GOOD GOVERNANCE FOR MUNICIPAL WATER CONSERVATION:

AN ANNOTATED BIBLIOGRAPHY

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UBC Program on Water Governance
Municipal Water Supply Infrastructure in Canada

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I Introduction

Motivation: Three main issues motivated the development of this annotated bibliography. First, there is a gap in source material for people working in water efficiency. Second, water efficiency and conservation is of increasing interest to municipalities in Canada – as shown through a recent series of workshops held by the Gordon Foundation[3]. Third, it acts as a companion to Furlong, Kathryn, Christina Cook and Karen Bakker. 2008. *Good Governance for Water Conservation: A Primer*. Vancouver. UBC Program on Water Governance and Infrastructure Canada Municipal Water Supply Project.

Methods: To locate sources, we conducted searches of scholarly databases (Web of Science, Academic Search Premier & Proquest), the Internet (Google Scholar and Google Books), and the University of British Columbia Library catalogue, for various key terms. Examples of key terms include: public utilities, water billing, full cost accounting, social equity, metering, water conservation, water efficiency, and water utilities' conservation practices. The Internet Quick Resources section provides links to country-specific internet resources relating to water conservation and governance.

Literature Overview: Much of the literature on demand management and water efficiency consists of either knowledge transfer documents wherein academics translate research into practical suggestions for policy makers and the public, or case study experiences prepared by academics and/or government employees. This literature has evolved from an initial focus on supplanting the supply management paradigm with demand management through to a proposed soft path approach to urban water management. The work tends to be practical in content, focusing on technical means of attaining efficiency (low-flow water appliances and fixtures) and conservation programs aimed at residents that both mandate technological change and encourage behavioural change.

Key Works: Several works in this bibliography should not be missed by practitioners. However, the two below are highlighted as key texts to provide the busy practitioner with comprehensive overviews of options for governance reform to improve conservation as well as the practical development and application of water conservation programs.

- Brandes, O., K. Ferguson, et al. (2005). *At a Watershed: Ecological Governance and Sustainable Water Management in Canada.* Urban Water Demand Management. Victoria, POLIS Project: 105.
- Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amherst, Massachusetts: WaterPlow Press.

Organization: The annotated bibliography is arranged according to the main subject of the article to correspond with the outline of the *Good Governance for Water Conservation: A Primer*.

[3] See National Research Consortium. 2008. Innovative Management and Treatment Options for Municipal Water Systems: Defining Opportunities for Research. Toronto and Calgary: Canadian Water Network and Ontario Centres of Excellence.

II Overview: Governance and Water Conservation

(A) Water Conservation & Efficiency Case Studies

Doi, A. K. (2000). *Planning for water conservation: Greater Vancouver Regional District*. Unpublished Masters of Resource Management Dissertation, Simon Fraser University, Burnaby.

> This Masters thesis seeks to determine the institutional arrangements that will result in the most sustainable water provision for the Greater Vancouver Regional District (now MetroVancouver) population. The main research focus was the water consumption patterns in four municipalities in the region. Barriers, including availability of water consumption data, hampered the evaluation of water conservation activities in the region. The study finds that metering and volumetric pricing have a greater impact on water efficiency than public or private ownership of a water utility.

Environmental Protection Agency (2002). Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs. Washington DC US EPA: 54.

> This report should be of interest to anyone working in water planning at an urban water utility. It is a convenient, accessible review of seventeen urban water systems from small (e.g. Ashland, Oregon) to very large (New York City). A concise table at the beginning provides a snapshot of each of the seventeen urban water system case studies. Each case study includes a discussion of the water system problem, the conservation/efficiency approach taken to resolve the problem, and the results of the approach. Further resources are listed at the end of each case study.

Ertsen, M., & van de Ven, F. (2007). Water in the Urban Environment. In N. Munier (Ed.), *Handbook on Urban Sustainability* (pp. 804). Dordrecht, The Netherlands: Springer.

> This chapter, in a handbook on urban sustainability, should be of particular interest to urban water managers and planners. The authors argue "appropriate, sustainable water management in urban areas will contribute to people's wellbeing, to the ecology of our planet, and to commercial operations." To achieve appropriate sustainable water management it is essential that water be incorporated into spatial planning rather than treated as an externality to planning. In other words urban planning should respect the city's watershed. Focusing on lowland/river deltas urban areas, the chapter seeks to take full account of the quantitative (complete water balance including water imports) and qualitative (wet and dry deposition of pollutants) components of the urban water system. The authors suggest that the design, operation and management of water management structures are key elements of a water management policy and should be integrated into a cyclical planning process. This means that earlier decisions are revisited to ensure appropriateness. The chapter includes two case studies where "urban water sustainability" has been applied.

Gilchrist, M. (2007). An Examination of Outdoor Water Conservation Efforts In Orange County, California. California State University (Fullerton), Fullerton.

> This Masters thesis examines the institutional, economical, and educational mechanisms that influence outdoor water conservation in Orange County, California. Finding that the county lacks leadership and an integrated effort to promote outdoor water conservation, the thesis recommends that an independent organization be created to oversee a cohesive network of interacting agencies. In closing, the thesis states what may be obvious to water managers, but bears repeating whenever possible, that it is imperative that residential water users "recognize their individual responsibility for reducing water demand."

Gopalakrishnan, C., & Cox, L. J. (2003). Water Consumption by the Visitor Industry: The Case of Hawaii. *International Journal of Water Resources Development, 19*(1), 29.

> This study focuses on the water consumption by the visitor industry in Hawaii, but should be relevant for any jurisdiction in which tourism constitutes a significant component of economic activity. Specifically, this study examined water consumption in hotels and resorts and golf courses on Oahu. The findings indicate that pricing could be an effective instrument in water allocation for golf courses. However, freshwater consumption in hotels and resorts is not responsive to small changes in price. The study concludes that alternate policies such as substitution of nonpotable water for potable water at golf courses associated with hotels and adoption of voluntary conservation measures may be more effective means of reducing water consumption.

Gregg, T. T., Strub, D., & Gross, D. (2007). Water efficiency in Austin, Texas, 1983-2005: An historical perspective. *Journal American Water Works Association, 99*(2), 76-86.

> This article details the development and implementation of various programs designed to conserve water in Austin over the last twenty-five years, relating interesting details of surprising program successes and failures in each of the three generations of water conservation programming. This is essentially a case study of Austin, TX, which should be of interest to municipal water planners. First generation programs include curbing landscape management, encouraging xeriscaping, and retrofitting plumbing. Second generation programs include ICI initiatives, rebates for high efficiency washing machines, submeters in multifamily dwellings, commercial irrigation metering, rainwater harvesting and customer newsletters. Austin is currently developing third generation programs that include introducing block water rates for commercial properties, water budgeting and conservation rate structures (to reach customers who are insensitive to metered rates), onsite water reuse, irrigation permitting for residential users, evaportranspiration irrigation controllers and commercial rainwater and stormwater harvesting incentives.

Mueller, K. B. (2001). *Improving a Good Thing: Municipal Water Conservation In California*. University of California, Santa Cruz, Santa Cruz.

> Integrating several research methods (case studies (records review and employee interviews), statistical analysis (regressions, correlations including some pricing analysis, and paired t-tests), customer survey analysis, and customer voting analysis), this doctoral thesis examines per-capita water production differences to better understand the role of water agencies in water conservation in California. It finds that water pricing has the potential to improve water conservation. However, it also notes that there is a behavioural component to water conservation, in other words, there is a need to better understand "water conservation-mindedness."

Uitto, T. (2006). Pipes, Pennies, and Politics: An Exploration of Water Conservation in the Greater Vancouver Area. University of British Columbia, Vancouver.

> This Masters thesis studies the barriers to and drivers of water conservation in the Greater Vancouver Regional District (GVRD, now MetroVancouver). It finds that the prevailing water management approach in the GVRD is one of supply and demand management with an emphasis on engineering and economics. The study concludes that this approach is not conducive to the establishment of a unified vision for coordinated water conservation in the GVRD.

(B) Demand Management & Soft Path Water Planning

The four reports in the Polis Project's Urban Water Demand Management Series:

(1) Brandes, O. and K. Ferguson (2003). *Flushing the Future? Examining Urban Water Use in Canada*. Urban Water Demand Management. Victoria, POLIS Project: 66.

(2) Maas, T. (2003). *What the Experts Think: Understanding Urban Water Demand Management in Canada*. Urban Water Demand Management. Victoria, POLIS Project: 64.

(3) Brandes, O. and K. Ferguson (2004). The Future in Every Drop: The benefits, barriers, and practice of urban water demand management in Canada. Urban Water Demand Management. Victoria, POLIS Project: 76.

(4) Brandes, O., K. Ferguson, et al. (2005). *At a Watershed: Ecological Governance and Sustainable Water Management in Canada*. Urban Water Demand Management. Victoria, POLIS Project: 105.

The first report in Polis' series on urban water management in Canada introduces an alternative to the traditional supply-side management paradigm: demand-side management (DSM). DSM is defined as "any measure that reduces average or peak withdrawals from surface or ground water sources without increasing the extent to which wastewater is degraded." Water DSM measures are grouped into three categories: socio-political, economic, and structural-operational. The appendix includes snapshots of water usage in Canadian cities divided into residential and total municipal usage in litres per capita per day. In examining urban water use in Canada, the report highlights the limitations of a supply-oriented approach to water conservation and should be of interest to urban water planners. A review of Canadian water use by sector shows that thermal power generation is the single largest water usage in Canada; municipal water use is third. The report discusses the factors that contribute to increasing demand and decreasing supply of water in Canada. More than half of Canada's increasing municipal water use is residential.

The second report in Polis' urban water management in Canada series provides a more detailed discussion of DSM in Canada based on interviews with water management experts in Canada. It frames the water DSM approach as consisting of two categories of activities: the means for reducing demand and the policy instruments that induce the means. According to the experts, the major obstacles to water DSM are administrative and institutional.

The third report in Polis' series on urban water management in Canada provides a guide for local, provincial, and federal policy makers. In advocating that urban water management in Canada ought to be comprehensive, long-term, and integrated, the report explores the barriers (attitudinal, financial, informational, and administrative) to this goal. In the second report (What the Experts Think), experts highlighted administrative and institutional barriers to DSM, i.e. governance issues. This report gives a comprehensive overview of the major issues in water governance including references for further information. The role of each of the three levels of government (municipal, provincial, federal) in water governance in Canada is reviewed and the specific challenges at each level are highlighted. To overcome those challenges the authors recommend and present an action plan.

The fourth report in the POLIS Urban Water Demand Management series provides the most comprehensive view of the status of urban water management in Canada and should be considered essential reading for anyone involved in urban water management. After explaining why it matters that water be better managed in Canada, Part I of the report provides an excellent discussion of ecological governance and the current state of urban water management in Canada. The report articulates just how wasteful Canadian usage is, the challenges of climate change generally and on specific regions in Canada, and the legislative framework of water resources in Canada. Part II explores how Canada might adopt ecological governance of water through a review of international best practices and application of tools to facilitate urban water demand management. This report is a key resource on the state of urban water management in Canada and should not be missed.

Brandes, O., & Brooks, D. B. (2007). *The Soft Path for Water in a Nutshell, 2nd ed*. Ottawa, Victoria: Friends of the Earth & POLIS Project.

This report articulates the concept of soft path management by explaining the original paradigm of supply-side management water and the now dominant demand management paradigm. The authors argue that the soft path goes beyond demand management's conservation and efficiency rubrics by challenging freshwater consumption patterns and viewing water as a service. They state that alternate patterns of water use, adoption of conservation attitudes, and development of different water institutions and infrastructures are all important components to adopting a soft path for water. The report includes a brief discussion of Canadian case studies on soft path water management and an appendix with the seven steps to creating a soft path plan.

Brandes, O., T. Mass, et al. (2006). Thinking Beyond Pipes And Pumps: Top Ten Ways Communities Can Save Water And Money. Victoria, Polis, University of Victoria: 56.

Aimed at a broad audience (utilities, local and senior governments, and individuals), this handbook provides a list of ten immediate opportunities for communities to take action to conserve water. The ten strategies are: metering, volume-based pricing, education, fixture rebates, leak reduction, demand-side management, rainwater harvesting, reuse and recycling, community-based social marketing and urban (re)design for water conservation. Although the ten strategies need to be spearheaded by utilities or governments, it is clear that individuals must adopt an ethic of water conservation. The study makes the business and ecological cases for water conservation and highlights the benefits of demand management.

Brooks, D. B. (2006). An Operational Definition of Water Demand Management. *International Journal of Water Resources Development, 22*, 521-528.

This article argues that water demand management is more a concept of governance than a set of techniques. Although water demand management has been shown to yield economic benefits, the lack of clarity of the concept and its implementation prevents it from playing a greater role in water policies and programs around the world. The article proposes a definition of water demand management that is intended to develop an understanding of how the concept operates and to facilitate its measurement.

Holtz, S. (2007). Crisis? What Crisis? *Alternatives Journal, 33*(4), 18-24.

This article argues for the adoption of the soft path for water management in Canada. The article explains that the soft path approach is meant to facilitate sustainable water use by using tools such as backcasting, matching water quality to water needs, and viewing water as a service rather than a requirement. The article notes the need for policy changes in water management in order to implement a soft path that will affect decision-making at water utilities and other agencies at all levels of government. In particular, the article focuses on three areas in need of a policy shift in order to facilitate adoption of the soft path: water pricing, beliefs and motivations, and data and monitoring of water use.

Kenney, D. S., Goemans, C., Klein, R., Lowrey, J., & Reidy, K. (2008). Residential water demand management: Lessons from Aurora, Colorado. *Journal of the American Water Resources Association, 44*(1), 192-207.

This article explores residential water demand in Aurora, Colorado during a turbulent drought period (2000-2005). It finds that water demand is a function of several factors some of which water utilities can control and others they cannot. The article seeks to expand the understanding of residential water demand in three salient ways: first, by documenting that water pricing and outdoor water restriction policies are not merely additive; second, by showing that pricing has a different impact on use in different classes of customers; and third, by demonstrating with real time consumptive data customers are better able to achieve water-use targets. Ultimately, the article suggests that there is a

need to better understand water-use decision-making processes at the household level in order to best manage water demand.

Savenije, H. H. G. and P. van der Zaag (2002). Water as an economic good and demand management - Paradigms with pitfalls. *Water International 27*(1): 98-104.

This paper considers the concept of water as an economic good (one of the 4 Dublin principles) to determine if economic pricing is an adequate means to manage water demand. The authors argue that water pricing should be used for cost recovery and financial sustainability, but in setting prices, equity considerations should not be overlooked. The article provides a good overview of the concepts of water as an economic good, demand management and water pricing, as well as water allocation between sectors. It should be of interest to anyone involved in price setting at water utilities.

(C) Reducing Consumption Residential & ICI Sectors

Canada Mortgage and Housing Corporation (2000). Household Guide to Water Efficiency, Canada Mortgage and Housing Corporation: 30.

This CMHC handbook is a practical guide to water conservation for homeowners. Although directed at homeowners, municipal water planners will appreciate the residential water efficiency suggestions. It begins with an overview of the importance of water including the hydrological cycle and then details water use in Canada and, especially, our growing demand for water. It helpfully gives instructions on making your home more water efficient inside and out. According to the CMHC, water efficiency in the home starts with 4Rs: reduce, retrofit, repair, and reuse. Tips for increasing water efficiency are given for the main water using rooms in the house: in the bathroom (install reduced flow fixtures and repair leaks), the kitchen (run only fully loaded dishwashers, keep drinking water in the fridge, wash dishes in a plugged sink), and the utility room (front-loading washing machines, full loads of laundry, use the suds-saver feature).

Canada Mortgage and Housing (2005). Water Reuse Standards and Verification Protocol Report. Healthy Housing and Communities: 89.

This report summarizes water reuse standards and treatment technology verification testing protocols in various countries, states and provinces with the objective of aiding CMHC in developing suitable reuse standards in technology verification protocols for use in residential applications in Canada. The first part of the project examines effluent quality standards with respect to biological, biochemical and physical water quality parameters. The second part identifies treatment technology verification protocols in use for both lab and field-testing appropriate for reuse applications. This report is of interest to water planners wanting to learn more about evolving standards of water reuse.

Canada Mortgage and Housing Corporation (2007). Energy and Water Tune-ups Multi-unit Residential Buildings Manual Housing Technology: 88.

This manual is a guide for property owners, managers, and custodial staff of high-rise residential buildings. Municipal water planners will find the guide to be a good resource for encouraging water efficiency in multi-residential buildings. It offers tips and tools to reduce energy and water bills while improving resident comfort through low-cost and no-cost tune-up measures. The manual sets out the order in which improvements to a building are best made (the "Tune-Up Sequence"). Providing information on opportunities to tune-up systems and equipment, the manual gives details of requirements of the various tune-ups. Systems covered are: envelope systems, heating and air conditioning systems, ventilation systems, domestic hot water systems, electrical systems and other systems (pools and spas, pumping systems, and in-suite plumbing).

Canada Mortgage and Housing (2002). Dual-Flush Toilet Project. Housing Technology: 39.

This report targeted to builders and homeowners, details the findings of a Canadian project to evaluate public perception, acceptance, and satisfaction; water savings; and cost effectiveness of dual-flush toilet technology. Participants in the study were sufficiently satisfied with the study toilets that they would be willing to pay the additional cost. The dual-flush toilets reduced existing flush volumes by nearly 70% in single family homes, just over 50% in office washrooms and in a coffee shop. The cost effectiveness of dual-flush toilets includes the cost of the toilet and the associated water savings. This report demonstrates that customers have a high acceptance of newer low-flow technology.

Canada Mortgage and Housing (2007). Water-Saving Tips for your Lawn. About Your House: 6.

This CMHC fact sheet provides numerous tips on using water efficiently in the garden. In particular it recommends designing a water efficient garden using the seven principles of xeriscaping. Beyond xeriscaping, water usage in other outdoor activities can be reduced by increasing efficiency (such as using a bucket to wash a car).

Canada Mortgage and Housing Corporation (2007). Buying a Toilet. About Your House: 4.

This short fact sheet for homeowners explains the features of water saving toilets. It details the differences in toilet technologies and provides a list of considerations when thinking of replacing a toilet.

DeOreo, W. B., Dietemann, A., Skeel, T., Mayer, P. W., Lewis, D. M., & Smith, J. (2001). Retrofit realities. *Journal American Water Works Association, 93*(3), 58-72.

This article reports the findings of a project by Seattle water providers (led by Seattle Public Utilities) to determine how much water could be saved through retrofitting high-efficiency indoor plumbing fixtures and appliances. The results show that in most homes retrofitting with high-efficiency fixtures and appliances can reduce residential water demand significantly. Based on measured savings, the most effective fixtures evaluated in the study were toilets, clothes washers and faucet aerators. Participating residential customers reported high satisfaction with most high-efficiency fixtures and especially with low volume toilets and clothes washers. The authors state that the importance of the study is its contribution to creating data on the actual effects of residential retrofits on individual and household water use.

Koeller, J. (2007). Water-Conservation Myths, Realities. *Heating/Piping/Air Conditioning HPAC Engineering, 79*(1), 9-9.

This article argues that new high efficiency (1.3 gallon) toilets (HETs) should be embraced by consumers as a proven product. Consumers should not be discouraged from purchasing HETs because there were problems with the first generation low volume toilets in the early 1990s. A wide variety of HETs, both tank-type and flushometer-valves should soon be available.

Miserly water recycler installed in Melbourne. (2006). *Ecos* (131), 7-7.

This article describes the massive water savings (reuse of up to 85% of wastewater generated on-site) achieved by the installation of a highly efficient AquaRecycle Laundry Water Recycling System by a commercial launderer, Melbourne Linen Services. The government owned water utility, City West Water, provided a grant to help with implementation expenses.

Watering within reason. (2007). *American City & County, 122*(2), 40-40.

This article describes the successful reduction in irrigation water waste at the civic center in Folsom, California by a retrofit of irrigation equipment. The added benefit of this retrofit was the near elimination of the accelerated wear and tear on roads, buildings and sidewalks resulting from latent water pooling as a result of inefficient irrigation. This article should be of interest to all municipal water managers, especially that it

demonstrates that wasted water is not the only result of water leaks and inefficient water use.

(D) Sustainability & Water

Gleick, P. H. (2004-5). The World's Water: The Biennial Report on Freshwater Resources. Washington, D.C.: Island Press.

The Pacific Institute prepares this biennial series to inform the public about the major debates regarding world water resources. New volumes are not updates of existing volumes; in each volume the most significant current water debates are presented. The fourth volume (2004-5) explores bottled water, groundwater, the privatization of water, and California water policy under climate change. The fifth volume (2006-7) focuses on water and terrorism, floods and droughts, and desalination among other topics. These volumes are easily accessible and should be of interest to anyone keen to understand the current debates on world water resources.

Means, E. G., West, N., & Patrick, R. (2005). Population growth and climate change will pose tough challenges for water utilities. *Journal American Water Works Association, 97*(8), 40-46.

This article argues that shifting population demographics and climate change will change how the water industry operates, requiring a broader total water management approach. According to the American Water Works Association, total water management exists when the water supply industry aims to ensure "that water resources are managed for the greatest good of the people and the environment and that all segments of society have a voice in the process." The article suggests that total water management expands integrated water resource planning to include watershed management, management of stormwater systems, and source water protection programs. Further, total water management is meant to shift water industry thinking from water as limitless to water as a limited resource that is subject to variability in quantity and quality.

Postel, S. L. (2007). Aquatic ecosystem protection and drinking water utilities. *Journal American Water Works Association, 99*(2), 52-63.

This article argues that conventional water supply methods can harm ecosystems by reducing and altering environmental flows, concentrating pollutants, causing long-term depletion of groundwater supplies, and in the case of dams, by altering the delivery of nutrients, sediment and organic matter. Within the framework of ecologically sustainable water management, the article suggests tools with which to combat these deleterious effects. Drinking water utilities are encouraged to modify their water supply methods using these tools, which include reducing water demand via effective conservation, management of water within the bounds of an ecological flow prescription, inclusion of ecosystem allocations during drought, and protection of source watersheds.

III Applying Good Governance

(A) Developing a Vision

American Water Works Association. (2006). *Water Conservation Programs: A Planning Manual (M52) First Edition*: American Water Works Association.

Water utilities in the process of developing a water conservation plan are the intended audience for this manual. It should be equally useful for water suppliers seeking to improve their existing conservation programs. The manual defines and advocates for water conservation while setting out the AWWA's water efficiency policies and positions. It details how to assess the need for conservation and establish conservation program goals. Relevant methodologies, such as forecasting future water needs and applying cost benefit analysis are discussed in relation to creating viable conservation programs. In addition to detailing how to develop water conservation plans the manual highlights issues

perceptions, barriers and obstacles that might derail the implementation of conservation plans and how they might be overcome.

DeOreo, W. B. (2006). The role of water conservation in a long-range drought plan. *Journal American Water Works Association, 98*(2), 94-101.

This article explores the relationship between water conservation programs and drought-response plans. Specifically, the author seeks to overcome the classic concern of water managers that demand hardening results from over ambitious conservation measures and makes drought management more difficult. The article "observes" a model community over 25 years through a plausible drought scenario and finds that drought management by water rationing rather than long-term conservation planning and programming is four times more costly.

Federation of Canadian Municipalities, & National Research Council. (2003). Potable Water: Establishing a Metering Plan to Account for Water Use and Loss. Ottawa.

This report is meant as a guide to best practices for water utilities in planning, implementing, operating and managing a metering plan to measure use and loss in water distribution systems. It should be useful to water managers engaged in any of those tasks. According to the report, full cost recovery for water utilities is a major driver for the installation of water meters, which are the essential tool to measure and monitor water consumption. Best practices for water metering require installation of meters in five locations: water withdrawal or intake, production or treated water output, distribution, district metered area, and consumers or end-users. The report provides strategies for selecting appropriate water meters as well as advantages and disadvantages of various features of both supply and consumption meters and associated billing structures. Finally, the report suggests that water utility managers should consider how to implement metering plans including testing and maintenance programs.

First for compulsory water metering. (2006). *Geographical, 78*(5), 6-6.

This article reports on the first-ever granting of permission by the UK Government to a water company to force households in southeast England to install water meters. The region has been suffering a severe drought since November 2004.

Jakubowski, T. (2005). 8 ways to help control water loss. (Cover story). *American City & County, 120*(1), 34-35.

This article suggests that the water audit is the essential resource management tool for a drinking water utility. The eight ways to help control water loss are briefly summarized as: leakage, pressure management, rehabilitation and replacement, leak repair time, meter accuracy errors, data transfer errors, data analysis errors, addressing theft and illegal consumption.

RAND Corporation. (2008). Identifying and Reducing Climate-Change Vulnerabilities in Water-Management Plans. Santa Monica CA.

This research brief highlights the importance of creating water management plans that are adaptable to the uncertain effects of climate change on future local weather. The brief reports specifically on RAND's project with Southern California's Inland Empire Utilities Agency to identify its "vulnerabilities related to climate change in its long-term water plans and to evaluate its most effective options for managing those risks." To cope with climate uncertainty, RAND deployed new decision support methods to identify short and long term actions that should perform well over a wide range of plausible future conditions. Decision support methods integrated four main tools: simulation models, downscaled climate data, statistical vulnerability assessments, and options analyses. This report should be useful for any longer term water planning.

Schlenger, D. L. (1997). Meter management: Best practices for water utilities. *Water Engineering & Management 144*(3): 33-33.

Although somewhat dated, this article provides a good overview for those considering implementing a comprehensive meter management plan. It reminds planners that the meter is not a stand-alone device and, for best results, it should really be considered one component of a revenue and information generating system.

Schneider, P., Davison, A., Langdon, A., Freeman, G., Essery, C., Beatty, R., et al. (2003). Integrated water cycle planning for towns in New South Wales, Australia. *Water Science and Technology, 47*(7-8), 87-94.

Written by staff at the New South Wales (NSW), Australia, Department of Land and Water Conservation, this article argues that integrated water cycle management is a means to reduce inefficiencies in water management in NSW. It should be of interest to urban water planners, especially in areas where water supplies are fully allocated. Specifically, the authors suggest that the three main urban water services – water supply, sewerage and stormwater – should be planned and managed together and integrated with other urban services (e.g. waste disposal, road drainage) and natural processes in order to maximize water efficiencies.

Standish-Lee, P., Loboschefsky, E., & Lecina, K. (2006). Half full or half empty? Either way it's time to plan. *Journal American Water Works Association, 98*(6), 76-79.

This article focuses on effective management of water quality and quantity for arid and semi-arid regions. Although focused on semi-arid and arid regions, water planners in all regions, including those with no apparent water scarcity, should find this article helpful. Noting that the vagaries of climate change could have a profound effect on water availability, the need for planning in urban, industrial and agricultural water sectors is emphasized. The article presents examples of long-term water supply strategizing and suggests that collaboration and commitment among different water utilities and agencies at different government levels is crucial to success.

Sturman, J., Ho, G., & Mathew, K. (2004). *Water Auditing and Water Conservation*: IWA Publishing.

This book provides a detailed review of water auditing targeted at water auditors that attempts to bring a standard to the practice of demand-side water auditing. It reviews the concepts of water auditing and water conservation and then describes the water audit and the water audit process. The book details the instruments used in water auditing; the relationship between water auditing and environmental auditing; water quality; and the impact of environmental legislation on water. Helpfully, this information is then contextualized as the book considers “arenas” (e.g. indoor and outdoor commercial water use, municipal and non-aquatic water use, aquatic centres) and “processes” (e.g. mining and paper industries, contaminated waters) of water use that are the particular focus of the water auditor. Finally, the book discusses water resources and reuse (e.g. domestic and small commercial wastewater reuse, conservation, stormwater, and desalination).

Vickers, A. (2001). *Handbook of Water Use and Conservation*. Amherst, Massachusetts: WaterPlow Press.

Vickers’ Handbook is an accessible, detailed reference guide for water efficiency and is rightly regarded as the leading reference for water conservation. It begins with the ten steps to planning a successful water conservation program. The four main chapters of the Handbook detail water use and efficiency measures (including costs and benefits) in each of the following domains: residential and domestic; landscape; industrial, commercial and institutional; and agricultural. Each chapter provides a detailed and technical review of water use and efficiency measures, including cost benefit analysis. The reader is presented with clear information that should facilitate easier selection of the most appropriate water conservation and efficiency options. Throughout the Handbook, information is presented

clearly with helpful visual references. The appendices include worksheets and tables to implement the various water efficiency measures discussed in the text.

Wilkie, K. (2005). *Balancing Act: Water Conservation and Economic Growth*. Calgary: Canada West Foundation.

This report is based on qualitative data gathered at two half-day consultations in October 2004 in Alberta (Edmonton and Calgary): the results have not been verified by external research. The report reviews water supply and the water decision-making framework in Alberta. The largest section of the report is a discussion of water use and economic growth in Alberta detailing the current situation and considering the future demands and pressures on Alberta's water supply. In discussing water management, the report presents a selection of demand management policy instruments (economic, technological, educational and trading). Notably, the report does not discuss the possibility of soft path management. Key themes raised during the consultations include how to value water and the role of the public in water allocation. The consultations (and report) concluded with five areas of public policy action (vision, governance, education, research, and implementation) that should be considered as a multi-pronged approach to water management in Alberta.

(B) Accountability, Fairness & Shared Governance

Bakker, K. J. (2001). Paying for water: water pricing and equity in England and Wales. *Transactions of the Institute of British Geographers 26*(2): 143-164.

This paper provides a review of the implications of the privatization of a nationalized water industry in England and Wales on domestic water consumers. The section discussing the different outcomes of policies pursuing economic equity and social equity will be of particular interest to those concerned about equity in water pricing. Specifically, the author reviews the impact on low-income consumers of an unusual policy in which economic equity was pursued in the absence of subsidies. In most industrialized countries social policy goals are incorporated into water regulations. The paper also discusses the questionable equity of using the rateable value of a house (based on decades-old property assessments) to assess water costs in the absence of metering.

Bishop, B. (2003). Water utility communication practices - What contributes to success? *Journal American Water Works Association, 95*(1), 42-51.

This article, by a professor of public relations, reports the results of a national research survey that sought to better understand water utility communication practices in the US. It would be most useful for those professionals focused on communications. The author applies a framework of ten principles of authentic communication to the survey results and finds that utilities communicated most successfully when they were attentive to what was said and how it was said.

Dresner, S. and P. Ekins (2006). Design of environmentally and socially conscious water metering tariffs for the UK. *Journal of Environmental Planning & Management 49*(6): 909-928.

This article argues that social equity concerns about compulsory water metering can be overcome with sensitive design. It should be of interest to anyone concerned with the social equity impacts of water metering. Most households in England do not have water meters, and instead pay a fixed amount comprised of a standing charge based on the rateable value of the home (related to the value of the property in 1973). Given the environmental benefits of universal metering, the research investigates the distributional consequences of tariffs and how they might be designed to minimize the negative social equity impacts. The research presents eleven scenarios of metering and each of them is progressive for the lowest-income households suggesting that resistance to metering in England on social equity grounds is unfounded.

Gaudin, S. (2006). Effect of price information on residential water demand. *Applied Economics, 38*(4), 383-393.

This article explores the power of price signals to influence water demand in residential consumption. Researchers and water utility managers will find its results insightful. The article provides evidence in support of its hypothesis that price information increases the price elasticity of demand. It also finds that the inclusion of additional information on water bills aside from simple price information does not significantly affect water demand. The author concludes that utilities can compel greater conservation levels at lower prices by providing marginal price information on water bills. In other words, water bill format matters.

Helgerson, S. W. (1997). Reengineering utility billing to improve efficiency. *Government Finance Review 13*(3): 49-49.

This article relates the experience of one small government that redesigned its utility billing system. Although the costs of the redesign were significant, the government felt they were offset by both tangible and intangible benefits. For this village government, better billing may be more expensive but is worth it for greater cost recovery and improved customer satisfaction.

Hengesh, J. (2001). AMR: an Asset Comes of Age. (Cover story). *Water Engineering & Management 148*(8): 23.

This article discusses the benefits of automatic meter reading system (AMR) as a solution to a variety of challenges that water utilities face. An AMR system requires the installation of a radio-based meter module on a new or existing water meter. The radio module is then read by either a radio device or by a fixed network system. The biggest advantage of AMR is that it improves accuracy and speed of meter reading. Additionally, AMR improves safety for customers and employees, enhanced leak identification, improved data for future infrastructure planning and shortens the billing cycle.

Huby, M. (1995). Water Poverty and Social Policy: A review of issues for research. *Journal of Social Policy 24*(2): 219-236.

This article argues that the effect of privatization of the water industry in England and Wales on low-income households has been significant and that the growing incidence of "water poverty" needs to be further researched. Notwithstanding its focus on the unique situation in England and Wales, this article may be of interest to those involved in water pricing policy. It proposes a water poverty framework to explore the three areas – increasing charges, ability to pay, and debt and disconnection. Understanding water poverty is complicated because of the plethora of diverse issues. In an effort to clarify debate, the author articulates specific issues for research within each area of the framework. Further research regarding increasing charges would include price regulation, customer views, waste reduction, charging systems and tariff structures. Needed research regarding ability to pay includes income, direct payments, other sources of help, water company policies and payment options. Debt and disconnection is an impact of water poverty that does not just affect individual consumers of water: it has major public health impacts which should be further explored.

Marbek Resource Consultants Ltd. and S. Renzetti (2005). Analysis of Economic Instruments for Water Conservation, Canadian Council of Ministers of the Environment Water Conservation and Economics Task Group: 103.

This report is a practical reference to economic instruments (EIs) that can be used for water conservation and would be of use and accessible to water planners at all levels of government, including those with limited economic expertise. The clear framework for approaching economic instruments and numerous tables that give concise detailed information on EIs are especially helpful. The report includes a review of the use of EIs both internationally and in Canada and an insightful discussion of case studies on water

valuation to assist water planners in setting a water use fee. Lessons learned in the report sum up best practices and the appendices include more details on the case studies presented.

Olmstead, S. M., M. W. Hanemann, et al. (2007). Water demand under alternative price structures. *Journal of Environmental Economics & Management 54*(2): 181-198.

This article explores two facets of water pricing – residential sensitivity to changes in water prices and whether alternative rate structures affect price elasticity. Although quite technical, the article should be of interest to those involved in water price structuring. The article applies models in an attempt to understand why elasticity estimates under increasing block pricing structures (IBPs) tend to be higher than under uniform pricing. The findings do not permit a conclusive statement that IBPs increase elasticity. The authors hypothesize that consumer response to IBPs is behavioural because IBPs give increased attention to price. Alternatively, heterogeneity in community characteristics such as aridity and conservation programs may partially explain the observed pattern in the literature of higher price elasticity under IBPs. The authors conclude that further research is required to better understand the effect of rate structures on price elasticity.

Pigram, J. J. (1999). Economic Instruments in the Management of Australia's Water Resources: A Critical View. *International Journal of Water Resources Development 15*(4): 493-509.

This article discusses the challenge of identifying the most appropriate mix of incentive-based and regulatory mechanisms for the management of Australia's water resources. Australia is at the vanguard of using economic instruments to encourage water conservation and improve management. The author advocates increasing the price of water to the point where essential inputs and costs are considered, but not to such a point that threatens economic viability. That said, the article argues that pricing and cost recovery alone will not secure efficiency gains in the allocation and use of water. Additional tools essential to efficiency include markets that allow for water trading within and between watersheds and environmental allocations. To minimize transaction costs, the article suggests that allocation/capacity sharing should partition entitlements to water at source rather than at the point of delivery. All of these economic instruments are meant to be grounded by some degree of regulation in order to provide greater security for property rights and to monitor the exercise thereof.

Renzetti, S. (1992). Evaluating the Welfare Effects of Reforming Municipal Water Prices. *Journal of Environmental Economics and Management 22*(2): 147-163.

This article simulates the impact of a water utility (Vancouver Water Works) moving from its then current practices to seasonally differentiated pricing and finds that it raises aggregate surplus by approximately 4%. The purpose of the article is to evaluate the potential for efficiency gains for North American water utilities. The author provides a good review of traditional water utility pricing practices and explains why they lead to inefficient pricing. The article concludes that then current (1992) accounting and pricing practices of North American water utilities promote inefficient levels of consumption. Three reasons for the inefficiency are a failure to reflect marginal costs; insensitivity to time of consumption; and exclusion of the value of water itself. These issues persist in water pricing across many utilities today.

Renzetti, S. (1999). Municipal water supply and sewage treatment: costs, prices, and distortions. *Canadian Journal of Economics-Revue Canadienne D Economique 32*(3): 688-704.

This article considers the operations of municipal water supply and sewage treatment facilities in Canada. It is of interest to anyone involved in pricing municipal water supply or sewage treatment. In particular, the article characterizes respective production technologies, estimates marginal costs of supply, examines pricing policies and computes the approximate welfare losses that arise when prices deviate from marginal costs for the combined activities. The article notes that critics of water supply and sewage treatment

pricing practices have mostly failed to quantify the magnitude of the deviations between actual and optimal consumption levels or the welfare losses associated with these deviations. Renzetti finds that the smallest municipalities and those that do not meter water use have the largest gap between price and marginal cost. In other words, they have the biggest problem of mispricing water resources. Water supply and sewage treatment prices are inefficient for four reasons. First, the lack of metering of residential water use causes inefficiency. Second, many Canadian municipalities that meter water use follow the AWWA pricing rules which are not designed to guarantee the efficient allocation of water. Third, prices typically do not reflect distance from source or time of use. Finally, accounting for costs at municipal utilities is frequently incomplete. The article finds that municipal prices understate the marginal costs of services provision by a wide margin. It concludes that such an error encourages excessive consumption and overexpansion of water supply and sewage treatment facilities.

Renzetti, S. and J. Kushner (2004). Full Cost Accounting for Water Supply and Sewage Treatment: Concepts and Case Application. *Canadian Water Resources Journal 29*(1): 13-22.

This article provides a good overview of full cost accounting with a case study on the Regional Municipality of Niagara, Ontario. Concerns that water and sewage utilities fail to account for "full costs" of their operations has been translated into legislation requiring full cost accounting (FCA) in Ontario. While defining full costs of a productive activity is in theory quite straightforward, the actual implementation of FCA is quite challenging. First, there is little agreement between analysts and regulators on the scope of FCA. Some think fully accounting for operating and maintenance (O&M) costs is sufficient for an agency to be doing FCA. Others take a broader view of FCA that includes O&M costs, capital costs and all external costs (including environmental damages and the opportunity costs of raw water – as seen in the EU Water Framework Directive). Second, there are no standardized guidelines for implementation of FCA. Without guidelines, the scope of FCA remains negotiable. Finally, there may be a lack of data, or difficulty in obtaining necessary data for estimations of cost components. The authors conclude that water and sewage utilities do not consider the full social costs of their operations, but rather significantly understate them. Although the impact of FCA on consumers will vary depending on each municipal utility's accounting and pricing rules, full cost pricing will result in significant water price increases and consumers will be encouraged to conserve water.

Reynaud, A., S. Renzetti, et al. (2005). Residential water demand with endogenous pricing: The Canadian Case. *Water Resources Research 41*(11): -. Article No. 11409.

Domestic users of water have observed economic and demographic characteristics that induce unobserved preferences in water consumption. Those unobserved differences are considered endogenous to the community (this is what the authors term "endogeneity"). The authors argue that assessing the impact of water pricing structure on water demand without consideration of endogeneity risks a selectivity bias. In other words, water pricing structures are not a "one size fits all" concept. Just because a particular structure has produced a result in one community does not guarantee it will produce the same result in another community. Using an econometric model that describes how water demand and pricing choice are simultaneously induced by these observable and unobservable traits, the authors assess the impact of pricing on residential water consumption in Canada. They suggest communities make pricing choices based on four factors: efficiency, equity, price discrimination, and stability of revenues. The model shows that endogeneity of pricing structures should be taken into account in deriving unbiased price and income elasticities. The authors draw two main policy implications from their findings. First, it is possible to construct a model to explain a community's choice of water pricing. Second, price structuring strongly influences price responsiveness of Canadian residential consumers. In other words, the type of water price structure is as important as the level of prices to affect water demand. A move to incentive pricing schemes should lower residential water consumption.

Romano, J. (2000). New Plan For Owners' Water Bills. *New York Times 150*(51612): 3-3.

This article discusses the Multi-Family Conservation Program (MFCP) adopted by the New York City Water Board in October 2000. The MFCP was designed to protect multi-unit dwellings (six or more units) from significant increases in water bills when metered billing was introduced. To be eligible for the MFCP owners had to fix leaks and install low-consumption fixtures in at least 70 percent of the building's water fixtures and convert to low-consumption washing machines within five years. For updates on New York's water billing practices visit http://www.nyc.gov/html/dep/html/water_and_sewer_bills/index.shtml

Tarricone, P. (1995). Turning water into dollars. *Civil Engineering 65*(7): 61-63.

This article reviews two American water departments' experiences with overhauling billing and collection procedures. The first department in Jefferson Parish, Louisiana had three specific issues, they needed: to raise water rates to ensure adequate funding for the future; to conduct a water meter review and replacement; and to conduct a review of the billing system. The Jefferson Parish department reviewed all its accounts, analyzed meter problems, and reviewed special account classifications and credits. In Houston, TX, the analysis showed that many customers who were not paying their bills had legitimate complaints. However, customer complaints were not addressed in a timely matter since only a few staff at the water department had the authority to adjust bills. By way of solution, more employees were empowered to make bill adjustments and the department clarified the account deposit policy. Additionally, Houston expanded its use of existing technology to reduce manual data entry and improve inventory. For both water departments, the improvements led to increased cost recovery.

Timmins, C. (2003). Demand-side technology standards under inefficient pricing regimes - Are they effective water conservation tools in the long-run? *Environmental & Resource Economics 26*(1): 107-124.

This article argues that the conservation potential of demand-side technology is compromised when policy makers set prices that are inefficient. In particular, the paper addresses the long-term consequences of policy makers' decisions to implement mandatory low-flow appliance installation policies and then to under price water, usually out of equity or political concerns. The author argues that this policy often offsets the conservation potential of low-flow appliances. Using several models in an attempt to understand the pricing policies of a group of water managers in a groundwater-dependant region of California, the author finds that municipal managers are more concerned with the welfare of water consumers relative to that of taxpayers. Regardless, the author concludes that if water conservation is the goal of low-flow appliance policy then it must be accompanied by, at minimum, status quo pricing and better, increasing prices for water at the margin.

Ward, F. A. (2007). Decision support for water policy: a review of economic concepts and tools. *Water Policy 9*(1): 1-31.

This is a review article of research on the application of economics to the analysis of the preservation, conservation, development, consumption, supply and allocation of water resources. The article provides a broad discussion of institutional economic designs that can be employed to manage water supply and demand. An overview of water policy objectives is followed by a review of the various existing mechanisms that affect water allocation. The main part of the article is a discussion of future water allocation institutions. Here the author takes a broad view of institutions to include various forms of marginal cost pricing, valuation of water in alternative uses, water quality management, optimization models, integrated supply and demand management, transboundary management, virtual water, decentralized management, common property institutions and watershed councils. The article provides a useful and accessible overview of economics and water allocation.

IV Internet Quick Resources

(A) Canada

Canada West Foundation. 2007. Publications. Accessed 28 February 2008 available at http://www.cwf.ca/V2/cnt/publications_index.php

Canada West Foundation is a registered Canadian charity engaged in public policy research on issues of importance to western Canada.

Two papers of particular interest are:

McFarlane, S. (2003a). On Tap: Urban Water Issues in Canada. Calgary: Canada West Foundation.

McFarlane, S. (2003b). Regional Water Works: Sharing Urban Water Services. Calgary: Canada West Foundation.

Environment Canada. 2004. Freshwater. The Management of Water. Water Efficiency/Conservation. Accessed 28 February 2008 available at http://www.ec.gc.ca/WATER/en/manage/effic/e_weff.htm

Environment Canada's Freshwater Website includes a comprehensive section of information on Water Efficiency and Conservation.

Friends of the Earth. 2007. The Lexicon of Water Soft Path Knowledge. Accessed 28 February 2008 available at http://www.foecanada.org/WSP%20Lexicon/WSP%20Index%20web.htm

Friends of the Earth Canada has been engaged in developing the concept of the Soft Path of Water Management. The Lexicon of Water Soft Path Knowledge is a collection of documents produced by the Water Soft Path Project to 2007. The collection begins with foundational documents and includes case studies, insights on the soft path in policy and practice as well as tools of the soft path.

Policy Research Initiative. 2007. Current Research. Freshwater for the Future. Publications. Accessed 28 February 2008 available at http://www.policyresearch.gc.ca/page.asp?redir=on&pagenm=rp_water_pubs&project=sd

The Policy Research Initiative (PRI) is a non-partisan policy research organization for the federal government. Its research supports the Government of Canada's medium-term agenda, thus it seeks to advance research on emerging policy issues. From 2003 to 2007 the PRI ran a four-year research project on managing Canada's freshwater resources. The results of the research are published on PRI's website.

Water & Duncan Gordon Foundation. 2005. Fresh Water Resources. Publications & Links. Accessed 28 February 2008 available at http://www.gordonfn.org/FW-pubs&links.cfm

The Walter and Duncan Gordon Foundation is an independent Canadian grant-making foundation that is dedicated to the development of innovative public policy, including environmental protection policy. The Foundation has a grant program specifically for research in Fresh Water Resources.

(B) Cambodia

Asian Development Bank. 2006. Country Water Action: Cambodia Phnom Penh Water Supply Authority: An Exemplary Water Utility in Asia. Accessed 2 March 2008 available at http://www.adb.org/water/actions/CAM/PPWSA.asp

Asian Development Bank. 2006. Water Champion: Ek Sonn Chan Pulling the Plug on Nonrevenue Water. Accessed 2 March 2008 available at http://www.adb.org/Water/Champions/chan.asp

Rehabilitation of the water infrastructure of Phnom Penh began in 1993. After twenty years of civil war, the water supply system was dilapidated characterized by old pipes, a poor

distribution network, limited metering and billing, and limited duration of supply. By 2006, the Phnom Penh Water Supply Authority (PPWSA) reported 100% metered coverage and a reliable 24-hour supply. The PPWSA has become a model water utility in Asia.

(C) Namibia

DRFN. 2007. Water Desk. Accessed 2 March 2008 available at http://www.drfn.org.na/water.htm or http://www.drfn.org.na/everyriver.htm

The Desert Research Foundation of Namibia is non-governmental sustainability organization that seeks to enhance decision-making for sustainable development in Namibia. It pursues a program of research, training and consultancy in the land, water and energy sectors. The DRFN coordinates the "every river has its people" project that aims to encourage exchange between people and facilitate understanding among all major stakeholders of local community problems in the Okavango River Basin.

USAID. 2004. Sharing Water Okavango/Kubango. Project Documents. Accessed 2 March 2008 available at http://www.sharingwater.net/ProjectbriefE.asp

More information on co-management of the Okavango Basin, including the February 2005 Final Report of *Sharing Water: Towards a Transboundary Consensus on the Management o the Okavango River Basin* can be found at USAID's Sharing Water Okavango/Kubango website.

(D) Singapore

Public Utilities Board. 2004. Conservation. Accessed 2 March 2008 available at http://www.pub.gov.sg/conservation/water_effciency_fund.aspx?l1=3&l2=32

The Public Utilities Board (PUB) is the water authority in Singapore. Its mandate is to ensure an adequate and reliable supply of potable water for Singapore. Water conservation and efficiency are central to the PUB. The PUB's website has considerable information on increasing efficiency through audits and construction principles as well as conservation through consumption calculators and recommended conservation measures.

Singapore. Ministry of the Environment and Water Resources. 2004. "Save 10 Litres of Water a Day." Accessed 2 March 2008 available at http://tenlitres.sec.org.sg/

The Ministry of the Environment and Water Resources coordinates with the Singapore Environment Council and Public Utilities Board to encourage water conservation in Singapore. The current conservation campaign encourages individuals to "Save 10 Litres of Water a Day."

(E) United Kingdom

Consumer Council for Water. Accessed 18 February 2008 available at http://www.ccwater.org.uk/

The CCOW is the collective voice of water consumers and advocates for that voice to be heard in national water debates so that consumers remain at the heart of the water industry.

Department for Environment, Food and Rural Affairs. Environmental protection. Water. Water Strategy – *Future Water*. Accessed 23 February 2008 available at http://www.defra.gov.uk/environment/water/strategy/index.htm

This is the UK government's new water strategy—released February 2008—a long-term vision for water and the water management framework.

Direct Gov UK. Environment and greener living. Saving Water in Your Home. Accessed 18 February 2008 available at http://www.direct.gov.uk/en/Environmentandgreenerliving/Energyandwatersaving/DG_064370

This website is a clearinghouse for public services, this page focusing on how to save water in the home and garden as well as links for further information.

UK Environment Agency. Are you saving water? Accessed 18 February 2008 available at http://www.environment-agency.gov.uk/subjects/waterres/287169/

This website provides a review of water use in England and Wales, arguments in support of water conservation, and ways to conserve in the home, garden, and agriculture and ICI operations.

Water UK. About Water UK. Accessed 18 February 2008 available at www.water.org.uk

Representing all UK water and wastewater service suppliers at national and European level, Water UK provides forum for the water industry to engage with government, regulators, stakeholder organisations and the public.

Waterwise. About us. Accessed 18 February 2008 available at www.waterwise.org.uk

Waterwise is the UK authority on water efficiency. This NGO works to build the evidence base for large-scale water efficiency while focused on decreasing water consumption in the UK by 2010. Waterwise hosts an annual water efficiency conference and many of the conference documents can be found on its website.

(F) United States

Arizona

Arizona. 2007. Department of Water Resources. Conservation Program. Accessed 25 February 2008 available at http://www.azwater.gov/dwr/Conservation/ConservationHome.html

An outline of the Arizona Department of Water Resources' comprehensive conservation program.

Arizona Municipal Water Users Association. 2008. Accessed 25 February 2008 available at http://www.amwua.org/conservation_main.htm

The Arizona Municipal Water Users Association represents 10 Greater Phoenix Area municipalities and assists them in areas of water resource management that require coordinated effort.

Arizona Water Institute. 2006. About. Introduction. Accessed 25 February 2008 available at http://azwaterinstitute.org/index.html

The Arizona Water Institute is a partnership of Arizona State University, Northern Arizona University, and The University of Arizona with the goal to position Arizona as a world leader in water resources management and technology.

Government of Phoenix. 2008. Phoenix in Drought. Accessed 25 February 2008 available at http://phoenix.gov/WATER/drtmain.html

Details regarding the effect of the Colorado River drought on Phoenix, Arizona can be found at the Phoenix local government web page. This site also provides links to the Phoenix Drought Management Plan and water conservation tips.

SAHRA. 2001. Residential Water Conservation. Accessed 25 February 2008 available at http://www.sahra.arizona.edu/programs/water_cons/index.html

The Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) is a National Science Foundation Science and Technology Center that focuses on developing an integrated,

multidisciplinary understanding of the hydrology of semi-arid regions. It partners with several universities in the USA, including the University of Arizona and Arizona State University. Among other publications, SAHRA has a residential water conservation clearinghouse website.

University of Arizona. 2008. Water Sustainability Program. Accessed 25 February 2008 available at http://www.uawater.arizona.edu/

The University of Arizona has a Water Sustainability Program that cultivates expertise in water development, use and conservation.

Water CASA. 2008. Water Conservation Alliance of Southern Arizona. Accessed 25 February 2008 available at http://www.watercasa.org/

Water Conservation Alliance of Southern Arizona is a multi-stakeholder group that works to improve public awareness and understanding of water conservation issues, methods and practices.

Nevada

Southern Nevada Water Authority. 2007. Accessed 25 February 2008 available at http://www.snwa.com/html/index.html

The Southern Nevada Water Authority (SNWA) is responsible for managing Southern Nevada's current water resources and ensuring future water supplies. As such, it is the entity that leads water conservation in Las Vegas.

Detailed water conservation tips along with links to the EPA Water Sense Program are found at http://www.snwa.com/html/cons_tips.html

The SNWA has a comprehensive conservation rebate program that encourages xeriscaping, water efficient technologies and smart car washing. The SNWA focuses on outdoor water use and especially xeriscaping and landscape conversion, and offers rebates for turf removal. http://www.snwa.com/html/land_index.html

Southern Nevada gets the vast majority of its water from Colorado River which is in the throes of the worst drought on record. The SNWA has a Drought Plan with four levels of drought status which is used to communicate drought restrictions to water consumers in Southern Nevada. The SNWA Drought Plan is available at http://www.snwa.com/html/drought_plan.html