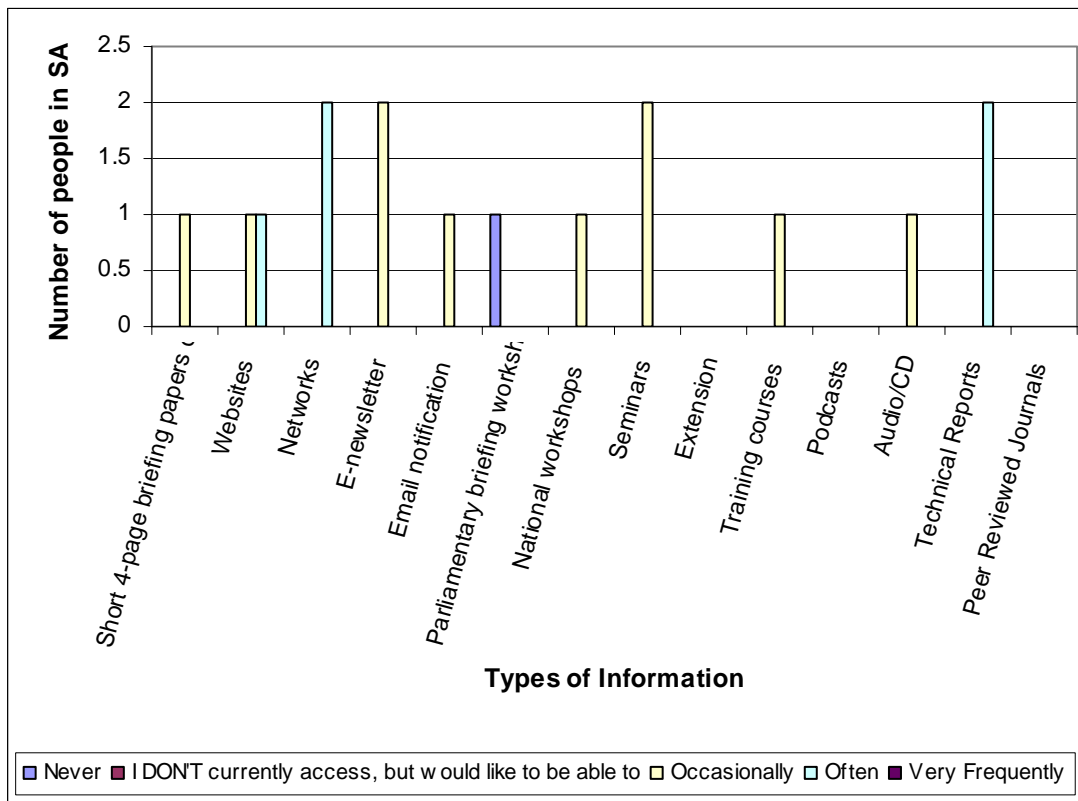
6.2.6.4 South Australia

Figure 6.6 shows that all the SA respondents were from State government (rather than regional), and most frequently rely on *networks* and *technical reports*, then *websites*, *e-newsletters* and *seminars*.

Parliamentary briefing workshops, *extensions* and *podcasts* were never used.

All respondents from SA indicated that they had too high a work load to access the resources that they would like to, and/or that the resources they desired did not exist or they were not aware of them.

Figure 6.6: Formats of information most frequently accessed in SA



Where “Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3”;

6.2.6.5 Tasmania

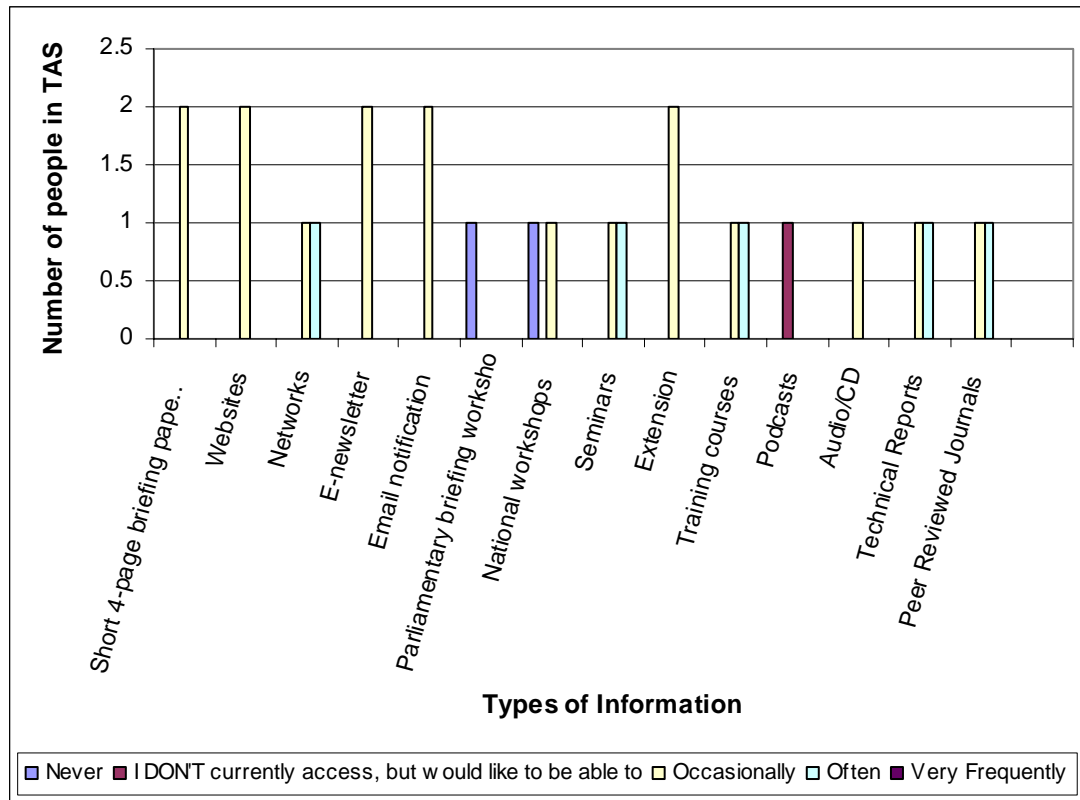
Only two Tasmanian respondents (one from Local Government and one from State government) responded to this survey question. There are too few respondents to provide meaningful interpretations of results – nevertheless, the results are included in Figure 6.7.

Networks, seminars, training courses, technical reports and peer reviewed journals are most frequently relied upon, then short 4 page briefing papers on specific topics, websites, e-newsletters, email notification, and extension.

Parliamentary briefing workshops and podcasts are never used.

Podcasts were the only desired type of information not currently accessed.

Figure 6.7: Formats of information most frequently accessed in Tasmania



Where “Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3”;

6.2.6.6 Victoria

Face to face and personal information communication is clearly valued highly in regional Victoria. *Networks* and *technical reports* are currently most heavily relied upon, followed by *seminars*, *websites*, *training courses* and *national workshops*.

Parliamentary briefing workshops, *extension*, and *podcasts* are never used.

VIC state government respondents also heavily use professional *networks*, followed by *technical reports* and *websites*, *email notification*, *seminars* and *peer reviewed journals*, *short 4 page briefing papers on specific topics* and *national workshops*, and to a lesser extent *e-newsletters* and *training courses*.

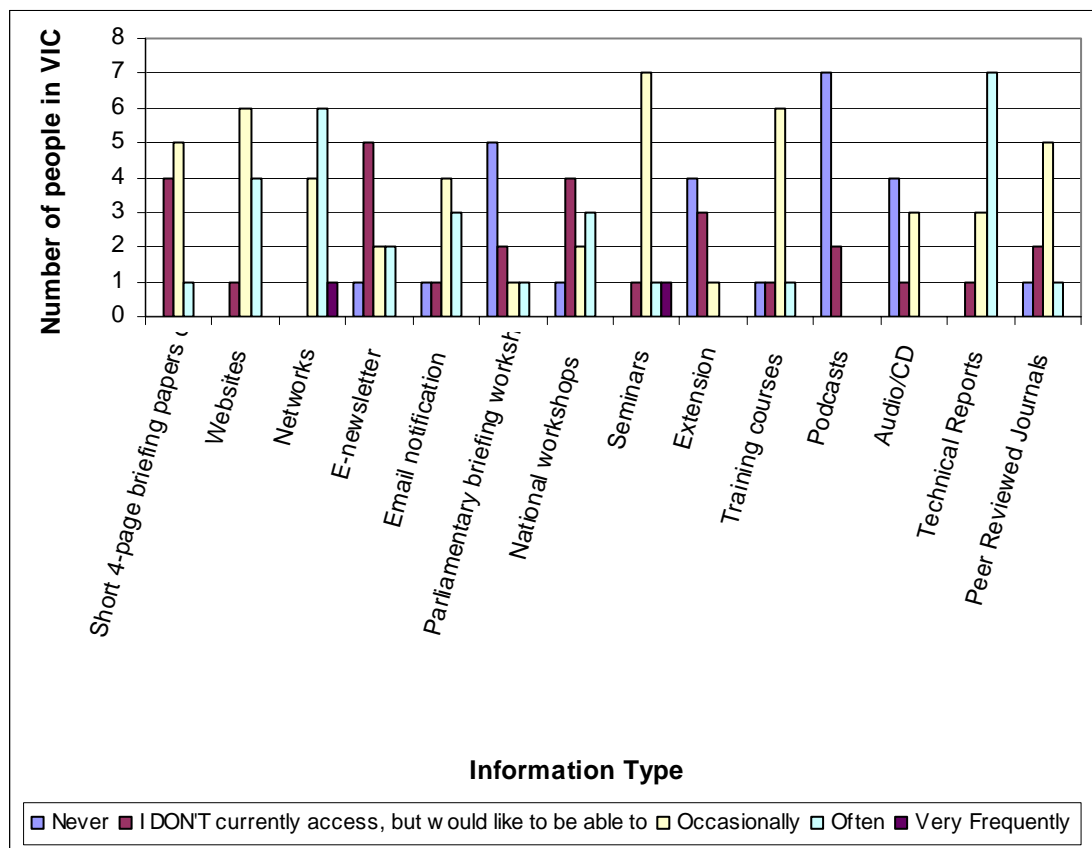
Podcasts are never used.

The most desired form of information not currently accessed much by both regional and state government respondents in Victoria are ‘*E-newsletters*’. The second most desired information type desired but infrequently accessed by both regional and state government respondents are ‘*Short 4-page briefing papers on specific topics*’ and ‘*National workshops*’.

The survey results indicate that Victorians are not accessing these types of information because a) their workload is too high (particularly to attend national workshops), and b) they are not available or not aware of this information source.

‘*Extension*’ and ‘*peer reviewed journals*’ were also more minimally noted as desired types of information not currently accessed by Victorian state government respondents and industry.

Figure 6.7: Formats of information most frequently accessed in Victoria



Where “Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3”;

6.2.6.7 Western Australia

WA regional respondents indicated that *websites*, *technical reports*, *peer reviewed journals*, *seminars* and *networks* are by far the most heavily relied upon sources of information.

Parliamentary briefing workshops, *podcasts* and *audio/cd* were never used, and others types very infrequently.

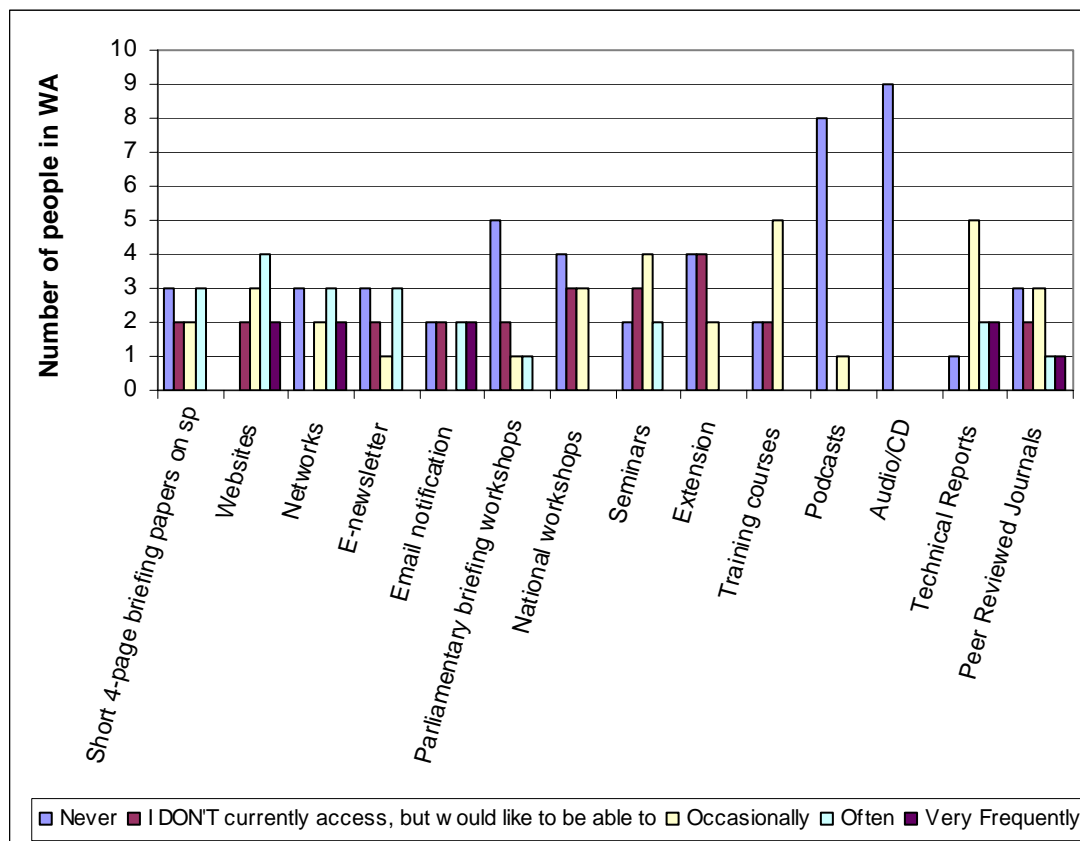
WA state government respondents clearly rely most upon *websites*, then *networks*, *email notification* and *technical reports*. *Short 4 page briefing papers on specific topics* and *e-newsletters* are also used fairly frequently.

Parliamentary briefing workshops and training courses were occasionally used, while extensions and audio/cd were never utilised.

'Extension' is the most desired form of information not currently accessed in WA by regional respondents and two WA state government respondents noted they would like 'extension' but this form of information was 'Not available or they are not aware of it'.

'National workshops' and 'Seminars' are the second most desired types of information for WA state government. Respondents thought that this information is currently *not available or the respondents are unaware of the availability* of such highly desired information types.

Figure 6.8: Formats of information most frequently accessed in WA



Where "Never = 0, Occasionally = 1, Often = 2, and Very Frequently = 3";

6.2.7 Specific delivery mechanisms for information on environmental water

Water policy makers and managers access a wide variety of information, with no clear 'stand out' mechanisms. Figures 11.1 and 11.2 show that the most commonly desired form of information, currently not accessed around the nation is *Short 4-page briefing papers on specific topics*.



Nationally, face-to-face communication of information is clearly favoured. The three next most desired forms of information currently not accessed across Australia, independent of jurisdiction run in this order: *Seminars, Extension, National workshops.*

Figure 6.9 – Nationwide most popular information sources:

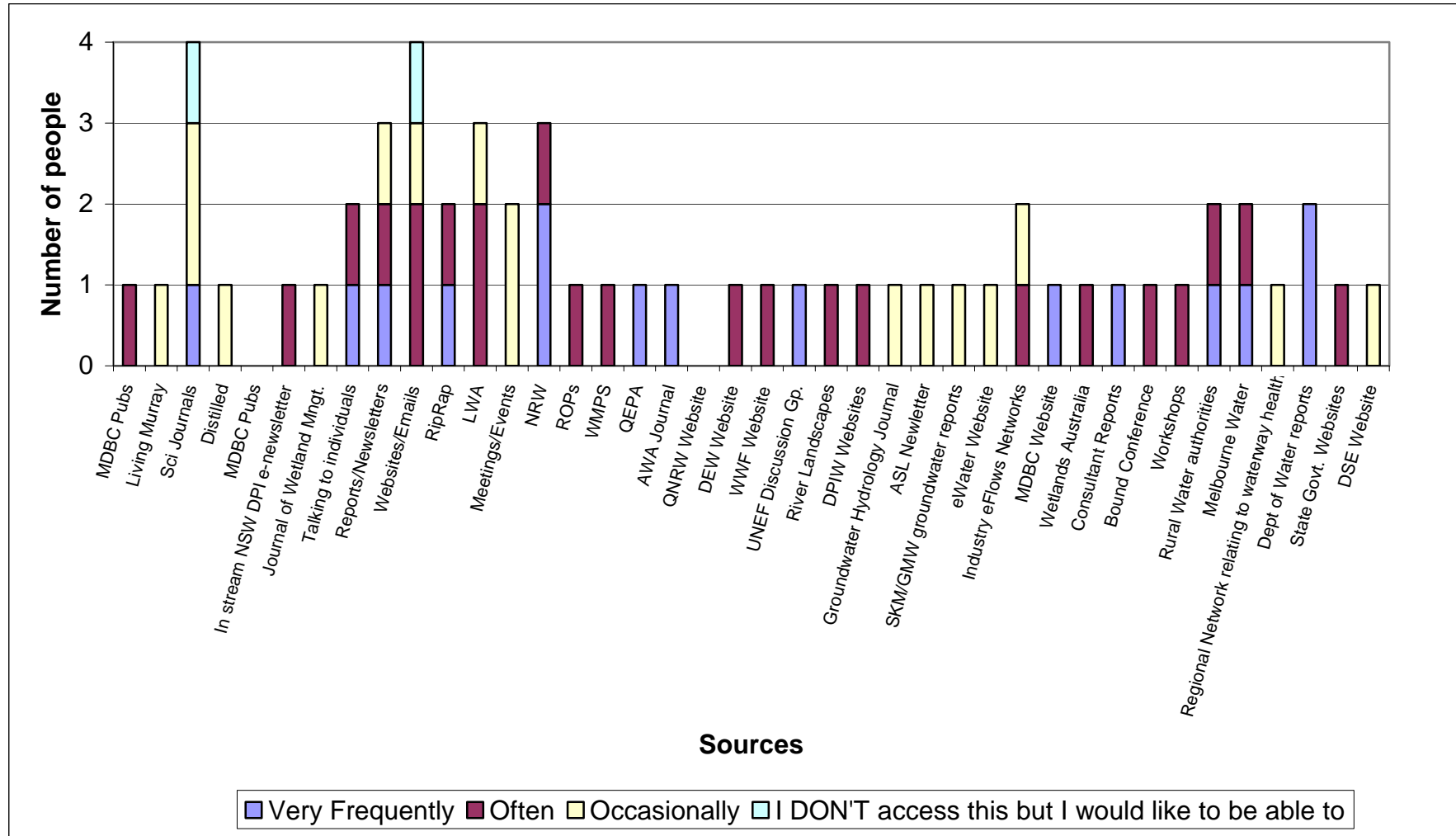


Figure 6.10 – State by State representation of most popular information products:

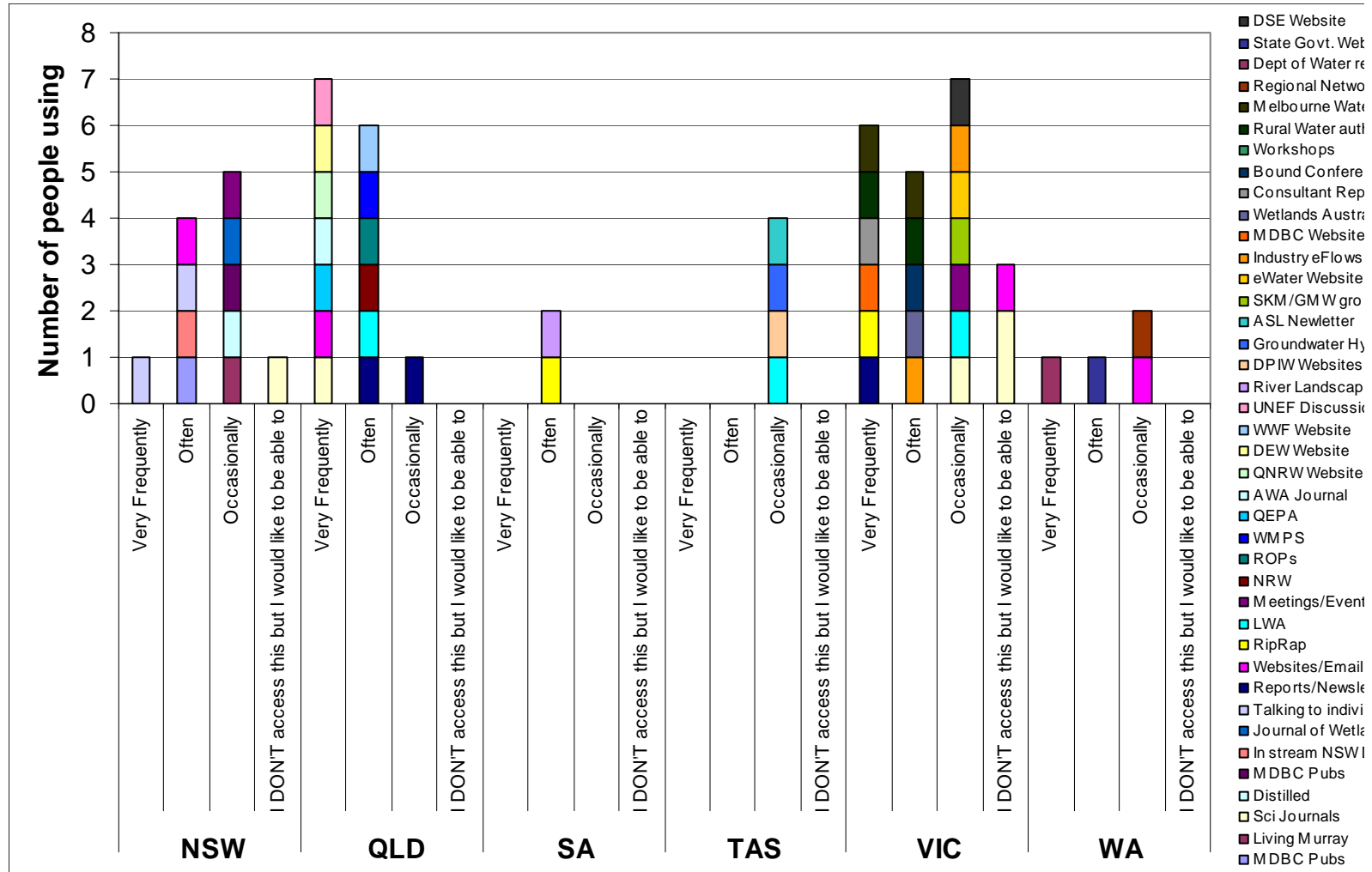


Figure 6.11: Reasons for not currently accessing desired information sources

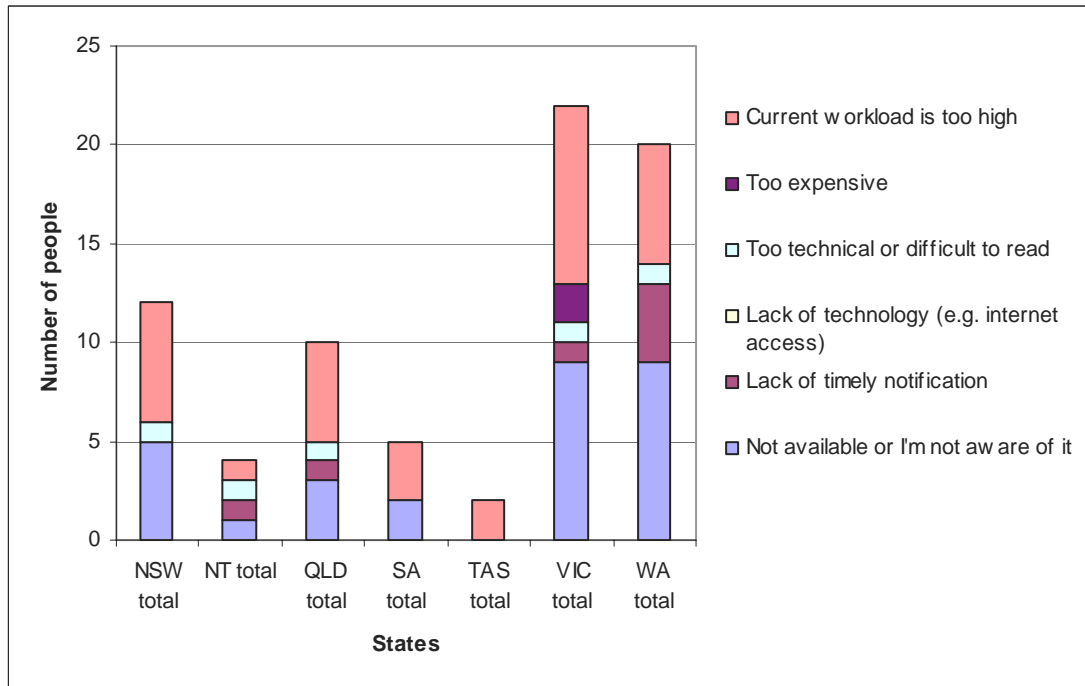


Figure 6.11 shows that the majority of respondents do not access desired information because their workload is too high. This is a significant finding for LWA. Information products must be made to be quickly and easily accessible for busy managers.

Respondents also believe that much of the desired information is not available, or they are unaware of it. This result is potentially representative of a failure in communication or networking of pre-existing knowledge. It may be resolved by effective marketing of knowledge through relevant channels.

Information types highly desired include region specific information such as:

- specific policy development to satisfy the various stakeholders and/or
- information linking groundwater flows with eco-system health and/or
- various ecological thresholds and indicators at different sites.

7. Recommendations and conclusions

7.1 Federal policy recommendations

As stated earlier, the information needs of decision makers at the federal policy level differs from the level of technical information required by state government policy makers and regional water managers. Federal policy makers will benefit most from increased access to the data and information collected by each state – particularly where this information is provided in a consistent and accessible format.

It is recommended that Land & Water Australia work closely with the National Water Commission, particularly as the initial phases of research and development of consistent water data standards and protocols takes place. There is an important opportunity for Land & Water Australia's Environmental Water Allocation Program to assist in developing an integrated framework for water accounting and management that incorporates both ecosystem and human usage requirements within a connected ground and surface water system.

Land & Water Australia could also assist in promoting research and understanding into the differing considerations and unique management issues faced across state boundaries that may affect water accounting frameworks.

In addition, Land & Water Australia could play a valuable role in collating and synthesising state level information for use at the federal policy level. This could improve the transparency of state and federal decision making. Information upon the types of research being conducted at a national level – or with national significance would be useful for ensuring consistent approaches and policy.

Given the recommendations that have been suggested by state level water managers below regarding an environmental water web-based portal, it will be important for Land & Water Australia to stay abreast of the progress, role and function of the water data portal being developed through the National Water Commission and the Bureau of Meteorology.

7.2 Overall state policy recommendations

While there are a number of consistent knowledge requirements across all states as discussed below, a key insight from this enquiry has been the degree to which state policy makers (and regional and state water managers) perceive the need for state and locally specific information, research and decision making frameworks. For this reason, the recommendations set out below are organised by state. It must be noted that due to the low number of Tasmanian state government respondents to this study, it was deemed inappropriate to make recommendations for this state at the policy level. However, regional recommendations for Tasmania are contained within section 7.5.2.

Most state policy makers perceived there to be a range of knowledge gaps that require further research to better inform decision making. Overall, policy makers saw the need for more robust technical information around the quantitative benefits of environmental watering for ecosystem functioning. It is clear that a poor understanding of groundwater / surface water interactions impedes decision making around environmental water allocation in all states and regions.

Importantly, state policy makers require information to be synthesised and delivered in formats specifically relevant for strategic policy decision making, as opposed to technical analysis or reporting. This means that technical research reports are less likely to be used than general frameworks and expert opinion.

South Australian, Western Australian and Victorian policy makers stated they would derive great benefit from a decision support framework and/or information system that linked species specific information to the benefits of environmental watering for whole ecosystems under a range of scenarios, including climate change. It is recommended that Land & Water Australia strongly consider developing such models with interested states.

It is important for LWA and other research bodies to be aware that most state government departments commission their own research into specific technical areas, and to synthesise existing research. It would be valuable for Land & Water Australia to develop ongoing partnerships with these departments to ensure that LWA research is appropriately targeted and relevant to its desired audience.

High levels of staff turnover in all relevant organisations were cited as the reason for perceived knowledge losses and the breakdown of contacts within existing networks – although most state government representative felt they had strong ties with individual researchers. Development of a central information portal that could direct decision makers to the appropriate experts, advisors, research information and tools was recommended by almost all respondents. They believed this would raise awareness of relevant experts and enable people to better search for and access the range of research commissioned by agencies and organisations nationally and in all states/territories.

State policy makers desire participatory research programs tailored to specific state-level needs. These are perceived to be successful in developing fostering relationships between researchers and policy makers, and build the knowledge of key decision makers without requiring extensive reading. Time constraints were cited as the main reason behind the unwillingness of state policy makers to engage in broad reading about environmental flows, with most preferring to rely upon individual expert consultation.

Personal and professional networks of experts are often the most highly consulted sources of information. An information portal could assist policy makers to broaden their networks of experts (rather than substitute them), and provide those experts with an up to date source of new and emerging research across all research institutes within all states and territories.

Understanding the whole system is critical for strategic policy making. For this reason, the development of useful frameworks and integrated decision support tools, in addition to research and synthesis was considered important.

The specific recommendations for each state appear in section 7.3 below.

7.3 Policy recommendations for each state

7.3.1 New South Wales

Knowledge of e-flows in this state was reported to be lower in NSW than in other jurisdictions.

To provide NSW with valuable information, Land & Water Australia should focus on assisting to clarify governance issues and arrangements for managers, and practical solutions to stakeholder management issues around environmental water allocation. Farm level information and options in the form of fact sheets and brief summaries would be useful. Simple information in fact sheet and email update formats could be of use – and it is recommended that several small workshops be held to raise awareness in the regions of the importance of e-flows to decision making in natural resource management.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.9: Recommended research areas for regional and state water managers in New South Wales

Ecosystem requirements for environmental water – benefits and impacts	
Scientific results showing the benefits of environmental watering. Off - stream watering systems	General information about environmental water - research, findings from past experiences, evidence of benefits achieved
Maps and Models	
Better and more transparent modelling of riverine systems	
Water use, institutional arrangements, management and administration	

<p>Information about equitable water usage.</p> <p>Information on the management of stakeholder conflict regarding location in catchment and water use (i.e. conflict over upstream landholders dams, water 'slowing' structures such as weirs etc)</p>	<p>Farm level options for improving environmental water management and relative merits of each e.g. transferring to high flow extraction, improved on farm water storage options specific to catchment hydrology (not state wide policies)</p> <p>The impacts of legislation and the trade of environmental water</p>
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7.3.2 Northern Territory

It is recommended that:

- LWA continue the LWA TRaCK Program and ensure wide uptake through appealing to existing networks
- LWA conduct research into minimum ecosystem requirements for e-flows to prevent severe change
- LWA initiate processes that facilitate researchers coming together allow collective ownership - potentially utilising Bayesian belief networks, which have recently been successful in the NT

It is recommended that research needs in the areas in the table below be addressed:

Table 7.5: Recommended research areas for state government in Northern Territory

Northern territory government knowledge gaps and research areas	
<ul style="list-style-type: none"> ■ Quantitative ecosystem benefits from e-flows ■ Recessional flows from floodplain back into river. Much material returning to the river as both dissolved organics, sediments – and in-stream processes and impact on in-stream health 	<ul style="list-style-type: none"> ■ The timing and duration of e-flows required to sustain ecosystem health ■ Acid sulphate issues around drying out some wetlands for evaporative savings. ■ The impacts of intercepting early flows and the timing issues involved in releasing e-flows

7.3.3 Queensland

It is recommended that:

- LWA could play a valuable co-investment role through the EWA program. This may assist in harmonising state and national level research and foster stronger networks across agencies and research institutions

- LWA could play a role in coordinating or providing a portal for research activities related to e-flows across the nation.
- Part of this role could involve generating reviews that synthesised all existing knowledge and research across the various jurisdictions.
- It is essential that LWA makes its research directly applicable and targeted to specific jurisdictions; Queenslanders do not see the value of more general research.
- In particular, the Estuarine Requirements program (NLWRA) requires more extensive investment
- LWA should communicate information through personal appearances at scheduled events, such as the EPA routine water planning meetings
- LWA continue to produce Rip Rap and Farm Notes, as these are useful – and make presentations at events and conferences where possible

It is recommended that research needs in the areas in the table below be addressed:

Table 7.2: Recommended research areas for state government in Queensland

Queensland state government knowledge gaps and research areas	
<ul style="list-style-type: none"> ■ Information and research in the Northern Tropics ■ Identification of the key ecological assets (and associated indicators) that are to be protected through environmental water ■ Link between hydrological regimes and ecological assets. Presently monitoring the effects of low flows ■ Water dependent wetlands and estuarine requirements. The Qld government is presently investing in monitoring conditions and outcomes. ■ Information on the groundwater refugia that require protection, and what research is currently being conducted in this area ■ Groundwater – surface water interactions 	<ul style="list-style-type: none"> ■ The nature and location of groundwater dependent ecosystems (e.g. wetlands) ■ The ways in which ecosystem health frameworks being developed incorporate or interact with knowledge around e-flows ■ Coastal groundwater and the impacts upon marine ecosystems and sea beds (requires modelling) ■ Environmental risks of the impacts upon assets and ecology of changes to hydrology ■ The lifecycle, flow and water quality requirements of many species ■ The ways in which diversions such as dams affect e-flows, and how these impact upon significant assets

7.3.4 South Australia

It is recommended that:

- LWA investigate the potential for developing decision support system that integrate the available guidelines for environmental water allocation in South Australia.
- LWA commission interactive research programs that involve the input of a wide variety of researchers and policy makers to strengthen networks and provide policy makers with ‘embodied’ knowledge in addition to reports.
- LWA synthesise the outcomes of locally targeted, issues-based research programs that integrate a range of ecological requirements and land use implications

It is recommended that research needs in the areas in the table below be addressed:

Table 7.4: Recommended research areas for state government in South Australia

South Australian state government knowledge gaps and research areas	
<ul style="list-style-type: none"> ■ Information that could assist in the quantification of the environmental benefits of watering, including for the sustainability and improvement of vegetation, terrestrial and aquatic animals and plants. ■ Timing and duration of flow events and impacts of this upon environmental outcomes 	<ul style="list-style-type: none"> ■ Information upon EG nutrients and carbon cycling through system as a result of water flowing out into floodplains. Quantifying this information as carbon comes back into river systems after floods would be useful. ■ Frameworks for use in comparing benefits for other uses in order to justify trade offs for competing uses

7.3.5 Victoria

It is recommended that:

- LWA commission research to better understand the benefits and outcomes of environmental water allocation on unregulated rivers as a priority.
- LWA initiate and/or collaborate in the development of a ‘centre of excellence’ or information portal to address or route queries, and to identify knowledge gaps and areas where knowledge is repeatedly sought about environmental water
- LWA partner with other organisations to develop a model that provides fairly accurate scenarios of consequences of various flow regimes / water use decisions for use both as a communication tool for communities and for decision making.
- LWA consider assisting in the development of a tool that better captures real flow events to make better decisions
- Data collection and mechanisms for sharing be improved around water usage statistics – although this is presently being addresses by the National Water Commission

It is recommended that research needs in the areas in the table below be addressed:

Table 7.1: Recommended research areas for state government in Victoria

Victorian state government knowledge gaps and research areas	
<ul style="list-style-type: none"> ▪ Sufficiently accurate hydrological data to calculate stream flows, including the amount of water used for domestic and stock purposes, including dams and extractions from watercourses ▪ Empirical data to support environmental flow models to estuaries ▪ The impacts of land use upon water flows ▪ General understanding of the nature of a healthy, yet altered, ecological system ▪ Groundwater interactions and ecosystem functioning of unregulated rivers 	<ul style="list-style-type: none"> ▪ Drought and ecosystem capacities to cope with drought ▪ The impacts of climate change upon all systems, especially shallow ephemeral wetlands ▪ The specific, measured benefits and impacts of e-flows upon ecological processes ▪ Sub-lethal effects on species, especially for mobile species such as birds ▪ The ways in which limits in over-bank flows affect adjoining ecosystems both for the channel and the ecosystem supported by overbank flows

7.3.6 Western Australia

It is recommended that:

- LWA commission research into the effects of both current and future development decisions upon ecological and hydrological systems (both ground and surface water implications)
- Commission research into the effects of the cessation of irrigation pipe leakage upon hydrological systems
- LWA commission geomorphological research in WA
- LWA consider developing a web based information resource for decision makers that identifies relevant people and resources to consult in decision making around a range of topics, including new land and resource developments
- LWA investigate the potential for developing and delivering online training courses with interactive, multimedia components.
- LWA continue to provide yearly training workshops similar to the LWA Rivers Program ones delivered in 2006.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.3: Recommended research areas for state government in Western Australia

Western Australian state government knowledge gaps and research areas	
<ul style="list-style-type: none"> ■ Knowledge of both ecology and hydrology in the North Perth Basin ■ Geomorphological data and information in all jurisdictions ■ The impacts of reduced irrigation pipe leakage upon the environment and in particular Environmental Water Reserves (EWRs) is not understood. The international experience of this would be helpful. 	<ul style="list-style-type: none"> ■ Information specific to WA water systems is required – particularly as much larger volumes of water are being managed than in eastern states ■ EWRs are not currently enforced for all rivers, and monitoring after releases is often not adequately performed. ■ Information upon specific areas of the interface of groundwater and surface water dependent ecosystems

7.4 Overall regional / state water managers recommendations

The main observable difference between the knowledge needs of federal and state policy makers, and state and regional water managers was the degree of integration and technicality of the information desired. While policy makers require decision support systems and frameworks for management, regional and state water managers require technical data, trends and condition reports.

Overall, it is recommended that Land & Water Australia:

- Synthesise existing information on the benefits and impacts of e-flows within local and locally relevant reaches and areas – including case studies of lessons learned within local and other contexts
- Commission new research into the effects of e-flows upon assets, resource condition and species relevant to the planning context within regions in the following general areas:
 - Ecosystem requirements for environmental water – benefits and impacts
 - Future ecosystem and water resource pressures and their likely impacts upon flow regimes
 - Ground water system and interactions
 - Water use, institutional arrangements, management and administration processes
 - Impacts of land use change upon catchment hydrology
- Facilitate the development of visual maps and spatial information to assist in decision making
- Develop scorecards, trends reports, guidance documents and practically relevant management tools

- Engage with regional and state water managers through existing network and planning meetings, workshops and conferences to build relationships and identify research and information needs on an on going basis
- Where possible, undertake research in partnership with local managers, universities, CRCs, researchers and state government departments to foster wide networks and effectively transfer knowledge and information
- Participate in planning workshops as a component of research projects to assist regional and state water managers to practically use information within a specific context
- Develop a regionally relevant, information portal that identifies relevant expertise and past and current research projects. This could either appear online, or could have staff members available to direct queries upon specific topics.

7.5 Regional / state water manager recommendations for each state

7.5.1 New South Wales

As for South Australia, the majority of e-flows decisions occur at the state policy level in New South Wales, and knowledge of e-flows in the regional is lower than in other jurisdictions.

To provide NSW with valuable information, Land & Water Australia should focus on assisting to clarify governance issues and arrangements for managers, and practical solutions to stakeholder management issues around environmental water allocation. Farm level information and options in the form of fact sheets and brief summaries would be useful. Simple information in fact sheet and email update formats could be of use – and it is recommended that several small workshops be held to raise awareness in the regions of the importance of e-flows to decision making in natural resource management.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.9: Recommended research areas for regional and state water managers in New South Wales

Ecosystem requirements for environmental water – benefits and impacts	
Scientific results showing the benefits of environmental watering. Off - stream watering systems	General information about environmental water - research, findings from past experiences, evidence of benefits achieved
Maps and Models	
Better and more transparent modelling of riverine systems	

Water use, institutional arrangements, management and administration	
Information about equitable water usage. Information on the management of stakeholder conflict regarding location in catchment and water use (i.e. conflict over upstream landholders dams, water 'slowing' structures such as weirs etc)	Farm level options for improving environmental water management and relative merits of each e.g. transferring to high flow extraction, improved on farm water storage options specific to catchment hydrology (not state wide policies) The impacts of legislation and the trade of environmental water

7.5.2 Northern Territory

It is recognised that in the Northern Territory, the specific nature of river systems and ecology requires specific research to be conducted in this region.

Table 7.9: Recommended research areas for regional and state water managers in Northern Territory

Ecosystem requirements for environmental water – benefits and impacts	
Quantification of level of impact on aquatic ecosystems resulting from change in low flow regimes in rivers of northern Australia Techniques for managing uncertainties when water resource and ecosystem information is poor.	Ecological impacts of changed flow regimes on ecology of tropical floodplains Techniques for applying indigenous knowledge to environmental water allocation
Maps and Models	
Better and more transparent modelling of riverine systems	
Water use, institutional arrangements, management and administration	
Analysis of governance models and options	

7.5.3 Queensland

For Queensland regional and state water managers, visual mapping and modelling was an important information gap – particularly around the location of groundwater dependent ecosystem and to enable a better understanding of groundwater surface water interactions. Engaging with regional managers in their efforts to improve data capture would be beneficial.

Regional managers strongly desired training and information to be shared at workshops and events. Land & Water Australia should endeavour to focus on the distribution of scorecards and trends reports, visual information and face-to-face engagement mechanisms for Queensland regional and state water managers.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.11: Recommended research areas for regional and state water managers in Qld

Ecosystem requirements for environmental water – benefits and impacts	
Environmental flow requirements for tropical freshwater fish species Wetland inundation	Specific information about water resources and environmental flows in the Wet Tropics. E.g. WRP; ROP available for Barron catchment, but not for other catchments
Groundwater system and interactions	
Local groundwater-surface water interactions Effects of mine site dewatering on groundwater aquifers Better modelling of changes in flow regime for systems not under a water resource plan	Groundwater systems in sediments from the carbonaceous time period Effect of subsidence in river systems due to underground coal mining Regional Mapping of riffles and pools
Water use, institutional arrangements, management and administration	
Research on acceptable draw down limits of pools in dry times.	

7.5.4 South Australia

“There is a lot of general info but the problem is in relating this to a specific site or reach of a watercourse.”

There are fewer specific information gaps both in South and Australia and New South Wales than for other regions – and they are not as interested in technical or academic research reports.

South Australian water managers are concerned with the ways in which to understand the impacts of e-flows upon resource condition. Most of the management of e-flows occurs at the state policy

level, meaning that Land & Water Australia should ensure that information they provide to regional water managers must clearly interface with regional planning priorities.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.8: Recommended research areas for regional and state water managers in South Australia

Ecosystem requirements for environmental water – benefits and impacts	
Practical information about the impact of management actions on the integrity of the particular ecosystems and the objectives set for their management. More information on watering requirements of floodplains	A checklist that allows you to tick off whether a particular aspect is relevant to the resource unit in question.
Groundwater system and interactions	
Interaction between groundwater and surface water as well the time step in some areas (hourly in some areas)	Investigation of flow measurement techniques in low velocity and low flow situations
Future ecosystem and water pressures and their likely impact upon flow regimes	
Research on carbon and nutrient fixing and connectivity between floodplains and rivers	

7.5.5 Tasmania

Most e-flows decisions in Tasmania are currently made at a state government policy level, However, Tasmanian regional managers are concerned with the amounts of flow required to sustain particular species and to maintain the integrity of wetlands as a priority.

There was a low awareness of the information provided by Land & Water Australia. It is recommended that Land & Water assist Tasmanian water managers through providing publications such as RipRap, email updates and fact sheets to raise awareness of issues and to share information on research.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.7: Recommended research areas for regional and state water managers in Tasmania

Ecosystem requirements for environmental water – benefits and impacts	
Flow regimes required to protect threatened species, such as <i>Astacopsis gouldii</i> . Flows required to maintain the integrity of wetlands.	Information to support understanding and prediction of the effects of the allocation of water for alternative uses on water-dependent ecosystems, relating to both surface water and groundwater.
Groundwater system and interactions	
More information on the outcomes of research into affects of changing groundwater levels on ecosystems [33] (local government)	
Impacts of land use change upon catchment hydrology	
Adequate information on the impacts of land use change on catchment hydrology i.e. plantation development.	Adequate, available and usable catchment hydrology modelling.

7.5.6 Victoria

Victorian respondents have a most immediate need for more information about environmental water. As stated earlier, Victorian regional water managers have a high level of knowledge about environmental water, and information provided should recognise their capability in this area.

It is recommended that Land & Water Australia provide more systemic information for Victoria, particularly in relation to ecological thresholds and e-flow impacts. In addition, research and trends reports that identify the future impacts and implications of water management and adaptation responses required for a range of future conditions would be highly useful. Scenario planning workshops could also be highly effective in this context.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.6: Recommended research areas for regional and state water managers in Victoria

Ecosystem requirements for environmental water – benefits and impacts	
Science underpinning environmental flow recommendations, Species specific flow requirements Interdependency of critical flow components Maximising ecological benefits from	Ecological response to different parts of flow regime Defining ecological thresholds Aquatic species and their needs, best way to use water to achieve environmental gains

environmental water allocations	Monitoring environmental flows to demonstrate benefits
Groundwater system and interactions	
Ground/surface water interactions Understanding impacts of groundwater management on river and water resources	Groundwater dependent ecosystems
Water use, institutional arrangements, management and administration	
Water delivery planning and management for environmental flows Rigorous decision making processes to assist managers	Improved understanding of CMAs role Effective monitoring programs to assess impact of e-flows on overall River Health Resource condition targets.
Future ecosystem and water pressures and their likely impact upon flow regimes	
Future impacts of climate change on water availability Land use changes on water availability i.e. farm dams	Effects of climate changes, estuarine flow needs, drought adaptations

7.5.7 Western Australia

As mentioned previously, fewer specific information gaps were reported in WA and SA than for other jurisdictions. Yet the mapping and modelling information is of importance in gathering information for decision making.

Western Australian water managers are concerned with the impacts of mining upon ecosystem and hydrological system health. It is recommended that Land & Water Australia synthesise information to assist in the management of e-flows in relation to mining, farm storage, and the requirements for Ramsar wetlands.

It is recommended that research needs in the areas in the table below be addressed:

Table 7.10: Recommended research areas for regional and state water managers in Western Australia

Maps and models	
High spatial resolution terrain and bathymetric	More detailed work on the relationship of

models. More information on impacts of water quality fluctuations.	vegetation/infiltration/interception to rainfall intensity and run-off
Ecosystem requirements for environmental water – benefits and impacts	
Effects of reduced flows on ecosystem health following obstructions in waterways Effects of mining operations on ecosystem health i.e. revegetation drawing more surface water and lowering groundwater	More research into the environmental water requirements of wetlands in our catchment
Groundwater system and interactions	
Groundwater impacts of releasing e-flows	
Water use, institutional arrangements, management and administration	
Environmental flow releases from dams Riparian management and rehabilitation Storm Water management	Greater recognition/adoption of guidance on environmental water requirements for Ramsar listed wetlands.
Future ecosystem and water pressures and their likely impact upon flow regimes	
Confidently predicting impact of change (especially increased development) - on ground and surface water resources.	Understanding impacts of natural water quality fluctuations as opposed to human induced change

Appendix A Themes of EWA Program

Land & Water Australia has established the Environmental Water Allocation (EWA) Program to provide technical and research assistance to state and regional water managers. The program has five themes:

- 1) *Improving, demonstrating and evaluating* the benefits of environmental management of stressed rivers such as the River Murray;
- 2) Research into *water regime-ecological dependence relationships* and the needs and management of environmental water allocation in poorly understood aquatic ecosystems across Australia;
- 3) Research into *holistic water budgets of complete river systems* that encapsulate the current temporal and spatial patterns of water distribution in regional catchments and the probably changes to water availability with future land use and climate change;
- 4) Research into *economic, social and institutional aspects of water reform* aimed at more sustainable use of water in rural Australia in the future; and
- 5) Research into the *dependence of ecosystems on the availability and quality of groundwater*.