

At a Watershed



**Ecological Governance and Sustainable
Water Management in Canada**



Urban
Water
Demand
Management

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BUILDING ON CANADA'S STRENGTHS



At a Watershed:

Ecological Governance and Sustainable Water Management in Canada

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About the project

At a Watershed is a collaborative project involving both The POLIS Project on Ecological Governance and the Environmental Law Centre at the University of Victoria.

Urban Water Demand Management Project (UWDM) is an initiative that began in January 2003 at the POLIS Project on Ecological Governance at the University of Victoria. The UWDM Project seeks to understand the structure and dynamics of urban water use, and to provide mechanisms to reorient Canadian water management from supply to demand-side approaches. In the context of "Governance for Innovation"—a term that promotes the adoption of innovative and alternative solutions—the UWDM Project works towards developing a comprehensive legal and policy framework, and decision making tools, that are of national and regional significance.

The first two reports by the UWDM team, *Flushing the Future?* (August 2003) and *What the Experts Think* (December 2003), laid out the examination and diagnosis of Canada's ailing urban water management system. The third report, *The Future in Every Drop* (April 2004), provided the prescription—practical action plans for all levels of government to implement demand management for urban water in Canada. *At a Watershed* goes beyond the urban environment presenting detailed solutions from around the globe to "operationalize" the prescriptions laid out in the third report. This report examines sustainable water management in the broader context of governance and provides a blueprint for a national water management strategy.

Web site: www.waterdsm.org

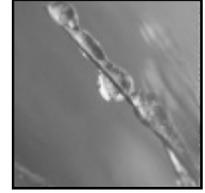


Environmental Law Clinic (ELC) is operated by the non-profit Environmental Law Centre Society, in collaboration with the University of Victoria's Faculty of Law. Staffed primarily by law students who get course credit for their work, the ELC is Canada's only hands-on academic program in public interest environmental law. The ELC provides legal representation and legal assistance to community/conservation groups and First Nations; produces citizen handbooks and other public legal education materials; and advocates on a wide range of environmental law reform issues. The Clinic is working to help create the next generation of public interest environmental lawyers in Canada.

Web site: www.elc.uvic.ca



Executive Summary



Critical to life in all its diversity, water is the lifeblood of society and a foundation of civilization. In addition to drinking water, freshwater ecosystems provide other fundamental “ecosystem services” such as irrigation water, habitat for wildlife, reserves for biodiversity, flood control and drought mitigation, mechanisms for environmental purification, and sites for recreation. All these functions are essential to the ongoing health and development of society.

As cities grow and environmental problems escalate, managing human demand for fresh water presents an immediate challenge. In Canada’s cities, scarcity of supply, wasteful use, pollution, climate change and other factors combine to increase the stress on aquatic ecosystems and water supply systems. The habits of a profligate past are colliding with ecological and economic limits—the need for innovative water management is acute.

Water is *the* strategic resource of the 21st century. As we write this report, Canada stands “at a watershed” in freshwater management. Attitudes, institutions and policies are changing, but an outdated supply-oriented paradigm still dominates. This paradigm treats fresh water as a virtually limitless resource; forecast demands are met by endlessly seeking additional sources of supply. A new approach is needed.

Demand management: The new water paradigm

Demand-side management uses less water to meet the same human benefits, through conservation and a dramatic increase in water use efficiency. Demand-side practices include conservation pricing, smart technologies, public education, and regulation that forces innovation by promoting efficiency, conservation and recycling.

Comprehensive demand management programs integrate diverse activities such as consumer behaviour, water provision, waste disposal, energy use, and land use to redirect social development onto a new “soft path.” This path focuses on meeting underlying human *needs*, for example, for sanitation and agriculture, instead of supplying more water. It requires water planners to satisfy demands for water-based *services*, rather than

simply delivering more water as the *product*.

A “soft path” for water moves away from “forecasting” the future by simply extrapolating from the past. Instead it relies on “backcasting”—a planning approach based on a future scenario that integrates human needs within ecological limits. After determining what water might be available (ecologically), planners then work *backwards* to find feasible paths to meet long-term social and economic needs. To reach a sustainable future, the soft path relies on policies and programs that change behavior and promote greater water productivity. At the core of this process are structural changes that embed conservation, complemented by technologies and practices that increase efficiency.

Water in Canada

The myth of abundance is firmly entrenched. This myth impedes Canada’s ability to change water use habits. Water prices in Canada are the lowest in the industrialized world, which encourages our pattern of excessive use and waste. Lack of consumer awareness and conservation incentives, a dearth of effective policies and innovative regulations, and limited strategic planning all reinforce the supply-side paradigm. Profligate water use not only causes environmental damage, but also inflicts huge and unnecessary infrastructure costs on already overburdened municipalities and taxpayers.

Structurally, myriad public agencies share authority in “a bewilderingly complex administrative galaxy” that fails to address the underlying problems. From coast to coast, Canada’s water management is in need of sober reform. The ultimate solutions are local in nature, yet those solutions are unlikely to be widely implemented unless situated within a broad national strategy.

Ecological governance to address water scarcity

At a Watershed focuses on the enabling environment that ensures holistic water management is institutionally embedded. Ultimately, the goal is “ecological governance,” where natural ecosystem processes are carefully considered at all levels of decision making, up and down the watershed. All three pillars of governance—government, business and civil society—must participate to fully incorporate sustainability into the very nature of our government, our industry and our civil society.

Developing Sustainability

By definition, sustainability respects biophysical limits. However, while *sustainable development* merely imposes constraints on traditional economic development, *developing sustainability* seeks to liberate new processes for social and economic transformation.

Developing water sustainability requires a shift that embeds ecosystem integrity in the fundamental basis of all planning. This approach limits the expansion of supply-oriented infrastructure, addresses cumulative effects at the watershed, and unleashes the full potential of conservation-oriented innovation. The best source of “new” water is not actually new water at all. It is better use of the water we already withdraw.

Key Concepts

To develop sustainability, four key concepts must guide water planning and management:

1. Prevention and Precaution

To maintain ecosystem integrity, prevention of harm is better than subsequent compensation or remediation. A precautionary approach is the best hedge against an uncertain future.

2. Ecosystem-based management

Ecosystem-based management adapts economic, political and social processes to fit within the ecosystem, instead of the reverse. Rather than managing a watershed as an adjunct to human needs, ecosystem integrity sets the context for management decisions.

3. Matching authority to jurisdiction

Watershed governance recognizes that local people and institutions are best situated to monitor environmental feedback and respond with tailored solutions. However, local powers must also be “nested” within higher level institutions that hold them accountable, co-

ordinate with other local institutions, and participate in broader collective actions.

4. Adaptive management

Plans and policies should be continually modified to respond to ecological, economic and social feedback through an ongoing process of informed “trial and error.” Decisions that are provisional and reversible can create and apply critical knowledge to refine decision making in an uncertain world.

Part II: Key Components of a national water strategy

Working together, federal and provincial governments can promote the tools and institutions to allow all local interests—suppliers, businesses, consumers and local governments—to take effective action in developing water sustainability. Real world experiences in many jurisdictions can provide signposts for Canadian authorities along the path to a sustainable water future.

The attached table summarizes these opportunities, experiences and best practices from around the globe (with reference to additional details in the full report).

Allocating water in the 21st Century

Ecosystem-based management starts at the source to protect ecological function and ecosystems. Only after ecological needs are met can water then be accessed for human activities. Once the ecological limit of an aquifer, river basin or watershed is reached, future water demands must be met through increased water “productivity.” This liberates the full potential of demand management.

Enabling local water planning and conservation

Senior governments can uniquely address the institutional inertia of the supply-side paradigm that now prevents the long-term planning and decision making needed to implement DSM. They can ensure local governments have a sustainability strategy based on long-term water conservation planning and an integrated approach to water management.

Patterns of supply and demand, ground and storm water use, energy and land use decisions can all be shaped and transformed. Specific tools and practices to foster such transformation include funding, guidelines, data and information, building and sharing technical knowledge, increasing staff resources, providing incentives for innovative management and ensuring widespread public education.

Facilitating urban water demand management

Demand management programs can reduce infrastructure costs and ecological impacts. However, water conservation does not just happen. Success requires coordinated efforts from all stakeholders and an environment where demand management is the primary focus of water managers.

Senior governments can facilitate a demand-oriented focus through the creation of model bylaws and standardized Best Management Practices (BMPs). They can act as a central clearinghouse of information and undertake research, pilot projects and educational programs. They can also move forward specific DSM opportunities such as product labelling, social marketing, conservation-based pricing and reuse and recycling technologies.

Thinking like a watershed

Sustainable water management requires managers, in effect, to “think like a watershed”—to consider the complex interaction of human activities and natural processes in planning and decision-making. Ecological governance is only possible where management focus shifts away from manipulating the watershed and toward managing human activities within the watershed.

Demand management is a foundational tool for watershed managers. When applied not only within the urban sector but in all sectors—including power generation, industry, manufacturing and agriculture—up and down the watershed a broader social process of ecological governance begins to take root.

Learning from other places

The strength of this report lies in the rich mosaic of experiences and examples from around the world where theory and concept inform practice. For example, experiences in *Australia* and *South Africa* reveal opportunities to integrate ecological considerations into water allocation systems and demonstrate how watershed-based management institutions can protect ecosystems. In these jurisdictions, nature is recognized as a legitimate “user” of water.

In *California* and some other parts of the United States, urban water management and innovation go hand in hand. Conservation planning, increasing water efficiency and improving water reuse and recycling are

fundamental aspects of water management. Dedicated government divisions for water efficiency, specific conservation laws and codes, targets and reporting requirements, and processes linking infrastructure funding to best practices ensure continual innovation and improvement.

In the *European Union*, integration at the watershed level is an important part of a “nested” planning approach promoted through the EU Water Directive. For many European countries the watershed is viewed as the starting point for sustainable water management. For example, *France* has created a water parliament system where government has modified its water management role from central controller to facilitator of local decisions in the context of river basins and watersheds. A management authority for the basin develops policies and plans that address basin-wide problems. These provide guidance to the management bodies of smaller, nested watersheds, which develop detailed action plans tailored to local conditions.

Similar efforts to integrate water resource management at the watershed level are occurring in *Washington State* where growing recognition of a need to shift away from centrally-driven efforts towards more collaborative watershed-based approaches is creating a dynamic adaptive management framework.

Future directions

A future different from the past is possible for Canada. Financial, technological, legal and social tools are available to grapple with water issues before they reach crisis proportions. But the long-term solution requires a fundamental shift to watershed governance—an institutional shift towards ecologically-based water allocation, innovation in planning, managing water use with a “soft path” approach, and ecosystem-based management at the watershed scale.

The challenge now is to ensure that these new approaches, resources and institutional arrangements are implemented across the country. Senior government must provide the leadership to make this happen, taking steps to ensure water agencies at all levels of government have the ability and the incentives to implement comprehensive solutions and programs. The opportunity is here, and the time for action is now.

Key elements of a national water strategy for Canada

	Practice (BMP)	Purpose(s)	Key enabling requirement(s)
Ecosystem-based water allocations Chapter 5	Water allocations that ensure watershed health	Allocate water to sustain ecosystem integrity	Provincial action on fundamental reform of water licensing and allocation systems
	Adaptive withdrawal permitting	Avoid future over-allocation of water sources by allowing permitted withdrawals to be adjusted over time in response to water availability	Change water licenses and entitlements; and demand detailed hydrological and human water use monitoring
	Market-based instruments for water sustainability	Provide incentives (financial rewards) for desired behaviour or impose fees on undesirable behaviour to reduce water use and provide potential revenue to subsidize conservation and restoration	Pricing - attention to distributive effects (i.e. political economy of water) Trading - property rights with clear ecological water allocations and significant government regulation Liability - public access to legal system
Innovative Urban Water Management Chapter 6 and 7	Long-term conservation planning	Overcome short-term decision making that increases long-term impacts/costs	Water conservation planning guidelines and incentives that require their use (conditional funding, legislation)
	Environmental management systems	Embed planning in an adaptive management framework, ensuring regular assessment of business practices and consequential environmental impacts	Overcome upfront costs for management process (e.g. plan, do, check, act) and ensure availability of detailed information
	Utility Full-Cost Accounting	May eliminate perverse subsidies by promoting a truer value of water to end users, ensuring long-term financial stability for the utility	Local political will or provincial legislation as in Ontario. Citizen/end-user education
	Developing conservation capacity	Develop professionals that create and run effective long-term DSM programs	Sufficient financial resources and recognition that DSM professionals are critical to any water supply team
	Best practices clearing-house	Disseminate information and opportunities to improve water management and promote innovation	Create one central and credible resource in collaboration with key stakeholders
	Promote market in DSM planning/implementation	Ensure ongoing innovation and continual integration of conservation technologies	Commitment by local government to link development with conservation incentives
	Labelling	Allow purchasers to identify and select the most water-efficient products to meet their needs, facilitating a market for conservation technologies	Credible oversight and enforcement of standards
Key DSM measures Chapter 7	Social Marketing	Promote behavioural change at community level	Specific training and direct public contact and involvement
	Conservation-based pricing	Provide incentives to reduce water use and signal the value of water	Universal metering and public and political buy-in
	Reuse and recycling	Cascade water use to reduce wastewater and water use	Dual plumbing, enabling regulation, pilot projects, national guidelines for reused water and health regulations
Watershed Governance Chapter 8	Water parliaments	Ensure holistic planning and decision making at the watershed scale by bodies aware of local needs and circumstances	Collaboration by key stakeholders and senior governments; sufficient resources and delegated decision-making authority

Impact/implications	Governance principle	Leading example(s)
Water allocated for ecosystems and basic human needs first; the remainder allocated to maximize social and economic benefits	Ecosystem-based management	<ul style="list-style-type: none"> • South Africa National Water Act (Sec 5.3) • Australia, COAG reforms (Sec 5.3)
May challenge expected long-term specific volume requirements for fresh water	Adaptive management	<ul style="list-style-type: none"> • Time-limited withdrawal permits in the UK, South Africa and Florida (Sec 5.4.1) • A consumptive pool - Australia (Sec 5.4.2)
<p>Tax shifting and green taxes may impact costs and individual company/industry competitiveness</p> <p>Commodification of water resources and potential corporate influence requires careful government oversight</p> <p>Cost recovery facilitated by environmental bond requirements</p>	Ecological modernization; full-cost accounting and user pay	<ul style="list-style-type: none"> • Europe (Sec 5.6.1) • South Africa (Sec 5.6.1) • Australia (Sec 5.6.2) • Alberta (Sec 5.6.2) • California (Sec 5.6.2) • Sweden (Sec 5.6.3) • Columbia (Sec 5.6.3)
Senior government must provide support (finances and information) to assist in preparation of plans, and must enforce penalties if plans are not implemented	Matching principle and deliberative democracy	<ul style="list-style-type: none"> • EPA guidelines (Box 39) • California's Urban Water Management Planning Act (Box 40)
Requires industry or government action to develop specific EMS frameworks for water utilities and providers, and requires establishment of indicators	Adaptive management	<ul style="list-style-type: none"> • ISO 14001 (Box 41) • North East Water in the State of Victoria Australia (Sec 6.3.1) • Sydney Water Corp., Australia (Box 42)
Concern that privatization may result; requires strong public oversight	Subsidiarity and ecological modernization	<ul style="list-style-type: none"> • CRD Victoria (Box 45) • Ontario's Sustainable Water and Sewers Systems Act (Box 44)
Changing utility focus from water supplier to service provider	Ecological modernization	<ul style="list-style-type: none"> • California - dedicated government division for water efficiency (Box 40) • Some Canadian cities have hired full-time DSM staff (Sec 6.6)
Compliance with practices can be part of criteria for linking funds for infrastructure expansion or DSM programs	Ecological modernization and subsidiarity	<ul style="list-style-type: none"> • WaterWiser Clearinghouse Web (Sec 7.2.2) • California MOU Regarding Urban Water Conservation (Sec 7.2.1, Box 47)
May increase developer costs leading to focused resistance	Ecological modernization	<ul style="list-style-type: none"> • WASCOs (private entities contracted to plan and implement DSM program (Sec 6.2.3) • Arizona Active Management Areas requires developers to reduce water use before new building permits are given (Sec 6.4.1)
Can help local water providers select models/brands for rebate and giveaway programs	Deliberative democracy and ecological modernization	<ul style="list-style-type: none"> • WaterStar (Sec 7.3) • EcoLabel (Sec 7.3) • WELS (Australia) (Box 49)
Requires detailed planning, pilot projects and evaluation	Ecological modernization	<ul style="list-style-type: none"> • The Region of Durham, Ontario (Sec 7.1.5, Box 19)
May effect municipal water revenue predictability	Ecological modernization; full cost and user pay	<ul style="list-style-type: none"> • Irvine Ranch Water District (Box 50) • EU Water Framework Agreement (Sec 7.4)
Requires additional technologies and technical expertise	Ecological Modernization	<ul style="list-style-type: none"> • California Water Code (Sec 7.5.2) • Florida Reuse Coordinating C'ttee (Sec 7.5.2) • Vernon, BC (Sec 7.5)
Changing role of government from central control to facilitator of local decisions	Matching authority and subsidiary	<ul style="list-style-type: none"> • France's Water Parliaments (Box 56) • COAG and the Murray-Darling Basin Initiative, Australia (Box 58) • Washington State, US (Sec 8.2, Box 57)

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*I do not know much about gods; but I think that the river
Is a strong brown god-sullen, untamed and intractable,
Patient to some degree, at first recognised as a frontier;
Useful, untrustworthy, as a conveyor of commerce;
Then only a problem confronting the builder of bridges.
The problem once solved, the brown god is almost forgotten
By the dwellers in cities—ever, however, implacable.
Keeping his seasons and rages, destroyer, reminder
Of what men choose to forget. Unhonoured, unpropitiated
By worshippers of the machine, but waiting, watching and waiting.*

.....
The river is within us, the sea is all about us...

T.S. Eliot, *The Dry Salvages*, 1941

Chapter 1

At a Watershed



Humans consume water, discard it, poison it, waste it, and restlessly change the hydrological cycles, indifferent to the consequences: too many people, too little water, water in the wrong places and in the wrong amounts.

Marq de Villiers, Water, (2000: 15)

Water is the lifeblood of civilizations—a critical component for all life and a necessary foundation for the growth and evolution of society. As cities continue to grow and environmental problems multiply, managing the demands for fresh water becomes a more urgent challenge that affects all aspects of society.

Water is *the* strategic resource of the 21st century. A recent poll of 200 leading scientists from 50 countries ranked lack of fresh water as an environmental priority second only to global climate change (GEO 2000; Praxis Inc. 2001; Brooks 2003: 29). Even in Canada, a nation perceived as rich in freshwater resources, water scarcity is a growing concern. In many areas, water supplies are limited and human water use is degrading aquatic ecosystems.

Currently, Canada stands “at a watershed” concerning freshwater management. Attitudes, institutions and policies are slowly changing, but the old paradigm still dominates. In response to the growing complexity that is driving this change, water managers worldwide are slowly abandoning the endless quest for more water. They are turning away from the traditional “supply-side” paradigm that has underpinned growth historically. Out of necessity, these “builders of bridges,” in T.S. Eliot’s metaphor, are now taking seriously the need to control our use of “the brown god,” and are moving incrementally toward a demand-side approach. This approach emphasizes efficient use of water and conservation—achieving the same benefit for humans while using less of the precious resource.

This new demand-side paradigm tells managers that it is no longer enough just to supply water for public and economic needs. A demand orientation requires institutions, consumers and others to protect the environment, restore ecosystems, and achieve social equity—it is only

within these constraints that they can carry out their function of supplying sufficient water for public safety, economic growth and ongoing development.

Too many Canadians view the supply of fresh water as limited only by the technology and infrastructure used to harness it. Conservation is often seen as a minor add-on. The impending collision between a profligate past and a sustainable future is acute in the urban environment where a range of factors—from increased demand and scarcity to pollution to climate change—create significant cumulative pressures on local aquatic ecosystems. Similar issues and limits face water users in agriculture, mining and manufacturing sectors.

Water scarcity presents a challenge for social *governance*. In looking to the future, this concept of governance expands our focus beyond the decisions and rules made by *government* to include other participants in social decision making—in particular, *business* and *civil society*. This broader focus is critical to moving ecological principles from the periphery to the core of decision making.

Incorporating ecological sustainability *into the very fabric of government, industry and civil society* represents a shift towards “ecological governance,” and requires reform of existing institutions and ways of thinking. One such reform involves how watersheds and, more broadly, ecosystems fit into our collective decisions. Such “ecosystem governance”—a subset of the broader ecological governance—provides the critical context within which a paradigm shift from supply-oriented to demand-oriented water management can and must occur. We are literally, “at a watershed.” The forgotten river does indeed flow into a larger social sea.

1.1 Purpose and overview

The fourth report in our series on urban water management in Canada, *At a Watershed*, addresses the enabling environment within which the recommendations, solutions and action plans of previous reports can be fully “operationalized.” It promotes the creation of a holistic water management system structured to *inherently* promote water sustainability, advancing both demand management and water conservation.

Urban water management is only a starting point. On the one hand, cities and the infrastructure that supports them constitute a critical nexus of decision making. On the other hand, urban areas are often the most significant feature on the landscape affecting a particular hydrological cycle. Yet, when one travels up and down the watershed, other sectors beyond the city—from agricultural irrigation to power generation for consumers and industry—must also be involved in the reshaping of institutional designs.

The case studies and examples of practical and innovative practices presented in this report reveal models that can be adapted and implemented in Canada. Institutional reform and ecological governance are attainable goals. The objective of this report is not to add more ad hoc programs. Its central goal is to elucidate the character of the enabling environment that can foster a long-term, integrated and comprehensive approach to water management in Canada where ecosystem health and social sustainability take a primary role.

The report is divided into two parts. Part I reviews the institutional context in Canada (Chapter 1), and provides the theoretical foundation for ecosystem governance (Chapter 2). Chapter 3 offers a snapshot of the Canadian water resource management scene that grounds our theoretical understanding, reviewing the roles of governments—provincial, federal and local/municipal—in achieving a comprehensive water management strategy. The institutional, jurisdictional and legal complexity associated with water management in Canada is a significant barrier to managing the resource effectively.

Part II reviews a diversity of “best practices” in ecosystem governance from around the world. Alive with concrete examples and detailed strategies, the chapters in Part II demonstrate how, by positioning ecological principles at the core of social decision making, Canada can begin to *develop sustainability* where it currently does not exist.

Ecological governance cannot simply be designed in the abstract and then implemented; instead it must evolve out of the constellation of interests, practices and institutions that already exist. Part II reveals many common themes amidst the real-world experience of water providers, regulators, consumers and civil society around the world. It provides a platform for institutional redesign—and the beginning of a dialogue to achieve water sustainability in Canada.

1.2 Ecological services provided by freshwater ecosystems

Freshwater ecosystems include a range of habitats—streams, rivers, ponds, wetlands and lakes-linked groundwater systems, and the ecological riparian zones that connect them to adjacent land. Aquatic systems provide a variety of “services” to society (Daily 1997: 6).¹

The most fundamental of these services is the provision of fresh water itself. The generally accepted minimum amount of fresh water required for human survival is approximately five litres per capita per day (lcd). To meet additional basic needs such as sanitation, food preparation and bathing, Health Canada recommends 60 to 80 lcd, and Gleick (1996: 83) recommends a minimum of 50 lcd.

In addition to providing water for broader social uses—agricultural, industrial and residential—freshwater ecosystems provide habitat for fish and waterfowl and instream services such as flood control and the purification of human and industrial waste (Baron et al. 2003). Healthy ecosystems are essential to sustaining these services for future generations and to ensuring the ecological capacity to adapt to environmental changes such as global climate warming (Baron et al. 2002: 1248). Box 1 provides a comprehensive list of the benefits provided by freshwater ecosystems.

Many attempts have been made to quantify the economic value of aquatic ecosystem services. Based on functions such as flood control, recreational fishing and water filtration, Schuyt and Brander (2004: 4) estimate the global value of wetlands alone at US\$70 billion annually. In Florida, Ruhl (2003: 53) estimates the natural flow of the Apalachicola River and its floodplain basin provide services such as flood control, nutrient regulation, and estuary health, with an economic value of over US\$5 billion per year. Similarly, Postel and Richter (2003: 10) estimate the value of goods and services provided by the world’s lakes, rivers and wetlands at

¹Daily (1997) defines these services as “the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life.”

Box 1: Services provided by freshwater ecosystems

Service	Benefits
Provision of water supplies	Greater than 99% of industrial, irrigation and residential water supplies worldwide come from natural freshwater systems
Regulation of ecosystem function	Ensures essential ecological processes and fundamental life support systems continue
Flood mitigation	Functionally intact freshwater systems buffer stormwater flows, reducing flood damage
Drought mitigation	Functionally intact freshwater systems absorb rainwater, slow runoff and help recharge groundwater
Maintenance of coastal zones	Freshwater flows maintain the salinity gradients that are critical to the biological diversity and productivity of deltas and coastal marine environments
Recreational opportunities	Freshwater ecosystems are sites for swimming, fishing, hunting, boating, wildlife viewing, and so on
Hydropower generation	Flowing freshwater ecosystems provide opportunities for both conventional hydropower generation and more environmentally sensitive micro-hydro options
Provision of habitat	Rivers, streams, floodplains and wetlands provide habitat and breeding sites for numerous aquatic, avian and terrestrial species
Biodiversity conservation	Freshwater and riparian ecosystems harbour diverse assemblages of species that support many of the services in this table and also conserve genetic diversity for future generations
Provision of food	Fish, shellfish and waterfowl are important food sources for people and wildlife
Sink services	Healthy freshwater systems possess an ability to absorb and neutralize pollution. For example, micro-organisms play a critical role in groundwater purification breaking down organic wastes, including petroleum hydrocarbons and synthetic halogenated organic compounds
Water purification	Wetlands filter and break down pollutants, enhancing water quality
Nutrient delivery	Freshwater systems store and transport nutrients within the watershed
Soil fertility maintenance	Functional river-floodplain systems constantly renew the fertility of surrounding soils
Land subsidence prevention	Groundwater stored in aquifers prevents land subsidence and reduces erosion through absorption of runoff
Aesthetic, cultural and spiritual values	Natural freshwater systems are sources of inspiration and deep cultural and spiritual values

Adapted from: (Postel and Richter, 2003; Moss et al. 2003)

US\$6.6 trillion. Ultimately, of course, these costing exercises are futile. All aspects of the economy depend on functioning planetary ecosystems; these human values are at best only rough indicators of economic importance.

1.3 Urban water management - Current and emerging paradigms

Generally, water management approaches can be viewed on a continuum that includes three distinct paradigms—*supply-side*, *demand management*, and “*soft path*” (Box 4). At one end of the spectrum, supply-side approaches seek to increase the capacity to withdraw water through large infrastructure of dams, reservoirs, pumps and pipelines. In the middle, demand-side management (DSM) complements the supply-side approach and shifts thinking to cost-effective measures that aim to reduce the need for more supply—measures such as consumer education, efficient fixtures and conservation-based pricing. At the other end of the spectrum, a “soft path” for water takes the management approach beyond traditional concerns to consider how we might redesign the underlying systems that generate supply and demand.²

Both supply and demand strategies are used today and the balance between them varies depending on geography, geology, culture, and economic and political choices. Canadian water utilities employ a variety of demand management techniques, most commonly education programs, watering restrictions and rebates for efficient fixtures and toilets. Nevertheless, supply-side thinking still dominates water management decisions.

1.3.1 The supply-side approach

Historically, the challenge for water managers has not been to accept limits, but to overcome them. In this vein, supply-side management treats fresh water as a virtually limitless resource, focusing policy and practice on securing sufficient quantities of water to meet forecast demand. Underlying this approach is the assumption that current levels of water demand are largely insensitive to policy and behavioural changes (Shrubsole and Tate

1994: 1; Renzetti 2003: 1). This supply-side orientation has historically not taken full account of environmental or economic impacts on municipal water services.

Treated water³ is often subsidized and generally not priced to recover the costs of delivery. With few or no incentives for water conservation, and effluent water treatment managed primarily through direct regulation,⁴ supply-side approaches are reinforced as the dominant water management paradigm in Canada (Campbell 2004). Given this history and the extensive amount of water available in Canada, especially in comparison with nations like Israel and Australia, it is not surprising that this approach still dominates. However, Canada is increasingly vulnerable to the diverse pressures that limit supply, such as increasing demands, large-scale urbanization, multi-source pollution, global warming, and dramatically increasing marginal costs.

Large, centralized engineering projects—dams, diversions, pumping stations and distribution systems—are products of the supply-side approach. Continuing to depend on expansion of these high throughput systems puts an increasing, and often unnecessary, strain on the economic stability of municipal water utilities and the integrity of the local aquatic ecosystems (Shrubsole and Tate 1994: 2; Gleick 2000: 128). Duncan Ellison, Executive Director of the Canadian Water and Wastewater Association suggests that “simply expanding supply to meet an unrestrained demand just doesn’t make sense in most cities” (Maas 2003: 8). Indeed, as more and more money is needed to achieve each additional unit of a given resource (a situation where marginal costs are increasing), supply-side options are less capable of meeting the needs for water across all sectors.

1.3.2 Demand management

Demand-side management (DSM)⁵ is a key component of the broad strategy of *ecological modernization*—seeking innovation that can simultaneously meet economic and environmental objectives. It is fundamentally about improving efficiency by doing more of the

²Talking about a soft path for water is an approach adopted from the energy field. Amory Lovins first coined the term “soft energy path” in a 1976 Foreign Affairs article, eventually developing a planning approach that carefully calculated requirements for energy services and energy economics. Environmental considerations were a core value in this analytical work.

³All municipal water is treated to drinking water standards. This sector is the third highest water user in Canada behind thermal power generation and manufacturing. Municipal water use encompasses water withdrawn for residences, public services, commercial and institutional enterprises (such as hospitals, schools, restaurants, and government offices), and some local light industrial uses.

⁴Direct regulation provides an incentive to limit harmful activities only to the extent that penalties for non-compliance are perceived as likely and severe. Regulation does not readily encourage “beyond compliance behaviours, i.e. it does not encourage innovation (Campbell 2004: 3).

⁵Curran (2000:18) defines DSM generally as “reducing the demand for a service or resource rather than automatically supplying more of the service or resource being sought.” DSM is commonly referred to simply as demand management.

same with less (in this case, water).⁶ Demand management is gaining recognition in a number of resource fields including energy, transportation and, more recently, water. In a recent report, the National Round Table on the Environment and Economy (2003) explicitly recommends demand management as a key strategy for mitigating environmental degradation in Canadian cities.⁷

In the context of urban water systems, DSM generally involves any measure or group of measures that reduces water use, or improves the efficiency and timing of water use. Brooks and Peters (1988: 3) specifically define water demand management as “any measure that reduces average or peak withdrawals from surface or groundwater sources without increasing the extent to which wastewater is degraded.” Pricing, education, water-efficient technologies, and regulatory regimes that promote efficiency and/or reuse and recycling are examples of demand-side approaches.

Opportunities for demand management abound in areas with high levels of urban water waste, and in a growing number of municipalities that face the limits of existing infrastructure capacity. Increasing capital costs for infrastructure expansion and the growing environmental impacts of water withdrawals and wastewater discharges exacerbate these trends. Demand management is not a panacea, but it can help mitigate such problems in the short term, and lay a foundation for long-term changes.

Urban water demand management recognizes that developing new water supply sources may be far more costly when compared with measures that can influence consumer demand. Brooks (2003a: 9) suggests that “in almost every sector, cost-effective savings of 20% to 50% of water use are readily available.” These estimates are reinforced when environmental and economic costs of urban water services are taken more fully into account.

Adopting DSM to urban water management can help reduce or at least cap current urban water use and wastewater production.⁸ In the context of population growth and urbanization, this means increasing per capita water use efficiency in order to stabilize or reduce total water use. Ultimately, DSM programs mitigate the pressures of excessive urban water use on municipal finances, infrastructure and the aquatic ecosystems that they rely on.

1.3.3 Soft path for water

As demand management programs become more comprehensive, long-term and integrated, they begin to fall into a more holistic approach to water management—the soft path. Like DSM, the *soft path* strives for sustainability and equity in water management by increasing water productivity rather than seeking out additional supplies. It also ensures that stakeholders are engaged in decision making and explicitly recognizes ecosystems themselves as legitimate users of fresh water (Wolff and Gleick 2002; Brooks 2003a).

The soft path differs fundamentally from conventional (or hard path) water planning in its conception of water demand. A soft path approach rarely views water as the end product, but more often as the means to accomplish certain tasks such as household sanitation or agricultural production. With some important exceptions, the demand considered in planning projections is not demand for water itself, but for services provided by water. Under a soft path approach, the role of water planning and management becomes one of a service provider—the objective is to satisfy demands for water-based services rather than supplying water per se.

A key feature of soft path planning is the recognition that many existing water needs can be met with far less water, and often with water of a lower quality, than is currently used. High efficiency toilets, for example, reduce the amount of water used for sanitation; there is also significant potential to increase water productivity further by using reclaimed wastewater to flush toilets or by shifting knowledge and values to, for example, dry sanitation systems (composting toilets) that completely eliminate water use. Similarly, denser urban development, smaller lawns, and less water-dependent products can dramatically reduce water needs (Gleick 2002; Brooks 2003a; Brandes and Maas 2004: 11).

An urban water soft path complements and works within existing water infrastructure to limit or eliminate the need for further supply-side developments. It relies largely on demand-side measures such as efficient technologies, education, regulation, and the use of economic instruments to increase the productivity of current withdrawals while ensuring equitable access to the resource. However, demand management itself does not generally challenge proximate

⁶For a thorough discussion of urban water demand management, including the relationships among DSM tools and barriers to implementation, see the first three reports in this series: *Flushing the Future* (2003), *What the Experts Think* (2003) and *The Future in Every Drop* (2004) published by the Urban Water Demand Management Project, The POLIS Project on Ecological Governance, University of Victoria. All reports and project details are available at www.waterdsm.org

⁷It is relevant to note, however, that the NRTEE report does not adequately consider demand management in the urban water context.

⁸A wide variety of recent publications (Hawkin et al. 1999; Vickers, 2001; Wolff and Gleick 2001; Brooks 2003a; Brandes and Ferguson 2004) demonstrate that in each end-use sector effective water use (the difference between input water and the service it provides) could be cut by factors of two to five with known, cost-effective technologies.

economic objectives or existing patterns of demand for water; instead “it treats re-allocation of water among sectors very carefully, and seldom by more than can be justified by market or cost criteria” (Brooks 2003a: 10). The soft path raises fundamental questions about water use.

Box 2: Soft path choices

"As long as basic needs are met, all remaining demands on water are acceptable as long as they do not impair the renewable nature of the resources and as long as allocations between both present and future generations are equitable. The criteria do not provide guidance for how to allocate the remaining demands; rather, they lay out guidelines for how to decide among conflicting demands. Because these remaining demands often conflict, a higher degree of social value judgment will be required to set standards or even decide which demand should come before another."

(Gleick 1998: 578)

Traditional methods for determining future water needs rely primarily on long-range projections that assume an ever-increasing demand based on extrapolating from past growth patterns. These projections rarely consider changes in technologies, costs, prices, customer preferences and market forces, and therefore commonly overestimate future demand (Wolff and Gleick, 2002: 29). Rather than forecasting future demand based on past trends, the soft path uses an approach to planning known as “backcasting”—planners define a preferred future, then work backwards to find feasible paths to reach that future situation (Box 3).

Critically important to the soft path approach is an effective strategy to assess ecological water requirements, and integrate these requirements into the backcasting process (Brandes and Maas 2004). The sustainability boundary, or volume of water required to meet basic human needs *and those of aquatic ecosystems*, should be established for the whole water system (i.e. watershed or aquifer). Soft path principles and a comprehensive demand-management approach can then be applied to ensure that the remaining resource is efficiently distrib-

Box 3: Key principles of the soft path for water

1. Resolve supply-demand gaps as much as possible through demand-side approaches. Human demand for water beyond the basic 50 litres per person per day can be satisfied in many different ways—not only through efficiency gains, but also through changing values, preferences and products.

2. Match the quality of the resource supplied to the quality required by the end use. It is almost as important to conserve the quality of water as to conserve quantity. High-quality water can be used for many purposes; low-quality water for only a few. But, happily, we only need small quantities of high quality (potable) water but vast amounts of low quality water.

3. Turn typical planning practices around. Instead of starting from today and projecting forward, start from some defined future point and work backwards to find a feasible and desirable way (a soft path) between the present and that future. The main objective of planning, after all, is not to see where current direction will take us, but to see how we can shape our desired goals in ways that are compatible with current and future water availability.

(Brooks 2003a)

uted, and productivity maximized for not only economic development and equitable social needs, but to ensure that this sustainability boundary is not breached.

Despite uncertainties about the practicality and potential of the soft path for freshwater management in Canada and abroad, interest is growing in this alternative.⁹ In the words of Peter Gleick (2002: 37):

The soft path will not be easy to follow. It will require institutional changes, new management tools and skills, and a greater reliance on actions by many individual water users rather than a few engineers. Yet when compared with the growing cost to society of continuing down the hard path, it is evident that a new way of thinking about our scarce water resources is long overdue (Gleick 2002: 373).

⁹David Brooks, Director of Research at Friends of the Earth (Canada), is generally regarded as the father of the soft path for water. In the past two years, he has prepared two reports that explore the concept of water soft paths. The first reviews the methodology of soft path analysis to determine the extent to which the soft energy model can be applied to water. The second explores the feasibility of undertaking water soft path analysis for Ontario. This study found that the methodology was sufficiently well developed to provide a framework for analysis and that, despite numerous gaps, enough data is available to permit a preliminary analysis.

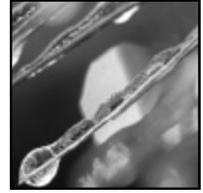
The best soft path analysis for any area was undertaken by Peter Gleick and his colleagues at the Pacific Institute in Oakland, California (www.painst.org). Their sector-by-sector review of urban water use in California showed that cost-effective gains in water efficiency would eliminate the need for any new water supply projects for the next several decades. The POLIS Project on Ecological Governance—Urban Water Demand Management Team is currently developing a similar practical urban water soft path feasibility study and pilot project.

Box 4 A Continuum of water management

	Supply-Side Approach	Demand-Management (DSM)	Soft path for Water
Philosophy	Water resources are viewed as virtually limitless; the primary constraint is capacity to access new sources or store larger volumes of water.	Water resources are viewed as finite, to be used efficiently. Conservation is key and economic cost-benefit analysis guides development choices between increased supply and managed demand.	Water resource are viewed as finite and driven by ecological processes. The focus is on a fundamental re-evaluation of the way we meet the services that water currently provides.
Basic Approach	Reactive. Currently, the status quo approach, developing resources driven by exogenous human needs and wants.	Short-term and temporary. Generally used as a secondary approach, complementing and deferring supply-side options until future supplies are secured. When used in a comprehensive, integrated and long-term fashion, DSM represents an incremental step towards a broader “soft path” approach.	Proactive. Long-term, based on making attitudinal changes (which are not seen as outside the process-not “exogenous”) and on fostering new patterns of resource use.
Fundamental Question	How can we meet the future projected needs for water given current trends in water use and population growth?	How can we reduce needs for water to conserve the resource, save money and reduce environmental impacts?	How can we deliver the services currently provided by water in new ways that recognize the need for long-term systemic changes to achieve social sustainability?
Primary Focus	Built infrastructure	Efficiency	Conservation
Tools and Primary Disciplines	Large scale, centralized, expensive engineering solutions. Examples include dams, reservoirs, treatment plants, pumping stations and distribution systems.	Innovative engineering and market-based solutions focused on any measure that increases the efficiency and/or timing of water use. Examples include low-flow technologies, drip irrigation, conservation-based pricing, education and policies and incentives to reduce use.	Encompasses the full suite of social sciences and generally relies on decentralized distribution coupled with management strategies aimed at ultra efficient ways of meeting end-use demand. The focus is on measures to deliver the services provided by the resource taking full environmental and social costs into account, and identifying new options to provide services associated with water use. Examples include drought resistant native landscaping, grey water reuse, ultra-low flow technologies, and dry sanitation. In addition, the soft path encourages new forms of urban development (“smart growth”) and industrial innovation (e.g. new products, changes in agricultural practices and food preferences) that are inherently more sustainable.
Planning Process	Planners model future growth, extrapolate from current consumption, plan for an increase in capacity to meet anticipated future needs, then locate and develop a new source of supply to meet that need.	Planners model growth and account for a comprehensive efficiency and conservation program to maximize use of existing infrastructure. Increasing capacity would be a final option as part of a least-cost approach.	Planners model future growth, describe a desired sustainable future state (or scenario) and then “backcast” to devise a feasible and desirable path to that future. Sustainability built into the economic, political and socio-cultural choices made along the way.

Chapter 2

Ecosystem Governance



A generation goes, and a generation comes, but the earth remains forever. The sun rises and the sun goes down, and hastens to the place where it rises. The wind goes to the south and goes round to the north; round and round goes the wind and on its circuits the wind returns. All streams run to the sea, but the sea is not full: to the place where the streams flow, there they flow again.

King Solomon

Hebrew Scriptures, quoted in (Jobin 1998: 9)

Increasing demand on resources, ecosystem complexity and scientific uncertainty pose challenges for environment management in Canada and around the world. In response, innovative “best practices” are emerging to integrate ecological, economic and social objectives. The quest for innovation has stimulated the search for new forms of governance that will ensure that these best practices are comprehensively implemented (Dorcey and McDaniels 2001; Dorcey 2002).

This chapter proposes an approach rooted in what the authors call *ecosystem governance*, a manifestation of the larger need for what we term *ecological governance*. It is no longer enough to simply tack minor reforms on to existing systems and processes, as is often the case with “sustainable development.” Instead, society must actually “develop sustainability” where new public and private arrangements are created with ecological principles systemically embedded.

This discussion provides the theoretical foundation for the remainder of the report.

2.1 Governance

Governance applies to the broad process of social decision making. It includes formal government institutions but also non-governmental actors—especially business and “civil society”—that informally establish rules of behaviour, create processes of exchange, and make decisions that shape collective life. Governance is a broad and encompassing concept. A context for social decision making, it is difficult to define precisely. Stoker (1998) explains that the term governance is used to:

- refer to a set of institutions;

- identify the blurring of boundaries and responsibilities between public and private actors tackling social and economic issues;
- explicate the power dynamics of collective action;
- describe autonomous self-governing networks; and
- recognize the capacity to get things done beyond government authority.

The Commission on Global Governance (1995) defines governance as:

[T]he sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest.

This broad structure of governance is inherently political, and involves bargaining and negotiation, especially as it evolves over time.

Government is only part of governance, since many decisions that affect our lives are not made by government bodies or through regulatory processes. Corporations, NGOs, business associations and community groups all take decisions every day that can have a direct and significant impact on broader society. The institutions of governance mediate the relationships between citizens, the economy and the environment,

and they embody the collective power of citizens to direct the future. For example, when private companies provide water-efficient fixtures in response to governmental policies and consumer demand—also influenced by the activities of environmental groups—the resulting water use system is a product of the diverse institutions of *governance* and not just of the decisions and rules of government.

Box 5: Water Governance

Water governance is “the range of political, organizational and administrative processes through which communities articulate their interests, their input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources and delivery of water services.”

(Bakker 2003: 5)

2.1.1 Institutional failure and in-built ‘unsustainability’

To achieve ecological sustainability, it is simply not possible to rely on government alone. A direct link exists between the character of the institutions of governance and specific results or outcomes. For example, low water prices (a governmental decision), a lack of innovative entrepreneurs creating new technology (a business decision), and apathetic consumers who waste water (an individual decision) can all lead to over-use of water, destructive environmental practices, over-exploitation and waste.

For freshwater resources, the symptoms of poor governance include over-pumped groundwater sources, depleted and degraded river flows, inefficient water use, excessive demand, and inequitable access. In contrast, where the institutions of “good governance” are well developed and have sufficient capacity, opportunities will exist to avoid these problems.

Governance includes the complex connections among institutions, including *formal* constraints such as rules, laws, constitutions, and *informal* constraints such as norms of behaviour, conventions and self-imposed codes of conduct (Berkes and Folke 1998: 5). Spangenberg et al. (2002: 63) approach governance in a different fashion, dividing its institutions into three types:

- identify organizations (e.g. government agencies and NGOs),
- identify mechanisms (e.g. laws, coordination agreements, organisational rules, markets), and
- identify orientations (e.g. social and cultural norms and ethics, perceptions of problems and the importance attached to them).

Many of our inherited institutions have “unsustainability” built into their character. In the traditional engineering disciplines, for example, an educational framework emphasizes the use of physical capital created by humans—with minimal consideration of “natural capital” and ecological processes. This thinking is then embedded in the structures and processes of water utilities. In turn, publicly-determined mandates reflect the political expectations of increasing water demands for a growing population. And so on. The character of this governance can change with sufficient dialogue, incentives, planning.

Take the case of Canada’s water protection laws. Existing water laws focus almost entirely on achieving ambient water quality by setting standards at the end of the pipe rather than protecting water sources on an ecosystem or watershed basis. Water protection laws do not include zero-discharge rules that could force dramatic technological innovation in industries for whom environmental externalities represent a large economic subsidy (Boyd 2003; Pardy 2003). It has been suggested that Canadian water law fails to address the underlying unsustainable patterns of production, consumption and fiscal policy that lie at the root of water quality and water supply concerns (M’Gonigle and Ramsay 2004: 335). As a result of the dysfunction of this complex system of water governance, Pedersen (1993: 970) comments that “[t]o clean the water, our system would rather impose ten billion dollars in regulatory costs on the politically vulnerable than achieve a greater clean up, and save money, by eliminating subsidies and tax preferences.” Or as Morris (1999-2000) argues, failed planning processes often result in continued degradation of water resources despite broad policies attempting to address social and environmental objectives.

The dominant planning framework is currently a process of “constrained optimization.” A single objective, as determined according to some form of monetary benefit-cost ratio, is optimized subject to the constraints of other secondary considerations such as environmental protection. Excluded from this process are strategies that optimize environmental or social objectives; instead the focus is on choosing the least offensive outcome. The planning frameworks of many water agencies rely so heavily on quantitative analysis that they implicitly promote a “social choice” that limits the consideration of non-monetary objectives.

Another governance issue involves public participation. If environmental and social values are to be reflected in policy outcomes, they must be incorporated in the

planning process. Too often, however, the planning process focuses on procedural compliance with participation requirements, rather than substantive evaluation of environmental and social objectives. Rarely is participation used to promote a genuine discussion of core community values; often, it becomes a tool to legitimize pre-existing norms and objectives (Morris, 1999-2000).

At another level, land use planning and water planning are often divorced from each other, resulting in fractured public and private decision making to the detriment of ecosystem health. When water demand increases following extensive residential development, DSM may be restricted to reducing per capita water use when, in fact, such land uses may not have been appropriate in the first place given the limited water supply in the area (Morris, 1999-2000).

2.2 Developing sustainability - A deeper perspective

The word “sustainability” has become part of today’s political lexicon.¹⁰ It is questionable, however, whether the popular phrase “sustainable development” actually describes the process for achieving true social sustainability, rather than describing those incremental and limited reforms that can instead support continued economic growth. In contrast, true sustainability demands that society create new forms of equitable development that support a high quality of life, now and in the future—development that really does maintain ecological health. Firmly grounded in modern ecological science and an awareness of political and economic imperatives, achieving sustainability must address the biophysical limits of the Earth and, specifically, the laws of thermodynamics.¹¹

Present development practices do not address these scientific and political imperatives; the challenge is to create the systemic changes that will (M’Gonigle

1989/90; Taylor 2000-2002: 247). *Sustainable development* imposes constraints on traditional development, whereas *developing sustainability* liberates transformative economic practices and the potential for innovation associated with an ecosystem-based approach. This requires the development of new public and private institutions that minimize energy and resource throughputs, while creating new forms of economic welfare.¹² To achieve these goals will require that we develop a network of adaptive institutional arrangements—the processes of ecological governance—that will lead to an active advance of new patterns of development.

Box 6: Sustainability

“Sustainability is a relationship between dynamic human economic systems and larger dynamic, but normally slower-changing ecological systems, in which

- 1) human life can continue indefinitely,
- 2) human individuals can flourish, and
- 3) human cultures can develop; but in a way so as not to destroy the diversity, complexity, and function of the ecological life support system.”

(Costanza 1991)

Four key concepts within this broader concept of “developing sustainability” combine to offer a comprehensive approach to inform water planning. To *maintain ecosystem services*, the *inherent uncertainty* of our current activities that undermine ecosystem integrity must be addressed through *prevention and precaution* that can in turn ensure our economy and politics are rooted in a *sustainable consumption*.¹³

2.2.1 Maintaining ecosystem services

Functioning ecosystems are the building blocks of life. Beyond providing such basics as air and water, ecosystems are the hidden underpinnings of the human

¹⁰For extensive examples and discussion of the many differing definitions of sustainable development and sustainability see <http://sdgateway.net/introsd/definitions.htm>. The SD Gateway on the Web site of the International Institute for Sustainable Development provides access to the policy debate in Canada and abroad.

¹¹The key implication of the laws of thermodynamics is that the more energy and resources consumed by society, the more “entropy” (i.e. disorder in the form of waste and pollution) will be created. For a detailed discussion of the implications of the laws of thermodynamics on sustainability, see Nicholas Georgescu-Roegen, *The Entropy Law and the Economic Process* Cambridge, MA: Harvard University Press, 1971; Herman E Daly, *Steady-State Economics: The Economics of Biophysical Equilibrium and Neutral Growth* (San Francisco: W.H. Freeman, 1977); J Homberg, K.H. Robert, and K.E. Erickson. “Socio-ecological Principles for a Sustainable Society” in R. Costanza, O Segura, and J. Martinez Alier, eds. *Getting Down to Earth: Practical Applications of Ecological Economics*. Washington, D.C.: Island Press, 1996.

¹²The distinction is between marginal reform of an otherwise unchallenged process of economic development (“they got the noun; we got the adjective”) to a fundamentally redirected process of economic growth to a future state for economic/ecological balance (“they get the verb; we get the noun”). See M. M’Gonigle, “Developing Sustainability: A Native/Environmental Prescription for Third-Level Government” (1989/90) 84 B.C. Studies 65. In a similar vein, Taylor advocates a shift from “the law of nations with respect to biosphere” to “the law of biosphere with respect to nations” Taylor, P. “Heads in the Sand as the Tide Rises: Environmental ethics and the Law of Climate Change” (2000-2002) 19 U.C.L.A. Journal of Environmental Law & Policy 247.

¹³The four concepts are not exhaustive, but together provide the reader with an idea of what needs to be “developed.”

economy. In addition to current uses, the principle of inter-generational equity implies that the present generation holds the Earth's resources in trust for future generations. To avoid creating an "ecological deficit" in the future, society must conserve:

- *options* for future generations which require conservation of biological and cultural diversity, and limit the use of renewable and non-renewable resources;
- *environmental quality* to ensure the planet is passed on in no worse condition than when it was received; and
- *equitable access* so that each generation will at least have similar access to natural capital available in the past (Hunter et al. 2002: 400).

In other words, do not run down the "natural capital" underpinning the ecological economy that in turn fundamentally supports human economy.

2.2.2 Uncertainty

The modern science of ecology is concerned with the diversity and complex inter-dependencies in ecosystems. Embedded within this science is the knowledge needed to maintain functioning and healthy ecosystems. Yet ecological inter-dependencies and the difficulties of fully understanding the effects of human activities on ecosystems create pervasive uncertainties (Mitchell 1997: 17-19,74-79; Holling et al. 1998: 352-354).

Chaos theory demonstrates how small errors in measurement can lead to actual outcomes that are very different from those predicted. The ecological effects of human activities may also follow a "non-linear" path. For example, unexpected "synergistic" or cumulative effects can produce relatively sudden, perhaps even catastrophic, changes when combinations occur, or unknown thresholds are passed. These possibilities challenge managerial abilities, promoting the development of a "new science," often referred to as complexity theory or complex systems thinking (Kay et al. 1999; Jackson 2000; Gunderson and Holling 2002).¹⁴ The rational response to this new knowledge in an increasingly crowded world is a change in attitude: "the world is far larger than human knowledge will ever be; certainty is a futile quest; respect and reverence for what we cannot know is as empowering as the pursuit of what we can

know" (Song and M'Gonigle 2001).

Given these inter-dependencies and uncertainties, a central goal of applied ecological science is to maintain ecosystem resilience, defined as "the buffer capacity or the ability of a system to absorb perturbations" (Berkes and Folke, 1998:6). This resilience is important because stressed ecosystems "tend not to change gradually but in lurches, through threshold effects and in surprises, whereby outcomes differ from predictive models not only quantitatively but qualitatively" (Berkes and Folke, 1998: 10). A sufficient margin of safety must be maintained by, for example, not extracting so much water that a system is pushed to a threshold that exposes it to significant and possibly irreversible degradation when a relatively minor drought or irregular weather pattern occurs.

Box 7: Wholeness and ecological integrity

The notion of wholeness is central to the concept of ecological integrity. As Angermeier and Karr (1994) note, "Integrity implies an unimpaired condition or the quality or state of being complete or undivided; it implies correspondence with some original condition." In this context, ecological integrity is generally used to describe the overall condition of an ecosystem relative to that of a natural or undisturbed system. This includes both biotic components, such as plant and animal life, and abiotic components, such as geological structure and hydrological processes. Rather than focusing on individual species or processes, ecological integrity reflects the broader structures (e.g. assemblages of plants, landforms) and functions (e.g. sediment transport, energy flow, hydrologic variation) in an ecosystem. Maintaining ecosystem integrity acknowledges that "it is the integration and interaction among the living and non-living elements of an ecosystem that enable it to function as a unit"

(Pardy 2003: 100).

The preservation of "ecological integrity" is an overarching objective to safeguard ecosystem features, such as resilience, elasticity and stress response, to allow ecosystems to maintain function and structure under changing environmental conditions (Higgs 2003: 122). For ecosystems to have integrity they must have the ability to operate under normal environmental conditions, cope with changes in

¹⁴This new science is based on the implications of the interrelated theories of complexity, and does not attempt to reduce the uncertainty and complexity inherent in complex phenomena assuming linear causality nor does it attempt to aggregate, assuming completely chaotic system. Instead, "complex systems thinking is an explicit attempt to embrace complexity and uncertainty within decision making through the use of complexity-based descriptive heuristics in the development of context-specific, adaptive, pluralistic and transparent planning and decision making approaches." McCarthy, D. 2003. Post-normal Governance: An emerging counter-proposal. *Environments*, vol. 31(1). For a general review see Kay et al. 1999, and for application to ecological systems see Gunderson and Holling 2002, and for application to human social/organisational systems see Jackson 2000.

environmental conditions, and continue to evolve and develop despite these stresses (Kay and Schneider 1994).

Box 8: Ecological integrity

“The condition of an ecosystem where the structure and function of the ecosystem are unimpaired by stresses induced by human activity, and the ecosystem’s biological diversity and supporting processes are likely to persist”

Parks Canada

“An ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes. Ecosystems have integrity when they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact.”

Panel on the Ecological Integrity of Canada’s National Parks

2.2.3 Prevention and precaution

To maintain ecosystem resilience and integrity, prevention of harm is far better than relying on remedies, compensation or remediation after the harm is done, especially as the full consequences of environmental damage are rarely known and often underestimated.

With rapidly advancing technologies and the increasing scale of economies, applying the precautionary principle has become an ecological imperative. This principle requires that when an activity may cause significant long-term harm to human health or the environment, absence of scientific proof of that harm should not forestall preventative action (Raffensperger and Tickner 1999). Precaution has an explicit scientific basis, but it also reflects the practical limits of managing natural systems in a changing and economically competitive world.

Central to the precautionary principle is a *presumption* of consequence in the face of uncertainty—the opposite to a “wait and see” attitude (Mitchell and Shrubsole 1997: 82). The approach is proactive, especially in the face of high risk activities, insofar as it places the burden of proof on those who propose such actions

to show they are safe, rather than on others to show they are unsafe. In the process, the regulatory burden of proving harm is shifted from regulators to resource users and polluters, demanding that such proof attain a fairly exacting level of probability (VanderZwaag 1993: 47,48,77).

One effect of this shift in thinking is a stronger emphasis on technological and process innovation to avoid harm, with a focus on minimizing waste through DSM and “clean production” that produces no effluent. This contrasts sharply with a focus on increasing resource supply and “end-of-pipe” regulation of waste discharges.

Box 9: Precautionary Principle

“Environmental measures must anticipate, prevent and attack the causes of environmental degradation. Where there are threats of serious or irreversible damage, lack of full scientific uncertainty should not be used as a reason for postponing measures to prevent environmental degradation.”

(1990 Bergen Declaration)

Prevention shifts regulation from a negative orientation (i.e. don’t exploit or pollute beyond a certain level) to a positive orientation that facilitates innovation and new opportunities. The focus is moving from the traditional regulatory model of “permissive regulation” to one of “preventative design” in decision making (M’Gonigle et al. 1994). This preventative design approach is based on creating new systems that are inherently “precautions” of their ecological context rather than regulatory systems that rely on an assumed “assimilative capacity” of the environment. For example, before waste permits and conditions for disposal are granted, a series of hurdles must be overcome. Before disposal into the environment is permitted, options such as waste prevention, on-site recycling, product reuse, destruction of hazards, and treatment to reduce or remove hazards would all have to be exhausted.¹⁵ This orientation has obvious implications for the DSM strategies and the soft path discussed in Chapter 1.

¹⁵Central to this procedure is the role of an independent technology assessment office. This structure would encourage state-of-the-art source reduction, and government would assume the role of forcing innovation (e.g. new technologies). In this way, the regulatory approach directly encourages preventative design. Positive economic incentives, such as direct financial and technical assistance, are used to promote the development and implementation of clean technologies. Negative economic incentives are used to minimize hazardous waste by increasing the cost of waste production, treatment, and disposal. Models of this type of regulation include the Massachusetts Toxic Use Reduction Act, and European Contracting Parties of the Oslo Commission (OSCOM) policy to reduce and terminate dumping of all industrial wastes into the marine environment. For a detailed discussion, see (M’Gonigle et al. 1994).

2.2.4 Sustainable consumption

Sustainable scale consumption is predicated on the fundamental idea that nature is finite, and that consumers (not just producers) have a responsibility to alter their behaviour accordingly. Central to determining the sustainable scale of consumption is the notion of “carrying capacity,” defined as the “maximum load” of production and consumption (i.e. population multiplied by per capita impact) that society can safely continue to impose on the environment (Wackernagel and Rees 1996: 158). As Wackernagel and Rees (1996) demonstrate in their studies of the “ecological footprint,” Western societies vastly exceed their carrying capacity. This footprint analysis means that the continuous expansion of material production is not possible. A shift to more efficient and smarter systems of production and consumption is required. In the following chapters, we consider how a sustainable scale of resource and energy “throughput” directly affects how we think about the critical unit of ecosystem functioning—the watershed.

Achieving a sustainable scale of throughput has specific policy implications. One is *dematerialization* to reduce the flow of materials and energy through society by improving the efficiency and productivity of resource use (e.g. low-flow toilets and fixtures). Another is *substitution* to replace scarce resources with alternatives. This is exactly the point of including the soft path to shift our economy from a focus on *producing* commodities to *providing* services (e.g. use of rain water or reclaimed wastewater for irrigation rather than fresh water). To achieve sustainable consumption requires broad technological and process innovation that will increase efficiency. DSM is a prime tool to achieve this innovation.

2.3 The challenge of developing sustainability

Institutions around the globe grapple continuously with the elusive concept of sustainability. Historically, economic growth and development have been equated to increasing material and energy throughput. Holling et al. (1998: 354) note that, in response, the “political window that drives “quick fixes” for solutions simply leads to more unforgiving conditions for decisions, more fragile natural systems, and more dependent and distrustful citizens.”

This approach was acceptable in the past when our political and economic systems had so much open space that they could undervalue the role of the natural environment in human prosperity. In this frontier context, economic theory and practice took a largely instrumental

Box 10: Sustainable consumption

“If we are to move forward toward our goal of sustainable communities ... we will need to unlock greater results from the materials we currently consume. Many experts believe we must learn how to get 4 to 10 times more service out of every tonne of steel, every tonne of wood fibre and every litre of water than we do today. This can be done. And it will save costs as well as the environment. We just need to make a more concentrated effort.”

(Paul Martin, Minister of Finance for Canada, 2000)

“A reduction in the volume of goods and services would be compensated for by sharing, reusing, and recycling goods and services, by promoting industrial ecology, and by emphasising ways of being that require minimal material inputs. The social system would be infused with ecological thinking, an appreciation of the fragility and magnificence of the natural world and the sanctity of place. In an ecological society, social wealth would be measured in terms of eco-system health and the integrity of the social structure: concretely in terms of high levels of biodiversity, old growth forests, clean water, adequate stocks of fish, and clean pollution-free, safe neighbourhoods.”

(Gale 1997: 15)

view of nature: “The dominant development paradigm sees the planet merely in terms of resources, ‘raw materials,’ to be exploited ‘developed’ thereby ‘adding value’ and exchanged for money on the world market. This approach aims at the maximization of production, and disregards the destruction and degradation which attend it” (Hayward 1994: 104; McKenzie 2002: 20).

As society bumps up against physical limits, ecological decline accelerates and becomes more visible. The North American Commission for Environmental Co-operation notes that these assumptions are no longer valid as the “prevailing emphasis on consumption—with high levels of waste, energy use, and greenhouse gas emissions—jeopardizes the capacity of natural resources and systems to support future generations” (NACEC 2002).

“The main flaw of sustainable development lies in its failure to challenge the fundamental assumptions of the dominant development model that it seeks to replace” (Rochette 2002). The solution lies less in incremental reforms of existing processes (e.g. more sensitive supply strategies) than in innovative new approaches (e.g. transformative demand strategies). This is the challenge of moving from “sustainable development” to “developing sustainability.” By embracing the potential of innovation

and developing sustainability in the context of a comprehensive approach—that *maintains ecosystem services*, recognizes *uncertainty*, is *preventative and precautionary*, and promotes *sustainable consumption*—new possibilities emerge. And, in embracing these possibilities, it is important to remember that government is only one actor within an intricate network of governance. The challenge for government is to create and guide the institutions and incentives that facilitate this transformation.

2.3.1 Embedding nature

Natural ecological systems are modelled on self-sustaining *circular* systems that recycle resources. In a

Box 11: Ecological system in decline

“Anthropogenic greenhouse gas emissions have pushed atmospheric concentrations of carbon dioxide to their highest level in at least 200,000 years, causing climate change. Scientists are increasingly concerned that abrupt, unpredictable climate shifts could occur. The Earth’s protective ozone layer was badly damaged during the 20th century by man-made chemicals. Vast areas of native forests, grasslands, coral reefs, and other ecosystems have been destroyed or damaged, invasive species have spanned the planet, and industrial pollution is ubiquitous. The majority of the world’s fisheries are depleted or declining and large marine fish have suffered population declines of roughly 90% since 1950. As result of the cumulative impact of these changes current rates of extinction are estimated to be 100 to 10,000 times the rate during periods of stasis, and are on par with the cataclysmic epoch when dinosaurs disappeared from the planet 65 million years ago. Climate change is expected to accelerate the decline in global biodiversity in the decades ahead.”

(Boyd 2003)

“Swedish scientists Matts Dynesius and Christer Nilsson report that 77 percent of the large river systems in the U.S., Canada, Europe, and the former Soviet Union—essentially the northern third of the world—are moderately to strongly altered by dams, reservoirs, diversions, and irrigation projects. They warn that, because of the extent of river modification key habitats such as waterfalls, rapids, and floodplain wetlands could disappear entirely from some regions, extinguishing many plant and animal species that depend on running water habitats. Perhaps the most startling finding about the scale of human hydrological impacts is that the weight of impounded waters at high latitudes in the northern hemisphere has slightly altered the tilt of the earth’s axis and increased the speed of the earth’s rotation.”

(Postel and Richter 2003: 14)

world of high resource throughput, however, economic systems have become dependent on *linear* processes. This is evident in the water context with large-scale supply infrastructure that has encouraged high levels of consumption. The infrastructure has created great wealth in the past; however, in the future, the potential lies in bringing these systems into a natural balance with the emphasis on circular patterns of production and consumption that “reduce, reuse and recycle.” Despite the comprehensive and pervasive character of our natural dependence, these concerns and possibilities are still largely marginalized into a set of environmental concerns. In reality, the significant opportunities exist where we can redesign the way we conduct business, in order to design with nature. The concept of ecological governance addresses this situation by embedding nature, or the environment, within the core of decision making.

2.3.2 Water sustainability - Threats and criteria

The scale and intensity of human activity in and around bodies of fresh water poses major threats to the sustainability of the aquatic environment. Municipal and industrial extractions deplete many sources of fresh water, while discharges of wastewater and pollution pervasively undermine water quality. Water policy often fails to address these cumulative impacts on aquatic ecosystems that threaten the ecological and economic services Canadians depend on.

Achieving water sustainability in Canada requires a basic shift to put the ecosystem in the centre of planning, limit the expansion of built infrastructure, address cumulative effects, and harness conservation. The next source of “new” water is not new water at all, but dramatically better management of the water we are already using.

2.4 Key elements of ecological governance

To develop sustainability, a critical place to start is the immediate context for human activities: the watershed. Historically, managers have focused on the physical environment of managing the watershed and not the human activity affecting it. A sustainable future requires that we begin to manage the whole system, including both human activity and the physical watershed, with the goal of maintaining ecosystem processes and functions.

Put another way, to safeguard the watershed, managers must identify and understand the necessary “green infrastructure” first, and then look at what activi-

Box 12: Threats to freshwater ecosystem services from human activities

Human activity	Impact on ecosystems	Services/benefits at risk
High or increasing water consumption	Increases pressure to dam and divert more water and to drain wetlands; increases water pollution, aquifer overpumping, and contributes to climate change	Virtually all aquatic ecosystem values
Dam construction	Alters timing and quantity of river flows, water temperature, nutrients and sediment transport, delta replenishment; blocks fish migrations	Habitat for native species, impacting recreational and commercial fisheries Deltas and estuarine fisheries
Dike and levee construction	Destroys hydrologic connection between river and floodplain habitat	Habitat, sport and commercial fisheries, natural floodplain fertility, natural flood control
Excessive river diversion	Depletes streamflows to damaging levels	Habitat, sport and commercial fisheries, recreation, pollution dilution, hydropower, transportation
Interbasin transfers	Alters timing and quantity of river flows, water temperature, nutrients and sediment transport, delta replenishment; destroys hydrologic regime; alters production and nutrient cycling; introduces exotic species and eliminates native species	Habitat, recreational and commercial fisheries, maintenance of deltas, productivity of estuarine fisheries
Deforestation/poor land use	Alters runoff patterns, inhibits natural recharge, fills water bodies with silt	Water supply quantity and quality, fish and wildlife habitat, transportation, flood control
Pollution - water and air	Diminishes water quality, alters chemistry of rivers and lakes	Water supply, habitat, commercial fisheries, recreation, human health
Overharvesting	Depletes species populations	Sport and commercial fisheries, waterfowl, other biotic populations
Introduction of exotic species	Eliminates native species, alters production and nutrient cycling	Sport and commercial fisheries, waterfowl, water quality, fish and wildlife habitat, transportation
Draining of wetlands	Eliminates key component of aquatic environment	Natural flood control, habitat for fish and water fowl, recreation, natural water purification
Climate-altering activities and pollutants	Potential for dramatic changes in runoff patterns from increases in temperature and changes in rainfall	Water supply, hydropower, transportation, fish and wildlife habitat, pollution dilution, recreation, fisheries, flood control

Adapted from (Postel and Richter 2003: 14-15)

Box 13: Criteria for sustainable use of freshwater resources

“Sustainable use is defined as achieving four things simultaneously:

- (1) providing all humans with access to safe, clean supplies to meet their basic needs,
- (2) sustaining healthy freshwater ecosystems that provide socially valued ecosystem services and products,
- (3) enabling the remaining water (after meeting 1 and 2) to serve the broadest possible array of socially valued purposes, and
- (4) doing all of this in a way that does not compromise the abilities of future generations to do the same.”

Brian Richter personal communication
in (Galloway and Pentland 2003: 9)

ties can take place around the essential green infrastructure. Then we look at the human needs, and think of ways to meet them that are consistent with maintaining ecosystem integrity. This is the context for ecological governance.

2.4.1 From ecosystem management to ecosystem-based management

The field of “ecosystem management” emerged in the 1980s to give presence in decision making to multiple ecosystem values. Today, with greater emphasis on maintaining ecosystem integrity, a shift is occurring to “ecosystem-based management” (ESBM) (Scientific Panel for Sustainable Forest Practices in Clayquot Sound 1995; Song and M’Gonigle 2001) that takes the ecosystem as the basic unit of analysis and is committed to ecosystem integrity. With the ecosystem as a starting point, ESBM emphasizes the need to adapt economic, political and social processes to fit within that unit. Instead of managing a watershed as an adjunct to the water supply, maintaining healthy watersheds is considered a prerequisite to water management; water allocations are constrained by the larger need to ensure that natural processes are maintained. Under ecosystem-based management, human activity is situated within the structure and functions of natural contexts—a shift that requires humans to manage themselves to fit into nature, not the reverse.

In the emerging field of “industrial ecology,” economic production is designed to mimic natural systems. Reuse and recycling are at its core—just as the waste of a natural ecosystem (e.g. a fallen tree) becomes nourishment for another system (e.g. course material for

new soil), so should waste from the industrial sector become an input for another (Powers and Chertow 1997). More generally, industrial production should build such linkages into the whole structure of industrial design. Economic incentives and policy measures are designed to ensure the system is cyclical by undertaking “life-cycle assessment” of development proposals, for example, or by encouraging new product designs that create no waste or can be recycled into other products at the end of their life.

These ideas are not new in Canada. And as Prime Minister Paul Martin commented when he was Minister of Finance, the time has come to apply them. (see Box 14)

2.4.2 Matching authority to jurisdiction

To undertake ESBM, formal jurisdictions of a governing body should *match* both the geographical and temporal scales of the problem being addressed. Many existing political boundaries have no ecological foundations, while political processes are biased toward the short term. Natural resources like water require institutionalized, long-term planning that can integrate *geographically* through and across watersheds, and *temporally* into a dynamic and uncertain future.

Matching jurisdictional boundaries to the affected geographic footprint naturally tends to re-orient decisions to facilitate consideration of environmental factors. In some countries, a recognition of this tendency has led to the creation of independent watershed management bodies whose mandate is to determine ecosystem limits to water use—source and sink services—and to create mechanisms to live within these limits.

As will be discussed in later chapters, water basin management (or Integrated Water Resource

Box 14: Abandoning waste

“If we are to move forward toward our goal of sustainable communities ... we will need to abandon the very concept of waste. This will require a fundamental shift in our thinking—away from linear models of production and closer to the example that nature sets for us. The traditional model takes in virgin materials at one end, creates waste and emissions during production, and throws away potentially valuable materials after consumer use. But nature long ago came up with a superior design. One where all waste is reused as food or energy elsewhere. Nature’s reuse and recycling of materials through a continuous or closed loop system is not radical. But it is rational. And we would do well to expand our powers of imitation.”

(Paul Martin, Minister of Finance for Canada, 2000)

Management—IWRM) can be accomplished by creating a single new management body or by setting rules for co-ordination between existing bodies. Regardless of the specific approach, some institutional mechanism must have authority over all hydrological concerns in a given basin. This authority must include surface and ground water, water quality and quantity, flood control, soil conservation, wetlands conservation, fisheries, recreation, stream enhancement, dams and reservoirs, pollution, and land uses with significant watershed impacts, such as forestry, mining, agriculture and urban development.

Watershed management has a local bias. Recognizing that local people and institutions rely on and are usually most aware of local conditions, local entities are best able to respond to environmental feedback quickly, and tailor solutions to these conditions. However, local bodies must also be “nested” within higher level institutions that hold such bodies accountable to their mandate, while the broader agencies can co-ordinate with other such institutions and participate in larger collective actions where desirable. The result is a decentralized, but co-ordinated, multi-tiered governance system that applies the principle of *subsidiarity* by allocating management responsibilities to the lowest level of government or social organization capable of effectively undertaking that management (Hunter et al. 2002: 416).

This local management within the context of central monitoring and accountability is, in fact, a growing regulatory trend increasingly referred to as “democratic experimentalism” which itself can be seen as a manifestation of a “new governance” movement.

Such an approach to governance is directed to overcoming the *vertical* fragmentation of higher from lower levels of government, and the *horizontal* fragmentation

Box 15: Principle of Subsidiarity

“A famous formulation of [the Principle of Subsidiarity] reads as follows: ‘It is an injustice and at the same time a grave evil and disturbance of right order to assign to a greater and higher association what lesser and subordinate organisations can do. For every social activity ought of its very nature to furnish help to the members of the body social and never destroy and absorb them.’... [This principle] teaches that the entire will gain in authority and effectiveness if the freedom and responsibility of the lower formations are carefully preserved, with the result that the organisation as a whole will be ‘happier and more prosperous.’” (Schumacher 1999: 205-206)

Box 16: Democratic experimentalism

Democratic Experimentalism is a new form of government that entails decentralized power to enable citizens and other actors to utilize their local knowledge to fit solutions to their individual circumstances. Important in this concept is that regional and national coordinating bodies require actors to share their knowledge with others facing similar problems. This information pooling increases the efficiency of public administration by encouraging mutual learning among its parts and heightens its accountability through participation of citizens in the decisions that affect them. In democratic experimentalism, sub-nation units of government are broadly free to set goals and to choose the means to attain them. Regulatory agencies set and ensure compliance with national objectives by means of best practice performance standards based on information that regulated entities provide in return for the freedom to experiment with solutions they prefer.

Source: (Dorf and Sabel 1998)

between different departments or municipalities in a watershed. The goal is a management system that focuses on promoting watershed health through integrated management, and to achieve that integration by devolving as much authority to the “lower” levels as is consistent with achieving better results.

Given the complex constellation of existing entities—federal, provincial/territorial, first nations, and local governments, NGOs, associations and community groups, business and industry—the experimentalist challenge of integration/devolution is significant. Many techniques have been developed to address this challenge, from the use of “bridge” documents (e.g. inter-jurisdictional agreements, legally authorized coordination managements agreements, MOUs, statements of principle) to setting “consistency requirements” across sectors. While decentralization is the goal, senior government leadership is critical to achieving these outcomes.

2.4.3 Adaptive management

Adaptive management is an important operational consideration when dealing with natural resources and ESBM. Given the complexity of a natural world that can never be fully modelled or managed, and the inevitable pressures generated by human uses, decision making is always undertaken in the face of uncertainty and dynamic change.

Adaptive management is a well-accepted management approach expressly developed to deal with “surprises” by institutionalizing a process of continual

experimentation and learning. Plans and policies are always subject to modification in response to ecological and non-ecological feedback. This informed process of “trial and error” emphasizes provisional, reversible decision making, with careful monitoring of impacts to refine decision making. Adaptive management differs from conventional approaches because it addresses uncertainty directly using the management process as a tool to gain critical knowledge. The overall goal of adaptive management is to develop an optimal management capacity. This is accomplished by maintaining ecological resilience that allows the system to react to inevitable stresses, and by generating flexibility in institutions and stakeholders that allows managers to react when conditions change (Holling 1978; Gunderson 1999; Johnson 1999; Gunderson and Holling 2002).

Adaptive management can be viewed as an inherently precautionary strategy insofar as it fosters dynamic governance capable of responding to unpredictable changes with institutional adaptability and resilience (IUCN 2003: 3). At a monetary level, this approach is more costly than traditional approaches because it attempts to account for multiple variables. It is also data intensive, and requires more co-operation across disciplines and jurisdictions, within agencies and among stakeholders.¹⁶ Extensive monitoring of ecosystem conditions through carefully selected indicators is critical, “[w]hat gets measured gets managed” (Hunter et al. 2002: 145). Despite potentially higher short-term financial costs, adaptive management is more economical when all costs are taken into account, especially over the medium and longer terms (Johnson 1999). “Flexible social systems that proceed by learning-by-doing are better adapted for long-term survival than are rigid social systems that have set prescriptions for resource use” (Holling et al. 1998: 358).

In the water management context, adaptive management has many manifestations including:

- provincial legislation and policies that require periodic reporting and planning by watershed bodies, local governments and water utilities;
- flexible timing, quantities and allocations of water withdrawals at the watershed level as understanding of impacts on local biodiversity and aquatic ecosystem health conditions change;
- implementation of certified environmental management systems (EMS), such as ISO 14001, to create

Box 17: Adaptive management

“Adaptive management as a resource technique began in the 1970s ... [it] tries to incorporate the views and knowledge of all interested parties. It accepts the fact that management must proceed even if we do not have all the information we would like, or we are not sure what all the effects of management might be. It views management not only as a way to achieve objectives, but also as a process for probing to learn more about the resource or system being managed. Thus, learning is an inherent objective of adaptive management. As we learn more, we can adapt our policies to improve management success and to be more responsive to future conditions.”

(Johnson 1999: 8)

- opportunities for self-critical reflection and development of internal environmental policies; and
- disclosure requirements, and information clearing-houses supported at the federal level

2.4.4 Business and civil society roles

ESBM, the matching principle, subsidiarity, democratic experimentalism and adaptive management are foundations of ecosystem governance. The implementation of these emerging principles, however, is primarily of concern to governments as they attempt to arrive at effective decisions and manage human interactions with natural resources such as water. Leadership by all levels of government is clearly critical for success.

Equally as important as developing sustainability and creating an ecological governance regime is action by business and industry, and the full engagement of broader civil society. Participation is key to allowing a productive system of ecological governance to emerge. Ultimately, full engagement and a synthesis of the environment and the economy facilitates—and, in return, is reinforced by—the development of a water “ethic.”

To support participation, many techniques have been developed to foster a greater level of *deliberative* as opposed to *representative* democracy. Resource decisions inevitably involve trade-offs between economic, social and ecological objectives, and inherently include value judgements and competing interests. This situation suggests the need for meaningful stakeholder participation to improve decision making and create more durable results as stakeholders take greater ownership of deci-

¹⁶Although adaptive management can be more expensive in the short term, it may prove less expensive in the long run if it leads to more effective management.

sions. More participation also enhances implementation and develops broader ecological awareness. The result is often characterized as enhanced “social capital”—stronger civic relationships of trust, goodwill and engagement (Gunton and Day 2003; Lehtonene 2004).

A growing inventory of deliberative methodologies indicates the need for individual citizens and groups to have access to balanced and accurate information, time to explore the intricacies of issues through discussion, and power to affect decisions. Common ways to enhance deliberation include citizen juries, study circles, planning cells, national issues forums, town meetings, consensus conferences, choicework dialogues, and scenario workshops. The overarching objective of these experimentalist strategies is to develop good governance practices including greater transparency, accountability, participation and representation in decision making. Government can promote citizen participation by establishing public rights of access to information and to judicial remedies (e.g. citizen suits/private prosecutions), or by expanding the public trust doctrine to allow for public standing to challenge governmental decisions that may result in substantial ecological degradation. Other institutional changes could include support for independent watchdog organizations, whistle blower protection, and greater resources to build citizen capacity.

Significant participation is most effective where citizen interest is strong. Collaborative efforts in watershed planning require ongoing opportunities to engage “civil society.” Above all, the procedural commitment to improve participation must be accompanied by a commitment to substantive innovation. Otherwise, as some have charged, participation could easily become a “new tyranny” (Cooke and Kothari 2001).

Ultimately, better decision making results in the harmonization of ecological, economic and social objectives. *Ecological modernization* promotes the idea that these objectives can be harmonized through dramatic efficiency improvements in production and consumption. By removing perverse subsidies, promoting economic efficiency and conservation, re-orienting markets and encouraging the development and adoption of new technologies, movement towards a sustainable scale for the economy is possible. The integration of environmental concerns in production and consumption is critical (Murphy 2001). Ecological modernization

Box 18: The need for public engagement

“The public, in my opinion, is miles ahead of both business and government on water issues, at least in terms of its alarm at the possible outcomes and its willingness to put effort into solutions. The critical issue is to improve communications between all three parties: civil society, government bureaucracies, and corporations.”

Marq de Villiers in an interview in *Corporate Knights* - 2004 Water Issue: 29

demands a broader approach to environmental policy—one that promotes new kinds of economic growth and competitiveness to create opportunities for profitable and “green” innovation (Esty 1999, Murphy 2000).

Macro-economic restructuring is a central element of ecological modernization. Gouldson and Murphy (1997: 75) describe this changing sectoral composition:

... ecological modernization seeks structural change at the macro-economic level. It looks for industrial sectors which combine higher levels of economic development with lower levels of environmental impact. In particular, it seeks to shift the emphasis of the macro-economy away from energy and resource intensive industries towards service and knowledge intensive industries.

Government must establish the imperative for change and create incentives to achieve it. Many mechanisms are available to do this, from regulations that mandate full-cost accounting, extended producer responsibility and “polluter pays” provisions to new processes for licensing such as the “prior justification procedure” that ensures producers use the best emerging technologies, and redistributive arrangements that shift the tax burden from labour onto resource users (M’Gonigle et al. 1994).

Developing a new ecological ethic is difficult because it demands that we change behaviour. Conventional education programs that focus on information dissemination fail to address the entrenched barriers associated with changing behaviour. New techniques, such as “social marketing” are needed to address barriers prior to program design and implementation (Maas 2003: 15).¹⁷

¹⁷The Region of Durham in Ontario has adopted this approach into its outdoor water efficiency program with notable success. The program commencing 1997, with the region employing summer students in a community-based social marketing to work with homeowners to reduce residential lawn watering resulting in a 32% reduction in peak water demand over a three-year period (Maas 2003: 16).

Box 19: Community-based social marketing

Community-based social marketing draws heavily on research in social psychology which indicates that initiatives to promote behaviour change are often most effective when they are carried out at the community level and involve direct contact with people. The emergence of community-based social marketing over the last several years can be traced to a growing understanding that programs which rely heavily or exclusively on media advertising can be effective in creating public awareness and understanding of issues related to sustainability, but are limited in their ability to foster behaviour change.

Community-based social marketing involves four steps:

- 1) identifying the barriers and benefits to an activity,
- 2) developing a strategy that uses tools proven effective in changing behavior,
- 3) piloting the strategy, and
- 4) evaluating the strategy once it has been implemented.

Source: (McKenzie-Mohr 2004)

Moving to a water ethic

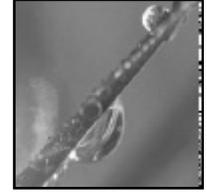
Developing a water ethic requires reconnecting modern society to water's life-giving role. A water ethic can serve as a guide in the face of complex decisions about natural systems. Sandra Postel (1997: 185) captures the significance of such a water ethic:

Adopting such an ethic would represent a historical philosophical shift away from the strictly utilitarian, divide-and-conquer approach to water management and toward an integrated, holistic approach that views people and water as related parts of a greater whole. It would make us stop asking how we can further manipulate rivers, lakes, and streams to meet our insatiable demand, and instead ask how we can best satisfy human needs while accommodating the ecological requirement of healthy water systems.

The river is, indeed, within us.

Chapter 3

Urban Water In Canada



*Laws and institutions must go hand in hand
with the progress of the human mind.*

Thomas Jefferson, 1786

Following the tragedies in Walkerton in 2000 and North Battleford in 2001, the focus in Canada has been on water quality—ensuring water is safe for human consumption. Since 2001, water policy and management strategies have been rapidly evolving, and many now include source protection as a priority. Other pollution-driven issues, such as the decline in aquatic species, have also increased awareness of the need to protect freshwater resources.

Although water quantity issues—supply and availability—receive less attention than water quality issues, they too are of critical concern. In Perth, Ontario, for example, area residents initiated a community-based campaign to prevent OMYA Canada Inc. from withdrawing large amounts of water from the Tay River, fearing it would damage the river’s ecology and potentially reduce the town’s water supply (Powell 2003: 20; Campbell 2004: 3).

In addition to being a fundamental part of Canada’s natural landscape, water is also critical to the economy—representing a foundation for our high standard of living. In 2000, Canadian business earned \$1.4 billion from water-related goods and services,¹⁸ and in 1992 Environment Canada estimated that water contributed \$7.5 to \$23 billion annually to the economy. Although this estimate is over 10 years old, it demonstrates the significance of water to the Canadian economy. The full value of fresh water is incalculable¹⁹ and its inherent

value is indisputable.

This chapter provides a snap shot of water quantity and supply availability in Canada and an overview of the institutions and legal framework that govern and manage Canadian freshwater resources. After a brief discussion about water availability, water use, and threats to water resources, we explore the institutional, jurisdictional and legal complexities associated with water management. The extent of this complexity represents a significant barrier. If sustainable water management is to become a serious goal in Canada, the governance of freshwater resources—specifically the institutions and management approach—needs reform.

3.1 Water in Canada

This section focuses on the state of Canadian freshwater resources, with particular emphasis on the urban context. To begin, key background information about water availability and the limits of supply is presented in an attempt to dispel the seemingly unshakable “myth of abundance,” which is often cited as a root cause of the resistance to change Canadian water use habits. Low prices and poor pricing structures further entrench high levels of use. The ramifications of profligate water use are significant, and are exacerbated by the uncertain impacts of climate change.

¹⁸Water-related goods and services include a diversity of systems, equipment and services related to water supply and conservation, wastewater management and sewage treatment. This includes manufacturing industries that produce water-disinfection systems, water clarification systems, filtration, wastewater treatment and industrial processes and storage systems. Other goods include the equipment and technologies for freshwater supply, delivery and water handling. Services include water delivery and water handling systems, maintenance and repair, and related consulting engineering and analytical services for freshwater, wastewater and stormwater (Statscan 2003: 31).

¹⁹Accurately measuring and assigning economic values to environmental goods and services is a difficult (if not impossible) task. However, calculating the value of certain services, such as providing clean drinking water, can be a useful indicator. For example, the 40,000 residents in Caledon, Ontario rely on groundwater as a drinking water source. The replacement cost of Caledon’s groundwater drinking water service (through enhanced treatment of surface water) has been calculated at \$33 million annually (Environment Canada 2004:128).

3.1.1 Myth of abundance

Compared with most other nations around the world, Canada is well endowed with fresh water. Encompassing approximately 7% of the world's land-mass, Canada has 9% of its renewable water and only 0.5% of the global population (Environment Canada 2003). The Great Lakes are one of the largest sources of fresh water in the world. However, these figures are misleading because much of Canada's fresh water is unavailable for human use.

Many of the country's water sources and major river systems are located far from where the majority of the population lives. An estimated 12% of Canada, or 1.2 million square km, is covered by lakes and rivers, but only 3% of that area is located in inhabited regions (Statscan 2003). Approximately 60% of Canada's fresh water flows north, primarily to the Hudson Bay and Arctic watersheds, while 85% of the Canadian population lives within 300 kilometres of the southern Canada/U.S. border (Environment Canada 2003). Despite the seeming abundance of fresh water associated with The Great Lakes Basin, most of the water it

contains is unavailable for sustainable use.²⁰

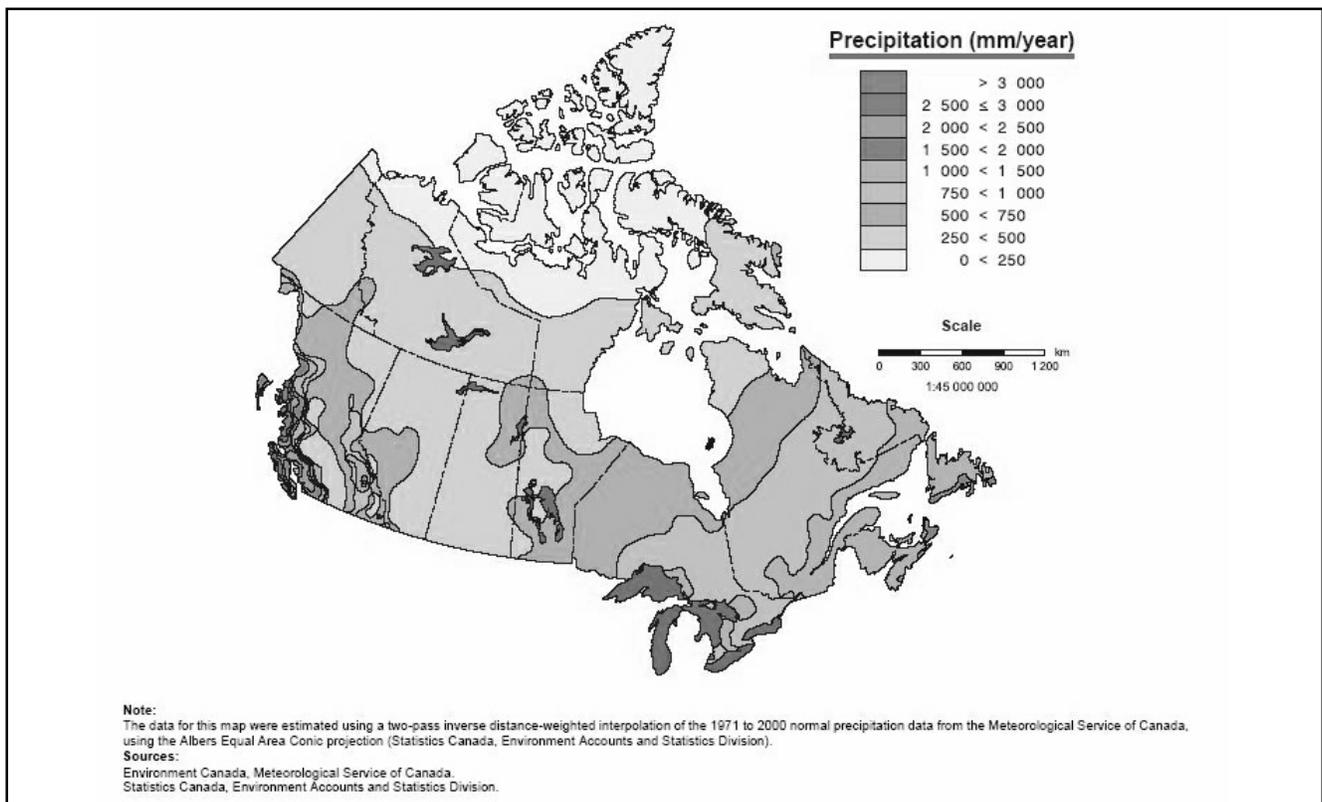
In the south where the majority of Canadians live, water availability varies greatly from region to region. Portions of Canada's Atlantic and Pacific coastal areas receive abundant rainfall (averaging between 1100 and 1400 millimetres of precipitation per year) while the Prairies fluctuate between flood conditions in the spring and near drought conditions in the summer, receiving less than 500 millimetres of precipitation annually (Environment Canada 2003).

3.1.2 Limited supply - An emerging reality in Canada

Water scarcity is a real concern in many parts of Canada, particularly in urban areas where the geographic concentration of human activity creates significant strains on existing, and limited, water resources.

Between 1994 and 1999 one in four Canadian municipalities reported water shortages due to increased consumption, drought or infrastructure constraints (Environment Canada 2002). Environment Canada's Web site states that fresh water in southern Canada is

Box 20: Canadian precipitation 1971-2000



²⁰Since the majority of Great Lake water is not renewable (i.e. our water "capital"), only the much more limited renewable water (i.e. our water "interest") can sustainably be used without permanently reducing lake levels or groundwater supplies.

“heavily used and often overly stressed.” In 2001, the Commissioner of the Environment and Sustainable Development commented that “at the current rates of use, the strain on the available supply of fresh water in the Great Lakes basin may contribute to decreased water levels, which could cause significant environmental damage and substantial social costs” (CESD 2001:24).

Many other regions, such as the Prairie provinces and the Okanagan Valley, face water demands that either exceed or are approaching the limits of their natural supply. In the Assiniboine-Red River Basin, home to more than 1.25 million Canadians, annual stream flow is only about 1,200 cubic meters per person, and is highly variable from season to season and year to year (Statscan 2003). By way of comparison, the average Canadian actually uses 1500 cubic metres of water per year.

In British Columbia, over 17% of surface water sources have reached or are nearing their capacity to reliably supply water for extractive uses. Many groundwater aquifers are also nearing water use capacity, with one third of aquifers vulnerable to contamination due to low water levels (MELP 1998: 9-12). The impacts of these limitations are significant. In 2003 approximately 25% of the province’s water supply systems were stressed, with two-thirds of those systems imposing water restrictions and 20% facing unusual or increased expenditures resulting from drought conditions (LWBC 2004: 1).

3.1.3 Ground water - The hidden resource

Groundwater is a crucial but under-appreciated and misunderstood resource in Canada. It is critical to satisfying drinking water needs and is a vital part of the hydrological system and health of the environment. Almost 10 million Canadians rely on groundwater for daily use, and the number is growing (Natural Resources Canada 2004a).

Groundwater use varies widely in Canada. Only 27.7% of Quebec residents depend on groundwater, while almost 70% of those living in New Brunswick, and 100% of the population in Prince Edward Island rely on it for drinking water needs (Environment Canada 2004a).

In the Great Lakes Basin, about 11.5 million residents in both Canada and the United States use groundwater for domestic purposes, and it is used extensively for agricultural and industrial purposes. Groundwater contributes more than 50% of the flow to rivers and

streams that feed the Great Lakes, sustaining important ecological resources, such as fisheries and wetlands (Grannerman et al. 2000; Gordon Foundation 2004: 6). In this region, groundwater pumping affects an entire water basin. A recent scientific study showed that pumping had reversed the direction of flow away from Lake Michigan (US Geological Survey 2000).

The Great Lakes Basin is one example of groundwater resources under stress. Other areas, such as the Fraser Valley in British Columbia, near Cache Creek and along coastal areas in the Gulf Islands, have documented evidence of groundwater withdrawal being greater than replenishment (WLAP 2002). Recently, in Estevan Saskatchewan, excessive water pumping significantly dropped the local water table. With a recharge rate of only 1mm to 3mm per year, the local water table is expected to take thousands of years to fully recover (Campbell 2004: 6).

Alphonso Rivera (2004: 6), Canada’s chief hydrologist, believes “the increase in groundwater use in the last 30 years and current trends strongly suggest that groundwater will become a more important component of water supply in the future of Canada” (Rivera 2004: 6). Yet the understanding and management of this resource is insufficient in Canada.²¹

3.1.4 Canadians - High urban water users

A previous report examined Canadian water use in detail.²² Canadians are intensive water users, especially in the urban sector. In 1999, the average Canadian used 343 litres per capita per day for residential use alone. When other municipal water use categories are included—light industrial, commercial, institutional and wastage-water use averages about 600 litres per capita per day (Environment Canada 2002).

In terms of total water use,²³ the Canadian average is 4,400 litres a day, or approximately 1,500 cubic metres per Canadian each year. By comparison, these water use levels are approximately 2.5 times the levels in European cities with similar standards of living for residential use and 4 times the levels for total water use (OECD 1999). In a 2001 report, Canada ranked 28th out of 29 OECD countries in a comparison of per capita water use (Boyd 2001). This poor showing relative to other OECD countries underscores how far Canada has to go before becoming a leader in *how* water is used, as opposed to

²¹For a detailed discussion of groundwater management across provinces see the forthcoming report from the Walter and Duncan Gordon Foundation *Buried Treasure—Groundwater Permitting and Pricing in Canada* by Linda Nowlan.

²²See UWDM Project’s Report 1—*Flushing the Future?*

²³In addition to municipal use, total water use includes other sectors such as agriculture, mining and power production.

how much.

Within Canada the amount of water used ranges enormously from city to city. A survey of major Canadian cities found a four fold difference between high and low water users. Winnipeg, Edmonton and Waterloo use less than half the amount of water used in Montreal, Calgary, Hamilton or St. John's (Brandes and Ferguson 2003).

While Canada's high water use is of significant concern, the fact that it continues to rise is of even greater concern. Over the past 20 years, water use in Canada has increased by 25%—in contrast with many other developed nations, including the United States where overall water use has decreased. The upward trend in Canada has continued throughout the 1990s, with total residential water use increasing 21%, and total municipal water use increasing 6% (Environment Canada 2001a; Brandes and Ferguson 2003).

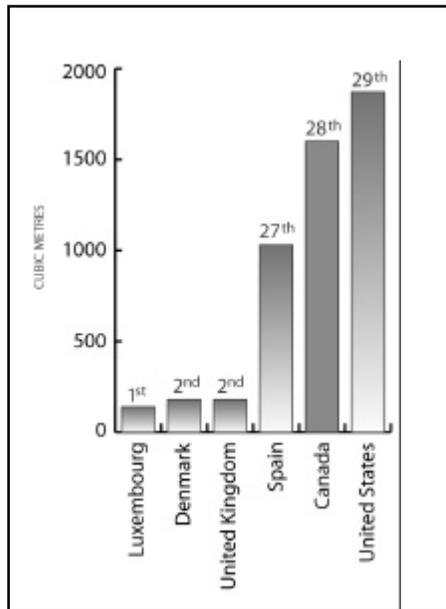
3.1.5 Low prices, high demand

Canadians are extravagant water users for many reasons—insufficient consumer awareness of water issues, lack of incentives (e.g. rebates for efficient fixtures), consumer resistance to new technologies (e.g. low-flow toilets), and out-dated regulations (e.g. plumbing and building codes). The North American fondness for expansive lawns and historical habits of excessive water consumption also contribute to over use. While the list of reasons is extensive, many observers credit the myth of abundance as the primary culprit, with low water prices simply reinforcing the myth.

Historically, water prices were low due to government grants and incentives for infrastructure development aimed at ensuring public health and encouraging housing developments and industrial growth (Loudon 1994: 235; Loudon 1994a: 249). A growing number of authorities now recognize that low water prices are no longer in the best long-term interests of Canadian society. In fact, low prices encourage wasteful and excessive use, artificially increase demand, provide little incentive for efficiency improvements and make overcapitalization almost inevitable (Tate 1997: 47).

Canadian water is the cheapest in the industrialized

Box 21: OECD Comparison



Freshwater Abstractions, Boyd 2001

world, with households paying from 20 to 60 cents per thousand litres of water, or 0.02 to 0.06 cents per litre (Environment Canada 1996). “On average they are less than half those in most OECD countries and roughly cover half the costs of supplying water and treating waste water” (OECD 2004: 71).

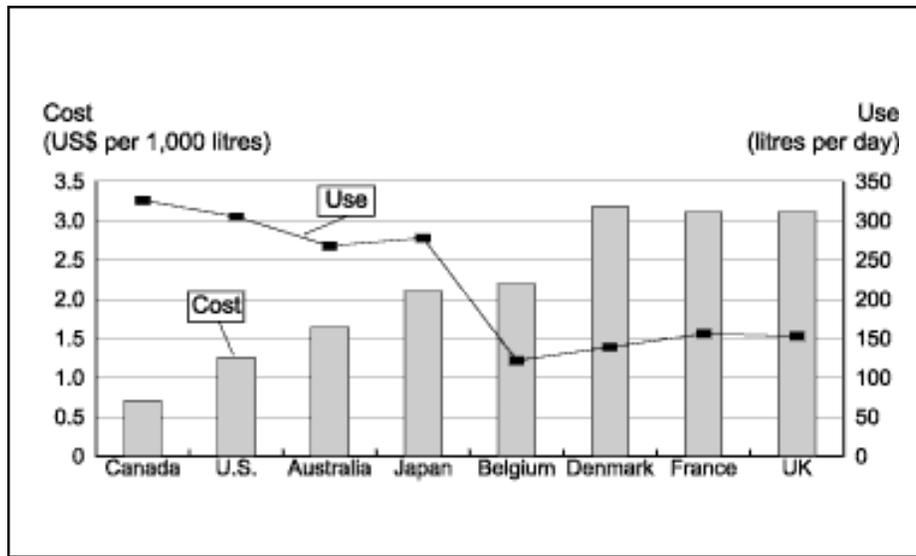
Pricing structure is an equally important consideration influencing water use. In Canada, volume-based and flat-rate structures are the two main types of pricing structures. With a volume-based pricing structure, cost is based on volume used. It is important to note, however, that the rate structure can be increasing,

decreasing or constant as water use increases, making the per unit cost of water higher, lower or constant as more volume is used. With a flat-rate structure, consumers are charged a fixed amount regardless of the volume used. Flat-rate is the most common pricing structure in Canada, used by 56% of utilities (Environment Canada 2001a). Canadian municipalities often prefer this method because it is perceived as simpler for both the customers and administrators.

In 1999, Canadians charged with a volume-based pricing structure used an average of 269 litres per person per day. In contrast, those paying a flat rate used 457 litres per person per day—70% more water than customers with volume-based pricing (Environment Canada 2001a). The OECD has repeatedly criticized Canada for failing to put economic instruments into practice to manage water. In its 2004 environmental performance review of Canada the OECD noted that: “user fees still cover only part of the cost of delivering water services, while fee structures generally do not encourage conservation” (OECD 2004).

The federal government's *Green Plan* suggested “the key to conserving water is paying a fair price for the water we use. If we pay more, we will use less and we will be able to raise the funds needed to build and maintain our water supply and treatment systems.” In comparison to voluntary methods such as education campaigns, “[p]ricing systems may have a more profound and long-lasting effect on individual behaviour than moral suasion, and will eliminate the possibility of inequity

Box 22: Canadians use more water and pay less for it



Source: CESD 2001: Chapter 1, Section 3.

between those who voluntarily change their behaviour in response to education and those who do not” (CRM 1996: 2,4).

In European cities people pay more for water, and utilities generally employ an increasing volume-based water pricing structure, with prices getting progressively higher as volume increases. This practice is guided by the principle that a certain level of water is required to meet basic human needs, and any additional water is considered a luxury (OECD 1999). In Canada, however, current water prices and pricing structures do not generally reflect the relative importance of this resource. The Canadian Council of Ministers of the Environment has even stated that “pricing policies in most municipalities actually discourage efficient use of water” (CCME 1994). Pearse (2002: 15-3) argues that, in Canada, “water is regarded as a free good, and is used liberally and often wastefully. There is no incentive to economize, or even to fix leaks.”

3.1.6 Environmental impacts of high use

Urban development and high water use in urban areas alter the hydrological cycle and place increasing demands on related infrastructure and services. Changes in the hydrological cycle can lead to flow and sediment regime changes, geomorphological changes, impaired water quality, reduced biodiversity and overall degradation of water resources (Environment Canada 2004).

Over 22 million Canadians live in river basins where humans use 10% or more of the stream flow in some way (Campbell 2004). Even when most of the used

water is returned to the river, water quality can be affected due to limited dilution. Summer flows in the Grand River system in southern Ontario, for example, contain up to 40% effluent from wastewater treatment facilities (Sproule-Jones 2003). Municipal wastewater effluent is the largest source of effluent discharged into Canadian waters, and it will continue to increase with continued population growth and urbanization (Environment Canada 2001). Discharged effluent contains residues of human waste, debris, nutrients, pathogens, endocrine disrupting

substances, unmetabolized pharmaceuticals, ingredients from households and personal care products, and other potentially toxic chemical contaminants (Pollution Probe 2004: 22).

High and increasing urban demand leads to more withdrawals from source waters and encourages large-scale supply infrastructure, such as dams and reservoirs, with significant long-term effects. Municipalities are responsible for 12% of total water withdrawals in Canada. Impacts are concentrated geographically and add to other cumulative factors, such as urbanization and point and non-point source pollutants that heavily impact the aquatic and riparian environment. Collectively, Canadians dump about 300 million litres of used motor oil into Canada’s waterways each year through urban runoff—more than seven times the amount of oil spilled during the Exxon Valdez disaster (de Villiers 2000).

Other direct impacts from high levels of source water withdrawals include physical changes of watercourses and ecosystems. These impacts disrupt the hydrological cycle, damage stream habitat and impair ecological function due to changes in flow and temperature of water. High levels of withdrawal (including over-pumping) also introduce exotic parasites and organisms, and can cause irreversible aquifer depletion and saltwater intrusion (Gleick 1998; Postel 2000: 943).

Aquatic habitats and freshwater species are among the most endangered and threatened ecosystems in the world (World Resources Institute 2000). The American Fisheries Society estimates that 354 species of fish in

North America are at risk, primarily due to habitat destruction through the excessive use and mismanagement of water (Postel 1994: 13). Gleick (2003: 1524) reports that 27% of all North American freshwater fauna are threatened with extinction. High levels of human water use amplify the stress on this already overburdened and critical ecosystem.

3.1.7 Canada's aging supply infrastructure

High urban water use also increases infrastructure costs. As water demands increase, the cost of maintaining existing infrastructure goes up, as do the costs for infrastructure expansion and future maintenance. Modern water and wastewater systems are the most capital intensive of all public works—with estimates of unmet water and wastewater infrastructure ranging from \$23 to \$49 billion (NRTEE 1996; Environment Canada 2003a). The National Round Table on Environment and Economy (1996: 10) estimates that “under current pricing regimes, new capital demands for water and wastewater infrastructure will exceed \$41 billion by the year 2015.” Much of the water supply infrastructure in Canadian cities is over 50 years old, and a growing population and high water use put further stress on this aging infrastructure.

Currently, provincial and federal governments subsidize urban water and wastewater infrastructure in Canada. Most water and sewage utilities, especially in larger urban cities, do not adequately account for the full costs of maintenance and operation, let alone capital or environmental costs (Pearse et al. 1985; NRTEE 1996; Renzetti 1999; O'Connor 2002). In the Niagara Region—a typical water utility in Ontario—the estimated range of unaccounted costs for 1998 is \$10 million to \$35 million, or between 16 and 55% of the operating budget (Renzetti 1999: 20).

Beyond the existing capital shortfall and maintenance and operations deficit, other factors, such as higher water treatment requirements, also increase costs (Environment Canada 2004: 37). Costs are increasing as a result of recommendations from the Walkerton inquiry (O'Connor 2002). As municipalities use lower quality sources of water due to depleted high quality sources, they also face the costs of new technologies. Lower quality water sources require more complex treatment systems that consume more water, creating a self-reinforcing and wasteful spiral (Environment Canada 2004: 37).

The combination of crumbling infrastructure, the costs associated with increasing quality requirements and the inaccessibility of new water sources, suggest that

urban water management can no longer function as it has in the past. Fundamental change is required in water management and in how Canadian utilities deal with the built and natural infrastructure. For many regions, current overall water use levels cannot be increased, implying that additional water needs associated with population and economic growth must be met through efficiency measures and alternative water sources, such as rainwater or recycled water.

3.1.8 Climate Change: The certainty of uncertainty

The full impacts of climate change are uncertain, but it will stress water supplies in Canada, making existing supply problems even worse (Campbell 2004). A recent Environment Canada report indicates that climate change will exacerbate water shortages throughout the country. Although, historically, droughts were most frequent in the southern Prairies, many climate experts agree that “climate change may increase [drought] frequency, duration and severity in all regions of the country” (Environment Canada 2004: xii).

Regional impacts will vary widely (see Box 23). Predicted impacts on the Great Lakes include further drops in water levels of between 0.5 and 1 metre due to increased evaporation and decreased runoff (Farid et al. 1997: 74). In the Prairies, the implications are potentially disastrous. Temperature increases during the last 75 years have led to a 40% reduction in flow in many Alberta Rivers (Schindler 2001: 18). This reduction in water availability will continue to have a direct impact on many western cities such as Calgary, Edmonton and Regina. Glacier recession and thinning due to climate change will also reduce other western rivers, such as the Fraser, Columbia and Saskatchewan-Nelson rivers (Schindler 2001: 18). There is no end in sight.

Groundwater supplies will be affected across Canada, especially shallow, unconfined aquifers that contain the highest quality groundwater and provide important sources of potable water and water for livestock (Natural Resources Canada 2004: 6). Timing of precipitation and drought conditions strongly affects the rate of groundwater recharge, therefore increasing their sensitivity and vulnerability to climate change.

Regions already under stress are most vulnerable to the effects of climate change. An obvious example is the Pallister Triangle in the southern Prairies, where drought and severe annual soil moisture deficits are recurring concerns (Natural Resources Canada 2004: 4). Even Ontario, generally viewed as a water-rich province, suffers

frequent water shortages (Dolan et al. 2000). In British Columbia, another water-rich province, more than 17% of surface water resources are at or near their supply capacity for extractive uses (MELP 1998). The increasing range of these water stressed areas suggests the broad effects that climate change will have throughout Canada.

Shrinking water supplies are a critical concern, but so are extreme events such as flooding, which are associated with changing weather patterns. Flooding can directly affect freshwater supplies by damaging infrastructure and contaminating water supplies, and indirectly by changing patterns of groundwater recharge (Environment Canada 2004).

Climate change also affects demand—human and environmental. Warmer temperatures and drier conditions due to climate change will further increase water demand in many regions (Natural Resources Canada 2004: 7). Agricultural and domestic demands will increase for irrigation, gardening and lawn watering, and drinking water (Natural Resources Canada 2004: 8).

In general, a high level of uncertainty exists, and will likely always exist, regarding the impacts of projections of climate and hydrological change at the local management level. Given the uncertainties and the potential impacts of climate change, common recommendations or suggested strategies include: improved planning and preparedness for droughts and severe floods, improved water quality protection, enhanced monitoring efforts and water conservation measures (Dolan et al. 2000; Cohen and Miller 2001; Schindler 2001; Environment Canada 2004; Natural Resources Canada 2004).

These recommendations are considered “no-regret” options that would benefit Canadians irrespective of climate change impacts. The International Panel on Climate Change (IPCC 1996) urges water managers to begin “a systematic examination of engineering criteria, operating rules, contingency plans and water allocation policies” and states with “high confidence” that “water demand management and institutional adaptation are the primary components for increasing system flexibility to meet uncertainties of climate change.”

3.2 Legal and institutional framework for fresh water in Canada

With a multitude of agencies and departments sharing authority, water management in Canada has been described as “a bewilderingly complex administrative galaxy.” It is “a true patchwork of authorities and responsibilities inherited from days when water was taken for granted, and other resources, such as timber,

minerals and fish, were the main concern” (Campbell 2004: 7). Water management cuts across departments such as environment, natural resources, agriculture, health, public works and infrastructure and varying jurisdictions at municipal, provincial, territorial and federal levels of government.

Although water is not specifically mentioned in the Canadian Constitution, as a natural resource it is a primary responsibility of provincial and territorial governments. Urban water management is typically delegated to local governments and water utilities, and the federal government’s role is less direct. The federal government does still have an important role promoting national standards and guidelines, providing infrastructure funding and supporting research and data collection.

3.2.1 Federal government

Constitutionally, federal authority relating to fresh water includes navigable waters, pollution prevention, shared waters (both national and international boundary waters), commercial fisheries and fish habitat, and water on First Nations’ land and in the northern territories. Within the federal government, responsibilities for fresh-water are fragmented. For example, 19 departments and agencies are represented on an interdepartmental assistant deputy ministers’ committee on fresh water (PRI 2004: 2).

The federal government has clear jurisdiction over fresh water in a few broad areas. In particular, it regulates the release of toxic substances, manages activities that impact and potentially harm fish habitat, ensures rivers remain navigable, and manages the water on federal lands. The federal government also has some responsibility for waters that cross international borders and provincial boundaries. The Government of Canada has an agreement with the United States to collectively manage international waters, most notably through the International Joint Commission. Federal authority over criminal law and the “peace, order and good government of Canada” (POGG) has been interpreted to give Parliament authority over the environment (including water) where federal laws regulate matters of national importance.

In the urban context, the federal government has limited involvement. However, it can directly influence water use and management through infrastructure funding policies. Federal money is substantial for infrastructure, upgrades, or replacement and expansion. Fiscal policies that link grants to conservation planning and/or demand management requirements can be powerful tools to promote efficient water use and reduce

Box 23: Potential impacts of climate change on water resources

Region	Potential Change	Associated Concerns
Yukon and coastal British Columbia	<ul style="list-style-type: none"> Increased spring flood risk, impacts on river flows caused by glacier retreat and disappearance 	<ul style="list-style-type: none"> Reduced hydroelectric potential, ecological impacts (including fisheries), damage to infrastructure, water apportionment
Rocky Mountains	<ul style="list-style-type: none"> Rise in winter snowline in winter-spring, possible increase in snowfall, more frequent rain-on-snow events 	<ul style="list-style-type: none"> Increased risks of flooding and avalanches Ecological impacts, impacts on tourism and recreation
Prairies	<ul style="list-style-type: none"> Changes in annual streamflow, possible large declines in summer streamflow Increased likelihood of severe drought, increasing aridity in semiarid zones Increases or decreases in irrigation demand and water availability 	<ul style="list-style-type: none"> Implications for agriculture, hydroelectric generation, ecosystem and water apportionment Losses in agricultural production, changes in land use
Great Lakes Basin	<ul style="list-style-type: none"> Possible precipitation increases, coupled with increased evaporation leading to reduced runoff and declines in lake levels Decreased lake-ice extent, including some years without ice cover 	<ul style="list-style-type: none"> Impacts on hydroelectric generation, shoreline infrastructure, shipping and recreation Ecological impacts, increased water loss through evaporation and impacts on navigation
Atlantic	<ul style="list-style-type: none"> Decreased amount and duration of snow cover Changes in the magnitude and timing of ice freeze-up and break-up Possible large reductions in streamflow Saline intrusion into coastal aquifers 	<ul style="list-style-type: none"> Smaller spring floods, lower summer flows. Implications for spring flooding and coastal erosion Ecological impacts, water apportionment issues, hydroelectric potential Loss of potable water and increased water conflicts
Arctic and Subarctic	<ul style="list-style-type: none"> Thinner ice cover, 1 to 3 month increase in ice-free season, increased extent of open water Increased variability in lake levels, complete drying of some delta lakes 	<ul style="list-style-type: none"> Ecological impacts, impacts on traditional ways of life, improved navigation, changes in viable road networks Impacts on ecosystem and communities

Source: (Cohen and Miller 2001; Natural Resources Canada 2004)

water demands. Proposals for new infrastructure could be contingent on preparing an effective demand management plan that explores least-cost alternatives, and on implementing education, metering, pricing and regulations to promote conservation. More directly, grants and funding could be used to promote conservation by funding specific demand management programs, such as exists with the Federation of Canadian Municipalities “Green Infrastructure Funds” program.

Significant federal legislation and policies

The federal government possesses powerful legal authority and tools to protect aquatic ecosystems. Sufficient legislation exists to protect against damage caused by infrastructure expansions, excessive withdrawals and pollution discharges. However, government is often criticized for a lack of effective enforcement. The Parliament’s Standing Committee on Environment and Sustainable Development concluded in 1998,

Box 24: Selected federal and provincial water related laws, strategies and plans

	Legislation	Strategies, plans and programs
Federal government	2002 amendment to International Boundary Waters Act 1999 Canadian Environmental Protection Act (Part 7, Division 2, Section 120-121) 1997 Oceans Act 1987 Federal Water Policy 1970 Canada Water Act (R.S. 1985, c. C-11)	2002 Oceans Strategy 2000 National Programme of Action for the Protection of the Marine Environment from Land-based Activities Five strategies (water pricing, science leadership, integrated planning, legislation, public awareness) 1994 National Action Plan to Encourage Municipal Water Use Efficiency
Alberta	1996 Water Act	2003 Water for Life Strategy 2001 Municipal (Drinking Water) Policies and Procedures Manual
British Columbia	Water Act Drinking Water Protection Act	2002 Living Rivers Strategy 2002 Action Plan for Safe Drinking Water 1999 Freshwater Strategy 1997 Water Conservation Strategy
Manitoba	2002 Drinking Water Safety Act 2003 Manitoba Water Strategy 2000 Water Resources Conservation and Protection and Consequential Amendments Act	2003 Manitoba Water Strategy
Newfoundland and Labrador	2002 Water Resources Act	Multi-barrier Strategic Action Plan
Nova Scotia	2000 Water Resources Protection Act 1995 Environment Act	2002 Drinking Water Strategy
Ontario 2002	Nutrient Management Act 2002 Safe Drinking Water Act 2002 Sustainable Water and Sewage Systems Act	
Quebec	1999 Water Conservation Law 1972 Environment Quality Act 1964 Watercourses Act	2002 Quebec Water Policy 2002 Mining and metal manufacturing 1993 Pulp and paper mills
Saskatchewan	2002 Water Regulations under the 2002 Environmental Management and Protection Act	1999 Water Management Framework
Northwest Territories	1992 Northwest Territories Waters Act	Framework for Management of Drinking Water Quality
Yukon	1992 Yukon Waters Act	

(OECD 2004: 55)

“Environment Canada and indeed some provinces are not enforcing environmental laws when they could and should. This failure to act is of deep concern” (SCESD 1998).

In particular, the *Canada Water Act*, the *Fisheries Act* and the *Canadian Environment Protection Act* are useful but underutilized federal tools for sustainable water management in Canada.

Canada’s *Federal Water Policy* was adopted in 1987 (Environment Canada 1987). Its two principle objectives are:

1. to protect and enhance the quality of water, and
2. to encourage the efficient and equitable use of fresh water in a way that can meet the social, economic, and environmental needs of present and future generations.

The Policy established goals and strategies for water management, and included a series of federal government commitments, including a central commitment to promote realistic water pricing that charges the true value of the resource and costs of its delivery. This policy has yet to be acted on. The Federal Water Policy has the potential to drive the federal position on freshwater management; however, a substantial reduction in staff and budgets of federal water departments and a general lack of follow-through has led some observers to question the federal government’s capacity to administer even a modest water policy (Pearse and Quinn 1996: 339; Boyd 2003; Brandes and Ferguson 2004: 50).

Despite inaction on national water policy, recent developments suggest that the federal government—Environment Canada in particular—is becoming more active in water management. At the 2002 World Summit on Sustainable Development, the federal government agreed to complete an integrated water resource management plan by 2005. Environment Canada also recently created a new Sustainable Water Use Branch. Although this new branch is currently in the process of developing its mandate, it could serve as an authoritative clearinghouse for research and best practices in water management. It is also working with other departments and agencies to build capacity for demand management, and to link infrastructure grants to demand management plans. Whether or not the Sustainable Water Use Branch will certainly have a significant impact remains to be seen, but the new branch will require sufficient resources, staff and training, to support a broader federal commitment to water sustainability as a national priority.

Box 25: Significant federal legislation to protect aquatic ecosystems

Under the **Canada Water Act**, the Minister of the Environment can enter agreements with provincial governments to restore and protect bodies of water of national interest. The Act also authorizes the Minister to undertake research and collect data to develop comprehensive management plans for nationally significant waters, in cooperation with provinces that have an interest in those waters. If the provinces cannot agree on management plans for federal, inter-jurisdictional, and international or boundary waters, the Act requires the Minister of the Environment to develop and carry out those plans without the provinces.

Provisions of the **Fisheries Act** allow the federal government to ensure that sufficient flows are maintained in rivers and streams to protect fish and fish habitat, particularly from the operation of dams and other obstructions. Sections 20 through 26 of the Act give Fisheries and Oceans Canada the power to require minimum water flows, the construction of fishways or fish ladders and/or the removal of obstructions. Water quality can also be protected through Section 36 which prohibits the discharge of harmful substances into waters used by fish.

The **Canadian Environmental Protection Act**, administered jointly by Environment Canada and Health Canada, mandates the federal government to protect the environment and human health from the use and release of toxic substances, pollutants, and wastes. Health Canada is responsible for protecting Canadians against health risks and the spread of disease carried by water, and plays a key role in developing guidelines for drinking water quality.

Bulk water exports

International trade agreements and water exports are increasingly of concern to Canadians. Water shortages faced by some regions of the world, including the United States, has brought considerable attention to Canadian freshwater resources. Statements such as “the wars of the twenty-first century will be fought over water” made by the vice-president of the World Bank and Chairman of the World Water Commission add tension to concerns about water export (de Villiers 2000: 15). International trade agreements such as NAFTA, and organizations such as the WTO, amplify Canadian worries about loss of sovereignty over water resources and the inability to

“turn off the tap” once trade has begun.²⁵

The 1987 Federal Water Policy stated that Ottawa would “take all possible measures within the limits of its constitutional authority to prohibit the export of Canadian water by interbasin diversions” (Environment Canada 1987: 2, 19). Despite this claim, proposals to export bulk water from Canada by Sun Belt Water Inc in British Columbia, the Nova Group in Ontario and the McCurdy Group in Newfoundland have forced the federal government to take action (Boyd 2003: 58). Due to significant debate about the federal government’s jurisdiction over decisions about water,²⁶ government opted not to ban bulk water export directly. Instead, the government acted indirectly (Thompson 1987; Saunders 1995; Boyd 2003:58), amending the *International Boundary Water Treaty Act* to prohibit bulk water removals from boundary watersheds (principally the Great Lakes) and promoting an *Accord for the Prohibition of Bulk Water Removal from Drainage Basins* (Campbell and Nizami 2001: 8; Boyd 2003: 58). By voluntarily signing the Accord, provinces and territories committed themselves to enact legislation that bans the export of bulk water from their respective jurisdictions. Currently, only New Brunswick is without a law banning bulk water exports. However, existing interbasin diversions—a form of bulk water export—are considered to be “grandfathered” and not subject to reversal (Environment Canada 2004: 6).

The most significant challenge facing Canadian laws and policies governing bulk water exports is NAFTA²⁷ and the considerable controversy over what extent NAFTA applies to all “goods” (Saunders 1995: 1182; Campbell and Nizami 2001: 7). The Government of Canada suggests that water in its natural state is not a “good” (DFAIT 1999). On the other hand, the Council of Canadians and the U.S. government argue that once water is traded between Canada and the United States, NAFTA applies (Boyd 2003: 60).

Due to the complexity of this issue, and the unpredictable nature of international arbitration panels,

which are not bound by precedents, it is difficult to ascertain whether or not NAFTA applies to water exports. Nonetheless, NAFTA does influence water policy and may even constrain Canada’s ability to restrict water exports (Campbell and Nizami 2001: 16). “At a minimum, there is a substantial risk that NAFTA applies to Canadian water” (Boyd 2003: 60). Existing laws such as British Columbia’s *Water Protection Act* could be deemed to violate investor rights and the potential outcome could see the B.C. government having to pay \$15.75 billion in damages in one case alone (Boyd 2003: 56). “Despite government claims to the contrary, NAFTA unquestionably restricts Canada’s ability to manage our fresh water, although not to the dramatic extent suggested by some critics” (Boyd 2003: 64).

The federal role and mandate - The Great Lakes example

The international nature of the Great Lakes has often provided a unique legislative challenge. Two provinces and eight states border the lakes and, as a result, addressing both water quantity and quality issues has been heavily influenced by federal legislation and a number of interjurisdictional agreements (Powell 2003: 22). At least nine pieces of federal legislation establish responsibilities for the federal management of fresh water in this area. A number of agreements, policies, and programs further articulate those responsibilities. Six federal departments play an active role in the government’s commitment to a safe and secure water supply in the basin. Environment Canada, as the lead, is the most active. Other departments are Fisheries and Oceans, Health Canada, Natural Resources Canada, Agriculture and Agri-Food Canada, and Foreign Affairs and International Trade (CESD 2001 Chapter 1 section 3).

International treaties and interjurisdictional agreements also play an important role and further complicate the situation in the Great Lakes Region. Recent federal

²⁵Canada is already exporting water in bulk to the United States. For example, Greater Vancouver water district (by pipeline), Clearly Canadian Ltd. (by tanker truck), and although it is not currently happening, a water export licence from B.C. to the U.S. exists for Alpine Glacier Water Inc (by tanker). Water is also exported by pipeline from Manitoba to North Dakota, from New Brunswick to Maine and from Alberta to Montana to supply American communities near the border (Boyd 2003: 55).

²⁶Then federal environment minister, David Anderson, told Newfoundland and Ontario that the federal government has no jurisdiction to make decisions about provincial resources, citing the long-standing position that the federal government does not have the constitutional ability to address provincial resource issues. On the other hand, some legal experts suggest “Parliament can pass laws regulating export of water from Canada” pursuant to its power over international trade, just as the federal government regulates energy exports (from provincial natural resources) under the *National Energy Board Act* (Boyd 2003: 58; Thompson 1987).

²⁷For a useful review of NAFTA as it pertains to Canada’s fresh water see Campbell K. and Nizami Y. 2001 “Security or Scarcity? NAFTA, GATT and Canada’s Freshwater.” West Coast Environmental Law available at <http://wcel.org/resources/publications/default.cfm>

amendments²⁸ to the *International Boundary Water Treaty Act (IBTWA)* are particularly relevant to the Great Lakes Basin (see 3.2.5 below). In December of 2001, the IBTWA amendments by the Government of Canada prohibited the bulk removal of boundary waters from the basin in which they are located. The amendments also require people to obtain licences from the Minister of Foreign Affairs for water-related projects that affect the natural level of flow of waters on the U.S. side of the border (Powell 2003: 24). Other examples of national and international agreements that affect the basin include the Great Lakes Water Quality Agreement between Canada and the United States, and the federal government's agreements with Quebec and Ontario and its own Great Lakes and St. Lawrence River ecosystem initiatives.

The Great Lakes example demonstrates that water management in Canada involves a wide variety of departments and institutions, even for one level of government. Given this complexity, the need for a comprehensive and coordinated approach is obvious.

3.2.2 Provincial and territorial governments

The provinces and territories have primary responsibility for water management in Canada. The provinces' power to create laws regulating water comes from specific clauses in the constitution assigning them jurisdiction over "property and civil rights" and "the management and sale of public lands." Water is traditionally regarded as a form of property, and the term "public lands" includes water (Pearse et al. 1985). Within this constitutional framework, provinces are the lead jurisdiction for setting policy, legislating prices, permitting all uses and managing water sources. Provinces generally devolve much of the management of urban water to municipalities, especially in larger urban centres. However, most municipalities, like any other major user, are still required to obtain a permit from the province to take water.

Provincial governments deal with water through a variety of different ministries and departments, including Environment, Municipal Affairs, Natural Resources, Fisheries, Infrastructure, Sustainable Resource Development and Health. Other departments are often still involved, adding to the complexity. In

Manitoba, however, the province opted to concentrate water-related issues in one department, a Water Stewardship Department. This amalgamation of all water-related issues represents a commitment to ensure water resources are managed in a co-ordinated and comprehensive way (Manitoba Government 2004).

Withdrawing and allocating water

All provinces require permits or licences to withdraw surface water. The detailed process for assessing and allocating permits varies across the country by province. In Ontario, for example, the *Ontario Water Resources Act (OWRA)* regulates water takings; in British Columbia, the *Water Act* and *Water Protection Act* provide the basic regulatory framework for water management.²⁹

Although statutory rules generally govern water allocation in Canada, many underlying legal doctrines still influence water allocations (Percy 1988; Nowlan 2005):

- *riparian rights*, where a landowner retain rights related to water quality/quantity for domestic use is still applies in Ontario and the Atlantic provinces;
- *prior allocation*, where a licensee acquires rights to water based on the date of application, is used in the western provinces of British Columbia, Alberta, Saskatchewan and Manitoba;
- rules based in the *civil code* are used in Quebec; and,
- the *authority management approach* is used in the northern territories of the Yukon, Nunavut and the Northwest Territories.

The current surface water licensing approach in Canada is oriented to regulating consumptive use of water rather than ensuring instream needs are met. Maintaining natural flows for the protection of ecosystems, wildlife habitat, fisheries, or traditional uses is, at best, a secondary consideration. The limited environmental protection that does exist is not required, and instead, relies on the discretionary power of decision-makers. This approach is generally considered to provide inadequate protection for maintaining instream flows and groundwater supply. This regime does not allow for individuals or NGOs to apply for a licence that "allocates water for environmental purposes by specifying natural or existing flows and quality as terms and conditions of the licence" (Thompson 1991).

²⁸These amendments were the federal response to the 2001 signing of *Great Lakes Charter Annex, A supplementary Agreement to the Great Lakes Charter "Annex 2001"*, an agreement signed by the Ontario and Quebec premiers and the eight Great Lakes governors (Powell 2003: 24).

²⁹For a detailed review of the legal frameworks governing water allocations across the various Canadian provinces and territories see Environment Canada's Freshwater Web site - Water Policy and Legislation (Provincial-Territorial) at http://www.ec.gc.ca/water/en/policy/prov_e_prov.htm, or the CWWA legislation database available at <http://www.cwwa.ca/legislation>

Some regions, such as the Okanagan Basin in British Columbia, or areas of southern Alberta, are facing an “Era of Reallocation” due to water overallocation. To limit further extractions, restrictions are now implemented on many water sources (Janmaat 2005: 209). Continued urban growth coupled with water restrictions suggests that the primary concern about water allocation is not to extract more water (because no more is available), but to put the available water to its most valuable use (Janmaat 2005: 209).

In most cases, provinces charge an administrative fee for water permits, but do not charge for the actual volume of water taken (Environment Canada 2003a). The lack of effective withdrawal fees does not support conservation-based pricing principles and is considered by many as a form of perverse subsidy, leading to overconsumption by individuals and other end-users. Ultimately, “the inefficient price of the resource becomes embedded in the stock of industrial capital and in the design of municipal water utility systems” (Renzetti and Dupont 2002: 495).

In general, various water allocation systems in Canada evoke similar concerns. They are not comprehensive and fail to integrate groundwater and surface water, and rarely account for environmental needs and proper ecological function. Furthermore, they do not promote conservation and are too rigid to adapt to the emerging social and environmental priorities.

Compensation for withdrawal rights

With some waters already over-allocated, any legally recognized right to compensation could impede efforts to reduce licensed withdrawals to sustainable levels. In this regard Lucas (1990: 31, v) argues that water withdrawal licences “do not convey real property interest, but are bare statutory licences conferring a personal right of use only,” so that no “legal basis [exists] for asserting rights to compensation in the event of confiscation or modification of water rights by water authorities.”

Nevertheless, some case law suggests that compensation may be required in circumstances where a government take-back of a granted right destroys a business.³⁰ Further, statutory requirements for compensation may still exist, as under Alberta legislation when a new, higher priority user requests cancellation of an existing, lower priority licence (in which case compensation for “loss” or “damage,” as opposed to the value of the interest taken, is required) (Lucas 1990: 92).

In regions across Canada, some watersheds are subject to existing permits for water withdrawals that exceed the water available, a potentially a dire concern for long-term environmental health. The uncertainty regarding compensation is a significant barrier to restoring water withdrawal licences to sustainable levels. Reversing overallocations and ensuring that future water allocations are sustainable is a pressing concern. And these problems will only intensify as demands increase and the impacts of climate change become more apparent.

Mandating efficiency

Mandating efficiency requirements through plumbing and building codes also falls under provincial responsibility for water. In Ontario, efficiency requirements are included in the *Ontario Plumbing Code* that applies to all permitted renovations and new construction. Amendments to the code include requirements for efficient faucets, showerheads and, more recently, low-volume toilets (Shrubsole 2001). However, most other provinces lag behind with outdated plumbing and building requirements (Maas 2003).

Instead of mandating specific efficiency requirements province-wide, some provinces such as British Columbia have opted to limit requirements to install low-flow toilets to selected regions or municipalities that wish to participate with this provincial program (MCAWS 2004). Although this type of change can promote conservation in certain areas, a more effective approach would be to change provincial Building and Plumbing codes to apply to the whole province.

3.2.3 Municipal governments

Municipalities and local governments operating under provincial legislation are generally responsible for delivering treated water to residents and customers, and for collecting and treating wastewater. Local governments also play a primary role in implementing conservation and water demand management programs, and are often responsible for stormwater management.

In Canada, municipal water use accounts for 11% of total water use, ranking third after thermal power generation and manufacturing. More than 80% of Canadians live in urban areas, and are served by municipal water supplies and some form of waste treatment system (Tate 1997). All the water that municipalities deliver to customers should be treated to the level of drinking

³⁰Manitoba Fisheries Ltd. v. R. (1978), 88 D.L.R. (3d) 462 (S.C.C.).

quality standards. However, these standards can vary extensively between, and even within, provinces. Municipalities and the utilities also decide what to charge their users, setting rates for homeowners, and deciding what rates larger users such as companies, hospitals and small industries will pay. In Ontario, under the *Municipal Act*, municipalities have broad powers to enact bylaws to impose fees and charges for services. This allows them to decide how rates are set for water and sewer services.

Local governments are not explicitly assigned jurisdiction over specific subjects under *Canada's Constitution Act, 1867*. Municipalities can only take action when explicitly authorized under provincial legislation. Despite these constraints, local authorities are gaining discretionary powers over local matters, as demonstrated by recent changes in provincial legislation governing local authorities, such as the *Municipal Act* in Ontario or the *Community Charter* in British Columbia or Alberta.

The Supreme Court of Canada has reinforced this trend in a recent decision dealing with pesticide regulation, the *Spraytech*³¹ case, gave local governments a direct role in protecting the environment. The Court noted that local governments are better equipped with local knowledge, and are more accessible to citizens. Other lower courts have since relied on the *Spraytech* case as a precedent in upholding local environmental bylaws over provincial or federal laws (Boyd 2003: 221).

Retail pricing

Currently in Canada, no uniform retail pricing structure exists. In some cases, charges increase as larger volumes of water are taken (increasing block price), but in other cases authorities charge a flat rate, or apply a discount when larger volumes are used (declining block rates).³² Cities that typically use significant amounts of water per capita, such as Montreal, Vancouver and St. John's, employ flat rates for residential users. Even water-stressed cities like Calgary and Hamilton are only partially metered, employing a mix of volume-based and

flat-rate pricing. Other cities, such as Edmonton, Winnipeg and Saskatoon, employ a declining block rate for residential users (Brandes and Ferguson 2003; Roach et al. 2004: 7).

Utility ownership

In Canada, most water utilities are owned and operated by local (municipal) governments. However, a variety of different models are now emerging, such as in Edmonton where the city is served by a public corporation, or "corporatized" utility that is owned by the city, but run as a corporation. Hamilton and Halifax provide another model where private companies are involved in management of specific services such as construction, maintenance or customer services.

In Ontario, 70% of municipal water systems are operated directly by the municipality. About 23% are operated under contract with the provincial Crown agency the Ontario Clean Water Agency. Roughly 6% are contracted to private companies, and fewer than 1% to another municipality³³ (O'Connor 2002: 279; Powell 2003: 8).

Although most water supply systems remain publicly owned, private companies have dramatically increased their market share over the past two decades, especially internationally. Opponents of private sector involvement warn of decreased accountability, threats to public health, and declining service levels and environmental quality. The debate is polarized over whether water should be treated as a public good (and "democratic right") or as a commodity for private property (Bakker 2004a).³⁴

Regional authorities

In many regions of Canada, local governments are structured with multiple levels. In certain jurisdictions, such as the Capital Region District (CRD) in British Columbia or the Region of Waterloo in Ontario, a tiered relationship exists where the regional authority acts as a wholesaler, treating and delivering water to member

³¹114957 Canada Ltee (Spraytech, Societe de'arrosage) v Hudson (Town) (2001), 40 C.E.L.R. (N.S.) 1 (S.C.C.)

³²43% of Canadian households employ a flat rate; 12% of Canadian households employ a declining block rate; 36% employ a constant block rate structure; 9% employ an increasing block rate (Roach, Huynh, et al. 2004: 7).

³³For a detailed discussion of the implications of utility ownership arrangements in general, see Bakker, K. (2003) *Good Governance in Restructuring Water Supply: A Handbook* at <http://powi.ca/goodgovernance.pdf>; for a discussion of the implications of utility ownership on demand management see Chapter 4, *The Future in Every Drop*, The POLIS Project on Ecological Governance at www.waterdsm.org

³⁴For a public sector union perspective, see CUPE's WaterWatch campaign (www.cupe.ca). For an NGO perspective critical of private sector participation in water supply, see the Council of Canadians Blue Planet Project (www.canadians.org). For a business perspective supportive of private sector participation, see the Canadian Council for Public Private Partnerships (www.pppcouncil.ca). See also: Elizabeth Brubaker's (Pollution Probe) book, *Liquid Assets: Privatizing and Regulating Canada's Water Utilities*, University of Toronto Centre for Public Management, 2002; Maude Barlow (Council of Canadians) and Tony Clarke's (Polaris Institute) publication *Blue Gold: The Battle Against Corporate Theft of the World's Water*, Earthscan 2002; and reports commissioned by the Ontario government's SuperBuild (www.superbuild.gov.on.ca) which seek to facilitate P3s in the water sector.

Box 26: Water supply business models in large Canadian municipalities

Municipality	Agency	Business Model
Calgary	Calgary Waterworks Municipal	Utility
Edmonton	EPCOR Water Services	Public corporation
Halifax (water)	Halifax Regional Water Commission	Public corporation
Halifax (wastewater)	Halifax Regional Environmental Partnership	P3
Hamilton	American Water Services	P3
Montreal	Public Works, City of Montreal	Municipal utility
Ottawa	Drinking Water Services Division, City of Ottawa	Municipal utility
Toronto	Toronto Works and Emergency Services	Municipal utility
Vancouver	Greater Vancouver Regional District	Municipal utility
Winnipeg	City of Winnipeg Water and Waste Department	Municipal utility

Bakker 2004a: 3

municipalities, which in turn act as retailers that sell to end users (e.g. households, businesses and local industries). This tiered system may create fragmented responsibility for water supply between the various levels of local government thereby requiring additional coordination and planning by stakeholders. Such regional authorities, however, can deliver some or all demand management programs and initiatives, but may not have sufficient authority to pass bylaws or mandate necessary changes, such as amending plumbing and building codes.

Influencing demand

Municipalities have the most to gain by promoting water conservation that reduces the costs of infrastructure, operations and maintenance, and protect source waters. As discussed above, full-cost pricing and conservation-oriented price structures discourage excessive water use. As Ontario’s *Sustainable Water and Sewage Systems Act* comes into force later this year, municipalities in that province will be required to charge end users the “true cost” of supplying water. The Act also requires utilities to incorporate the costs of maintaining and building new water and sewage infrastructure (including source protection) into water rates.

Beyond increasing the cost of water, municipalities can influence water use in a variety of ways. Delivering

comprehensive demand management programs, which include an appropriate mix of pricing, regulations, leak repair, incentives for conservation technologies, and public education is the best way for municipalities to influence water demand.

Installing meters is the first step and one of the most effective ways for municipalities to manage water and enable water conservation efforts. Once meters are installed, utilities can measure the amount of water used, identify excessive use and address the problems through demand management. Meters are also a necessary precondition for conservation-based pricing systems. In systems where customers are charged by volume, they generally use less water. Some authors report that metering alone, without pricing changes, has resulted in water use reductions of 10% to 40% (Shrubsole and Tate 1994: 7).

The initial costs of metering are high. In 1995, the estimated cost to achieve “universal” metering throughout Canada was \$650 million (Tate 1997: 53). In addition to installation and meter-reading costs, a meter maintenance repair program is also required since meters may “under-report” as they wear out. These costs are relatively small, however, compared with the billions needed for infrastructure repair and upgrading due to excessive water use. When coupled with price re-struct-

turing, metering can become cost/revenue neutral (Tate 1990: 17).

In addition to the critical need for universal metering, a comprehensive integrated and long-term approach to demand management is necessary. Previous reports in this series have discussed the need for, and the characteristics of, such programs. A comprehensive approach³⁵ requires sufficient capacity in the form of staff, training and resources for implementation and ongoing long-term demand management initiatives, and an effective conservation plan, including a demand management study, inventory of options and measurable targets, developed with local expertise and effective public participation (Brandes and Ferguson 2004).

Currently, the lack of effective planning is a significant stumbling block to effective demand management programs. In British Columbia, for example, only 13% of municipalities engaged in strategic planning, which was likely limited to basic conservation planning (MELP 1998: 26,30). A study in Ontario found that, although individual DSM measures are being implemented, supply-side management continues to predominate, and only one in five of the Ontario municipalities studied had any kind of DSM plan or strategy in place (deLoe et al. 2001: 57, 66). Other estimates suggest that fewer than 20% of Canadian municipalities have established demand-side management plans (Cantin et al. 2005: 3). Effective planning and implementation of water conservation policies and programs is critical for *all* municipalities to ensure long-term water sustainability.

3.2.4 Intergovernmental coordinating mechanisms

The division of powers between federal and provincial governments can often lead to uncertainty and jurisdictional problems in managing freshwater resources. The issue of water pollution, for example, does not fall within the exclusive jurisdiction of either level of government, making it difficult to determine which level has the power and responsibility to deal with it. The general rule is that where “overlapping jurisdictions exist, both levels of government are free to deal with the matter” (Estrin and Swaigen 1978). According to the doctrine of paramourty, when federal and provincial laws conflict,

federal law has priority.³⁶ In practice, federal-provincial coordination is the usual governmental response to such environmental problems.

Developing freshwater resources raises issues of provincial jurisdiction, and has important economic consequences for many sectors, such as industry, agriculture, manufacturing and tourism (Kennett 1991: 31). Therefore, water management could be a source of major intergovernmental conflicts, and the need for coordination is particularly acute.

A consensus is emerging among academics, freshwater resource managers and policy analysts that water management should begin at the watershed level. However, provincial and international boundaries are not drawn with this in mind, and water management must bridge the gap between political and physical realities (Pearse et al. 1985; Saunders 1988: v; Kennett 1991). Commenting on recommendations for watershed management and the need for coordination, Thompson (1991: 157) suggested that the “jurisdictional maze gives more than platitudinous significance to Pearse’s principle calling for integrated watershed planning and management because, without such integration among the federal and provincial governments, water laws and policies tend to self-destruct in Canada.” To address this need for coordination and co-operation, various intergovernmental institutional arrangements have evolved.

Over the past three decades, numerous joint programs between the federal and provincial governments were implemented to address a wide variety of environmental problems and issues in Canada. Between 1975 and 1980, the emphasis was on water management, but since then, the focus has shifted to an emphasis on broader ecosystem approaches and programs related to land-use management, wildlife, and air pollution (Dwivedi et al. 2001). In this approach, water is primarily considered in the context of the landscape. Not naming water specifically contributes to recent concerns that water management is not enough of a priority for government and the importance of freshwater resources is being undervalued.

The roles of senior government in federal-provincial environmental initiatives have changed. Lately, the federal government has played the role of financier and

³⁵For a detailed discussion see *The Future in Every Drop*, The POLIS Project on Ecological Governance at www.waterdsm.org (in particular, Chapter 5).

³⁶Over the years, different theories (and some confusion) have emerged as to when the “doctrine of paramourty” arises. The Supreme Court of Canada has resolved the matter by concluding that there must be an operational incompatibility or operational inconsistency between the federal and provincial laws before paramourty arises (see *Smith v. The Queen*, [1960] S.C.R. 776). That is, the courts now say that there must be an actual conflict between federal and provincial laws before the “doctrine of paramourty” is triggered, then the provincial law will be held to be inoperative only to the extent of the conflict or operational incompatibility or operational inconsistency.

supplier of equipment, information, and technical expertise. Provincial governments have operated as program implementers (Dwivedi et al. 2001: 77), often downloading responsibilities to regional or municipal governments that lack sufficient resources to implement programs effectively.

Conventions, task forces and agreements serve as intergovernmental mechanisms for coordination. Several examples include: the *Canadian Framework for Collaboration on Groundwater*, the *Accord for the Prohibition of Bulk Water Removal from Drainage Basins*, and the *1988 Canada-Quebec Convention*, designed to address the major environmental problems of the St. Lawrence Rivers Basin. Also, in the *1994 Canada-Ontario Agreement on the Great Lakes Basin*, both federal and provincial governments agreed to a strategy to eliminate toxins, upgrade sewage treatment plants, improve stormwater quality, rehabilitate several species, and conserve and protect human and ecosystem health.

The most significant intergovernmental coordinating institution is the *Canadian Council of Ministers of the Environment (CCME)*. Although *The Prairie Provinces Water Board* is considered a model for dealing with inter-jurisdictional issues (Environment Canada 2004: 120).

The Canadian Council of Ministers of the Environment

CCME's mandate is to promote effective intergovernmental co-operation and co-ordination to address interjurisdictional issues such as air pollution, toxic chemical contamination, water quality and water conservation and economics (CCME 2004). CCME members, the 14 environment ministers from federal, provincial and territorial governments, collectively establish nationally consistent environmental standards, strategies and objectives. The CCME proposes changes, but it has no authority to implement or enforce legislation. Each jurisdiction decides individually whether to adopt CCME proposals (CCME 2004).

Recent CCME activities have focused on water quality, such as the development of the Water Quality Index, a mechanism for Canadian jurisdictions to report water quality information and make comparisons to other jurisdictions (CCME 2004). The CCME has also initiated a specific task force on water conservation and economics.

3.2.5 International co-operation

Canada made international commitments on sustainable water management at the World Summit on

Box 27: Prairie Provinces Water Board

The Rocky Mountains are the primary source of water for the large southern prairie rivers. To manage the complexities of river systems that flow through multiple jurisdictions, Alberta, Saskatchewan, Manitoba and Canada established the Prairie Provinces Water Board (PPWB) in 1948. The PPWB recommends the best use of inter-provincial waters and associated resources in the provinces, and recommends water allocations for streams flowing from one province to another.

The Master Agreement on Apportionment, signed in 1969, provides a formula to determine eastward flowing inter-provincial water. Since the Agreement was signed, various amendments have been to clarify apportionment arrangements, add water quality issues, and define inter-provincial lakes as "water courses." The federal government provides 50% of the funding for the PPWB, and the remainder is funded by equal shares from each of the three member provinces. The board reports on implementation of the apportionment agreements and reviews and makes recommendations on water management issues. And three permanent committees on water quantity, water quality and groundwater assist with technical work and provide advice.

The Master Agreement is considered a model for dealing with inter-jurisdictional issues, and the consensus-based model of the PPWB allows for an effective mechanism for dispute resolution.

(Environment Canada 2004: 121)

Sustainable Development in 2002 and, in 2004, Canada pledged with other United Nations member countries to meet the UN Millennium Development Goals by 2015. One of those goals is to work cooperatively with other member countries to reduce by half the number of people without access to reliable, safe fresh water. To coordinate policies specifically between Canada and the United States, the *International Joint Commission (IJC)* is an example of a well-developed and valuable mechanism for international coordination.

Watersheds and water management issues often cross international boundaries. Over 20 million Canadians live in watersheds that cross the Canada-U.S. border (over 17 million of them in the Great Lakes-St Lawrence watershed) and are affected by American policies, or affect American water quantity and quality. To address the lack of harmonization between Canadian and U.S. water policies, an array of international treaties, agree-

ments and compacts has been developed to promote co-operation and to resolve disputes.

The *St Lawrence Vision 2000* agreement, for example, was launched in 1988 in order to protect the health of St. Lawrence River ecosystems, safeguard human health and involve riverside communities. The *Great Lakes 2001 to 2006* agreement involves the co-operation of eight federal government departments, the province of Ontario and the U.S. government (Statscan 2003).

Other significant agreements and institutions promoting international co-operation pertaining to water quantity include The International Boundary Waters Treaty Act, The International Joint Commission, The Great Lakes Charter, and Annex 2001.

The International Boundary Waters Treaty Act

This Act governs Canada's obligation under the *Boundary Water Treaty of 1909*, with respect to the 300 lakes and rivers shared by Canada and the United States. Basic principles for the use, obstruction and diversion of boundary and transboundary waters have been established by the Treaty and administered by the International Joint Commission (IJC), which was formed as part of this treaty (Powell 2003: 24).

The International Joint Commission (IJC)

The IJC assists both the Canadian and U.S. governments to resolve problems in their shared waters. Six commissioners, appointed by both the Canadian and U.S. governments, administer the IJC, and follow the principles established by the Treaty as they try to prevent or resolve disputes. The organization has created more than 20 boards, comprised of experts from Canada and the United States to assist in carrying out its responsibilities (IJC 2004).

The Great Lakes Charter

The eight governors of the Great Lakes states and the premiers of Ontario and Quebec signed The *Great Lakes Charter* in 1985. The original voluntary agreement outlined a series of principles for the collective management of the lakes. The governments agreed that no state or province could proceed with a new or increased diversion or consumptive water use over 5 million gallons per day without seeking the consent of the other affected governments (CELA 2004b).

Annex 2001

Annex 2001 is a recent amendment to the original *Great Lakes Charter*. It commits to preparing binding standards within three years to “govern large scale withdrawals of Great Lakes water, protect the water resources of the Great Lakes ecosystem, and resolve disputes with respect to withdrawal and protection” (Powell 2003: 24). The amendment builds on the structures of the Charter but is more far-reaching. For example, although it does not reference water diversions or exports, it does apply to withdrawals of water from the basin, regardless of size. Even small or routine withdrawals for use within the basin are evaluated under a common standard and those over a certain threshold quantity are subject to regional review (Valiante 2003: 56).

Annex 2001 came about following the approval by the Ontario government for the Nova Group to withdraw 60 million gallons of water per year from the Lake Superior. The approval underscored the vulnerability of the lakes to private withdrawal proposals and, consequently, the governments of Canada and the United States asked the IJC for a detailed report studying the impacts of major water withdrawals on the Great Lakes Basin. The IJC found that there is never a surplus of water in the Great Lakes system and that withdrawals reduce the system's resilience. In its final report, the IJC recommended that the Canadian and U.S. federal, provincial and state governments should not permit the removal of water from the Great Lakes Basin unless the proponent can demonstrate that it will not endanger the integrity of the Great Lakes ecosystem (IJC 2000).

3.3 Conclusion

The apparent wealth of water in Canada is deceiving. The bulk of renewable water is found far from where the majority of Canadians live or is only available in abundance during the “wet season.” Additional stresses, such as population growth, increasing urbanization, aging infrastructure, pollution, poor pricing signals, and the wild card of climate change combine to challenge water management in Canada. A new reality of freshwater scarcity is emerging as a serious threat to Canadian cities. Attention to the importance of regional variability and consideration of water resources as part of a complex and integrated ecosystem is paramount.

The complexity associated with jurisdictional responsibilities exacerbates Canadian water management prob-

lems, limiting sustainable solutions and further entrenching excessive water use.

The institutional overview of this chapter suggests that management of freshwater resources is in need of sober reform if Canada is going to take water sustainability seriously. Despite the constraints inherent in the federal system of government, considerable potential for innovation to improve water management exists. Solving

Canada's water resource problems will require accommodating various competing interests, understanding historical forces that have created the existing framework, innovation and leadership to address emerging and complex problems, and policy coordination at all political and administrative levels.

While solutions are local in nature, a national approach to water management is vital.

PART II:

Developing water sustainability - Lessons from elsewhere

Chapter 4

A national strategy for sustainable water use



The water crisis is essentially a crisis of governance.

UNDP World Water Report 2003

Historically, water conservation in Canada has been composed of individual responses by local authorities to specific local water crises. This approach addresses proximate and short-term concerns, but does not take advantage of strategic opportunities to reduce environmental impacts and enhance long-term human well-being. A national strategy is necessary to achieve the environmental, social, and economic benefits of sustainable water use.

Managing water effectively requires an integrated, long-term and comprehensive approach. This demands a commitment by all levels of society and government leadership. Senior governments are uniquely situated to promote and encourage the tools and institutional structures that allow all stakeholders to take effective action.

4.1 Avoiding the water crisis

In Australia, a Senate Committee (ECITA 2002) outlines the benefits of a proactive national strategy that:

- establishes a National Partnership to coordinate management actions of governments, water management authorities, stakeholders, civil society and the general public;
- overcomes jurisdictional barriers;
- rationalizes and simplifies institutional arrangements;
- coordinates research, and distributes conservation information to managers;
- ensures conservation measures are known and implemented;
- raises awareness and encourages efficient use of water; and,
- drives change by encouraging water conservation targets.

4.2 Comprehensive national strategies in Australia and Europe

Innovations to resolve water problems are emerging

across the globe. Australia and Europe are leading the way in developing comprehensive continental strategies. Canada has a federal water policy that has, however, not been fully or effectively implemented because it has not specifically addressed provincial and local action. The leadership demonstrated by Australia and Europe could guide all Canadian jurisdictions in overcoming these jurisdictional barriers.

4.2.1 Australia

Over the past decade, the federal, state and territorial governments of Australia have worked together to create and implement a comprehensive national strategy for water reform. Most recently, a 2004 Intergovernmental Agreement (IGA) triggered a National Water Initiative (NWI). In the area of urban water reform, the NWI aims to:

- increase water use efficiency;
- promote the reuse and recycling of wastewater;
- encourage innovation; and,
- improve pricing.

As a first step, the States and Territories agreed to undertake the following specific actions in regard to demand management by 2006:

- review the institutional and regulatory models for achieving integrated urban water cycle planning and management, followed by preparation of best practice guidelines;
- take immediate action to develop national guidelines for water sensitive urban designs (including recycled water and stormwater);
- enact legislation to implement the Water Efficiency Labelling Scheme (WELS), a mandatory product labelling scheme for appliances, and a Smart Water Mark labelling scheme for household gardens, including garden irrigation equipment, garden

- designs and plants;
- review the effectiveness of temporary water restrictions and associated public education programs, and assess the feasibility of making low-level restrictions standard practice;
- implement cost-effective measures to address system losses, and related maintenance issues; and,
- review incentives to stimulate innovation.

4.2.2 Europe

Another good example of a multi-party strategy is the European Water Framework Directive, or WFD. This Directive is based in binding legislation among European states to:

- Implement watershed management - The territory of each member state will be divided into river basin

districts with a management authority assigned to each. A river basin that covers the territory of more than one member state will be assigned to an international river basin district. Member states must collect and maintain information on the characteristics of surface and ground waters for each district by 2004; put in place a monitoring system by 2006; and establish a program to control withdrawals from surface and ground waters, and develop a River Basin Management Plan (RBMP) through a public consultation process by 2009.

- Improve the quality of all water bodies - Member states must aim to achieve good ecological and chemical status for all surface waters and good chemical status for all groundwater by the year 2015.
- Avoid groundwater overdraft - Member states must

Box 28: Council of Australian Governments (COAG) leading water reforms

Similar to Canada, Australia's federal system assigns primary responsibility for natural resource management, including water, to the states and territories. Recognizing the need for coordinated action to halt the widespread deterioration of Australia's natural resources, the Council of Australian Governments (COAG) was established in 1992. It comprises the Prime Minister, State Premiers, Territory Chief Ministers and the President of the Australian Local Government Association.

In 1994, COAG made water resource management a top priority and developed the Water Reform Framework (WRF). The WRF attempts to create a consistent approach to water reform throughout Australia, leaving each state and territory the flexibility to adopt its own approach to implementation. Some key components of the WRF include: water pricing based on the principle of full-cost recovery; a comprehensive water allocation requirement that considers environmental flows; improved water trading; integrated catchment management (the Australian term for watershed management); greater public education about water use; and research into water conservation technologies.

In 1995, COAG endorsed the National Competition Policy (NCP) that offers to pay states and territories for the successful implementation of reforms such as the WRF. The National Competition Council assesses the progress of implementation, and determines which states or territories will receive the full share of payments under the NCP. Between 1999 and 2001, over \$1 billion was awarded in competition payments to states and territories. During the following two-year period, the payments totaled \$740 million. Non-compli-

ance with WRF requirements results in reduced payments. For example, Queensland's annual payment was reduced by \$270,000 in 2001-2003 due to Townsville City Council's lack of progress on water pricing reform.

At the June 2004 COAG meeting, the federal and most state/territorial governments entered into an Inter-Governmental Agreement (IGA) on the National Water Initiative (NWI). The purpose of the IGA was to address outstanding issues from the WRF, such as the commitments to protect water sources and their dependent ecosystems; to increase urban water conservation; to deal with over-allocation and to create a nationally compatible system for water allocation.

A National Water Commission (NWC) was created as an independent statutory body to advise COAG on national water issues, and to assist with implementation of the NWI. The Commission will be responsible for the accreditation of state/territorial implementation plans for the NWI and biennial assessments of their progress.

The COAG water reforms have led to a significant conceptual shift in Australia's water management. Together with the Murray-Darling Basin Initiative, the reforms have resulted in:

- an integrated approach to catchment management across Australia;
- a national scheme to adjust water allocations to sustainable levels;
- more efficient water use through water trading; and,
- an increase in urban DSM.

Source: (COAG 2004; NRMCC 2004)

aim to achieve good quantitative status for all groundwater by 2015.

- Adopt efficient pricing - Member states must implement full-cost recovery, with pricing policies aimed at encouraging efficient water use by 2010.

As with the Australian national strategy, the WFD has led to the study and development of many practical initiatives to guide jurisdictions as they implement these reforms. For example, A Common Implementation Strategy (CIS), initiated in 2001, focuses on information sharing tools, the creation of working groups and expert

advisory bodies to develop guidance documents, and the testing of such documents across a network of 15 pilot river basins involving 18 countries.

4.3 Key elements of a national water strategy

An effective national water strategy must address a range of issues, from the control of water withdrawals and source protection at the watershed level to the creation of institutions for DSM implementation at the urban level. Each of these issues is addressed in detail in the following chapters and summarized here.

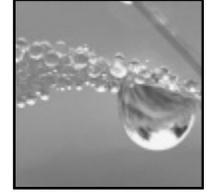
Key elements of a national water strategy for Canada

	Practice (BMP)	Purpose(s)	Key enabling requirement(s)
Ecosystem-based water allocations Chapter 5	Water allocations that ensure watershed health	Allocate water to sustain ecosystem integrity	Provincial action on fundamental reform of water licensing and allocation systems
	Adaptive withdrawal permitting	Avoid future over-allocation of water sources by allowing permitted withdrawals to be adjusted over time in response to water availability	Change water licenses and entitlements; and demand detailed hydrological and human water use monitoring
	Market-based instruments for water sustainability	Provide incentives (financial rewards) for desired behaviour or impose fees on undesirable behaviour to reduce water use and provide potential revenue to subsidize conservation and restoration	Pricing - attention to distributive effects (i.e. political economy of water) Trading - property rights with clear ecological water allocations and significant government regulation Liability - public access to legal system
Innovative Urban Water Management Chapter 6 and 7	Long-term conservation planning	Overcome short-term decision making that increases long-term impacts/costs	Water conservation planning guidelines and incentives that require their use (conditional funding, legislation)
	Environmental management systems	Embed planning in an adaptive management framework, ensuring regular assessment of business practices and consequential environmental impacts	Overcome upfront costs for management process (e.g. plan, do, check, act) and ensure availability of detailed information
	Utility Full-Cost Accounting	May eliminate perverse subsidies by promoting a truer value of water to end users, ensuring long-term financial stability for the utility	Local political will or provincial legislation as in Ontario. Citizen/end-user education
	Developing conservation capacity	Develop professionals that create and run effective long-term DSM programs	Sufficient financial resources and recognition that DSM professionals are critical to any water supply team
	Best practices clearing-house	Disseminate information and opportunities to improve water management and promote innovation	Create one central and credible resource in collaboration with key stakeholders
	Promote market in DSM planning/implementation	Ensure ongoing innovation and continual integration of conservation technologies	Commitment by local government to link development with conservation incentives
	Labelling	Allow purchasers to identify and select the most water-efficient products to meet their needs, facilitating a market for conservation technologies	Credible oversight and enforcement of standards
Key DSM measures Chapter 7	Social Marketing	Promote behavioural change at community level	Specific training and direct public contact and involvement
	Conservation-based pricing	Provide incentives to reduce water use and signal the value of water	Universal metering and public and political buy-in
	Reuse and recycling	Cascade water use to reduce wastewater and water use	Dual plumbing, enabling regulation, pilot projects, national guidelines for reused water and health regulations
Watershed Governance Chapter 8	Water parliaments	Ensure holistic planning and decision making at the watershed scale by bodies aware of local needs and circumstances	Collaboration by key stakeholders and senior governments; sufficient resources and delegated decision-making authority

Impact/implications	Governance principle	Leading example(s)
Water allocated for ecosystems and basic human needs first; the remainder allocated to maximize social and economic benefits	Ecosystem-based management	<ul style="list-style-type: none"> • South Africa National Water Act (Sec 5.3) • Australia, COAG reforms (Sec 5.3)
May challenge expected long-term specific volume requirements for fresh water	Adaptive management	<ul style="list-style-type: none"> • Time-limited withdrawal permits in the UK, South Africa and Florida (Sec 5.4.1) • A consumptive pool - Australia (Sec 5.4.2)
<p>Tax shifting and green taxes may impact costs and individual company/industry competitiveness</p> <p>Commodification of water resources and potential corporate influence requires careful government oversight</p> <p>Cost recovery facilitated by environmental bond requirements</p>	Ecological modernization; full-cost accounting and user pay	<ul style="list-style-type: none"> • Europe (Sec 5.6.1) • South Africa (Sec 5.6.1) • Australia (Sec 5.6.2) • Alberta (Sec 5.6.2) • California (Sec 5.6.2) • Sweden (Sec 5.6.3) • Columbia (Sec 5.6.3)
Senior government must provide support (finances and information) to assist in preparation of plans, and must enforce penalties if plans are not implemented	Matching principle and deliberative democracy	<ul style="list-style-type: none"> • EPA guidelines (Box 39) • California's Urban Water Management Planning Act (Box 40)
Requires industry or government action to develop specific EMS frameworks for water utilities and providers, and requires establishment of indicators	Adaptive management	<ul style="list-style-type: none"> • ISO 14001 (Box 41) • North East Water in the State of Victoria Australia (Sec 6.3.1) • Sydney Water Corp., Australia (Box 42)
Concern that privatization may result; requires strong public oversight	Subsidiarity and ecological modernization	<ul style="list-style-type: none"> • CRD Victoria (Box 45) • Ontario's Sustainable Water and Sewers Systems Act (Box 44)
Changing utility focus from water supplier to service provider	Ecological modernization	<ul style="list-style-type: none"> • California - dedicated government division for water efficiency (Box 40) • Some Canadian cities have hired full-time DSM staff (Sec 6.6)
Compliance with practices can be part of criteria for linking funds for infrastructure expansion or DSM programs	Ecological modernization and subsidiarity	<ul style="list-style-type: none"> • WaterWiser Clearinghouse Web (Sec 7.2.2) • California MOU Regarding Urban Water Conservation (Sec 7.2.1, Box 47)
May increase developer costs leading to focused resistance	Ecological modernization	<ul style="list-style-type: none"> • WASCOs (private entities contracted to plan and implement DSM program (Sec 6.2.3) • Arizona Active Management Areas requires developers to reduce water use before new building permits are given (Sec 6.4.1)
Can help local water providers select models/brands for rebate and giveaway programs	Deliberative democracy and ecological modernization	<ul style="list-style-type: none"> • WaterStar (Sec 7.3) • EcoLabel (Sec 7.3) • WELS (Australia) (Box 49)
Requires detailed planning, pilot projects and evaluation	Ecological modernization	<ul style="list-style-type: none"> • The Region of Durham, Ontario (Sec 7.1.5, Box 19)
May effect municipal water revenue predictability	Ecological modernization; full cost and user pay	<ul style="list-style-type: none"> • Irvine Ranch Water District (Box 50) • EU Water Framework Agreement (Sec 7.4)
Requires additional technologies and technical expertise	Ecological Modernization	<ul style="list-style-type: none"> • California Water Code (Sec 7.5.2) • Florida Reuse Coordinating C'ttee (Sec 7.5.2) • Vernon, BC (Sec 7.5)
Changing role of government from central control to facilitator of local decisions	Matching authority and subsidiary	<ul style="list-style-type: none"> • France's Water Parliaments (Box 56) • COAG and the Murray-Darling Basin Initiative, Australia (Box 58) • Washington State, US (Sec 8.2, Box 57)

Chapter 5

Water allocations for the 21st Century



We're all downstream.

Ecologists' motto

Throughout the 20th Century, to accommodate a growing population, Canadian laws and policies encouraged rapid economic growth. This resulted in substantial freshwater withdrawals and large-scale modifications of aquatic systems, through dams, reservoirs and diversions.

As Canadian cities grew and their water use increased, surrounding water resources were developed. Where local water resources were insufficient, distant water sources were diverted. This pattern of incremental development has had significant negative impacts on these water bodies and, if followed in the future, will ultimately limit the ability of the ecosystems to continue to provide clean and sufficient water.

Water quality, geomorphology, riparian vegetation, the composition of aquatic species, and the connectivity between a stream, its floodplain and underlying groundwater have all been altered. Significant ecological impacts can occur even at low levels of withdrawals depending on the particular characteristics of a river (Schofield, Burt and Connell 2003: 16). Pollution, climate change and increasing water use associated with population growth impose additional threats to these aquatic and riparian systems. To address the ecological limits on the amount of water that can be safely removed from watersheds, a shift to ecosystem-based management (ESBM) is beginning. ESBM suggests that a “cap” or “sustainability boundary” on such withdrawals be established to protect the key physical, biological and chemical processes in the aquatic ecosystem.

Natural variability of flows must be substantially maintained or restored to retain aquatic ecosystem function and services (IFC 2002; Gillilan and Brown 1997; Postel and Richter 2003).³⁷ Caps must be adjustable and flexible enough to respond to changing conditions or new information (e.g. from climate change). The goal is to withdraw water for human use in patterns that

emulate, as closely as possible, natural fluctuations in levels and flows (Naimen et al. 1995; Brooks 2005).

Reserving water for environmental needs should be established even in areas where water is considered abundant since the opportunity to do so may not exist in the medium to long term. (IFC 2002: 307). Gillian and Brown (1997: 100) emphasize this urgency noting that “[o]ne of the lessons we’ve learned with instream flow filings and possible water development is never to assume a stream is protected by its location alone. Water flows uphill to money. Where there’s enough money, there’s a feasible project.”

By setting a limit on available water, the cap also becomes a driver for DSM in the watershed. If current water withdrawals already exceed ecological limits, or trends indicate that they will be exceeded in the future, the need for conservation becomes obvious. The existence of a cap acts as an early warning system to signal that increasing water consumption will lead to an ecological threat, thus allowing communities to act early. Indeed, DSM makes reductions in water withdrawals more palatable because it helps to maintain lifestyle with less water.

5.1 Water needs for ecosystems

Withdrawals from surface waters, together with the associated infrastructure have so altered the timing and quantity of water flow that managing withdrawals to provide for minimum, constant flows is no longer sufficient. Critically important is the nature of the flow, including variables such as the magnitude, frequency, duration, timing and the rate of change (as discussed in Box 30).

The science of watershed management is now sufficiently advanced to prescribe targets and management options that offer new ways to achieve an optimal

³⁷Extracting groundwater faster than it is recharged can also disturb the water cleaning ability of groundwater ecosystems and lead to pollution, salt-water intrusion, exhaustion of supply, and even the permanent destruction of an aquifer through land subsidence. Such groundwater overdraft will also impact connected surface waters by reducing the base flows that streams rely on during dry periods.

balance between human needs and long-term river and riparian health.³⁸ This science draws on the interdisciplinary skills of hydrologists, geomorphologists, water quality specialists, aquatic biologists, and riparian ecologists to improve integration between environment agencies and water-licensing agencies which are often separate entities with different mandates and biases (Gillilan and Brown 1997: 127).

Computational tools to support decision making have been developed to determine the variable instream flows necessary to meet ecological water needs (IFC 2002; Gillilan and Brown 1997: 79-94; Schofield, Burt and Connell 2003). South Africa is a leader in the development of such tools (Brown and King 2000; Hughes and Hannart 2003; Postel and Richter 2003). The DRIFT (Downstream Response to Imposed Flow Transformations) methodology uses teams of biophysical and socio-economic specialists to determine the expected environmental, social and economic consequences of a number of flow scenarios, providing decision makers with a range of options. Another tool known as WEAP (Water Evaluation and Planning) analyzes water allocation scenarios on a watershed basis to determine the level of DSM required to meet ecological water needs (Lévite et al. 2003).

Expert guidance is central to setting instream flows and maintaining groundwater balance, and to developing tools for doing so. The U.S. Fish and Wildlife Service (USFWS) funded a National Instream Flow Program Assessment (NIFPA) project in 1995 that brought together coordinators from across the country to evaluate instream flow programs and methods (IFC 2002: xiv). This led to the formation of the Instream Flow Council (IFC) in 1998, a non-profit organization dedicated to improving the effectiveness of instream flow programs for conserving aquatic resources. Because of differences in data, technical capacity, funding, and available time to complete ecological flow assessments depending on location, a suite of tools should be customized to suit each location (Postel and Richter 2003: 55).

Identifying instream flow requirements is a complex task; the scientific uncertainty is significant especially given the unpredictable interaction between human and natural activities. With the effective integration of social science knowledge about human values, perceptions,

behaviours and institutional culture, the science can better inform decision making processes (Poff et al. 2003). Involving broad range of stakeholders improves the assessment of socio-ecological systems.³⁹

5.2 Water allocation in Canada

In Canada, the provinces have primary responsibility for the regulation of surface and ground water. Federal interests are generally limited to trans-boundary waters, waters on federal lands, and navigation and fisheries. As introduced in Chapter 3, the main system for allocating surface waters in Canada is through statutory permitting rules. These permitting systems are underpinned by various water law doctrines: from British Columbia to Manitoba based on prior allocation; in Quebec the civil code; in Ontario and the provinces east of Quebec a riparian rights approach; and, in the North an authority management approach (Percy 1988).

Although the details vary from province to province, the general permitting process is similar. Sometimes a posted notice and a public hearing are required before an application is allowed. In most cases, however, public hearings are waived if there are no objections. Unless all the available water has been allocated, an interim conditional licence is usually approved, subject to the interests of downstream licence holders. When the project has been completed and inspected, a final licence is issued that sets out the authorized use or nature of the work and the authorized flows. A licence is sometimes issued for an indefinite period although it can be revoked or altered, often with repercussions (i.e. compensation) if specific rights are expropriated. In some cases, licences are cancelled if they are not exercised (Pearse et al. 1985: 92; Percy 1988; Lucas 1990).

Water licences issued under the common law rules still operate in parts of Canada. Large irrigation licences in Alberta, for example, and older municipalities and industries in Ontario received licences before 1961 when the *Water Resource Act* was passed. These large volume licences have challenged water management efforts, their priority over other uses contributing to water shortages and exacerbating conflicts over water allocation in scarce water regions, such as the Okanagan in British Columbia and in southern Alberta.

In most cases, provinces charge an administrative fee

³⁸Significant research and practical experience in South Africa, Australia and some areas in the United States have led to the development of holistic methods for assessing the water needs of aquatic ecosystems. In South Africa, the federal Water Research Commission receives all its revenue from a tariff on national water consumption the funds from which are then distributed to the research community.

³⁹"Indeed, science alone cannot 'solve' environmental problems, because there are a multitude of legitimate perspectives and desired outcomes that defy objective, technical resolution" (Poff et al. 2003).

Box 30: Freshwater and ecosystem integrity

Five interconnected environmental drivers regulate the structure and function of aquatic ecosystems. Each varies according to changes in climate and length of day. Focusing on any one driver will not provide a true representation of ecosystem structure and function. Effectively assessing and managing human impacts on aquatic ecosystem integrity—from land use changes, to flow modifications, to pollution inputs—requires consideration of all of these factors in an integrated and ongoing basis (Baron et al. 2003: 4).

Environmental drivers in freshwater ecosystems include the following:

1. the **flow regime** defines the rates and pathways by which rainfall and snowmelt enter and circulate within river channels, lakes, wetlands, and connecting groundwater. It also determines how long water is stored in these ecosystems.
2. **sediment and organic matter inputs** provide raw materials that create physical habitat structure, refugia, substrates, and spawning grounds, and supply and store nutrients that sustain aquatic plants and animals.
3. **temperature and light characteristics** regulate the metabolic processes, activity levels, and productivity of aquatic organisms.
4. **chemical and nutrient conditions** regulate pH, plant and animal productivity, and water quality.
5. the **biotic assemblage** (plants and animals) influences ecosystem process rates and community structure.

The natural flow regime

Under natural conditions, the flow regime is regarded as the “master variable” that changes over space and time according to local climatic conditions and the surrounding landscape

structure (Richter et al, 2003: 207; Poff et al. 1997: 769). Temporally, flow may vary on hourly, daily, and intra/inter-annual bases. Spatially, the fluctuations in flow influence the degree of river and stream channel inundation, lake levels and groundwater and wetland recharge. The ecological structure and function of streams and rivers are regulated by five critical components of the flow regime (Poff et al. 1997: 770):

- **magnitude** - the amount of water moving past a fixed location at any given time;
- **frequency** - how often a flow of a given magnitude is observed over a given time interval;
- **duration** - the period of time associated with specific flow conditions;
- **timing** - the regularity with which a given flow condition occurs (e.g. annual peak flows); and,
- **rate of change** - how quickly a flow changes from one condition to the next.

Together, these components describe the variable flow conditions for aquatic ecosystems. Each of these flow conditions has a unique influence on the integrity of river and stream ecosystems and related lake, wetland and groundwater systems.

The cumulative impacts of flow modification and the myriad other human disturbances on freshwater systems result in marked changes in ecosystem processes. If flow regimes are altered beyond critical limits, the ecological integrity and self-sustaining productivity of aquatic ecosystems become severely compromised (Poff et al. 1997: 770). This in turn compromises the ability of ecosystems to provide goods and services vital to human health and economies such as storage and purification of water for drinking water supply, as well as fisheries production and flood mitigation.

Source: (Brandes and Maas 2004: 36)

for water permits but not for the water taken (Environment Canada 2003a). This licensing system does not support conservation pricing but creates a “perverse subsidy” that leads to overconsumption: “the inefficient price of the resource becomes embedded in the stock of industrial capital and in the design of municipal water utility systems” (Renzetti and Dupont 2002: 495).

Current surface water licensing schemes in Canada are primarily designed to license the consumptive use of water rather than to meet instream needs that maintain natural flows for ecosystems, wildlife habitat, fisheries, or navigation (Percy 1988: 48, 65; Thompson 1991: 160). Groundwater licensing schemes are also deficient, and little effort has gone into identifying the interconnections between surface and ground waters. Too rigid to adapt to

emerging ecological considerations or the changing priorities of society, these systems leave environmental protection to the discretion of decision makers, rather than enshrining mandatory legal protection. In some cases, more water has been allocated than even exists. Similarly, groundwater allocation systems fail to protect aquifers and the surface ecosystems that rely on them.

5.3 Water allocation that ensures watershed health

Once ecological water needs have been identified, they require legal protection. Instead, the current system of water allocation in Canada produces a constant decline in the residual amount of water available to sustain ecosystem health and productivity.

Box 31 presents an alternative that “nests” the human water economy within the finite “natural water economy.” Placing a “sustainability boundary” on human water use acknowledges the hydrologic limits of watersheds and aquifers, and sets an explicit goal of allocating water to sustain healthy aquatic ecosystems (Postel and Richter, 2003: 37).

Australia, Europe, Israel and South Africa build the ecological sector directly into their water-planning framework. Ontario has indicated in its White Paper on source protection that it intends to do the same. The European Union issued a directive establishing a new framework for water policy that includes a focus on river flows. A key feature of the directive is the establishment of criteria for classifying the ecological health status of rivers (and other water bodies) as high, good, moderate, poor, or bad, depending upon how much the river’s ecological characteristics deviate from a natural or undisturbed condition (Postel and Richter 2003: 83).

Australia

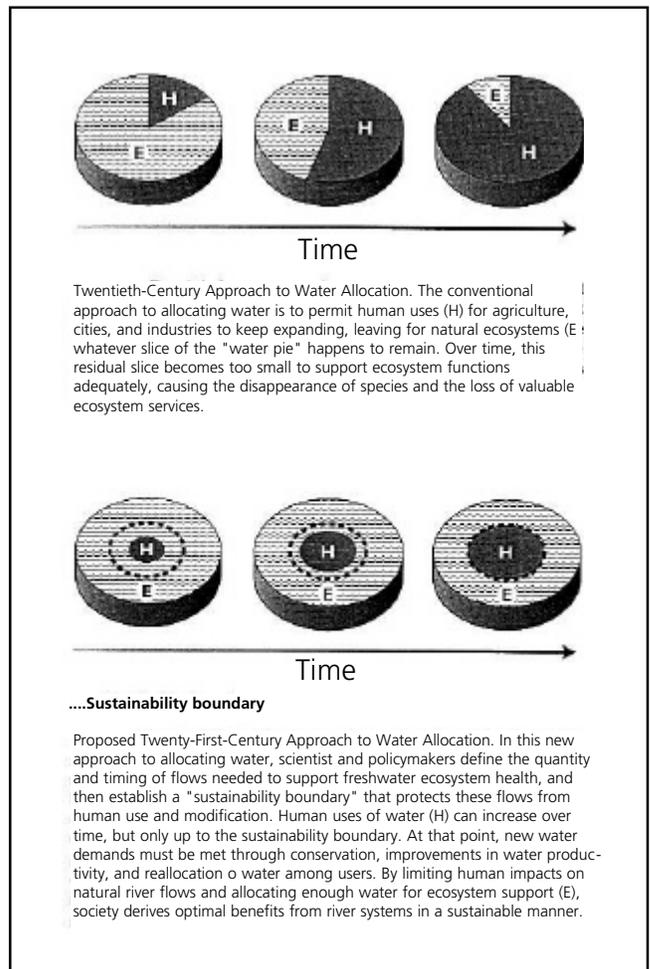
In Australia, rivers and wetlands are recognized as legitimate “users” of water, and jurisdictions implement water allocations to sustain and restore ecological processes and biodiversity of water dependant ecosystems (Schoefield et al. 2003). For example, New South Wales responded to the COAG water reforms in Australia with significant legislative reforms. These reflect “the fundamental principle that the needs of the environment, as defined by the rules of WSPs [Water Sharing Plans], are met before the needs of other entitlement holders-water utilities, stock and domestic users, and licensed users” (NSW Ministerial Statement 2004; NSW WMA). “Planned environmental water,” as committed by the rules of a WSP, cannot be used for any other purpose while “adaptive environmental water” is primarily dedicated for the environment but may be withdrawn for other uses when available.

South Africa

Similarly, South Africa has undertaken significant water reforms over the past decade (Abrams 1996; Allan 2003). The national government has authority over water and, in 1998, passed the National Water Act (South Africa NWA) which mandates that the water needs for the effective functioning of all ecosystems be protected. A classification system of water resources is to be adopted based on factors such as quantity and environmental flow characteristics.

Once a particular water resource is classified, a

Box 31: Water allocation models



Postel and Richter, 2003:39

“reserve” must then be determined. Even prior to classification, a preliminary reserve must be set before certain uses of water are authorized. The reserve consists of two parts: the “basic human needs reserve” to provide for the essential needs of individuals, and the “ecological reserve” required to protect the aquatic ecosystems of the water resource (see Box 32). The Act states: “the quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved so that the human use of water does not individually or cumulatively compromise the long-term sustainability of aquatic and associated ecosystems.” Public consultation is required before setting these reserves. A similar “reservation” scheme is in place in Florida.

In some cases, land use activities are included in water withdrawal permitting schemes. Deforestation, afforestation, agriculture, and urbanization all significantly alter the quantity and timing of water flows, as does watershed “hardening” due to increasing areas of

Box 32: Water allocations under South Africa's National Water Act

Water Allocation	Purpose of Water			Objective	Mode of Allocation
Water for Basic Human Needs	To support basic human needs (i.e. drinking, cooking and sanitation)			Meet human survival needs	Nonnegotiable
Water for the Ecological Reserve	To sustain a certain state of the ecosystem (e.g. substance fishing and recreation)	State of the ecosystem associated with a specific range of goods and services	Use of goods and services to support a range of benefits	Social and economic growth and well-being	Negotiated through ongoing stakeholder dialogue and consensus around trade-offs

Postel and Richter 2003-87

impermeable surfaces. *South Africa's National Water Act* allows a land use practice in dry-land areas to be declared a "stream flow reduction activity" (SFRA) if it reduces the yield of downstream water from natural conditions. Once declared, such land use activities are potentially subject to the water allocation licensing system. Afforestation was declared a SFRA in South Africa because it permanently changes land use from its naturally low water use status, and because it occurs in areas that produce the majority of the country's water. Existing and new forestry plantations will require water use allo-

cation permits. Other non-dryland farming activities may also be declared SFRA's in the near future.

5.3.1 Withdrawal permitting

Instream flows must be determined and protected on a watershed-by-watershed basis and potentially for each river on a reach-by-reach basis to ensure that no part of a river's flow is significantly affected. Similarly, groundwater balance must be considered on a catchment-by-catchment basis.

Such a system is in place in Florida and in Arizona.

Box 33: Watershed protection in Florida, U.S.

Florida's water management system has been the envy of many U.S. states for over 25 years. Florida's *Water Resources Act* of 1972 was based on the *Model Water Code* developed by the University of Florida Water Resources Research Center. The Act delegates significant water management authority to five regional Water Management Districts (WMDs) based on hydrologic basin boundaries. Each WMD has a governing body consisting of citizen volunteers appointed by the Governor.

The Act requires WMDs to establish minimum instream flows and levels for surface and ground waters within their jurisdictions. Minimum flow is defined as the "limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." "Water resources" include environmental, fish and wildlife components. WMDs are required to set water aside for the protection of fish and wildlife or public health and safety. These "water reservations" vary depending on seasonal water needs. If water sources are inadequate to provide for existing and projected uses and natural systems, the WMDs will mitigate this through water supply planning.

In addition to state statutory requirements, each WMD sets its

own rules concerning permits for consumptive uses. The Southwest Florida Water Management District (SWFWMD), for example, requires all applicants for major withdrawals to provide reasonable assurances, on an individual and cumulative basis, that the water use:

- will not cause quantity or quality changes that adversely affect surface and ground water resources;
- will not cause adverse environmental impacts to wetlands, lakes, stream, estuaries, fish, wildlife or other natural resources. Each "wetland hydroperiod shall not deviate from their normal range and duration to the extent that wetlands plant species composition and community zonation are adversely impacted;"
- will use the lowest quality of water possible, and will not pollute an aquifer; and,
- will incorporate water conservation measures, apply practicable reuse measures, and reduce water losses.

Withdrawal permits typically contain requirements to monitor water quality, maintain minimum aquifer levels, and provide water use interim reports that describe adverse environmental impacts and the mitigation of such impacts.

Source: (Regan 2003, Sumero 2003)

South Africa is also moving to a watershed-based withdrawal permitting scheme under its *National Water Act*. The country is divided into 19 Water Management Areas (WMAs), each containing one or more watersheds. Although the Department of Water Affairs and Forestry (DWAF) manages each WMA initially, a Catchment Management Agency (CMA) will eventually be created for each. At such time, the bulk of management responsibilities will be delegated to the CMA, including licensing water withdrawals. This will leave DWAF to serve as a policymaking and standard setting authority. The NWA requires that catchment management strategies are developed for each WMA, including water allocation plans. An independent Water Tribunal was created to hear appeals against the decisions of CMAs.

Watersheds or catchments that cross provincial or

international boundaries require national regulation or coordination to overcome the disincentive for one province to protect instream flows or groundwater balance that cross the border into an adjacent province.

5.3.2 Integrated management of surface and ground waters

As surface and ground waters often form a single, connected resource, extracting water from one will affect the other. Ground and surface water policies should therefore be integrated through conjunctive water management. In Connecticut, the *Water Diversion Policy Act* requires a permit for any withdrawal exceeding 50,000 gallons per day (gpd) from either ground or surface water sources (IFC 2002: 149). The same criteria, including impacts on fisheries, wildlife, and

Box 34: Groundwater balance through DSM and land use planning in Arizona, U.S.

In the past, groundwater overdraft led to significant problems in Arizona. Costs for drilling and pumping increased as water tables fell, water quality decreased, roads and building foundations subsided, always with the threat of eventual loss of supply. This prompted the creation of the Groundwater Management Act (GMA) in 1980 and, to administer the Act, the Arizona Department of Water Resources (ADWR). A faculty associate position at Arizona State University was also created to address the overdraft. In 1986, the Ford Foundation selected the GMA as one of the 10 most innovative programs in state and local government—due in part to its explicit recognition that control of land use is essential to control water demands.

Under the GMA, five Active Management Areas (AMAs) are designated where groundwater overdraft is most severe, areas that include the majority of Arizona's population. AMA boundaries are usually defined by groundwater catchment areas. The primary management goal in four of the AMAs is to attain "safe-yield" by 2025. This requires a long-term balance between annual extraction and annual recharge (although it does not take into account potentially diminished surface water flows). To prevent local water tables from experiencing long-term declines in the Santa Cruz AMA, a program of groundwater rights and permits was created and a number of demand and supply-side requirements imposed to resolve significant international, riparian and ground/surface water issues.

On the demand side, no new agricultural irrigation is allowed within AMAs, and ADWR is required to prepare a Water Management Plan for each AMA every 10 years.

These plans must contain rigorous and enforceable water conservation requirements for all major water users, a plan for increasing groundwater supplies, and a conservation assistance program. In the first management plan, municipal water utilities, for example, were required to reduce per capita consumption by a fixed percentage (0-11%, based on their 1980 per capita use) and to reduce system leakage below 10%. To achieve these goals, utilities have implemented an appropriate set of DSM measures. For example, working with local governments to establish more water-efficient landscaping bylaws.

On the supply side, developers within AMAs must demonstrate an assured water supply (AWS) before new urban subdivisions are approved. The utility must do this if the development is within their service area. The developer must demonstrate a 100-year assured water supply, predominantly from renewable water sources that are physically and legally available and of adequate quality. Supply uses must be financially feasible and consistent with the management and conservation goals of the AMA.

Finally, the GMA requires water users within AMAs to meter and report their annual water use. Audits are conducted frequently. ADWR maintains a groundwater use database for enforcement and for long-range planning. Groundwater users pay an annual groundwater withdrawal fee, directed to offset the costs of administration, supply augmentation (such as aquifer recharge and effluent re-use), and grants and technical assistance in conservation. After 2006, such fees may also be used for retirement of irrigated land.

Source: (Vance 1995-96; Jacobs and Holway 2004; ADWR 2004; Arizona GWMC 2001)

instream flows, are applied to all applications. Reversing the burden of proof, the applicant must submit convincing evidence to the contrary, or else the state will presume that groundwater withdrawal will create an equivalent (1:1) reduction in surface flow.

Under the European Water Framework Directive (WFD), member states must aim to achieve “good quantitative status” for all groundwaters by 2015. This means that groundwater withdrawals must not exceed the average rate of recharge less the rate of flow required to achieve the ecological quality objectives for associated surface waters and terrestrial ecosystems such as wetlands. The WFD thus provides, for the first time, a partial framework for integrated management of ground and surface waters throughout Europe.

5.3.3 Dealing with urbanization and drought

Urban development “hardens” a watershed, and then creates additional demand for water. Ensuring water supplies are available before such developments proceed is essential to long-term planning. In Arizona, new urban developments must demonstrate a 100-year assured water supply to meet the new demand. Similarly in Florida, the local withdrawal permitting bodies (WMDs) are required to undertake long-term water supply planning if water sources are not adequate to meet all existing and projected reasonable-beneficial uses. This relationship between land use and water allocation planning is one reason why many jurisdictions are moving to integrated watershed management.

In the past, environmental water needs have been given low priority in relation to human withdrawals even in times of drought. To correct this, drought response plans are required, which prioritize water uses and implement water use reductions in times of drought to protect instream flows and groundwater balance. South Carolina’s *Drought Response Act* of 1985 declares water used for instream flows to be an “essential water use” with out-of-stream uses designated as nonessential, and curtailed first during periods of drought (IFC 2002: 89).

5.4 Dealing with overallocations

Overuse of water resources occurs when too many withdrawal permits are granted or when actual withdrawals exceed permitted amounts, possibly a result of poor metering and/or monitoring. While improved enforcement could address metering and monitoring problems, undoing past over-allocations is difficult and expensive. The Murray-Darling Initiative in Australia, for example, recently devoted \$500 million to reversing

past over-allocations. Despite the expense, failure to address over-allocation increases ecological damage and costs in the future.

Reducing all volumetric allocations *pro rata* appears to be a simple solution. Yet, such an approach is politically unpalatable, may take water away from the most efficient water users, and fail to target areas where environmental concerns are most pressing (Schofield, Burt and Connell 2003: 9). Targeted DSM measures can help rectify past overallocations. By requiring all water withdrawers and users in an over-allocated watershed to redress imbalances in a systematic fashion, and then adjust water allocation to better reflect ecological realities, viable solutions can be achieved.

In 1997, a Government Water Summit in the U.K. made a commitment to reverse environmental damage caused by past over-allocations (U.K. Environment Agency 2004a; U.K. Environment Agency 2004c). The Restoring Sustainable Abstraction (RSA) program was first created to identify sites affected by over-use and determine priority actions to reduce environmental damage and achieve sustainable withdrawal levels. In 2001, the U.K. Environment Agency launched the Catchment Abstraction Management Strategy (CAMS), a six-year program to develop a CAMS for every watershed in England and Wales. To reduce over-allocation, many permanent withdrawal licences would have to be changed or revoked, with statutorily required compensation costing hundreds of millions of pounds. One method being considered to minimize compensation costs is “reverse auctions,” where licence-holders compete with one another to sell their water back to the government.

To avoid overallocations in the future, adaptive water withdrawal permitting would allow permitted withdrawal volumes to be changed over time in response to water availability, varying as a result of the variable instream flow needs of a river, seasonal variations in precipitation, droughts, and long-term changes due to climate change. Permitted withdrawal volumes might also be reduced in response to new understanding of the ecological impacts of withdrawals.

Permanent vested water rights in a particular volume are a “serious legal barrier to wise water development” Regan (2003: 173). Although adaptable allocations systems are required to deal with changing and emerging realities, they challenge the certainty required by water users, whose plans and investments reflect expected water availability. Two approaches to address this tension are: *time-limited withdrawal permitting*, and *the granting of shares in the “consumptive pool.”* A third, more gradual

approach to handle over-allocation and create adaptability is through water trading schemes, with an instream flow reservation being applied with each water transfer. In Alberta, under the new *Water Act* such a system is possible. The Act authorizes the Government to withhold up to 10% of the water being transferred, although this hold back is discretionary and may come under political pressure.

5.4.1 Time-limited withdrawal permitting

Time-limited withdrawal permits provide security during the lifetime of the permit, subject to water use restrictions during drought or emergency conditions, thus providing some certainty that signals the appropriate level of capital investment (Beck 2000-2001: 154). Once the time period expires, the allowable extraction volume on the permit may be reduced, the permit renewed or cancelled. What route is taken will depend on changes in water availability, new water conservation technology, unforeseen impacts from past withdrawals, or increased knowledge of ecosystem needs.

The U.K. announced a time-limiting policy in 2001, which became a statutory requirement in 2003. All new licences and variations are now subject to time limits (U.K. Environment Agency 2004a; U.K. Environment Agency 2004c). To encourage holders of existing permanent licences to convert to time-limited status, the Environment Agency is considering a reduction in withdrawal charges for time-limited licensees. And after July 2012, existing withdrawal licences that are not time-limited and that have the potential to cause serious damage to the environment, may be revoked or adjusted without compensation. In contrast, holders of time-limited licences will retain the right to compensation if licences are revoked or varied prior to their expiration date.

Under South Africa's *National Water Act* licenses are time limited to a maximum of 40 years and must be reviewed at least every 5 years to allow for changes in response to water availability. And in Florida, Water Management Districts can award consumptive use permits for up to 20 years. Upon application for renewal, permitted volumes may be reduced and new permit conditions.

5.4.2 Awarding shares in the consumptive pool

An alternative approach to dealing with the tension between adaptability and security is being implemented across Australia following the 2004 National Water Initiative (NWI). The government has committed to returning previously over-allocated and/or overused

surface and groundwater systems to “environmentally sustainable levels of extractions.” In particular, an agreement commits governments to a nationally compatible system for water allocation, planning, accounting, and risk sharing (COAG 2004; CEOGW 2003):

- *Water allocation.* The consumptive use of water requires a “water access entitlement,” which is a perpetual or open-ended share of the “consumptive pool” of a specific water resource. For each water resource, the water available for consumptive withdrawals will first be calculated to determine the pool, then allocated among water withdrawers according to the number of shares each one holds. While the shares are secure (and registered, allowing them to be traded, leased, subdivided, or mortgaged), the total consumptive pool will change according to the actual volume of water available from season to season and over the years.
- *Water plans.* States/territories will develop statutory water plans for ground and surface water management units in which access entitlements are to be issued. Such plans will describe the rules to determine the consumptive pool and to allocate water, as well as the ecological outcomes to be attained. Periodic independent audits, reviews and public reporting will be undertaken to assess the achievement of those outcomes. “Environmental” water will be given at least the same degree of security as the consumptive water access entitlements.
- *Water accounting.* A nationally compatible water accounting system will be put in place in each jurisdiction to measure, monitor and report on the amount of water being traded, extracted for consumptive use, and managed for environmental purposes. Each jurisdiction will identify areas that have close interaction between surface and ground water. By 2008, the system will include an accounting of such interactions.
- *Risk assignment.* In addition to reductions required for dealing with over-allocation and overuse, entitlement holders bear the risk of reduced volume assignments due to drops in the consumptive pool from seasonal or long-term climate changes, or periodic natural events such as drought. Entitlement holders also bear the risk of reductions in response to a better understanding of water systems’ capacities to sustain extraction levels until 2014. After 2014, this risk will only apply to the first 3% reduction, with the remainder to be shared between the state/territory and federal governments.

5.5 Linking water conservation to permits

Legislation and/or withdrawal permit conditions often require efficient water use. In Florida, for example, the Southwest Florida Water Management District (SWFWMD) requires all applicants for major withdrawals to provide assurances that they will incorporate water conservation measures, apply all practicable reuse measures, and ensure that water is not wasted. Arizona has also imposed conservation requirements on water utilities that withdraw groundwater.

In some cases, withdrawal permits were denied where applicants had not demonstrated sufficient efforts to implement DSM measures (Fleming and Hall 2000: 82). The City of Roswell's (New Mexico, United States) request for additional water was denied because of a high per capita rate of water use coupled with the lack of a conservation plan with specific efficiency measures to reduce consumption. The City of El Paso (Texas) was also denied its request for additional water in part because the state officials determined that the city could meet its 40-year needs through conservation and more efficient use.

Similar requirements and permitting conditions have

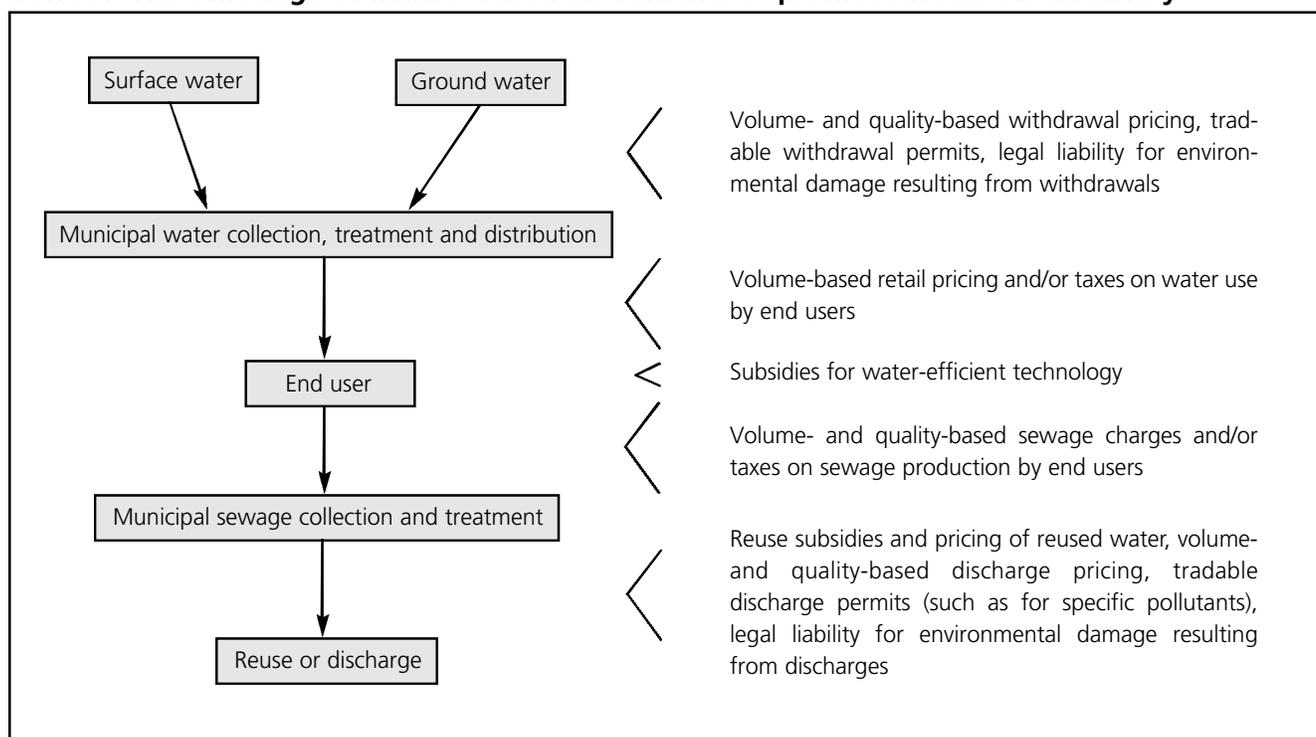
prompted DSM efforts in Canada. For example, the Government of Ontario recently refused to issue another water taking permit to the City of Guelph until the municipality demonstrated that its existing water supply was being used as efficiently as possible. In response, and in an effort to meet the provincial requirement, the City of Guelph implemented an Outside Water Use Program to improve outdoor water conservation (Brooks 2005: 90).

5.6 Market-based instruments for water sustainability

A range of market-based and economic instruments exist that can promote more efficient use of water resources. As illustrated in Box 35 these instruments can be applied to withdrawals at the source, and to end users (discussed in later chapters).

Market-based instruments are usually part of a larger policy package and, to be effective, must be combined with other tools into a comprehensive management strategy. Cantin et al. (2005: 3) cautions "location and context are everything," emphasizing that market-based instruments alone are not a silver bullet for water sustainability, but must be applied with a clear understanding of the policy objectives they are to achieve.⁴⁰

Box 35: The full range of market-based instruments to promote water sustainability



⁴⁰The authors go on to suggest that market-based instruments "maybe be most useful if applied in an Adaptive Management framework, such as the soft path analysis..." (Cantin et al. 2005: 9).

5.6.1 Withdrawal pricing

Volume-based withdrawal pricing charges for each unit of water withdrawn or licensed to be withdrawn, creating a constant incentive to reduce water use (Renzetti and Dupont 2002). Charges vary according to what incentives they create, how the unit price is set, and how generated revenues will be used. In Hamburg, Germany, withdrawal prices are volume- and quality-based (Kraemer et al. 2003: 10-13). “Good groundwater” from deep and relatively well-protected aquifers carries a higher unit price than poorer groundwater, creating an incentive to use lower quality water where feasible.

In Denmark, a “tap water tax” is charged for water utility withdrawals, the cost of the tax then passed on to consumers (Kraemer et al. 2003: 13-15; ECOTEC 2001: 71-74). This is part of a “green tax-shifting” scheme where taxes on economically-beneficial activities (such as income from employment) are partially replaced by taxes on damaging activities (such as resource consumption). To this end, water utilities must pay the tax on 90% of the water they withdraw, but can only pass on to end-users the tax of their actual metered water consumption. The utility must pay the tax on any water losses due to system leakage over 10% (leakage below 10% is generally considered reasonable). In addition to helping reduce end-user water consumption, this general revenue tax has helped decrease leakage from water works by 23% since the program was instituted.

Earmarking revenues for purposes related to the tax can improve its political acceptability (Kraemer et al. 2003: 5,45; daMotta et al. 2003: 76). In Brazil, which is gradually shifting to watershed management, River Basin Committees suggest the water charges for the basin, and the resulting revenues be used to pay for the programs necessary to achieve the environmental targets identified in the Water Resources Plan for the basin (Brazil ANA 2004, Kraemer et al. 2003: 44,45; daMotta et al. 2003). Under the Brazilian *Federal Water Resources Law*, only up to 7.5% of such revenues can be transferred out of the basin.

In South Africa, withdrawal pricing includes a volume-based consumptive charge, a levy to fund the Water Research Commission, and a charge to pay for water management within the Water Management Area (WMA). This WMA charge funds, among other things, for planning and implementation of watershed management strategies, monitoring and assessment of water resource, water quality and uses, and conservation and demand management. Ultimately, as Catchment Management Agencies (CMAs) are established, these

more local bodies will take over price setting from the central government department, with revenues shared between the CMA and DWAF according to the relative responsibilities within the management area.

These examples illustrate ways withdrawal revenues are directly used to subsidize DSM measures or restoration of damaged ecosystems from past water projects. Other options include compensation payments to farmers for restrictions in land use (e.g fertilizer reduction) as is done in Baden-Württemberg (one of Germany’s Länders, or provinces) (Kraemer et al. 2003: 10-13).

A recent report by the Independent Competition and Regulatory Commission (ICRC) in the Australian Capital Territory (ACT) recommended that withdrawal charges include a broad range of values (ICRC 2003). In addition to covering government costs for watershed management and related environmental protection, the ICRC recommended including two new charges. A “scarcity charge” offsets the lost-opportunity costs resulting from consumptive water use, as measured by the market-trading price for temporary water entitlements, while an “environmental charge” offsets the costs of ecological impacts caused by reduced downstream flows, as measured by the cost of permanently buying back such flows.

An effective approach to abstraction pricing consists of a flat rate *licensing fee*, to cover administrative costs, in combination with an *availability charge*, that reflects the capital and environmental cost of providing the supply, and an *actual charge* based on the volume of water withdrawn. A similar pricing approach could apply to discharge of treated wastewater into receiving waters (Brandes and Ferguson 2004: 44).

In many cases where volume-based withdrawal pricing has been implemented, exceptions or price reductions have been provided for specific types of end-users (Kraemer et al. 2003: 9-14; ECOTEC 2001: 69). Some of these, such as for emergency fire-fighting and to ensure poorer people can meet their basic water needs, can be justified for equitable social objectives. Others, however, are more politically driven “perverse subsidies” that may impede the ability of the economic instrument to allocate water to its most beneficial end use, and instead facilitate continuing ecological degradation. Water and water services should not be provided free except in the most severe cases. Whether a subsidy is appropriate should be publicly evaluated and debated. Fundamentally water rates and withdrawal charges should be designed to encourage efficient and effective use of water (Gleick et al. 2002).

5.6.2 Tradable withdrawal permits

An ecological analysis of instream needs and ground-water balance helps to determine how much water can be withdrawn for consumptive uses, but does not help determine who should get the water to maximize the social benefits. One market-based approach to this allocation problem is to use public auctions (such as bidding and tendering processes) to sell new withdrawal permits.

Going further, water withdrawal rights can be made freely tradable. This would help ensure that allocations are directed to the most economically beneficial uses, and create positive incentives for rights holders to invest in conservation technology, since the water saved can then be sold. The ability to transfer water rights can provide flexibility for overallocated systems.

Tradable water rights have existed in Chile for a couple of decades. Hearne and Easter (1996) found substantial efficiency gains, with both sellers and buyers benefiting (although results generally indicated buyers captured the larger share of gains). Other studies found similar results, but examined the nature of the gains and found they accrue disproportionately to large farmers (Romano and Leporati 2002; Janmaat 2005). This disproportionate benefit is of concern if left unchecked because water rights may become concentrated in the hands of a few wealthy farmers or corporate interests.

Australia has been trading water for decades, and their trading schemes have generally provided for an instream flow reservation when transfers occur (IFC 2002: 153,154). Under the rules of a pilot interstate trading project in the Murray-Darling Basin, an exchange rate of 0.9 was set for transfers so that 10% of the original allocation would be returned to the river.⁴¹ A similar system is allowed under the Alberta *Water Act*, with water trading possible in the South Saskatchewan Basin.

Water markets can promote conservation. Being able to sell unused portions of water rights may provide an incentive to reduce use or substitute conservation technologies. However water markets and transfer of water rights are controversial. There are, as above, serious equity concerns that must be protected. As well, they are often associated with the idea of “water for sale” and the commodification of water, sparking fears about the potential privatization of what is generally considered the most precious and fundamental resource (Nowlan 2005: 80).

The legal framework directly influences how a market operates and functions. The laws that define property rights are crucial to the functioning of markets, as are the laws that structure and regulate that market. How entitlement rights are defined influences the values that market participants assign to them, especially, the definition of who will incur the related regulatory and financial risks (Horbulyk 2004). However, a clear definition of water rights can be a challenging and politically charged task. Furthermore, water’s mobility, volatility, and variable (and changeable) quality make it difficult to define and regulate as property (Cantin et al. 2005).

Any trading schemes, such as the one outlined, must situate water withdrawals in a watershed or catchment context. Any trading system must account for ecological needs first. A basic volume of ecological water is not a luxury but a necessity. Only when a sustainable limit is established that is sensitive to instream flows and groundwater balance, can a market system, when functioning properly, facilitate the movement of water to its highest value.

Markets work best when accompanied by other instruments (regulations, oversight, education, etc.) to ensure equity and environmental goals are met: “The water market can be a very good servant to move water around between competing uses and drive the process towards sustainable rural communities, but if left to its own forces, it could prove a very unforgiving master” (Bjornlund 2004).

Box 36: Limits of water markets

“Markets, trades, and transfers, however, can accomplish only a small part of the large challenge of rebalancing water allocation between human uses and ecosystem support. They are not a substitute for a broader legal or regulatory mandate to designate flows for the health and functioning of freshwater ecosystems.”

(Postel and Richter 2003)

5.6.3 Legal liability for environmental damage

The third type of market-based instrument for water withdrawals outlined in Box 35 is legal liability of water withdrawers for environmental damage (Regan 2003: 160; Hunter et al. 2002: 411,415; Fiorino 1999: 449,450). Such environmental liability schemes can

⁴¹Under the COAG reforms, Australia is now moving to the trading of perpetual shares in the consumptive pool. New South Wales is implementing a number of initiatives to facilitate such trading. The state publishes data on the long-term average volume of water likely to be available per share, it established a water entitlement registry that will eventually provide for indefeasibility of water entitlements, and it provides an absolute guarantee that a registered entitlement is accurate.

create incentives for users to investigate and avoid potential environmental harm that might result from their activities. If harm does occur, they are legally responsible for the costs of restoration.

Liability schemes have been used successfully in Sweden in relation to water pollution (Kraemer et al. 2003: 35). More broadly, the recent Europe-wide “Directive on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage” requires liability schemes to be put in place by all member states (E.U. Directive 2004). It explicitly includes liability for significant adverse effects on the ecological, chemical or quantitative status of waters, whether caused by discharges or withdrawals.

To enhance the legitimacy and efficacy of legal liability regimes (or indeed any environmental law), some jurisdictions allow the public to enforce them, and some even provide monetary incentives to do so. For example, in Colombia, anyone pursuing environmental liability judicial action is entitled to receive 10 to 15% of the total compensation. This has significantly increased the number of violations taken to court (Kraemer et al. 2003: 43).

The United States similarly allows the public to enforce most environmental legislation through the statutory mechanism of citizen suits, which is considered an important civil liberty and a key component of ecological democracy (Delogu 1992; Thompson 2000). The Public Trust Doctrine in the United States also provides citizens with an effective mechanism to oversee withdrawal and pollution permitting. The recent European Union directive on environmental liability also facilitates citizen access to the courts. In contrast, few Canadian environmental laws include citizen suit provisions, and a number of Canadian jurisdictions, such as British Columbia, routinely intervene to stay private prosecutions by citizens attempting to enforce environmental laws (Proctor 1991; Webb 1991; Tingle 1994; Ferguson 2004).

5.7 Conclusion

A starting point for water use reform is to protect ecological function at the source, providing water for other human activities only after ecosystem preservation

Box 37: The Public Trust Doctrine in the United States

The U.S. Public Trust Doctrine is based on the fundamental recognition that certain resources are of too high a public value to be given over to private control, but should be held in trust by the state for the benefit of all citizens. In the case of water, the doctrine has required that waterways remain usable for navigation, commerce and fishing. In some U.S. states, such as California, the courts have expanded this list of trust responsibilities to include recreation, open space, scenery, and habitat for birds, fish and wildlife.

U.S. courts have held that consumptive water rights are subject to the Public Trust Doctrine, and that water rights or regulatory approvals of withdrawals must also adhere to the doctrine where feasible. One of the most famous cases and a leading precedent is *National Audubon Society v. Superior Court of Alpine County*. In this 1983 Californian case, the court ordered the State Water Resources Control Board (SWRCB) to review the 42-year old grant of Mono Lake waters to the City of Los Angeles. The review was to determine whether diversions that were causing significant environmental damage should be cut back to maintain public trust values in Mono Lake. As a result of the review, water diversions were reduced by two-thirds.

Source: (IFC 2002: 11-20,136; Gillilan and Brown 1997: 151-157)

is assured. Once human water extraction and flow modification have reached the limit in a river basin or watershed, new demand for water must not be met by further river manipulation. Instead, water productivity must be increased. This entails unleashing the full potential of demand management for water.

The scientific knowledge of ecological flows for rivers is already sufficiently advanced to prescribe targets and management options that will ensure long-term river and riparian health. Policy tools for these approaches exist. As the examples in Australia, South Africa, Europe and the United States have shown, the policy toolbox can be adapted to different legal and cultural settings. This toolbox also holds significant potential in Canada.

Chapter 6

Enabling Local Water Sustainability



Efforts now need to focus on the institutions that can creatively manage and accelerate the adoption of demand-side management practices and policies — on governance of demand management.

(Brooks 2003: 33)

In Canadian cities water use is profligate and the impacts are geographically concentrated. As a result, the urban sector faces escalating environmental degradation, threatened future supplies, and ballooning infrastructure costs (Brandes and Ferguson 2004: 5-10; Maas 2003: 5-8). Demand management (DSM) for urban water use is critical to any national water strategy.

Although DSM has many benefits, local authorities (such as local and regional governments, and water wholesalers and utilities) often fail to fully implement it. This failure is a result of many obstacles—institutional inertia, the lack of long-term planning and legal powers to implement or mandate DSM, insufficient data, technical knowledge, staff and financial resources, and a general lack of public awareness and support (Brandes and Ferguson 2004: 11-17; Maas 2003: 25-27). Senior governments can play a key role in addressing this situation, catalyzing a collaboration of professional and industry associations, NGOs and local authorities to implement comprehensive demand management.

This chapter focuses on how the management and operational structure of local authorities can be adapted to promote sustainability. Restructuring the management of local authorities so that long-term water conservation planning is embedded within an adaptive management framework, and integrated with land use planning, helps create a cultural shift within local authorities. While a few local authorities might undertake such initiatives on their own, such restructuring is unlikely to occur in any widespread or systematic way without senior government involvement.

6.1 Promoting demand management

Many water efficiency improvements are available, and under-utilized, such as:

- *system improvements* to repair leakage in system distribution pipes;
- *indoor improvements* to retrofit existing fixtures,

install new efficient fixtures (e.g. low-flow toilets), reuse water on-site (e.g. bathwater for toilet flushing), change behaviours (e.g. turning off taps);

- *outdoor improvements* to install efficient technologies (e.g. drip irrigation), re-landscape (e.g. replace lawns with native plants that require little water), reuse water on-site (such as bathwater for irrigation), change behaviours (to avoid over-watering for example);
- *large scale reuse* to reclaim water through neighbourhood- or municipality-wide collection and treatment for reuse in irrigating park or farmland, or for return to residences and businesses through dual plumbing systems (Vickers 2001).

Many individual DSM measures have been developed to require or encourage such efficiency improvements. Some can be undertaken by water utilities directly, such as through monitoring and maintenance programs to identify and fix system leaks. Others target homeowners and businesses, such as legislative requirements that mandate the use of efficient technologies, educational programs, conservation pricing, rebates and giveaways. A comprehensive DSM program implements a carefully chosen suite of such measures to maximize their collective impact.

Senior governments and NGOs can undertake a broad array of such actions to promote urban DSM. They include “sticks” such as mandatory requirements, “carrots” such as conditional funding, and general support such as guidelines and technical assistance. Some lead directly to water savings (such as provincial building and plumbing code provisions that require water-efficient fixtures in new construction), while others are necessary to make local initiatives possible (such as provincial regulations and technical guidelines to help ensure that water reuse is conducted safely). As the examples in this and the next chapter demonstrate, such actions can be used in a variety of innovative combinations.

Box 38: A range of actions to promote urban DSM

Legislative actions

- Authorization - Provincial governments can authorize local authorities to undertake and/or impose conservation measures (such as outdoor watering restrictions or banning the sale of inefficient fixtures).

- Mandatory requirements - Senior governments can impose requirements, ranging from DSM measures themselves (e.g. building and plumbing codes) to mandating local authorities to undertake DSM planning and basic DSM measures.

- Mandatory-enabling legislation - Senior governments can use hybrid legislation that mandates a higher-level body, such as a federal or provincial government department, to produce tools (e.g. planning or best-management guidelines) that enable local governments to undertake DSM.

Policy actions

- Model bylaws - Senior governments, associations and other NGOs can develop model bylaws for voluntary adoption by local authorities, who might adapt them to local conditions.

- Guidelines & technical assistance - Senior governments, industry and professional associations, and other non-governmental organizations can provide a broad range of guidelines and technical assistance to help in the design and implementation of DSM programs. This range includes development of computational tools, provision of information on best management practices, and on-site training.

Economic actions

- Conditional funding - Since water system infrastructure is costly, senior governments can place conditions on infrastructure support to require conservation planning so that all DSM opportunities are explored and implemented where feasible, or require implementation of specific DSM measures such as conservation pricing.⁴²

- Dedicated funding - Senior governments and others can provide financial assistance through grants or loans to local authorities to help them undertake DSM planning and implement DSM programs (some of which, such as universal metering, can have significant up-front costs).

- Green taxes - Senior governments can impose green taxes to help internalize environmental costs and provide economic incentives for DSM and development of water-efficient technologies. As described in Chapter 5, such taxes include volume-based water withdrawal and wastewater discharge pricing.

- Government procurement - by purchasing water-efficient technologies themselves, all levels of government can decrease water use, demonstrate their use to the public, and promote the development of such products.

Collaborative actions

- Public-private partnerships - Local authorities can enter into a PPP with a private company that is able to plan and/or implement a DSM program. This can help develop a competitive market in water conservation provision, utilize the expertise of the private partner, and help the local authority avoid up-front costs through "savings financing" (where the private partner pays the up-front costs in return for a share of the resulting cost savings).

- Public participation - Urban DSM relies on changes in public and business behaviour, so it is critical to include them in DSM planning and implementation. Such participation might involve including members of the public and businesses on local water planning bodies, creating a citizen/business advisory committee on water issues, establishing of a "citizen jury" to evaluate and make recommendations on proposed projects or turning to civil society implementation of specific DSM measures.

- Collaboration - Comprehensive DSM programs can involve many different parties, such as the federal government providing guidelines and education, provincial governments legislating conservation requirements and providing funds, local authorities and the public undertaking local conservation planning, and professional associations providing technical assistance. Such multi-tiered collaborative efforts to coordinate these activities, perhaps under the guidance of a national water sustainability strategy, are often critical.

A collaborative multi-agency task-force, working group or water commission could be established by senior governments to provide advice to government, promote dialogue and research, and coordinate DSM efforts.

DSM program and staffing actions

- Dedicated programs & staff - All levels of government can create dedicated departments, programs and/or staff positions to further water conservation. The U.S. Environmental Protection Agency (EPA), for example, has a comprehensive Water Efficiency Program that provides information and assistance on water efficiency, including case studies on successful DSM programs. Similarly, the Office of Water Use Efficiency in the California Department of Water Resources is responsible for water use efficiency planning and coordination, and provides expertise to local agencies and individuals on water conservation and reuse. Local authorities usually require dedicated DSM staff to make a comprehensive DSM program work. One option is for senior government to create dedicated staff to be shared between various smaller municipalities.

Educational and research actions

- Pilot and demonstration projects - Pilot projects can range from a single house fitted with water conservation fixtures to a large-scale development with closed-loop water reclamation. Such pilot projects can help spread, test, and familiarize people with efficient technologies and processes in a public setting. Senior governments, local authorities, industry and professional associations, other NGOs and the public can all play a role in such projects.

- Education - Broad education can instil a public "water ethic," and inform politicians, planners and managers of the need for and potential of DSM.

- Award and recognition programs - Highlighting utilities and/or private entities that undertake innovative and successful DSM efforts can provide encouragement and help educate others.

- Research - A great deal is already known about water conservation that we are not using, so the major focus should be on implementation. Nevertheless, important roles exist for research, on how to improve the effectiveness of DSM programs, or how to ensure that on-site water reuse and recycling is conducted safely.

⁴²For conditional funding to be effective, there must be some mechanism for monitoring and withdrawing the funds if conditions are not fulfilled.

6.2 Long-term planning for water supply and conservation

As mentioned in Chapter 3, the lack of effective planning is a significant stumbling block to effective demand management programs. Some Canadian municipalities are implementing DSM measures;⁴³ the majority typically do so in a limited, ad hoc and reactive manner. This approach is unlikely to produce the substantial and long-term water savings that comprehensive demand management has to offer. Indeed, the relatively short-term decision processes in many local authorities represent one of the key institutional barriers to water sustainability. In many cases where supply-side infrastructure expansion appears necessary, it could have been avoided if DSM had been fully considered with sufficient lead time.

What is required then is a comprehensive, long-term (at least 20-50 years) and integrated planning approach that considers the full-range of DSM measures and determines the least-cost combination of demand- and supply-side options (Brandes and Ferguson 2004: 2,3,35-42). Such planning should take into account future water availability (including climate change scenarios), operating costs (including chemical and energy use), future infrastructure expansion costs, and ecological impacts. Collectively, these considerations will usually mean that supply-side options should only be undertaken as a last resort. Indeed, a soft path approach “backcasts” from a preferred scenario of future water sustainability that embeds demand management throughout the water systems. Such a planning process would indicate, for example, how the “service” of attractive landscapes could be more cost-effectively undertaken through rebates for re-landscaping with low-water-use plants than through the provision of additional water. In this soft path future, senior governments would ensure that local planning efforts are consistent with broader-scale (watershed or provincial) water-related planning processes.⁴⁴

6.2.1 Guidelines, tools and financial assistance for conservation planning

Providing local authorities assistance in water conservation planning is critical, given its importance and complexity. In 1998, the U.S. EPA published the *Water Conservation Plan Guidelines*, one of the first compre-

hensive and generic sets of guidelines available to water utility managers in the United States. The guidelines provide water utilities with a step-by-step planning process, including detailed worksheets and descriptions of the types of information required at each step. They also describe how to implement water efficiency measures, and what strategies and assumptions to consider when calculating costs and savings. Straightforward and easy to understand, the guidelines contain region-specific information and an extensive reference/resource section, including online resources.

Box 39: EPA Water Conservation Plan Guidelines

The EPA *Water Conservation Plan Guidelines*, created under the Safe Drinking Water Act, set out a simple “Comprehensive Water Conservation Plan” template that directs a water utility to:

- specify conservation goals on the basis of community involvement;
- develop a water system profile;
- prepare a demand forecast;
- describe planned facilities;
- identify water conservation measures and barriers to implementation;
- analyze benefits and costs;
- select conservation measures;
- integrate resources and modify forecasts; and,
- prepare an implementation and evaluation strategy.

The guidelines direct local authorities to collect and analyze data to evaluate the effectiveness of a wide range of potential DSM measures, such as universal metering and conservation pricing, public education, retrofits and rebates, promotion of landscape efficiency and recycling. Different sets of guidelines have been developed for water systems of different sizes.

States are given the option of making the guidelines mandatory for water utilities or of requiring local authorities to prepare plans consistent with the guidelines as a condition for funding.

Source: (EPA Water Conservation Plan Guidelines)

⁴³With estimates of approximately 20% of Canadian municipalities having established demand-side management plans (Cantin et al. 2005: 3).

⁴⁴See Chapter 8 for a discussion of watershed management. As for provincial-scale planning, in the United States, 21 states have adopted state-wide water conservation plans or strategies (Miri 1998: 5). The *California Water Code*, for example, requires the Department of Water Resources (DWR) to develop a *California Water Plan* to provide for the coordinated utilization and conservation of the water resources of the State, and must include a discussion of water conservation, recycling, water pricing policies, etc. (§10004). Once such a state-wide plan has been developed, local-level plans are then usually required to be consistent with the plan.

To effectively use such guidelines, local planners need to be able to predict water (and energy) use reductions that might result from different combinations of DSM measures, and be able to compare their costs and benefits to supply-side options. A number of tools have been developed to aid planners in this task, such as:

- Environment Canada's Water Use Analysis Model (WUAM) and the U.S. Army Corps of Engineer's IWR-MAIN.
- WATERGY, a spreadsheet model funded by the U.S. Federal Energy Management Program (FEMP), to estimate water and energy savings, as well as total cost and payback times, for a number of conservation measures such as installation of water-efficient fixtures and appliances.
- CALVIN, a decision support tool that evaluates the most economically efficient package of supply and demand management actions given the current infrastructure, precipitation levels, withdrawal patterns, etc. (Lund 2004).

Ongoing development of such tools is an important area for future funding and research by senior governments and NGOs.

Local authorities, and especially smaller utilities that tend not to have undertaken DSM planning before, will also often require financial and more personalized assis-

tance. With this in mind, in 1997 the U.S. Bureau of Reclamation created the Water Conservation Field Services Program (WCFSP). The WCFSP helps water utilities develop and implement effective water management and conservation plans through technical assistance, field visits and financial aid. It also encourages water conservation generally and coordination of utilities with state and local conservation efforts.

6.2.2 Mandatory conservation planning and conditional funding

Providing assistance through guidelines, tools, funds and other means can help local authorities undertake planning if they so choose, but sometimes more forceful "carrots" or "sticks" are required. In the United States, 27 states stipulate conservation objective requirements or mandatory water conservation plans. A number of states require such planning as a prerequisite for state funding (Miri 1998: 4). Similarly in British Columbia, to qualify for provincial water and wastewater infrastructure funding, municipalities are required to submit water conservation plans with grant applications (Maas 2003: 17).

California's water legislation is one of the most progressive and conservation-oriented in the United States, and demonstrates the use of both mandatory

Box 40: Water supply and conservation planning in California

California's *Urban Water Management Planning Act* (CA Water Code §10610-10657) requires all urban water suppliers over a certain size to prepare, and update every five years, an Urban Water Management Plan. The Act includes extensive requirements related to DSM. For example, the Plan must include supply and demand projections, including an evaluation of the reliability of such supplies and their vulnerability to seasonal or climatic shortage. For any water source that may not be available at a consistent level of use, the Plan must include provisions to supplement or replace that source with alternative sources or with DSM measures.

In addition, plans must include a description of all ongoing or planned DSM measures and how their effectiveness will be evaluated, and an evaluation of 14 specified DSM measures (such as metering, retrofits, rebates, education, and pricing reforms) if they are not being implemented. The potential use of recycled water must also be addressed, including ongoing or planned actions to encourage it. Further, the Plan must include provisions to deal with droughts.

The Act uses conditional funding to promote DSM planning. If a water supplier fails to submit or update its Plan as required, it becomes ineligible for various state funding and drought assistance. In addition, in evaluating applications for grants and loans for urban water conservation projects, the Department will take into account the extent to which a water supplier actually implemented DSM efforts identified in its Plan.

Finally, the Act promotes broad participation in developing such plans. Water suppliers must encourage the active involvement of "diverse social, cultural, and economic elements" in the local area prior to and during preparation of the plan, and they must hold a public hearing.

The Office of Water Use Efficiency in California's Department of Water Resources (DWR) assists utilities to prepare their plans by providing guidebooks, worksheets and workshops.⁴⁵ In addition, California voters passed Proposition 50 in 2002, making \$30 million of funding available for water use efficiency grants in the urban and agricultural sectors, and \$42 million for recycling planning and implementation.

⁴⁵Available at the Office of Water Use Efficiency Web site at <http://www.owue.water.ca.gov/urbanplan/index.cfm>

requirements and conditional funding to motivate DSM planning and implementation.

6.2.3 Promoting a market in DSM

Rather than plan and implement a DSM program itself, a local authority might use a competitive bidding process to involve the private sector. Just such a process was undertaken by the City of Kelowna in British Columbia. The City invited the private sector to submit creative proposals for a 15-year DSM program to meet the city's water reduction targets, and encouraged bidders to submit plans with the most innovative and least expensive ways to meet those targets. The result was a public-private partnership (PPP) in which a private company undertook a metering and education program.

This is one example of a new market in water conservation, where private companies develop conservation expertise and compete with one another to provide services to utilities and/or end users (Burrill 1996; Louw and Kassier 2002: 60). One such water service company—or “WASCO”—in Virginia charges a contingency fee based on a fraction of the measured water savings achieved.

Known as “savings financing,” this allows a private company to pay the up-front costs for planning and/or implementation of water conservation efforts in return for an ongoing part of the resulting cost savings (Foerstel 1994: 66). Such financing schemes can provide a means for cash-strapped local authorities to undertake DSM programs. They can also help overcome the “payback gap,” whereby end-users are often unwilling to invest in water-efficient technology if it will take more than a year or so to pay for itself through reduced water fees. This “gap” results in a collective under-investment in conservation, and over-investment in supply-side options. WASCOs are not yet widespread but are expected to take off in the United States in the same way that energy management services developed in the 1980s following concerns over energy supplies.

6.3 Embedding planning

Water supply and conservation planning should not be a one-off exercise but should be embedded in an adaptive management framework. It is essential to monitor the effectiveness of a DSM program and adjust it as necessary to maximize its effectiveness over time and account for unforeseen circumstances. Program monitoring can also be used to inform society about progress on water conservation goals and as a means to maintain interest and raise awareness.

6.3.1 Environmental Management Systems (EMSs)

One well-developed method for embedding planning in an adaptive management framework is through a “continual improvement management system,” such as an Environmental Management System (EMS). An EMS, such as ISO 14001, is based on a cyclical “plan, do, check, act” process in which an organization develops procedures to identify and manage its environmental impacts, then regularly monitors and adapts those procedures over time.

At their best, environmental management systems can help create a cultural shift within an organization by embedding a routine assessment of business practices,

Box 41: The ‘plan, do, check, act’ cycle in Environmental Management Systems (EMS)

An EMS, such as ISO 14001, includes five basic components:

- **Policy:** Establish and commit to a written environmental policy that sets overall direction and vision.
- **Plan:** Identify current environmental impacts and applicable legal requirements. Establish objectives, goals and targets for reducing impacts. Develop plans and timelines for achieving those objectives and targets, including metrics for measuring progress towards them.
- **Do:** Start implementation of the plan. This may require adjusting organizational structures and procedures, as well as staff roles and responsibilities, to align them with the policy and objectives. Training of managers and employees on the EMS and plan implementation is likely required, as is setting up appropriate document control procedures and communications.
- **Check:** Establish techniques for auditing the management system, for measuring progress towards the objectives and targets, and for reporting on progress.
- **Act:** Establish procedures for making regular, ongoing improvements. Use these to make adjustments to the objectives, plans and operations, as well as the management system itself, to remedy any problems and to promote continual improvement.

ISO 14001 also provides for external auditing, in which an organization's EMS is analyzed by an independent auditor and certified if it conforms to the required procedures.

Source: (Ross & Associates 2002; Wood 2002-2003)

and developing an improved sense of accountability for the organization's environmental impacts. An EMS can be implemented on a variety of scales, ranging from an entire local government to a particular facility or department within a single utility.

Australia is a leader in the use of EMSs by water utilities. North East Water in the State of Victoria, for example, has achieved ISO 14001 certification for its EMS (NERWA 2005). The utility's EMS environmental impacts registry includes several environmental aspects related to water consumption, and it is incorporating its water conservation strategy into its annual review processes (Maconachie 2004). The Sydney Water Corporation has an ISO 14001 certified EMS for their wastewater sewer system, and also an organization-wide EMS (SWC 2003). The latter has incorporated the water conservation and demand management targets specified in their State operating licence (Newall 2004). The Australian Institute of Engineers actively supports the use of EMSs by water utilities, and in 2000 released a position paper to that effect (IEAust 2000).

In the United States, since 1997, the EPA has partnered with the Global Environment & Technology Foundation (GETF) and 23 local governments in three ISO-14001 based "EMS for Local Government Initiatives" (GETF 2005; EPA 2005). The EPA and GETF provide EMS training and technical assistance to selected municipalities in order to pilot EMS in local government operations, develop experience, and share it with others.

Participating local governments report significant water savings. One used stored rainwater for dust control and so conserved about 800,000 gallons of potable water per year, while another eliminated the use of potable water in its "Greens, Dirt and Trash" operations saving approximately 31 million gallons of potable water. The EPA and GETF have also created an online national Public Entity EMS Resource (PEER) Center, and eight Local Resource Centers, to help local governments understand and adopt EMSs for their operations.⁴⁶

While ISO 14001 is a generic EMS, industry-specific environmental management systems can be developed for particular sectors. For example, a National Biosolids Partnership (NBP) was created in the United States to develop an EMS specifically tailored for biosolids operations in wastewater utilities.⁴⁷ In addition to the standard

components of a continual improvement management system, the NBP EMS includes requirements for public participation and communication, and commitment to the principles of a Code of Good Practice. Such tangible requirements can be critical because, as critics point out, generic EMSs require little or no public involvement and do not require any specific environmental outcomes to be met (Wood 2002-2003: 192-210).

As a first step in creating an integrated management system tailored for water and wastewater utilities, the EPA partnered with the Association of Metropolitan Sewerage Agencies (AMSA), the Water Environment Federation (WEF), and a number of utilities to create an EMS Integration Project Workgroup. This workgroup concluded that the large number of potential management systems, combined with numerous specific management tools,⁴⁸ is creating confusion and "initiative overload" for many utilities (Ross & Associates 2002). As a result, "even the most successful initiatives are reaching only a small portion of utilities nation-wide." The workgroup concluded that "an EMS is a natural fit for water and wastewater utilities" with many benefits. Nevertheless, it highlighted the need for guidance, such as:

- further "proof-of-concept" efforts, including utility-based pilot and demonstration projects;
- ongoing education of utility management about the long-term benefits of EMSs;
- provision of guidance materials, financial subsidies and technical assistance (such as that provided by the National Biosolids Partnership); and,
- development of award and recognition programs for utilities that successfully implement an EMS.

The EPA has followed up on this study by funding a three-year project through the AWWA Research Foundation to develop an EMS for Water Utilities, in partnership with a private environmental consulting firm and about a dozen water utilities (AWWARF Project #2930).

Putting an EMS in place in a public utility can involve significant up-front costs, and numerous jurisdictions have offered grants, tax credits, preferential access to government loans and other financial incentives to promote EMSs (Wood 2002-2003: 178; EPA 2001). Some jurisdictions have made EMSs mandatory in

⁴⁶Available at the PEER Center Web site at <http://www.peercenter.net/>

⁴⁷More information available at the NBP Web site at <http://www.biosolids.org/>

⁴⁸Such tools have been developed for water and wastewater utilities, such as the EPA's CMOM (which provides a range of best practices for the management and maintenance of sewer systems) and the AWWA proposed Accreditation Program (which provides a series of standards on operational-level best-practices). These are not management frameworks themselves, as is an EMS. Rather, they provide concrete guidance on specific issues and can be nested within an EMS to provide for a complete management package (see Ross & Associates 2002).

certain sectors. Nova Scotia and New Brunswick, for example, made ISO-based EMSs mandatory in the gas pipeline industry (Wood 2002-2003: 181), and Victoria, Australia, made EMSs mandatory for all non-metropolitan water authorities in the state (IEAust 2000).

6.3.2 Indicators

An important part of adaptive management frameworks is monitoring the outcome of activities and adjusting them accordingly. As Benjamin Franklin once said, “what counts is what gets counted.” “Indicators” are measurements of key outcomes. For urban water provision, they range from simple measures such as per capita water use and number of DSM measures undertaken, to full environmental footprint analysis of a water utility. Such indicators can be used to set priorities for reducing environmental impacts, to determine progress of a DSM program, and to provide the basis for awarding and monitoring conditional permits or funding (Long Peak Working Group on National Water Policy 1994: 134).

Under South Africa’s 1998 *National Water Act* (NWA), the *Regulations Relating to Compulsory Standards and Measures to Conserve Water* require water service institutions to conduct, and report on, an annual water service audit (Allan 2003). This audit must include:

- total volume of water supplied, and volume supplied to each sector;
- volume of wastewater accepted into the sewerage system;
- volume of wastewater approved for reuse;
- the number of meters installed, and the percentage tested and replaced;
- the pricing rate structure and the percentage of total costs recovered through revenues; and,
- water conservation and demand management steps undertaken, including a determination of the amount of unaccounted-for water (i.e. system leakage and metering errors) and steps taken to reduce it, and the progress made in the installation of water efficient devices.

The South African regulations also mandate certain DSM measures. These include repairing any “major, visible or reported” system leaks within 48 hours, fitting all connections with water volume measuring or controlling devices within two years, and ensuring water pressure for domestic customers remains below a defined maximum (900kPa). Water services institutions must also employ a consumer service person to receive reports of non-compliance with the regulation.

To gain a more general overview of the environ-

mental impact of a water utility, a broader set of indicators can be used, such as the amounts of water, chemical and energy consumed, pollution produced, and water and nutrients recycled (Lundin and Morrison 2002).

One of the most sophisticated indicators is the environmental footprint, which attempts to give an indication of the total land and sea area an organization or population relies upon to provide for their material and energy consumption. Such indicators can help understand and raise awareness of the full extent of an operation’s environmental impacts, some of which are often far from obvious.

Requiring that indicators be publicly reported can be a powerful incentive, encouraging local authorities to reflect and change behaviour—due to both competitive desires to

Box 42: The ‘environmental footprint’ as an indicator

The Sydney Water Corporation (SWC) in Australia has undertaken a pilot environmental footprint (EF) calculation as part of a national initiative to develop sustainability indicators.

The SWC calculated its EF by measuring all “upstream” land requirements for its activities. This included, for example, the land used for mining the iron ore for steel to build machinery for SWC’s infrastructure works, and the projected land impacts of climate change caused by SWC’s use of energy from fossil fuels. Land impacts were ranked according to the degree of alteration of the land from its natural state. SWC’s EF was estimated at 73,100 hectares: 54,000 due to climate change, 16,700 due to SWC’s suppliers (such as machinery), and 2,400 due to the footprint of SWC’s buildings and other physical works.

The SWC reports that the footprint exercise has helped them better understand and communicate their environmental performance and progress towards sustainability. It revealed some of SWC’s less obvious environmental impacts, and in particular has highlighted the need for SWC to reduce their energy use. The SWC also uses its EF to calculate individual environmental footprints for each customer. This provides educational tool for individual customers helps them see how conservation efforts (such as installing a low-flow toilet) can reduce their personal impact.

In its pilot calculation, the SWC EF calculations included only “upstream” impacts. “Downstream” impacts that result from their water withdrawals and wastewater discharges (such as negative effects on aquatic ecosystems from disrupted and polluted stream flows) were not included. This is a rich area for further research.

Source: (Lenzen et al. 2003)

be an environmental leader, and to avoid negative publicity. In the case of pollution, for example, the Indonesian Program for Pollution Control, Evaluation and Rating (PROPER) rated dischargers of water pollution from gold (“world class”) to black (no effort at all) (Fiorino 1999: 448,449). This simple requirement increased compliance with pollution control legislation by over 50% in two years.

A set of consistent, nationwide measures is needed to realize the full benefits of indicators. Senior governments can bring stakeholders together to work collaboratively to define the desired indicators. A national, independent environmental monitoring and reporting body could coordinate the development of indicators for urban water utilities. For example, the National Round Table on Environment and the Economy could expand its work on national indicators to deal specifically with water quantity issues.

6.4 Integrating water planning with land use management

Water supply and conservation planning is not an isolated process although it is often treated that way. Land use developments, for example, can create significant new water demands. If such developments are not undertaken in coordination with conservation efforts, they can lead to further supply-side water and wastewater infrastructure expansions. Such developments can also impact local water sources through impervious surfaces and stormwater sewers, resulting in increased pollution run-off and altered groundwater recharge patterns. In short, some form of integrated planning is required that considers water supply and conservation, land use, wastewater and stormwater collectively.

6.4.1 Conditional development permits

Senior governments can take steps to ensure that new development has adequate water supplies, and that DSM is implemented. For example, Arizona stipulates that in specific areas (that include most of the state’s population) development projects can proceed only if adequate future water supplies are assured. In Active Management Areas (AMAs) in Arizona, water suppliers are required to undertake supply and conservation planning to achieve progressively more efficient water use. This occurs in five implementation stages covering a period of 45 years, with increasingly stringent reductions in water use per-capita per-day required from one stage to the next (Arizona DWR). In addition, developers intending to offer land within AMAs for sale or lease to the public must get an

“assured water supply certificate” from the Arizona Department of Water Resources, by demonstrating that “water of sufficient quantity and quality is available to sustain the proposed development for 100 years.”

New developments can be designed to minimize water use. Toronto and Barrie in Ontario, for example, require all draft subdivision plans and development proposals to include a water efficiency and conservation plan (Waller and Scott 1998: 387). North Miami Beach, Florida, requires development plans to incorporate water efficiency principles before a building permit can be issued (Vickers 2001: 159,169,179).

Some local communities are also using innovative DSM measures targeted at developers. For example, in Morro Bay, California, builders can either pay a standard hook-up fee for new developments, or they can retrofit existing houses to the point that the reduction in existing water use matches the water requirements of the new development. Such an approach again has the potential to enhance a competitive market of WASCOs in water conservation. Indeed, “[o]ne can image a homebuilder coming to the door and offering free fixture retrofits, and the householder replying, ‘What’s it worth to you?’” (RMI 1991: 69).

6.4.2 Integrated water cycle management

Integrated Water Cycle Management (IWCM) looks in an integrated way at managing water as it cycles through the water supply system, sanitary (wastewater) sewer system, and stormwater sewer system. This can promote numerous ways to use water more efficiently. For example, some Canadian cities use stormwater to irrigate golf courses and parkland, as well as for wetland preservation, which has the added benefit of reducing wastewater treatment where stormwater was previously directed to sanitary sewers (Marsalek et al. 2002: 28).

Institutionally, these three components of the urban water cycle are often separated in different departments, which can make integration difficult. Thus one approach is to create a single local institution for managing water, wastewater and stormwater, such as EcoWater in Waitakere, New Zealand.⁴⁹

The State of New South Wales (NSW) in Australia uses conditional funding to promote IWCM (NSW DEUS 2004). A local water utility must demonstrate substantial compliance with six criteria before it can make a dividend payment or seek financial assistance under the Country Towns Water Supply and Sewerage Program. One such criterion is IWCM planning,

⁴⁹More information available at the EcoWater Web site at <http://www.waitakere.govt.nz/AbtCnl/to/ecowtr.asp>

intended to motivate water utilities to adopt long-term, comprehensive strategies for the integrated delivery of water, wastewater and stormwater services. The State provides guidelines to help local authorities develop such plans, and the NSW Department of Energy Utilities and Sustainability is conducting a pilot program to test IWCM strategies in partnership with ten local water utilities. The NSW Water Directorate, established in 1999 to provide independent advice to local governments on water and sewerage operations, is also active in promoting IWCM (NSW Water Directorate 2004).

Another form of integration is that between various utilities (gas, electric, water and wastewater). Coordinating efficiency programs between such utilities can help spread the cost of DSM programs, and the combined water, sewer and energy cost savings can make efficiency improvements cost-effective, when they would not be for a single utility.

6.4.3 Water sensitive urban design

Water sensitive urban design (WSUD) is a broad concept that considers all impacts of urban design on water sources. This approach integrates water supply, wastewater and stormwater management, but also land use planning and management to optimize water conservation.

Impervious surfaces—paving, roofing, and

compacted soil—can increase stormwater runoff and decrease groundwater recharge. To help reduce such impacts, numerous communities in the United States have linked stormwater fees to the size of such impervious surfaces (Kornfeld 2001-02: 372-376). In Washington State, the town of Lacey has pioneered a performance-based approach that promotes “zero effective impervious surface projects,” under which a developer may be released from the usual stormwater requirements by using pervious materials for driveways, smaller rooftop exposures and/or rooftop gardens, for example.

Water sensitive urban design has suggested decentralized, “clustered” infrastructure, including onsite rainwater harvesting and stormwater draining technologies. A number of pilot projects demonstrate such ideas. At Simon Fraser University in Vancouver, for example, a design approach developed in British Columbia called the “Water Balance” model is being applied to a new residence development.⁵⁰ The approach uses the natural hydrology of the area to guide the design of landscaping and infiltration systems, so as to maintain absorption of rainfall into the ground and keep runoff close to pre-development levels. The Hammarby Pilot Project in Sweden is a fine example of an urban redevelopment project that comprehensively addresses water concerns (see Box 43).⁵¹

Concepts of industrial ecology can also be incorpo-

Box 43: Water sensitive urban design in the Hammarby Pilot Project, Sweden

The Hammarby Sjostad Project (developed jointly by Birka Energi, the Stockholm Water Company, and the City of Stockholm Waste Management Administration) is an urban redevelopment project that is transforming a run-down port area into a large energy- and water-efficient commercial/residential development. Dubbed the “Hammarby Model,” the project’s primary aim is to develop and apply a new model of urban water and energy cycle management.

By 2010, the project will include 8,000 residences and 25,000 people living or working there. The redevelopment aims to make efficient use of water, and to be as self-contained as possible in energy use and waste production/recycling. With its own state-of-the-art sewage treatment plant, the development goal is to cut current water use by 50%.

Full life cycle analysis is applied to all activities, and monitoring and verification systems will be used to assess the success of the project. A unique “Environmental Load Profile” system has been created to evaluate different scenarios regarding the design of technical infrastructure (water, heating, cooling, sewerage, and waste), as well as the lifestyles of the residents. A monitoring station is being built to measure the composition of wastewater at the local sewage treatment plant, and residents’ consumption patterns for energy and water will be measured by individual measuring systems for each apartment. In addition, new information systems developed by Swedish researchers through the Sustainable Urban Water Management Programme will be tested as part of the Hammarby development.

Source: (Hammarby Sjostad 2004)

⁵⁰The Water Balance Model (WBM), developed as an extension of *Stormwater Planning: A Guidebook for British Columbia*, is a decision support and scenario modeling tool that was formally launched at the Urban Forum of the Annual Conference of the Union of BC Municipalities in September 2003. The WBM enables users to compare scenarios for reducing volumes of rainwater runoff to achieve a light “hydrologic footprint”. The intention is that it will become standard practice for land development decisions in British Columbia. WBM is Web-based and can be found at <http://www.waterbalance.ca>

⁵¹The proposed Docksider project in Victoria, British Columbia is an example of a “triple bottom line” development that will integrate a closed loop, water system featuring cutting-edge conservation technologies, alternative sources, water reuse and recycling to minimize municipal water demands. The proposed development plan is available at http://www.city.victoria.bc.ca/cityhall/pdfs/currentprojects_docksider_prpsl2.pdf

rated into urban designs so that the output wastes from one activity can become the inputs for another. A new golf course, for example, might be designed to reuse treated wastewater from an existing nearby residential area for irrigation purposes. Similarly, a sewage treatment plant might be located next to a power generation facility for reuse of sewage biosolids.

Assistance is required to help make WSUD more widespread. In Australia, the Lower Hunter and Central Coast Regional Environmental Management Strategy has developed a *National Design Guide for Water Sensitive Urban Design* (LHCCREMS 2003). This provides local governments with a set of model planning provisions that can be used to promote “water smart development.” Melbourne Water in Australia is another leader in developing integrated urban water-cycle management and promoting best practice guidelines for WSUD (WSUD 2004).

For WSUD to truly take hold, however, senior government leadership is required, through legislated requirements, guidelines, technical assistance, funding and green taxes. In Australia, the NWI initiated by COAG in 2003 includes a commitment to develop national guidelines on water sensitive urban designs (COAG NWI: para. 92).

In Canada, the Canadian Water Network (CWN) within the Networks of Centres of Excellence presents an opportunity to develop WSUD concepts and develop pilot projects in collaboration with progressive communities. The *Stormwater Planning Guidebook* for British Columbia, mentioned above, is a good Canadian example of applying the watershed/landscape-based approach to assist local government to set performance targets for land development and rainwater management at the site, neighbour-

hood and watershed scales (Stephens et al. 2005).

6.5 Full-cost accounting

Another institutional arrangement addresses how local authorities fund water and wastewater infrastructure and operations. Given the aging water infrastructure in Canada, reduced funding from senior governments, and a lack of sufficient economic incentives to promote sustainability, consensus is emerging on the need for “full-cost accounting” in water and wastewater utilities. The Canadian National Round Table on the Environment and Economy (NRTEE 1996) has noted how the lack of user pay systems in many regions and municipalities discourages water conservation, and predicted that a trend toward full cost, user pay principles to meet basic infrastructure requirements, thus increasing the demand for eco-efficient environmental technologies while redirecting patterns of economic development.

At a minimum, “full cost” should include infrastructure operation, maintenance, and eventual replacement or expansion. However, true full cost should include sewage and wastewater costs, as well as social and environmental costs (which are currently external to most economic accounting methods). Including these externalities is difficult, since they can rarely be calculated directly and estimates vary widely. For example, estimates of annual unaccounted-for costs in the Niagara Region utility ranged from \$10 to \$35 million (Renzetti and Kushner 2004). Nevertheless, this indicates that the costs of water and wastewater services are substantially understated by 16% to 55%.

Municipalities and utilities have little incentive to

Box 44: Full-cost accounting under Ontario’s Sustainable Water and Sewage Systems Act

<p>The goal of <i>The Sustainable Water and Sewage Systems Act</i>, passed in December 2002, is to ensure that municipalities can finance essential water and sewer services and ensure clean, safe drinking water. The Act provides a framework for implementing full-cost accounting and recovery, making it mandatory for municipalities to assess the costs of providing water and sewage services, and to recover the amount of money needed to operate and maintain them.</p> <p>All designated municipalities that provide water and sewage services must first prepare a report, called a Full Cost Report, containing:</p> <ul style="list-style-type: none"> • an inventory and management plan for their infrastructure; 	<ul style="list-style-type: none"> • an assessment of the full costs of providing water services, including costs for source protection, operations, financing, renewal and replacement, and improvements; and, • revenue received to provide water and sewage services. <p>After the Full Cost Report is approved, the municipality must, within six months, prepare a Cost Recovery Plan that shows how it will pay for the full cost of water services. If a municipality refuses to prepare a report or a plan, the minister may prepare a report or plan and recover the costs from the municipality. The Act also requires municipalities to set up dedicated reserve accounts to pay the full costs of water and sewage services.</p>
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Sources: (Renzetti and Kushner 2004: 14; CELA 2004a).

account for their costs where provincial and federal governments supply unconditional capital grants and subsidies for water infrastructure. This funding subsidizes the consumption of water by keeping prices artificially low and promotes the extension of inefficient infrastructure into new developments (Environment Canada 2001a). In response, Ontario recently passed the *Sustainable Water and Sewage System Act* to promote conservation, and to help ensure capital costs are better accounted for and there are sufficient funds for infrastructure maintenance.

Some concerns exist with a move to full-cost accounting. The accounting challenge of ensuring all costs—especially those related to the environment—are adequately valued, may not in practice be technically possible (Pearse and Bocking 2002: 15-6). Some view full-cost accounting as a prelude to privatization of water utilities, although numerous examples exist of full-cost accounting within public utilities (Gleick et al. 2002; Pearse and Bocking 2002: 15-12). The Capital Regional District (CRD) in Victoria, British Columbia, for example, employs full-cost accounting without privatization (see Box 45).

Yet another concern is the impact of full-cost accounting on low-income households. For this reason, the Pacific Institute (a leading water conservation think tank), supports the use of sound economics in water management but does not necessarily advocate full-cost recovery pricing. Although water and water services should be provided at fair and reasonable rates, and be designed to encourage efficient use of water, the Institute maintains that subsidies must be transparent and evaluated and discussed by the public (Gleick et al. 2002: vi).

6.6 Water conservation capacity

A significant barrier to DSM in Canada is the ongoing supply-side engineering bias entrenched in many local authorities and private consulting firms contracted by them (Maas 2003: 25). Educating municipal politicians, planners, managers, and utility staff about the impacts of urban water use and training them in the implementation of DSM are priority requirements.

Establishing staff positions and/or departments

Box 45: Full-cost accounting in the Capital Regional District (CRD), B.C.

The CRD supplies wholesale water through various municipalities to a population of approximately 310,000. The Water Department is responsible for the wholesale treatment and delivery of bulk drinking water to its municipal customers, and for the operation of the retail water distribution system in some outlying communities in addition to management of the watershed.

The Water District (now the CRD Water Board) moved to a “full cost” accounting system in 1997 as consequence of rate hearings ordered by the provincial Comptroller of water under provincial legislation. The new funding mechanism does incorporate lifecycle costs of infrastructure—depreciation, operating and maintenance costs into cost accounting to ensure funds are available to replace worn out infrastructure. These “full costs” include some components of environmental costs since the CRD owns and manages the long-term health of the water source.

This approach is a model of sustainable asset management.

Source: (Dore and Hull 2003, CRD 2005)

within local authorities that are focused on conservation efforts can bring many advantages. They can institute and run DSM efforts over the long-term, keep abreast of the latest developments in DSM around the world, develop an understanding of local needs and barriers, and adapt a DSM program to such local circumstances (Brandes and Ferguson 2004: 25,26). Some local authorities in Canada have hired such staff. For example, the Region of Ottawa-Carleton hired a Water Efficiency Coordinator, and Edmonton has a full-time Water Conservation Engineer to administer their city’s conservation programs. The CRD in Victoria, British Columbia has two full-time demand management coordinators, one focusing exclusively on the ICI sector. Senior governments can financially support such new staff positions, make them pre-requisites to further funding, or direct hire DSM staff at the provincial and federal levels to work with local and regional entities.

Chapter 7

Facilitating urban water demand management



“We have so much knowledge about water that we are not using; we know what we should be doing, it’s just a matter of getting on with it.”

Bocking, quoted in (Maas 2003: 25)

Clearly the potential exists for senior governments and NGOs to embed water-sustainability into local institutions. This chapter focuses on the role of senior governments in encouraging the application of specific DSM measures and programs. For example, they can impose legislative requirements for water efficiency, provide funding, undertake pilot projects and educational programs, or develop green building certification programs. Such actions can motivate and support local communities to undertake innovative programs of their own.

Given the broad range of potential DSM measures, it may be difficult for local authorities to determine what to implement and in what combinations. Many jurisdictions have undertaken collaborative efforts to develop best management practices to guide integrated DSM program design and implementation. In addition to discussing such collaborations, this chapter considers how to promote the use of national and provincial coordination for more sophisticated DSM measures. Water reuse-recycling and conservation-based pricing incentives stand out as promising measures to reduce water use and promote water sustainability that provide immediate opportunities in regions of acute scarcity and limited supply.

7.1 Actions to promote and implement urban DSM

Immediate actions can be undertaken to ensure urban DSM. Together these actions are a critical component of any long-term urban water management strategy.

7.1.1 Mandatory building and plumbing codes

In 1992, the U.S. federal government passed the *Energy Policy Act*, imposing water-efficiency require-

ments for faucets, showerheads, toilets and urinals in all new construction and renovations. As a result, water use is estimated to be reduced by 8% by 2020, saving water utilities an estimated \$7.5 billion in water infrastructure costs across the country, and \$35 billion if energy savings are included (Dickinson et al. 2001). In addition, the International Association of Plumbing and Mechanical Officials (IAPMO) recently released its 2003 edition of the *Uniform Plumbing Code (UPC)*, a model code that can be adopted by states or cities (IAPMO 2004). Scottsdale, Arizona, for example, has adopted the *UPC* water conservation provisions (§402) unaltered.

7.1.2 Model bylaws

The State of Florida has employed “mandatory-enabling” legislation to encourage local authorities to adopt outdoor water conservation bylaws. Water Management Districts (WMDs) were required to develop model xeriscaping ordinances and incentive programs for use by local governments, as well as an incentive program to encourage local governments to adopt these ordinances and programs (§373.185, Florida Statutes). *Local governments were then required* to undertake feasibility studies and to adopt a xeriscaping ordinance if the benefits of a xeriscape program were found to outweigh the costs. In addition, local governments must have an adequate xeriscaping ordinance in place to qualify for district financial incentive programs (§166.048). WMDs are also empowered to make adoption of xeriscaping mandatory as a condition of any consumptive use permit.

Rather than develop model ordinances individually, the five Florida WMDs developed a single model ordinance in collaboration with several other organizations,

including various gardening and landscaping associations, a number of state departments, and the University of Florida. The result was a comprehensive model ordinance that includes a range of best management practices for outdoor water conservation.

7.1.3 Pilot and demonstration projects

The Canadian Mortgage and Housing Corporation (CMHC) designed the Toronto Healthy House as a pilot project to demonstrate water self-sufficiency through on-site recycling of wastewater, and rain and snow collection (CMHC 2001).

7.1.4 Funding

In Australia, Melbourne's four water authorities, with the support of the State government, have established the Smart Water Fund (Melbourne SWF). Open to any individual, community group or commercial enterprise, the Fund's purpose is to encourage and support development of innovative biosolids recycling and water-saving projects. Funded projects have included:

- a partnership of 11 schools that attempted to save water and change the water use habits of children, such as through conducting water audits and installing rainwater tanks for toilet flushing; and,
- evaluation of the water efficiency of car washes and development of an accreditation system by the

Australian Car Wash Association.

In the United States, the federal EPA has produced a guidebook, *Tools for Raising Revenue*, to help local authorities and NGOs raise revenue to pay for water conservation efforts such as through differential pricing for water consumers and permitting fees. The guidebook also assists them to use financial tools to encourage environmental self-auditing.

7.1.5 Education

Educational efforts usually involve simply disseminating information to end users, and can often make use of materials developed by Environment Canada, the CWWA, and others. Educational materials have also been developed collaboratively. The Water Conservation Coalition, a partnership of water utilities and agencies in the Puget Sound area of Washington State, developed a single "brand" for water conservation materials-the "water, use it wisely" campaign.⁵²

Community-based social marketing, emphasizes direct contact between end-users and those delivering the program, to increase the effectiveness of educational efforts (Maas 2003: 15,16). The Region of Durham, Ontario adopted this approach by employing summer students to visit and work repeatedly with homeowners to reduce residential lawn watering. The results were an impressive 32% reduction in peak water demand.

Box 46: Community building while saving water: The San Antonio experience

San Antonio, Texas, found standard rebate programs to be unsuccessful in getting people to replace wasteful, but still functional, toilets. San Antonio Water Services then tried providing toilets free of charge, but still only half those who received a toilet voucher actually picked one up. This prompted an innovative and collaborative program called "The Season to Save Community Challenge," paid for through a conservation charge on top-tier residential and commercial customers.

Water Services distributes vouchers and provides training to participating non-profit organizations, such as youth and church groups, homeowner associations, and sports clubs. Members of these groups distribute the vouchers in the community, and for each new toilet collected the community group receives \$25. The group receives an additional \$15 for each toilet actually installed within a month, and some community groups set up their own installation service to earn this bonus. People were less likely to let

down their favourite community group, and redemption of vouchers soared to 90%.

In their last campaign, 50 non-profit groups participated and over 4,000 toilets were distributed, saving approximately 1,000 acre/feet of water and raising \$100,000 for participating community groups. One Girl Scout group used its money to build a new playground and landscape a school. Other community groups have also been reinvigorated by the activity, through both the funds it brings and the resulting renewed contacts with the community.

Water Services estimates that the program costs them \$275 per acre-foot of water saved (in contrast with an estimated \$1,000/acre-foot to seek out and develop new water sources). The program thus represents not only an innovative means to reduce water use, but also a progressive redirection of public funds from costly physical infrastructure works to social reinvestment.

Source: (SAWS 2004; Guz 2004)

⁵²More information at The Water Conservation Coalition Web site at <http://www.bewatersmart.net/>

Educational programs have also been directed at plumbers, builders and landscape gardeners. In Arizona, a Master Gardeners training and certification program includes an eight-week program on the design, installation and maintenance of efficient irrigation systems (Phoenix 1998).

7.1.6 Voluntary green building certification programs

Voluntary certification programs can reward those who exceed mandatory standards. The Leadership in Energy and Environmental Design (LEED) program, for example, is designed to encourage energy and water efficient building practices. Building projects are rated as platinum, gold, or silver according to five criteria sets, including water safety and efficiency. Building professionals can also be accredited by the Canadian Green Building Council (CAGBC) or the U.S. Green Building Council (USGBC).⁵³

Similarly, the City of Austin, Texas, has developed a local Green Building certification program that provides a “green building basics” training course, sustainable building guidelines for municipalities, a Green Building logo, and a rating system for buildings according to six

criteria (including water efficiency).⁵⁴

7.2 Developing and disseminating Best Management Practices

Many innovative DSM measures are being used around the world to promote water sustainability but local authorities do not have the resources to tap into this wealth of ideas and experience. Authorities need access to those who can investigate, document and disseminate these “best management practices” (BMPs).

BMPs can be developed for just about every aspect of water sustainability, including supply and conservation planning, water sensitive urban design, and water-use reduction in existing buildings. Professional and industry associations have an obvious role to play in the development of such BMPs due to their experience, direct communication channels, ongoing role in professional development and training, knowledge of utility interests, and established credibility with industry. By encouraging collaborative efforts with such associations and other NGOs, local authorities, and citizens, senior governments can ensure that BMPs have broad acceptance and are likely to be successfully implemented.

Box 47: California MOU on best management practices (BMPs)

<p>The California MOU commits signatory water suppliers to implement 14 BMPs:</p> <ul style="list-style-type: none"> • BMP 1: Residential surveys - For each reporting period, audit 20% of customers for leaks, use of efficient devices, water-efficient landscaping, etc; • BMP 2: Retrofits - Develop a strategy to distribute low-flow showerheads, toilet retrofits and faucet aerators, and meet ambitious targets for showerhead replacement (e.g. retrofitting 75% of older homes); • BMP 3: Audits - Audit the distribution system for leaks; • BMP 4: Metering - Require meters for all new connections, billing by volume of use, and establish a retrofit program 	<p>for existing unmetered connections;</p> <ul style="list-style-type: none"> • BMP 5: Landscape - Provide support and incentives to improve landscape water use efficiency; • BMP 6: Clothes washers - Offer a financial incentive, if cost effective, to purchase high-efficiency washing machines; • BMP 7: Public information - Implement a public information program to promote water conservation; • BMP 8: School education program - Implement an education program to promote water conservation in school curriculum; • BMP 9: Conservation programs for commercial, industrial and institutional (CII) accounts - Implement audits and specific measures to deal with indi- 	<p>vidual users;</p> <ul style="list-style-type: none"> • BMP 10: Wholesaler incentives - Wholesale water suppliers to provide financial incentives for conservation efforts to their retail water agency customers; • BMP 11: Rates - Implement rates that are consistent with conservation pricing; • BMP 12: Conservation coordinator - Designate staff to coordinate conservation programs and act as “In-House Best Practices Keepers;” • BMP 13: Waste prohibitions - Enact measures to prohibit wasteful uses of water; and • BMP 14: ULFTs - Implement programs to replace high-water-using toilets with ultra-low-flush toilets.
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Source: California Urban Water Conservation Council (CUWCC)

⁵³See the Canadian Green Building Council Web site at <http://www.cagbc.org/> and the LEED Web site at <http://www.usgbc.org/DisplayPage.aspx?CategoryID=19> and the U.S. Green Building Council Web site at <http://www.usgbc.org/DisplayPage.aspx?CategoryID=1>

⁵⁴See the Austin Green Building Web site at <http://www.ci.austin.tx.us/greenbuilder/>

7.2.1 The Council on Urban Water Conservation

California provides an example of an effective collaboration. A diminishing water supply, rising production costs, and worrisome environmental impacts motivated nearly 100 water suppliers, state agencies, environmental groups and others to collaborate to improve conservation practices across the state. In 1991, they entered into a joint “Memorandum of Understanding (MOU) Regarding Urban Water Conservation” (CUWCC 2005). Under this MOU, a package of 14 best management practices (BMPs) were developed, and signatory water suppliers pledged to use good faith efforts to implement them within ten years.

One of the keys to the MOU was establishing a collaborative central body, the California Urban Water Conservation Council (CUWCC). Made up of representatives from each signatory, the CUWCC coordinates studies on the effectiveness of water conservation measures and oversees implementation of the MOU. It also provides practical and technical resources, such as guidelines, cost-benefit calculators, a consultant database, and model water-efficient landscape ordinances. Together with the EPA, the CUWCC created the “H₂OUSE” Web site which promotes and provides resources for residential water conservation.⁵⁵

Under the MOU, the Council will continue to study emerging BMPs, that relate to such innovations and economic incentives for water conservation, greywater reuses, distribution system pressure regulation, and novel efficiency standards for industrial and commercial processes. The Council currently has over 300 members, including almost half of the urban water utilities in the state, as well as public advocacy groups, state agencies and other interested groups.

The State of Texas emulated the California approach in 2003 by setting up a Water Conservation Implementation Task Force to develop a set of BMPs for water conservation in various sectors, and to provide recommendations on water conservation policy (Texas WCITF 2004). Membership of the Task Force is diverse, representing federal and state agencies, professional water organizations, municipalities, environmental groups, and

agricultural and industrial water users. Its recommendations to the State legislature have included development and funding of a statewide public-awareness program on water conservation, authorization of a conservation coordinator position in each of Texas’ regional water planning areas, and creation of a standing Water Conservation Advisory Council (Texas WCITF 2004).

7.2.2 Clearinghouses

Web-based clearinghouses disseminate BMPs very well. In the United States, collaborative efforts created the on online WaterWiser Clearinghouse Web site initiated in 1992. Following a feasibility study contracted by the EPA, in 1993 the EPA provided \$250,000 for the creation of the Web site by the American Water and Waste Association

WaterWiser contains conservation and efficiency materials, an events calendar, a company directory for water-efficient services, a Web-based forum, and a detailed bibliographical database. The AWWA Water Conservation Division maintains the WaterWiser Web site.⁵⁶ In Canada, a comprehensive national clearinghouse could be created, modelled on Environment Canada’s “Canadian Pollution Prevention Information Clearinghouse” (CPPIC).⁵⁷ The key would be to create a single resource linking all stakeholders (CWWA, Environment Canada, FCM, CHMC, CCME, and the CWRA) and ensuring that it is effectively monitored and regularly updated with Canadian examples.

7.2.3 Civil society’s ideas for conservation

Australia has undertaken a fascinating experiment in the collection and dissemination of conservation ideas from the public. Under the “Water Savings Project,” a public call was made netting 555 responses with suggestions, for water conservation in all water use sectors—residential, garden, business, agricultural and public places (AFFA 2004). This has led to feasibility studies, infrastructure renewal, recycling and re-use options, institutional changes, and new management systems and practices. To disseminate these ideas, the Australian Government has partnered with “savewater.com.au” (the state of Victoria’s water conservation Web site) to

⁵⁵More information at the H₂OUSE Web site at <http://www.h2ouse.org/>

⁵⁶The B.C. Water and Waste Association (B.C. chapter of the AWWA) has also recently begun its own BMP Guidelines program, and, led by the water sustainability committee, is providing a Web-based clearinghouse of best practices and successful water conservation examples in British Columbia available at www.waterbucket.ca.

⁵⁷Lessons can also be learned from the National Guide to Sustainable Municipal Infrastructure—the InfraGuide—an excellent example of how senior governments can collaborate with local governments and experts to produce useful information. The InfraGuide documents proven and cost-effective approaches to sustainable infrastructure, and currently provides 31 BMPs.

Box 48: Research institutions for water sustainability

Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO)

CSIRO is a national laboratory and research institution that provides research data for governments and other decision-makers developing policies and management strategies. CSIRO's National Research Flagships program has been an invaluable driving force for water reforms in Australia. For example, its Policy and Economic Research Unit (PERU) recently published a report for the Australian Water Conservation and Reuse Research Program entitled, "Exploring the Institutional Impediments to Conservation and Water Reuse: National Issues" (MacDonald and Dyack 2004).

In 1998, CSIRO (with support from the Australian water industry and COAG) embarked on an ambitious research program directed at improving the sustainability of Australia's urban water systems.⁶⁰ "CSIRO Urban Water" has recently concluded its feasibility stage by identifying the most promising technological opportunities to improve system performance. Now proceeding to the second phase, CSIRO Urban Water researchers are analyzing existing urban water, wastewater and stormwater systems. The researchers have identified significant opportunities to increase system sustainability and reduce costs by integrating water and

wastewater systems, and a large scale demonstration site of these concepts is planned.

U.S. National Institutes for Water Resources (NIWR)

The NIWR is a network of Water Resources Research Institutes (WRRIs), one in each state, established by the *Water Resources Research Act*.⁶¹ Each Institute conducts basic and applied research to solve water problems unique to its area. For example, the Texas WRRI is looking into increased irrigation efficiency and water conservation for the Rio Grande Basin Initiative, while a proposal from Wisconsin seeks to identify the causes of exponential growth in groundwater pumping and its relationship to population and land-use changes.

Arizona's Water Sustainability Program (WSP)

In 2000, Arizona enacted a 0.6% increase in its sales tax specifically earmarked for education funding. This funding enabled the University of Arizona to establish the *Water Sustainability Program*.⁶² It provides education for grades K-12 through graduate school, and supports collaborative research and technology transfer initiatives. It has fostered partnerships with over 70 businesses, governments, NGOs, water management districts, schools and industry associations.

provide its own online conservation clearinghouse.

7.2.4 Data collection and research

A lack of information on such things as the expected water savings from specific DSM programs creates wariness about initiating comprehensive DSM programs, and limits the effectiveness of such programs when they are attempted. Up-to-date, detailed and consistent data on urban water use is required to help understand urban water use levels and trends, and to evaluate DSM programs across the country. Environment Canada's Municipal Water Use Database (MUD) is a useful resource, but requires more detailed and consistent data collection and evaluation (Brandes 2003: 33). Another resource for Canadian data collection is found in the private sector. The National Water and Wastewater Benchmarking Initiative, coordinated by the consulting company EarthTech Canada, began as a pilot project in 1998 in partnership with the National Research Council

and several Canadian municipalities. The initiative continues to develop as a source of standardized data on water use for its 38 member municipalities across the country.⁵⁸

Given the number of potential DSM measures and diverse combinations that can be created, research into the optimal design is important to the development of effective planning strategies. Some jurisdictions have created specialized water research institutions, but even a network of experts can provide an information resource and foster further dialogue, research and policy development on DSM.⁵⁹ In Canada, the Canadian Water Network (CWN) within the Networks of Centres of Excellence provides a potential platform for coordinating research and creating such a network (CWN 2004). This type of knowledge network is most effective *in conjunction with* a national clearinghouse of best practices.

In 2000, Arizona enacted a 0.6% increase in its sales tax specifically earmarked for education funding. This

⁵⁸See the National Water and Wastewater Benchmarking Initiative Web site at <http://www.nationalbenchmarking.ca>

⁵⁹The UWDM Project initiated just such a network in 2003 (Maas 2003: 31-51).

⁶⁰See the CSIRO urban water Web site at <http://www.cmit.csiro.au/research/urbanwater>

⁶¹See the NIWR Web site at <http://wrri.nmsu.edu/niwr/>

⁶²See Arizona's Water Sustainability Program Web site at <http://www.uawater.arizona.edu/>

funding enabled the University of Arizona to establish the Water Sustainability Program. It provides education for grades K-12 through graduate school, and supports collaborative research and technology transfer initiatives. It has fostered partnerships with over 70 businesses, governments, NGOs, water management districts, schools and industry associations.

7.3 Labelling

Helping consumers to make conservation-oriented choices through labelling of products is a potentially powerful means of supporting water-efficiency. Specifically, such labelling programs:

- allow purchasers to identify and select the most water-efficient products that meet their needs;
- allow local authorities to choose suitable models for giveaway and rebate programs; and,
- increase the visibility and market penetration of water-efficient products.

In the United States, a “WaterStar” labelling program is being developed as part of the voluntary Water Efficiency Product Market Enhancement Program operated by the EPA’s Water Efficiency Program (Flowers 2004). Initiated in 2003, the final WaterStar program will apply labels with water use performance information to a range of products, such as plumbing fixtures, appliances, and landscape irrigation equipment. Canada has had success with such labelling programs, most related to energy, and there is significant interest in Canada to make the WaterStar banner applicable across North America. For example, a number of Canadian government agencies, utilities, and NGOs participate as stakeholders in discussions related to the WaterStar proposal (Dietemann 2004).

The European Union already runs such a multi-jurisdictional voluntary labelling scheme (known as “Ecolabel”) that denotes both energy and water efficiency, and even indicates whether a manufacturer offers free take-back of products for recycling (EU Ecolabel 2004). Australia has found such voluntary programs to be of only limited success, and is therefore developing a mandatory water efficiency-labelling program.

In Canada, CSA currently certifies ultra-low-flush toilets (ULFTs) but has in the past certified a number of poorly performing toilets (Maas 2003: 12,13). Such situations can actually reduce water savings from DSM programs by undermining consumer confidence in new technology. This situation made some provinces reluctant to mandate the use of ULFTs. More generally, such problems have raised concerns over the CSA certification

Box 49: Australia’s mandatory Water Efficiency Labelling and Standards (WELS) Scheme

Australia’s successful mandatory energy labelling system produced improvements in energy efficiency of 50% for refrigerators and freezers over a 13 year period, with projected improvements of 70% over 25 years. Australia is now moving to a similar mandatory labelling system for water-using products (WELS 2004).

Since 1988, the Water Services Association of Australia ran a voluntary National Water Conservation Rating and Labelling Scheme with only modest success because few suppliers chose to label their products, and those that did tended to label only their better performing products (for obvious reasons). This experience suggested the need to switch to a mandatory program.

The Australian Government is currently working with State and Territorial governments to introduce a national mandatory Water Efficiency Labelling and Standards (WELS) scheme that will label and set minimum performance standards for domestic water-using devices. WELS is expected to produce a reduction in total household water use of about 5% by 2021 with a net saving of \$267 million, as well as associated energy and greenhouse gas reductions.

Source: (DEH 2004: 10,12)

process itself (Burrell 1997). Clearly collaborative labelling/certification processes must be carefully designed and monitored.

7.4 Conservation pricing

The Organization for Economic Cooperation and Development (OECD 1999) has called Canadian water “cheaper than dirt” and repeatedly reprimanded Canada for its lack of effective use of economic instruments to reduce overconsumption of water by end users. As discussed in Chapter 3, municipal water rates in Canada—the retail prices to end-users—are among the lowest in the world, and flat-rate pricing is still widespread (Brandes and Ferguson 2004: 13). This combination of low prices and poor market signals associated with flat rates ensures wasteful water habits, and is a primary reason that urban Canadian’s are such profligate water users. Evidence suggests that per capita water use can be up to 70% lower with volume-based (over flat rate) pricing (Environment Canada 2001a: 10; Pearse 2002: 15-3).

Carefully designed conservation pricing can provide

more accurate information of the true cost of water, create incentives to reduce use, and generate funds for infrastructure and conservation programs. It also provides a catalyst for other water conservation initiatives. High volume water users will need ways to reduce their water use when a shift is made to conservation pricing. In 1991, California's Irvine Ranch Water District (IRWD) shifted to conservation pricing, which prompted a water conservation program that includes recycling, water conserving landscape design, and an education program for all types of customers (Wong 1999). The result was "a significant drop in per-capita water use."

Many OECD countries are united in the goal of internalizing full marginal costs (including environmental costs) in water pricing (OECD 1999).⁶³ Most OECD countries use volumetric pricing. To further promote reducing water use, increasing block tariffs allow for financial incentives to increase as the user's inefficiency decreases.

European Union member states have specifically

agreed to implement pricing reforms as part of the EU Water Framework Directive (EU Directive 2000/60/EC; EUROPA WFD 2004; Ast and Boot 2003; Rijswick 2004). The Directive requires member states, by the year 2010, to ensure that their water pricing policies provide adequate incentives to use water resources efficiently, and that different water users (such as industry, households and agriculture) are each required to make an adequate contribution to the cost recovery of water services.

Individual Canadian communities have taken steps to adopt progressive pricing schemes. Kelowna, British Columbia began a large-scale program in 1996 to install water meters to allow for volume-based pricing. The City's volumetric charge (which is in addition to a monthly base rate and a water quality enhancement fee) has helped the City reduce average residential water use by over 20% (Cohen et al. 2004). To create an even greater incentive to reduce use, the City has recently proposed a move to an increasing block rate structure (Kelowna 2005). Barrie, Ontario, which has water meters for all its customers moved from a decreasing to

Box 50: Conservation pricing in Irvine, California

Irvine Ranch Water District serves the City of Irvine, California. The District uses volume-based pricing, and replaced its single rate-per-unit charge with an innovative increasing block rate structure in 1991.

Each residential customer is given a "base allocation" of water according to the number of household residents, the size of the lot, and other factors such as weather and evapotranspiration rates for the area. Customers using 41-100% of their allocation pay a "conservation base rate" for each unit of water use. Those who use less than 40% pay only 75% of this base rate for each unit of water. However, those using between 101-150% of their allocation pay the "inefficient rate" (two times the base rate), those using 151-200% pay the "excessive rate" (four times the base rate), and those using over 200% of their allocation pay the "wasteful rate" (eight times the base rate). Customer bills clearly show the customer's baseline water allocation and indicate when water use goes into the "inefficient," "excessive," or "wasteful" penalty blocks, helping to build

customer awareness.

The District's rate structure is regarded as a long-term water management tool. It is broadly credited with forming the foundation of a larger water conservation program, strengthening a water conservation ethic, and intensifying customer participation in District conservation programs. For example, the District responds to customer complaints about water rates by offering them a water audit and landscape analysis, help with fixing leaks, and replacement of plumbing fixtures and toilets. The information so gathered about water use also helps the District identify patterns of excessive use or other problems that need to be addressed.

During the first six years of using the rate system, average residential water use fell by 12%. The revenues from penalty prices for wasteful use have been directed to a Conservation Fund that subsidizes efficient water use, recycling infrastructure, and conservation programs.

Source: (Wong 1999)

⁶³Marginal cost pricing sets the price for a good equal to the cost to produce one more unit (although modifications are required to make it practical in the water sector). It is considered optimal by basic economic theory, and is forward-looking in the sense that if increasing demand will require supply-side infrastructure expansions, then current prices will include those future costs (thus creating an incentive to use less water). In contrast, "average cost pricing" simply divides the total current costs of a utility (including debt repayments for previous infrastructure expansions) by the total water delivered. While commonly used, this simple approach is backward in that it does not include price signals related to future infrastructure expansions resulting from rising demand. It is a poor system for attaining the optimal mix of supply expansions and conservation efforts.

an increasing block structure in 2002.⁶⁴

7.4.1 Assistance, collaboration and conditional funding

Developing conservation rate structures to capture marginal costs and maintain revenues can be complex. Because it requires universal metering, a shift to volume-based pricing carries substantial up-front costs. Such pricing reform does, however, represent an improvement in equity because low water users will no longer subsidize high water users. Nevertheless, it can gather significant opposition from large water users thus, leading many municipal politicians to avoid the issue (Maas 2003: 23,27). Assistance and encouragement from senior governments, professional associations and others is therefore of great use in motivating such beneficial pricing reform.

In the United States, the EPA's Water Efficiency Program provides technical assistance and information to assist local authorities in developing conservation water pricing structures (Flowers 2004; EPA WEP 2004). Similarly in Canada, the CWWA has produced a rate manual for utilities to provide guidance on pricing. It recommends a two-part tariff, consisting of a volume-based charge based on marginal costs, and a flat rate charge to ensure full cost recovery.

Australia provides a good example of senior government collaboration to help shift the national paradigm on water pricing. In the recent Intergovernmental Agreement on a National Water Initiative (NWI), state and territorial governments agreed to pricing policies that facilitate efficient water use (COAG 2004). As an educational tool, they agreed to develop national guidelines for a billing system that provides urban customers with information on their water use relative to equivalent households in the community. Conditional funding has been used to provide further motivation to actually implement such reforms.

By mandating full-cost accounting, Ontario has provided an impetus to re-examine local pricing policies. Collaboration has also proved successful. Signatories to the California MOU (which include almost half of the urban water utilities in the state) have pledged to implement rates that are consistent with conservation pricing. Additionally, the signatories are collaborating through the California Urban Water

Box 51: Conditional funding under the National Competition Policy in Australia

In 1995, Australian governments agreed upon a National Competition Policy (NCP) to promote enhanced competition across the country. This included an agreement to implement related reforms, including the COAG water reforms. As a result, States and Territories must implement these water reforms if they are to receive their full share of federal government payments under the Competition Policy.

A separate body, the National Competition Council, has been responsible for assessing jurisdictions' progress in implementing the reforms and for recommending the level of payments. Since the 2004 intergovernmental agreement on the National Water Initiative, the Competition Policy assessments for water reforms are now to be conducted by a new National Water Commission.

In December 2001, COAG senior officials agreed to make national water reform commitments a priority in each of the 2002 to 2005 NCP assessments. For example, the 2003 NCP assessment focused on urban water pricing and cost recovery, institutional reform, intrastate trading arrangements, integrated catchment management and water quality reforms.

Source: (National Competition Council 2004)

Conservation Council (CUWCC) to develop new BMPs on economic incentives, such as pricing rate structures (including consideration of seasonal rates and increasing block rates).

7.4.2 Citizen input on setting rates

Citizen participation in rate setting is important to defuse potential opposition but it can also promote public understanding that helps to ensure "ownership" of pricing reforms. In El Paso, Texas, a new tariff policy was designed by a 27-member citizens' committee representing interest groups in the local community, including industries, environmental NGOs, and trade unions (Kallis and de Groot 2002). Similarly, the Los Angeles Department of Water and Power encouraged broad participation in its pricing reform efforts.

⁶⁴Every cubic meter of water used over 45m³ costs twice as much as the first 15 cubic meters. Note that sewage charges are not applied to water use over 30m³ on the assumption that such usage is mostly for irrigation, which may have the effect of reducing the economic incentive of the increasing block pricing structure (Barrie 2005).

Box 52: Broad participation in setting rates in Los Angeles

In Los Angeles, a drought resulted in rates being raised by the Department of Water and Power so that it could maintain its revenues in the face of reduced water usage. This raised concerns, however, that it might be penalizing conserving consumers. The Mayor of L.A. therefore appointed a Blue Ribbon Committee on Water Rates to investigate and propose a new rate structure to City Council.

The 24-member Committee was composed of 12 citizen members with voting privileges, and 12 non-voting members from the Department, the Mayor's office, and City Council. The voting citizens were representatives of a broad range of interests, including homeowners, renters and landlords, business owners, organized labour, developers, and environmentalists. The Committee was provided technical assistance from the Department, but was given a budget to hire an independent consultant who reported directly to the Committee.

At over 75 meetings, Committee members were educated on water rate structures, heard the experiences of other jurisdictions, and learned to appreciate the needs and concerns of fellow stakeholders. Public hearings, hosted by the Committee, provided additional citizen input. At the hearings, the Committee learned that people wanted a fair rate struc-

ture that encouraged conservation but that did not penalize conserving consumers with rate increases if the Department revenues dropped.

In the Committee's final report, they recommended eliminating the fixed charge portion of the previous billing system and creating higher per unit rates for high users. When the new rates were brought into effect, however, some citizens felt they were unfair to homeowners with large lots who were taking conservation measures. As a result, the committee was reconvened with additional members to better represent those concerned. The rates were modified to address such concerns while maintaining efficiency incentives. In the end, the process:

- created efficiency incentives;
- addressed equity issues (it expanded coverage of low-income reduced rates from 60,000 to 160,000 households);
- created a citizens' group of experts able to offer leadership on water issues, previously the sole domain of the Department; and
- created a durable rate-setting decision, because it was responsive to the interests of the community.

Source: (Pacific Institute 1999: Chapter 3)

7.5 Reuse & recycling

In many parts of the world reclamation of wastewater is widespread. Israel, for example, treats 70% of its wastewater, which is then used for agricultural irrigation (Gleick 1998). As noted by Vassos, "The scale for water reuse is unlimited—from household greywater systems to communal collectives to municipal wastewater reclamation" (quoted in Maas 2003: 13). At the household scale, on-site reuse of wastewater might simply involve reusing bathwater for toilet flushing or irrigating the garden. At the municipal-wide scale, water utilities can collect and treat wastewater centrally for reuse in specific applications (such as for irrigating golf courses or nearby agriculture) or for general redistribution through a dual-plumbing system (Marsalek et al. 2002).

Water recycling may not always be the least-cost alternative, but it does offer the long-term economic benefit of future reliability, in addition to environmental benefits that other alternatives may not offer.

At present, water reuse and recycling in Canada is practised on a relatively small scale and varies regionally depending on the availability of water supplies and regulatory flexibility (Schaefer et al. 2004). Typical examples

Box 53: Closing the loop

By using municipal water supplies twice—once for domestic use and again for irrigation—would-be pollutants become valuable fertilizers, rivers and lakes are protected from contamination, irrigated land boosts crop production, and reclaimed water becomes a reliable, local supply. Unfortunately, conventional sanitary engineers tend to emphasize the linear approach to managing water and sewage—use, collect, treat thoroughly, and then dispose of waste. And the benefits of closing the cycle—use, collect, treat partially, and then use again—go unrealized. St. Petersburg, Florida, for example, closed its cycle completely by reusing all of its wastewater and discharging none to surrounding lakes and streams. The city has two water distribution systems: one that delivers fresh water for drinking and most household uses, and another that distributes treated wastewater for irrigating parks, road medians, residential lawns, and other functions that do not require drinking water quality. For residents hooked up to the dual system, the reclaimed water costs only about 30% as much as the drinkable supply. Also, because of the nutrients it contains, using reclaimed water cuts down on the use of lawn fertilizers.

(Postel 1997: 128, 134)

include using treated municipal wastewater to irrigate agricultural non-food crops, urban parkland, landscaping, golf courses, some isolated facilities, and experimental housing.

Roughly 3% of wastewater is reused in British Columbia, and reuse is already a component of B.C.'s water conservation strategy (Schaefer et al. 2004: 200).⁶⁵ Vernon has recognized for some time that reclamation is not only a treatment method, but also an alternative supply approach. Other leading international examples of using recycled water for agriculture include the Cities of Visalia and Santa Rosa in California, which use secondary-treated wastewater on fodder and fibre crops. However, growers are also irrigating fruits and vegetables with tertiary treated water, and producing high-quality crops and high yields (Fidell and Wong 1999). The Laguna water treatment plant provides water to about 4,100 acres of fodder, sod, and pasture, 500 acres of urban landscaping, 700 acres of vineyard, 250 acres of row crops, and seven acres of organic vegetables⁶⁶ (Fidell and Wong 1999: 144). Both projects pushed current boundaries of acceptable uses for reclaimed water and have met almost no resistance. There have been no public complaints or marketability problems.

A significant barrier is negative public perceptions over the reuse of wastewater, and so educational programs, and safeguarding health regulations, are critical. As working modes do exist, the public fear and engineering professions reluctance of re-using “contaminated” water in Canada is outdated. Converting existing buildings to use reclaimed wastewater can be costly, however, even prohibitively expensive. It is all the more important therefore to initiate “future-proofing” with plumbing and building codes that requires dual piping systems to be installed in new construction so, when the time comes, reuse projects will be economically feasible (Brandes and Ferguson 2004: 48).

7.5.1 Health and safety regulations

Valid health concerns do exist with wastewater reclamation, but they are addressed through clear standards and guidelines on quality and treatment levels to protect public health. Where reclamation of wastewater has been most successful (Israel, Tunisia, South Africa, California,

Florida and Arizona), regulations set the basic conditions for safe reuse of wastewater. Many countries and regions follow or base their own rules on the guidelines established by the World Health Organization. In the United States, the EPA has developed a set of detailed Guidelines for Water Reuse, which includes a description of health concerns, treatment requirements, and numerous case studies (EPA 2004).

In Canada, only British Columbia and Alberta have regulations that set standards for the reclamation and reuse of wastewater (Marsalek et al. 2002: 9,13,14). The B.C. *Municipal Sewage Regulation* (1999) and its associated *Code of Practice for the Use of Reclaimed Water* (2001) allow for large-scale water reclamation projects, and specify water quality standards and detailed guidelines for appropriate end-uses for reclaimed water (Maas 2003: 21,22). Smaller scale projects, however, require permitting by the B.C. Ministry of Health.

Health ministries are often unduly reluctant to issue such permits due to fears of potential contamination, suggesting a need for further collaborative efforts to develop mandatory requirements and practical guidelines for safe on-site reuse. The CWWA, CMHC, the Centre of Sustainable Communities Canada (CSCC) and others are developing national water quality guidelines for reclaimed water, and protocols for research, validation and commercialization of on-site reuse technologies (Maas 2003: 14).

7.5.2 Promoting reuse in California and Florida

California

California is the undisputed pioneer of water recycling in the United States, having used recycled water since the 1800s (SWRCB 2004). The *California Water Code* states that “the primary interest of the people of the state in the conservation of all available water resources requires the maximum reuse of reclaimed water” (§461), and sets a state goal of achieving one million acre-feet of recycled water per year by 2010 (§13577).

California's Department of Health Services sets water reuse regulations that require different levels of treatment for different water uses based on the potential for

⁶⁵In 2001, British Columbia produced the fact sheet “Guide to Irrigation System Design with Reclaimed Water” (BCMAFF 2001) to provide a reference for the design of irrigation systems, using reclaimed water in accordance with the Municipal Sewage Regulation. In May 2001, the Province published a Code of Practice for the Use of Reclaimed Water (BCMELP 2001), which serves as a guide for using reclaimed water in the province, and is designed to support the requirements of the Municipal Sewage Regulation (Schaeffer et al. 2004).

⁶⁶The row crops are primarily several varieties of squash, started with recycled water then switched to well water when the fruit sets. Walnut yields in Visalia have increased since switching from surface water to recycled water.

public contact, and sets requirements for treatment plant design (*California Code of Regulations*, Title 22, Division 4). In 1992, the State also legislated a requirement that pipes containing recycled water be purple, providing one element of the necessary standardization to accommodate widespread and safe reuse (WateReuse 2003).

Other California regulations include the *Uniform Plumbing Code* provisions, which contain requirements for the construction, installation, and repair of reclaimed water systems such as for toilets and urinals. Use of recycled water for these applications is limited to non-residential buildings. California also authorizes public water agencies to require the installation of separate systems for use of recycled water on private property (*California Water Code* §1009,13550-13556 and *Government Code* §65601-65605).

The California Department of Water Resources plays a central role in the promotion of reclamation and reuse in the State. The *California Water Code* requires the Department to conduct studies on the availability and quality of wastewater, the uses of reclaimed water for beneficial purposes, and on technology for reclamation and reuse (§462,463). Through the Water Reuse and Desalination program in the Office of Water Use Efficiency, the Department provides technical assistance to local authorities that are considering reclamation projects or in the process of implementation (OWUE 2004).

Dedicated funding for recycling projects is provided through the Office of Water Recycling (SWRCB 2004). This includes the Water Recycling Facilities Planning Grant program (provides funds to local public agencies to study the feasibility of water recycling in their area), and the Water Recycling Construction Program (provides low-interest grants and loans to local agencies for design and construction of water recycling facilities).

As part of its efforts to meet its reuse targets, and with urging from the Governor's Advisory Drought Planning Panel, California legislatively created a State Recycled Water Task Force in 2001 (OWUE 2004). The Task Force was given 15 months to come up with recommendations on how to triple recycled water use (from the almost 500,000 acre-feet recycled in 2000 to 1.5 million acre-feet). A diverse membership was appointed, including representatives from all levels of government, water suppliers, industry, environmental NGOs, and individuals.

Task Force members joined working groups with consultants, university professors, and others to address specific issues, and state agencies provided technical advice. The Task Force focused on identifying obstacles

and disincentives to increased use of recycled water and explored ways to overcome them. The final recommendations of the Task Force were designed to make it clear that recycled water can be safe, reliable, and economically viable; to coordinate the regulatory requirements of recycling programs; and to promote them to water suppliers (Recycled Water Task Force 2003). Specific recommendations included:

- increase grant (not loan) funding;
- develop a uniform method for cost-benefit analysis of recycling projects that incorporates “non-market values” (i.e. environmental and social externalities);
- establish a Water Recycling Committee to coordinate with funding agencies;
- appoint an independent review panel on the safety of indirect potable reuse to reassure state residents;
- involve the public in the early stages of project planning; and,
- coordinate local regulatory and enforcement agencies to ensure that recycled water ordinances exist, are clearly written and can be easily enforced.

Florida

Florida is another leader in state-wide action on water recycling in the United States. In addition to authorizing the use of reclaimed water for certain outdoor and indoor uses, and health regulations to help ensure that recycling is undertaken safely, Florida makes some reuse mandatory and has developed extensive coordinating processes.

Under Florida law, Water Management Districts (WMDs) can designate an area with critical water supply problems as a “resource caution area.” Within such areas, applicants for permits to construct or operate a domestic wastewater treatment facility must prepare a reuse feasibility study, and must then implement reuse to the extent feasible. Several WMDs also provide considerable funding for such reclaimed water projects within their areas (Reuse Coordinating Committee 2003: 27).

To ensure the State takes advantage of opportunities to match potential sources of reclaimed water with potential customers, coordination of the different state agencies is necessary. For example, the Department of Environmental Protection (DEP) issues permits for domestic wastewater treatment facilities (which are potential *sources* of reclaimed water), and Water Management Districts issue consumptive use permits to potential users of reclaimed water.

In 1992, Florida established the Reuse Coordinating Committee to coordinate such activities and promote

communication between state agencies. Together, they identify areas where reuse is not occurring, develop strategies to encourage and promote reuse, and identify opportunities to bring users and suppliers of reclaimed water together (Reuse Coordinating Committee 2003: 26). The Department of Health (DOH) serves as a technical advisor for public health issues on the Coordinating Committee, and is also represented on the Reuse Technical Advisory Committee.

Agencies also work together to integrate government actions into a progressive state-wide strategy. The Department of Community Affairs, for example, worked with DEP to make the state's Building Codes consistent with Florida legislation that allows for reuse within buildings. Several MOUs have been signed to help clarify the roles and responsibilities among the various authorities. The Public Service Commission (PSC) and the five WMDs have signed an MOU committing the PSC to helping the WMDs review reuse feasibility studies submitted by PSC-regulated utilities.

The Southwest Florida WMD is a leader in encouraging efficient use of reclaimed water. Since 1987, the District has provided more than \$180 million in grants for over 200 reclaimed water projects. It has recently announced dramatic goals of 75% utilization and 75% efficiency of reclaimed water flows by 2020 (Reuse Coordinating Committee 2003: 27). The District has also produced a *Reclaimed Water Guide* to share its experiences on successful reuse projects, which includes ordinances, contracts, financial information, etc. One of the most outstanding examples of reuse in the United States occurs in the City of St. Petersburg, located within the Southwest Florida WMD.

7.6 Conclusion

Immediate benefits from demand management include saving infrastructure costs, and reducing ecological impacts. However, water conservation does not just happen. It requires significant effort from a range of

Box 54: Closing the loop in St. Petersburg, Florida

Closed-loop –“zero effluent”– systems are now feasible. With such a system all treated wastewater is kept within the human water management loop rather than being discharged to the surrounding environment. The City of St. Petersburg, Florida, has already achieved this objective.

In the mid-1970s, the City of St. Petersburg initiated a regional water reclamation system to help stabilize potable water demand and to reduce discharges to the adjacent coastal water of Tampa Bay. This nationally-recognized program has made the city the largest community in the United States achieving zero-discharge into surface waters.

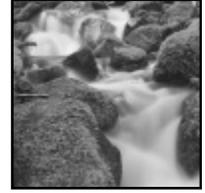
As part of the \$100 million program, all four of the city's water reclamation facilities were upgraded, an extensive (over 250 mile) piping network was constructed to provide reclaimed water for residential landscape irrigation throughout the city, and ten deep injection wells were built to allow highly treated effluent to be pumped into the salt-water aquifer when the demand for reclaimed water falls below the plant discharge rate. By 1995, almost 21 million gallons of reclaimed water was being used by over 8,000 customers each day. As the system expands, it is estimated that approximately 17,000 customers could be served, irrigating almost 9,000 acres.

Source: (Grobicki and Cohen 1999)

stakeholders and, in particular, leadership from senior governments. Chapters 6 and 7 have outlined, in some detail, the many opportunities for senior governments to demonstrate leadership and their commitment to water conservation. By embedding demand management in local institutions and by facilitating demand management practices, a comprehensive, integrated and long-term approach to DSM can become reality. This approach can start in the urban sector. Ultimately, however, it must travel up and down the watershed to be truly effective.

Chapter 8

Thinking like a watershed



When we try to pick out anything by itself, we find it hitched to everything else in the universe.

John Muir, 1911

A watershed is a complex ecosystem. Soil, vegetation, animals, humans, water and climate are all integral and interacting parts. Water extraction, land use changes, urban developments, and industrial, forestry and agricultural operations all impact the watershed. The cumulative impacts of these human activities often lead to problems with water quantity and timing of surface flows, as well as with water quality, groundwater recharge, and floodplain maintenance. Only by addressing these concerns in an integrated management approach can we ensure watershed and ecosystem health, as well as adequate water supplies.

It is now widely accepted that management of water should be accomplished at a full watershed level. Watershed-based management requires water managers to account for the complex interactions in the watershed, and encourages them to, in effect, “think like a watershed” especially where interactions between naturally occurring and human activities are involved. Recognition of the watershed’s importance to society is not new; integrated public management on a watershed basis is.

Opportunities for such management are the major theme of this report. These include integration of water supply and conservation planning, surface and ground water management, waste and storm water management, and urban design. The watershed is the logical context for a holistic integration that moves away from end-of-pipe treatment toward watershed-specific identification of water quality and quantity problems and solutions (Gabor et al. 2005: 7). To maintain reliable future water supplies, healthy aquatic ecosystems, adequate instream flows and groundwater balance, all actions will have to be considered for their cumulative impact on the entire watershed. Demand management is a foundational tool for watershed managers that must be applied not only in the urban sector but also to other water users, such as power generation, industry and agriculture.

Watershed management is not an end point. Quite the opposite. This report concludes by considering how the watershed is the *starting point* for sustainable water management. By examining all actions in the context of the watershed, we begin to move towards an *ecosystem governance* regime. The focus moves to managing people within the watershed, not trying to control the watershed itself. The ecosystem is the physical foundation and long-term, sustainable *ecological governance* of society is the goal.

Box 55: Watershed management

“While water managers generally understand and advocate the inherent powers of the concept of a watershed as a unit of management, where surface and groundwater quantity and quality are inexorably connected, the institutions which have developed to manage the resource have historically followed these tenets only in the exception.”

(Wolf 2003: 168)

8.1 Finding the proper scale for management

Many problems at the watershed level are the result of wasteful water use, widespread non-point pollution and other dispersed activities throughout the area. Involvement and “buy-in” by the various groups in the watershed is fundamentally required to solve such problems.

Watersheds are generally selected as the proper scale of management based on the idea that water management organizations should reflect the physical unity of water bodies to account for potential sources of conflicts. The river basin—comprised of many watersheds—is a logical administrative unit to handle the regional externalities linked to water pollution and conflicts of use. Such institutions can bring relevant groups together to work on problems collaboratively and—provided sufficient management authority is devolved to them—

Box 56: Water parliaments

French River Basin Committees (RBC), described as local “water parliaments,” serve as consultative bodies responsible for analyzing any subject relevant to the river basin. Various parties concerned with the water management are represented such as communities, water users and the central administration (which comprises less than half of the representatives). On this decentralized committee, stakeholders resolve conflicts related to water quality and water availability. By assembling the interested parties in the river basin, RBC decisions are expected to reflect the general interest of all users and stakeholders.

Water Agencies (WAs) are the executive branch of the RBCs. Financially autonomous, they are in charge of collecting the water charges that finance their activities. Through loans and subsidies, they finance private and municipal investment projects intended to reduce pollution and increase water availability. Financial assistance is aimed at giving polluting firms and communities incentives to reduce pollution and at water-saving investments. Eligible investment must be in accordance with the priorities defined by the WA (and later approved by the RBC) in the multi-year working plan, established for a five-year period. The plans are supposed to reconcile demands for multiple water users and set priorities for the most important pollution reduction actions and water availability measures to be taken in the river basin during the period.

Source: (da Motta et al. 2004: 37)

implement solutions (EPA 1997; EPA 2002; Ruhl et al. 2003; Schoefield et al. 2003: 35).

France has embraced this approach with its water parliament system. Water Agencies and River Basin Committees exist in each of the six French river basins. The water agencies perform executive functions and the River Basin Committees act as the central clearinghouse and consultative bodies, as discussed in Box 56 (da Motta et al. 2004: 4).

Australia is also managing activities on a watershed scale. The Australian focus has shifted from government as the administrator of policy on behalf of industry and the community as passive recipients to government as “enabler” and “facilitator.” This way, government supports an empowered industry-community alliance to articulate catchment strategies. This brings together the

three pillars of governance outlined in Chapter 2.

In the United States, a number of state governments also use the watershed as the unit for water management. To deal with pollution discharge permits and ambient water quality monitoring, the State is split into a number of watershed management units. For any particular unit, state management activities are spread over a five-year, five-step process: 1) data collection and monitoring, 2) assessment and prioritization, 3) strategy development, 4) basin plan review and approval, and 5) implementation (EPA 2002).

Once the first “round” of activities for a management unit is complete, the cycle is repeated, in recognition that watershed management is not a one-time planning process but an ongoing, adaptive one. To help distribute government resources effectively, these five steps are staggered between watersheds. Thus in any one year, different management activities are undertaken for different management units. Mechanisms for agency-to-agency coordination (such as a multi-agency steering committee) can attempt to integrate different sectors. Processes to increase public involvement are often included.⁶⁷

8.1.1 Watershed management in Canada

The importance of a watershed focus has certainly been recognized in Canada. The 1987 Federal Water Policy (Environment Canada 1987) states: “Increasingly, watersheds are becoming the preferred spatial unit for water resource planning. It is an approach that makes sense at any scale of planning.” In Ontario, as far back as 1946, the creation of Conservation Authorities embodied a watershed approach.

Other more recent initiatives that embrace a watershed approach include the Saskatchewan Watershed Authority, Manitoba Water Strategy, Alberta Water for Life Strategy, source water protection reforms in Ontario and the Quebec Water Policy. Canadian policymakers increasingly recognize that sound management practices implemented at the watershed level will protect ecosystem functions, and protect water resources as well. This evolution in thinking puts watersheds at the centre of environmental decision making. The challenge is translating this understanding into an appropriate, effective and collaborative governance regime.

⁶⁷Successful integration and participation in mainly government-run watershed management schemes such as those in the United States have, however, been limited. The management of different sectors in the watershed remains fundamentally split between government agencies with varying mandates. “Turf battles” between agencies are common. And experience in a number of states has shown that attendance by NGOs and citizens at government-led basin meetings is poor, likely because many perceive the government agency to be simply “going through the motions” (EPA 2002: 26).

8.2 Collaborative governance at the watershed level

The U.S. Environmental Protection Agency (EPA 2002: 26), in a review of state-wide watershed management experiences, noted: “[s]tates often describe their most notable successes as occurring in watersheds with strong stakeholder groups supported by state and other resources. While it may be difficult in some cases for states to devolve agenda-setting and priority-establishing powers—and the associated funding—to local entities, such an approach enhances the prospect for local buy-in, support, and action.”

Similarly, *Washington State’s Watershed Management Act* states: “the local development of watershed plans for managing water resources and for protecting existing water rights is vital to both state and local interests. The local development of these plans serves vital local interests by placing it in the hands of people who have the greatest knowledge of both the resources and the aspirations of those who live and work in the watershed, and who have the greatest stake in the proper, long-term management of the resources. (Revised Code of Washington §90.82.010).

The evolution of watershed management in Washington State provides an example of the growing recognition of a need to shift away from centrally-driven efforts towards more collaborative watershed-based approaches that embody an “experimentalist” ethic (see Box 57). Australia has become a world leader in state-wide “integrated catchment management” (ICM)—the Australian term for watershed management—under the leadership of COAG and the Murray-Darling Basin Initiative. A number of Australian states have also expressly legislated the devolution of powers to the catchment level (see Box 58).

For large watershed basins, a “nested scale” approach is often appropriate, as illustrated in the French Water Parliament example discussed above. A management authority for the basin develops policies and plans that address basin-wide problems. These provide guidance to the management bodies of smaller, nested watersheds, which develop detailed action plans tailored to local problems. This approach is used in the Chesapeake Bay and the Great Lakes programs, as well as in the Murray-Darling Basin in Australia (EPA 1997: 27; Karkkainen 2002: 209).

Watershed management institutions must include broad participation from the watershed community. Local people and businesses should be invited to participate in various ways, including representation and

consultation during planning, and direct involvement in implementation and monitoring (Webler and Tuler 2001; Chess et al. 2000). Participation by non-local interests may also be included, such as representatives from higher level governments or national NGOs, to ensure these watershed bodies do not become too heavily weighted toward local economic or political interests at the expense of broader ecological goals (EPA 2002: 27).

Raising public awareness of watershed management issues is also critical. Significant transformative potential exists by ensuring meaningful public participation in watershed management, shifting how citizens and institutions relate to one another and to their watersheds and providing a broad-based societal sense of place (Cannon 2000: 419-425). A volunteer program in Oregon’s McKenzie Watershed, for example, engages students throughout the watershed in the evaluation and monitoring of water quality parameters. This program allows for monitoring of activities at a number of diverse sites on a weekly basis, and has proved an effective outreach tool, helping citizens link their personal actions with watershed problems (EPA 1997: 30).

Watershed management bodies require adequate and secure long-term funding. A common frustration is the lack of resources for implementation after so much effort has gone into the planning process. Options for funding include state grants, watershed levies, and dedicated water withdrawal revenues for watershed management.

8.2.1 Government role in nested watershed management

The multi-tiered governance structure discussed above embodies the experimentalist principle of *subsidiarity*, with each level of governance addressing those issues that are most appropriately handled at its scale of management. Watershed management bodies must be given sufficient authority to plan and ensure their plans are implemented. However, such devolution must also ensure sufficient higher (senior government) and lower (municipal and regional bodies) level government involvement.

A hierarchy of plans and policies is usually created by the various governing bodies, starting with international and inter-provincial water sharing agreements, moving down through provincial land and water use policies, individual basin and watershed plans, and finally to local/municipal DSM and land-use plans.

Vertical integration between these levels of governance is important. Legislation can require lower level plans and policies to be consistent with higher-level

Box 57: Evolving watershed management in Washington State, U.S.

Washington State's first state-wide watershed management framework splits the State into 23 Water Quality Management Areas (WQMAs), with each WQMA assigned to a Regional Office of the State Department of Ecology. A five-step, five-year rotating management process establishes a point-source pollution permitting (NPDES) procedure and a Total Maximum Daily Load (TMDL) program, two requirements of the federal *Clean Water Act*.

Watershed Management Act (WMA), enacted in 1998, initiated a second, more locally-led and collaborative state-wide watershed management program. Under this program, the State was split into 62 Water Resource Inventory Areas (WRIAs) based on watershed boundaries. Local citizens, NGOs, governments and native tribes can voluntary form a Planning Unit for one or more WRIAs. State agencies, such as the Department of Ecology, provide grants, technical assistance, training and if requested can serve on Planning Units.

The only legislated requirement of a Planning Unit is a water quantity plan to address the competing demands for water. Planning Units may choose to address a number of other issues, including water quality, aquatic and riparian habitat, and in-stream flows.

The planning process proceeds in four phases.

1) **Start-up.** Initiating governments (counties, the largest city, tribes, or the highest volume water utility within a WRIA) can apply for an organizing grant of up to \$50,000.

2) **Assessment.** Planning Units may apply for up to \$200,000 per WRIA to fund watershed assessments, which gather information on surface and ground water availability, current human use, and recharge rates of aquifers and surface waters. An additional \$300,000 is available to Planning Units that pursue the optional (non-quantity) issues.

3) **Plan development.** Up to \$250,000 per WRIA is available for development of a Watershed Management Plan. If the Planning Unit approves the Plan by consensus, governments at the table are obligated to implement the plan, which is then submitted to each county government in the WRIA for ratification. If the Planning Unit develops instream flow recommendations, they can be adopted as binding State rules that limit subsequent water withdrawal permits.

4) **Implementation.** Once a Plan has been approved, an implementation

grant of up to \$100,000 per year for the first three years, and \$50,000 for the next two years, is available per WRIA.

As of March 2003, 42 of the 62 WRIAs were represented by 33 Planning Units, a number of which have recently completed their Watershed Management Plans. For example, the Elwha-Dungeness Planning Unit recently completed its draft plan after five years of work. The Planning Unit chose to address all the optional issues, and the resulting draft plan includes recommendations on water quantity and quality, habitat, instream flows, stormwater, land use and management, education and outreach.

As for water conservation, the Elwha-Dungeness draft plan includes a detailed examination of water quantity issues, including urban DSM efforts within the WRIA. Some of its innovative recommendations include: a conservation plan developed by all water suppliers, annual maintenance shut-downs scheduled by industry during low water flow periods, reduction targets established for water utility system leakage, and the elimination of taxes on conservation materials and equipment.

Source: (Elwha-Dungeness Watershed Plan; EPA 2002: 25,64,65)

ones. This creates accountability mechanisms up through the hierarchy, and ensures that higher-level bodies provide guidance and assistance to lower level ones. Efforts in various Australian states, including South Australia and Victoria provide fine examples of such nested integration.

Horizontal integration between governance entities at the same level is also important, such as coordinating actions between watershed management bodies and helping them learn from one another. For example, a Common Implementation Strategy (CIS), discussed in Chapter 4, consists of a number of work groups and

expert advisory bodies to develop practical guidelines and tools to promote information sharing as part of the European Union Water Framework Directive (WFD) to adopt river basin management (EU Directive 2000/60/EC; Ast and Boot 2003; Rijswick 2004).

In the United States, the EPA has provided significant assistance to state watershed management efforts over the past decade (EPA 1997; EPA 2002). This has included training for state personnel, organization of a National Watershed Forum and regional roundtables, comprehensive Internet training tools, and funding and awards programs.

Box 58: The Murray-Darling Basin Initiative in Australia

The Murray-Darling Basin covers most of inland south-east Australia. It is over one million square kilometres, and spans five states/territories. Intense development pressures led to rising salinity levels, reduced instream flows and endangered native fish populations. Federal, state and territorial governments responded by creating the Murray-Darling Basin Initiative, the largest integrated catchment management program in the world, and a model for governance. Three key governance bodies have been created.

- The **Murray-Darling Basin Ministerial Council (MDBMC)** determines major basin-wide policy for the Initiative. It consists of ministers responsible for land, water and environmental resources from each of the collaborating governments, and acts by unanimous votes so that decisions reflect government consensus across the basin.

- The autonomous **Murray-Darling Basin Commission (MDBC)** provides assistance and advice to the Ministerial Council, and coordinates implementation of Council measures. It consists of senior public servants from each signatory government, and is assisted by a Strategic Investigations

and Education (SI&E) program to fund scientific research for policy development.

- The **Community Advisory Committee (CAC)** advises the Ministerial Council, participates in basin-wide policy development, and disseminates Council decisions to basin communities. Its 21 members include a representative from each of the catchments across the basin, five from national special-interest stakeholder groups, and two Indigenous representatives.

These governing bodies have initiated a broad range of programs.

- In 1990, the Ministerial Council called for integrated catchment management (ICM) and community-government partnerships across the basin. Since then, 19 catchment management organizations have been created under state ICM programs.

- In 1993, the Ministerial Council initiated an Audit on Water Use in the Basin, which led to the Council placing a cap on diversions. This limits collaborating states to the volume of water that would have been diverted under 1993/94 levels of development.

- In 2000, the Ministerial Council initiated the Sustainable Rivers Audit, an ambitious assessment of river health and ecological conditions to obtain consistent, basin-wide information.

- In 2001, the Ministerial Council initiated the Living Murray Initiative, aimed at restoring instream flows of the River Murray. In 2003, the collaborating governments agreed to provide \$500 million over five years to address water over-allocation in the basin.

- In 2001, a new Integrated Catchment Management (ICM) Policy Statement was released. Jointly developed by the Ministerial Council and the Community Advisory Committee, it commits the Commission to setting and achieving resource condition targets for water quality, consumptive uses and environmental flows, the re-establishment of native aquatic species, etc. Recognizing its ambitious agenda, the ICM Policy concludes: "Significant costs will be incurred in establishing the arrangements outlined in this document and in managing the basin's catchments into the future. However, these costs are dwarfed when compared with the inevitable costs-economic, environmental and social-if current management practices are not changed."

Source: (MDBC 2004; COAG 2004; Bellamy 2002: 42; Purdie 2003)

In Canada, provincial and federal governments will need to collaborate to provide an effective legislative framework and suitable assistance to facilitate cross-Canada watershed management. A national strategy on water sustainability is key. Local governments also have important roles to play, both as planning partners on watershed bodies and in the implementation of watershed strategies and plans, such as urban water DSM. Australia has devoted considerable efforts to improving such catchment-municipal linkages. For example, the Australian National Heritage Trust (NHT) has undertaken a project entitled "Incorporating integrated catchment management into local government planning."

8.3 From reactive to proactive watershed management

A number of high profile watershed management initiatives have been undertaken in response to mounting ecological crises or lack of existing controls. These include:

- **New York City's Watershed Protection Program.** In an attempt to avoid building an expensive water filtration plant, a Memorandum of Agreement (MOA) was signed in 1997 by the City, the State, the federal EPA, five environmental groups, seven counties, and 71 watershed towns and villages. Under the MOA, watershed management is being

implemented on a scale unprecedented in the United States. It includes an acquisition program to buy water-sensitive lands, a set of rules controlling activities close to bodies of water, funds for environmentally conscious development, and a set of best practices for agriculture and forestry to reduce water impacts. The initiative is expected to cost the City \$1.5 billion over 10 years (NRC 2000; Kimmerling et al. 2000-2001; Yaggi 2000-2001).

- **The Murray-Darling Initiative in Australia.** Under this initiative, the federal and five state/territorial governments cooperate to address the over-demand for and degradation of water and land resources in the Murray-Darling Basin (see Box 58).
- **The CALFED Bay-Delta Program in California.** Under this program, the state and federal governments cooperate to address poor water quality, the water needs for endangered aquatic species, and the competing and increasing water demands of the Bay-Delta area. Water conservation plays a significant role in CALFED. \$1.8 billion was proposed for urban and agricultural conservation, including water

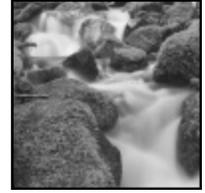
recycling, with a baseline level of water use efficiency a condition for permitting new surface storage projects (Dyballa 1999: 45; Adler and Straube 2000-2001).

These initiatives have achieved notable successes, and provide many important lessons in designing ongoing, dynamic, collaborative management processes, especially in inter-jurisdictional contexts. They are, however, “reactive” responses to existing or mounting problems and are applied on an ad hoc basis. Such an approach allows problems to grow until they are difficult and costly to remedy, not only because of the significant ecological damage that has occurred, but also because of the deeply entrenched and conflicting positions that have often formed.

One of the main lessons to be learned from these three examples is that the crises and lack of controls that necessitated them should (and could) be avoided with a proactive approach. Province-wide collaborative watershed management is required to achieve this, ideally as a central component of a national water sustainability strategy.

Chapter 9

Conclusion and future directions



In the context of natural resource management, with all its many forms of externalities, neither the price mechanism nor the creation of property rights can provide a durable solution. Therefore, policy prescriptions, which have moved from ‘getting the prices right’ to ‘getting the property rights right’, now center on ‘getting institutions right.’

(Saleth and Dinar 2004: 23)

The Commissioner of the Environment and Sustainable Development (2001) declared that “water is becoming the world’s most sought after resource...The availability and management of fresh water is becoming one of the greatest environmental, political, and social challenges of the 21st century.” Even for Canada, a nation relatively rich in freshwater resources, achieving sustainable freshwater management poses a significant challenge.

Canada is indeed at a watershed as it moves from a situation of historic abundance of water, to a future of freshwater scarcity. Yet, Dr. David B. Brooks (2003a: 42), Canada’s foremost water conservation specialist, warns that “[o]ur management systems for fresh water in Canada are becoming less, not more, sustainable...”

The question is not about whether Canada must use water more efficiently. It is to what extent Canada will go beyond increasing efficiency to a more fundamental change—a paradigm shift in water management.

Political and institutional constraints are considerable. Institutions that will creatively manage and accel-

erate the adoption of sustainable solutions are needed. *At a Watershed* demonstrates that change is possible and that long-term solutions to water scarcity exist.

Canada has the opportunity to break from its historical pattern of wasting water. A future different from the past is possible. Financial, technological, legal and social tools are available to grapple with water issues before they reach crisis proportions. But the long-term solution requires a fundamental shift to *watershed or ecosystem governance*. It requires an institutional shift towards ecologically-based water allocations, the soft path for water, ecosystem-based management, and innovative urban water management.

The challenge now is to ensure that these new approaches, resources and institutional arrangements are implemented across the country. Senior government must provide the leadership to make this happen and take steps to ensure water agencies have the capacity and incentives to implement comprehensive solutions at the local level.

References

- Abrams, L.J., (1996). *Policy Development in the Water Sector — the South African Experience*. Cranfield International Water Policy Conference, Cranfield University, Bedford, UK. [Electronic version]. Retrieved from www.thewaterpage.com/south_africa.htm
- Adler, R.W. & Straube, M. (2000-2001). Watersheds and the Integration of US Water Law and Policy: Bridging the Great Divides. *William and Mary Environmental Law and Policy Review*, 25, 1.
- ADWR (Arizona Department of Water Resources). (2004). Groundwater Web site: <http://www.water.az.gov/adwr>
- ADWR (Arizona Department of Water Resources). (2005). *Securing Arizona's Water Future*. [Electronic version]. Retrieved from www.water.az.gov/adwr/Content/Publications/files/conservreqts.pdf
- AFFA (Agriculture, Fisheries and Forestry Australia). (2004). Water Savings Web site: <http://www.affa.gov.au/watersavings>
- Allan, A. (2003). A Comparison Between the Water Law Reforms in South Africa and Scotland: Can a Generic National Water Law Model Be Developed from These Examples? *Natural Resources Journal*, 43(2), 419.
- Angermeier, P. L. & Karr, J. R. (1994). Biological integrity versus biological diversity as policy directives: Protecting biotic resources. *BioScience* 44(10), 690-697.
- Arizona GWMC (Governor's Water Management Commission). (2001). Final Report of the Governor's [Gov. Jane Dee Hull] Water Management Commission. [Electronic version]. Retrieved from <http://water.az.gov/adwr/Content/Publications/default.htm>
- Arizona WSP (Water Sustainability Program) Web site: www.uawater.arizona.edu
- Ast, J.A. van, & Boot, S.P. (2003). Participation in European Water Policy. *Physics and Chemistry of the Earth*, 28, 555.
- Austin Green Building Web site: <http://www.ci.austin.tx.us/greenbuilder>
- AWWA Web site: <http://www.awwa.org>
- AWWARF (AWWA Research Foundation). *Developing an Environmental Management System for Water Utilities*. Project #2930 summary. [Electronic version]. Retrieved from <http://www.awwarf.org/research/TopicsAndProjects/projectSnapshot.aspx?pn=2930>
- Bakker, K. (2003). *Good Governance in Restructuring Water Supply: A Handbook*. Toronto: Federation of Canadian Municipalities.
- Bakker, K. (2004a). *Water Supply Privatization — Canada and the New American Empire*. Briefing Note. Centre for Global Studies. [Electronic version]. Retrieved from http://www.globalcentres.org/can-us/water_bakker.pdf
- Baron, J. S., N. L. Poff, P. L. Angermeier, C. N. Dahm, P. H. Gleick, N. G. Hariston, R. B. Jackson, C. A. Honston, B. D. Richter & A. D. Steinman (2003). Sustaining Healthy Freshwater Ecosystems. *Issues in Ecology: Ecological Society of America*.
- Baron, J.S., Poff, N.L., Angermeier, P.L., Dahm, C.N., Gleick, P.H., Hariston, N.G., Jackson, R.B., Honston, C.A., Richter, B.D. & Steinman, A.D. (2002) Meeting ecological and societal needs for freshwater. *Ecological Applications*, 12(5), 1247-1260.
- Barrie (2005). City of Barrie Web site: <http://www.city.barrie.on.ca/>
- BCWWA (BC Water and Waste Association) BMP Web site: <http://www.bcwwa.org/bmp>. See also www.waterbucket.ca for additional BCWWA efforts aimed at water sustainability.
- Beck, Robert E. (2000-2001). The Regulated Riparian Model Water Code: Blueprint for Twenty First Century Water Management. *William and Mary Environmental Law and Policy Review*, 25, 132.
- Bellamy, J., Ross, H., Ewing, S., & Meppem, T. (2002). Integrated Catchment Management: Learning from the Australian Experience for the Murray-Darling Basin. CSIRO Sustainable Ecosystems. [Electronic version]. Retrieved from http://www.mdbc.gov.au/naturalresources/icm/icm_aus_x_overview.html.
- Bergen Declaration (1990). Bergen Conference on Sustainable Development, May 1990. Hosted by Norway and co-sponsored by the United Nations Economic Commission for Europe (ECE).
- Berkes, Fikret & Folke, Carl. (1998). Linking Social and Ecological Systems for Resilience and Sustainability. In Fikret Berkes & Carl Folke (Eds), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge, UK: Cambridge University Press.
- Bjornlund, H. (2004). Formal and informal water markets: Drivers of sustainable rural communities? *Water Resources Research*, 40.
- Boer, Ben. (1995). Institutionalising Ecologically Sustainable Development: The Roles of National, State, and Local Governments in Translating Grand Strategy into Action. *Williamette Law Review*, 31, 307.
- Boyd, D.R. (2001). *Canada vs. The OECD: An Environmental Comparison*. Victoria: University of Victoria.
- Boyd, D.R. (2003). *Unnatural Law: Rethinking Canadian Environmental Law and Policy*. Vancouver: UBC Press.
- Boyd, David R. (2004). *Sustainability Within a Generation: A New Vision for Canada*. David Suzuki Foundation.[Electronic version]. Retrieved from <http://www.davidsuzuki.org/WOL/Sustainability>
- Brandes, O.M. & Ferguson, K. (2003). *Flushing the Future? Examining Urban Water Use in Canada*. Victoria: University of Victoria —The POLIS Project on Ecological Governance.
- Brandes, O.M. & Ferguson, K. (2004). *The Future in Every Drop: The benefits, barriers, and practice of urban water demand management in Canada*. Victoria: The POLIS Project on Ecological Governance — University of Victoria.
- Brandes, O.M. & Kriwoken, L. (2005). *Changing Perspectives —*

- Changing Paradigms: Demand management strategies and innovative solutions for a sustainable Okanagan water future.* CWRA Conference: Water — Our Limiting Resource, Kelowna BC, February 2005.
- Brandes, O.M. & Maas, T. (2004). *Developing Water Sustainability Through Urban Water Demand Management — Environment Canada Backgrounder.* Victoria: The POLIS Project on Ecological Governance — University of Victoria.
- Brazil ANA. (2004). National Water Agency Web site: <http://www.ana.gov.br/ingles/indexingles.asp>
- Bressers, Hans Th.A. & Kuks, Stefan M.M. (2003). What Does “Governance” Mean? From Conception to Elaboration. In Hans Th. A. Bressers & Walter A. Rosenbaum (Eds), *Achieving Sustainable Development: The Challenge of Governance Across Social Scales.* Westport, Connecticut: Praeger.
- Brooks, D.B. & Peters. (1988). *Water: The Potential for Demand Management in Canada.* Ottawa: Science Council of Canada.
- Brooks, D.B. (2003). Against the Flow. *Alternatives*, 29(2), 29-33.
- Brooks, D.B. (2003a). *Another Path Not Taken: A Methodological Exploration of Water Soft Paths for Canada and Elsewhere.* Ottawa: Friends of the Earth.
- Brooks, D.B.(2005). Beyond Greater Efficiency: The Concept of Water Soft Paths. *Canadian Water Resources Journal*, 30(1), 83-92.
- Brooks, Richard O., Jones, R. & Virginia, R.A. (2002). *Law and Ecology: The Rise of the Ecosystem Regime.* Aldershot, Hampshire: Ashgate Publishing Ltd.
- Brown, Cate & King, Jackie. (2000). Environmental Flow Assessments for Rivers: A Summary of the DRIFT Process. *Southern Waters' Information Report*, No 01/00. [Electronic version]. Retrieved from <http://www.southernwaters.co.za/downloads/drift.pdf>
- Brunckhorst, David J. (1998). Creating Institutions to Ensure Sustainable Use of Resources. *Habitat International*, 22(4), 347.
- Burrell, Terry. (1997). *CSA Environmental Standards Writing: Barriers to Environmental Non-Governmental Organizations Involvement.* Canadian Institute for Environmental Law and Policy.
- Burrill, A. (1996). What a Waste... of Water and Market Opportunities. *IPTS (Institute for Prospective Technological Studies, European Commission Joint Research Centre) Report.* Volume 9. [Electronic version]. Retrieved from <http://www.jrc.es/home/report/english/articles/vol09/welcome.htm>
- Burström, Fredrik & Korhonen, Jouni. (2001). Municipalities and Industrial Ecology: Reconsidering Municipal Environmental Management. *Sustainable Development* 9, 36.
- CAGBC (Canadian Green Building Council) LEED (Leadership in Energy and Environmental Design) Web site: http://www.cagbc.ca/building_rating_systems/leed_rating_system.php
- California Water Code (2005). California Code of Regulations. [Electronic version]. Retrieved from http://ceres.ca.gov/topic/env_law/water/
- California Urban Water Conservation Council (2005) Web site: <http://www.cuwcc.org/aboutus.html>
- Campbell, I. (2004). Toward Integrated Freshwater Policies for Canada's Future. *Horizons*, 6(4), 3-7.
- Campbell, K. & Nizami, Y. (2001) Security or Scarcity? NAFTA, GATT and Canada's Freshwater. *West Coast Environmental Law*, 16.
- Campbell, Lee, C. & Heck, Walter W. (1997). An Ecological Perspective on Sustainable Development. In F. Douglas Muschell (Ed.), *Principles of Sustainable Development*, Delray Beach, Florida: St. Lucie Press.
- Canadian Water Network (CWN) Web site: <http://www.cwn-rce.ca/>
- Cannon, Jon. (2000). Choices and Institutions in Watershed Management. *William and Mary Environmental Law and Policy Review*, 25, 379.
- Cantin, B., Shrubsole, D. & Ait-Ouyahia, M. (2005). Using Economic Instruments for Water Demand Management: Introduction. *Canadian Water Resources Journal*, 30(1), 1-10.
- CCME (1994). *National Action Plan to Encourage Municipal Water Use Efficiency.* Canadian Council of Ministers of the Environment
- CCME (Canadian Council of Ministers of the Environment). (2004). Web site: <http://www.ccme.ca/about/>
- CELA (2004a). *Canadian Environmental Law Association FAQ — What are the major features of the Sustainable Water and Sewage Systems Act?* [Electronic version]. Retrieved July 16, 2004 from <http://www.cela.ca/faq/detail.shtml?x=1621>
- CELA (2004b). *FAQs — What actions have the states and provinces taken to control water removals from the Great Lakes?* [Electronic version]. Retrieved July 28, 2004. 2004 from <http://www.cela.ca/faq/detail.shtml?x=1642>
- CEOGW (Chief Executive Officers' Group on Water, Australia). (2003) *Report to the Council of Australian Governments: Water Access Entitlements.* [Electronic version]. Retrieved from http://www.affa.gov.au/corporate_docs/publications/word/nrm/water_reform/ceogw_final.doc
- CESD (2001). *Report of the Commissioner of the Environment and Sustainable Development.* Ottawa: Commissioner of the Environment and Sustainable Development — Office of the Auditor General of Canada, Minister of Public Works and Government Services.
- Chess, C., Hance, B.J. & Gibson, G. (2000). Adaptive Participation in Watershed Management. *Journal of Soil and Water Conservation*, 55(3), 248.
- CMHC (Canadian Mortgage and Housing Corporation). (2001). *Commissioning Guide for the Toronto Healthy Houses Water Systems.* [Electronic version]. Retrieved from <http://www.cmhc-schl.gc.ca>
- COAG (Council of Australian Governments). (2004). Web site: <http://www.coag.gov.au>
- COAG NWI (National Water Initiative). (2004)

- Intergovernmental Agreement on a National Water Initiative*, (paras. 65,66). [Electronic version]. Retrieved from www.coag.gov.au/meetings/250604/iga_national_water_initiative.pdf
- Cohen, S. & Miller, K. (2001). North America. In J. McCarthy, O. Canziani, N. Leary, D. Dokken & K. White (Eds), *Climate Change 2001: Impacts Adaptation and Vulnerability*, Cambridge, UK: Cambridge University Press.
- Cohen, S., Neilsen, D. & Welbourn, R., (Eds). (2004). *Expanding the Dialogue on Climate Change & Water Management in the Okanagan Basin British Columbia*. Final Report January 1, 2002 to June 30, 2004. Ottawa: Climate Change Action Fund.
- Collin, Martin L., & Melloul, Abraham J. (2001). Combined Land-Use and Environmental Factors for Sustainable Groundwater Management. *Urban Water*, 3, 229.
- Commission on Global Governance (1995). *Our Global Neighborhood*, Oxford University Press.
- Cooke, B. & Kothari, U. (Eds). (2001). *Participation: the New Tyranny?* London: Zed Books.
- Coombes, Argue, & Kuczera. (1999). Figtree place: A Case Study in Water Sensitive Urban Development (WSUD). *Urban Water*, 1, 335-343.
- Costanza, R. (Ed). (1991). *Ecological Economics: The Science and Management of Sustainability*. Columbia University Press.
- CRD (2005). CRD Web site: <http://www.crd.bc.ca/water/overview.htm>
- CRM (1996). *Demand Side Management: A Primer*. Vancouver: Compass Resource Management Ltd.
- CSIRO (Commonwealth Scientific and Industrial Research Organization). Urban water Web site: <http://www.cmit.csiro.au/research/urbanwater>
- Curran, D & Leung, M. (2000). *Smart Growth: A Primer*. Vancouver: Smart Growth British Columbia.
- CUWCC (California Urban Water Conservation Council) Web site: <http://www.cuwcc.org>
- da Motta, R.S., Feres, J.G., Nauges, C., Thomas, A., Saade, A. & Saade, L. (2003). *Synthesis of Regional Experiences: From Theoretical to Practical Issues. In Economic Instruments for Water Management: Experiences from Europe and Implications for Latin America and the Caribbean*. Inter-American Development Bank, Regional Policy Dialogue Study Series. [Electronic version]. Retrieved from <http://www.iadb.org/int/drp/ing/Red7/Docs/EconomicInstrumentsWater12-03eng.pdf>
- da Motta, R.S., Thomas, A., Hazin, L.S., Feres, J.G., Nauges, C. & Hazin, A.S. (2004). *Economic Instruments for Water Management: The Cases of France, Mexico and Brazil*. Northampton, Massachusetts: Edward Elgar.
- Daily, G. C., (Ed). (1997). *Nature's Services: Societal dependence on natural ecosystems*. Washington DC: Island Press.
- DEH (Australian Department of the Environment and Heritage). (2004). WELS (Water Efficiency Labelling and Standards) Web site: <http://www.deh.gov.au/water/urban/scheme.html>
- DEH (Australian Department of the Environment and Heritage). (2004). *Regulation Impact Statement for Proposed National System of Mandatory Water Efficiency Labelling and Standards for Selected Products*. [Electronic version]. Retrieved from <http://www.deh.gov.au/water/urban/ris.html>
- Delaney, Dennis R. (1996). Federal Guidance: A Middle of the River Approach to Water Conservation. *Boston University Law Review*, 76, 375.
- deLoe, R. C., Moraru, L., Kreutzwiser, R. D., Schaefer, K. & Mills, B. (2001). Demand-Side Management of Water in Ontario Municipalities: Status, Progress, and Opportunities. *Journal of the American Water Resources Association*, 37(1), 57-72.
- Delogu, O. (1992). Citizen Suits to Protect the Environment: The U.S. Experience May Suggest a Canadian Model. *University of New Brunswick Law Journal*, 41, 124.
- de Villiers, M. (2000). *Water*. Toronto: Stoddart Publishing.
- DFAIT (Department of Foreign Affairs and International Trade) (1999). *Bulk Water Removal and International Trade Considerations*. [Electronic version]. Retrieved from www.dfait-maeci.gc.ca
- Dickinson, Mary Ann, Maddaus, Lisa A. & Maddaus, William O. (2001). *Benefits of the United States Nationwide Plumbing Efficiency Standards*. California Urban Water Conservation Council and Maddaus Water Management. [Electronic version]. Retrieved from www.isf.uts.edu.au/whatsnew/PlumbingStandardsPaper.pdf
- Dietemann, A. (2004). Seattle Public Utilities. Personal communication, July 6, 2004.
- Dolan, A. H., Kreutzwiser, R.D & deLoe, R.C. (2000). Rural water use and conservation in southwestern Ontario. *Journal of Soil and Water Conservation*, 55(2), 161-171.
- Dorcey, T. & McDaniels, T. (2001). Great expectations, mixed results: Trends in citizen involvement in Canadian environmental governance. In E.A. Parson (Ed.), *Governing the Environment: Persistent Challenges, Uncertain Innovations*. Toronto: University of Toronto Press.
- Dorcey, T. (2002). Sustainable Governance: Surfing the Waves of Transformation. Resource and Environmental Management in Canada. In *Addressing Conflict and Uncertainty* (2nd ed.). B. Mitchell (Ed.), Harlow: Prentice Hall.
- Dore, M. & Hull, J. (2003) Alternative Funding Mechanisms For Water Infrastructure Renewal. In *INFRA 2003, Proceedings of the 9th Annual Urban Infrastructure Week*. Centre for Expertise and Research on Infrastructures in Urban Areas (CERIU), Montreal, Quebec, Nov. 18-20, 2003.
- Dorf, M. & Sabel, C.F. (1998). A constitution of Democratic Experimentalism. *Columbia Law Review*, 98(2), 267-473.
- Dwivedi, O., Kyba, P., Stoett, P. & Tiessen, R. (2001). *Sustainable Development and Canada: National and International Perspectives*. Peterborough: Broadview Press.
- Dyballa, Cindy. (1999). The Role of Water Conservation in Watershed Management. *Water Resources Update*, 114, 45.
- ECITA (The Australian Senate Environment, Communications, Information Technology and the Arts References Committee).

- (2002). *The Value of Water: Inquiry into Australia's management of urban water*. Canberra, Australia: Senate Printing Unit. [Electronic version]. Retrieved from http://www.aph.gov.au/Senate/committee/ecita_ctte/completed_inquiries/2002-04/water/report/contents.htm
- ECOTEC. (2001). *Study on the Economic and Environmental Implications of the Use of Environmental Taxes and Charges in the European Union and its Member States*. [Electronic version]. Retrieved from http://europa.eu.int/comm/environment/enveco/taxation/environmental_taxes.htm
- EcoWater Web site: <http://www.waitakere.govt.nz/AbtCnl/to/ecowtr.asp>
- Elwha-Dungeness Watershed Plan. (2002). Retrieved from http://www.clallam.net/environment/html/wria_18_draft_watershed_plan.htm
- Environment Canada. (1987). *Federal Water Policy*. Ottawa.
- Environment Canada. (1996). *Municipal Water Pricing Survey*. Ottawa: Minister of Public Works and Government Services.
- Environment Canada. (2001). *Municipal Water Pricing 1991-1999*.
- Environment Canada. (2001). *Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada*. Burlington: National Water Research Institute.
- Environment Canada. (2001a). *Municipal Water Pricing 1991-1999*. Ottawa: Environmental Economics Branch — Environment Canada.
- Environment Canada. (2002). *Urban Water Indicators: Municipal Water Use and Wastewater Treatment*. Ottawa: Environment Canada.
- Environment Canada. (2003). *Water and Canada — Preserving a Legacy for People and the Environment*. Ottawa: Environment Canada.
- Environment Canada. (2003a). *A Primer on Fresh Water — Questions and Answers* (5th ed). Ottawa: Environment Canada.
- Environment Canada. (2003b). [Map]. *Normal Precipitation, 1971 to 2000*. Adapted in part from Statistics Canada Environmental Accounts and Statistics Division.
- Environment Canada. (2004). *Threats to Water Availability in Canada*. Burlington Ontario: National Water Research Institute, 128.
- Environment Canada. (2004a). *Percentage of Population Reliant on Groundwater*. [Electronic version]. Retrieved from www.ec.gc.ca/water/images/nature/grdwtr/a5f6e.htm
- Environment Canada. (2004b). [Map]. *Water Use and Availability Ratio, by Drainage Area*. Adapted in part from Statistics Canada, Environmental Accounts and Statistics Division.
- EPA (US Environmental Protection Agency) (1997). *Top 10 Watershed Lessons Learned*. [Electronic version]. Retrieved from <http://www.epa.gov/owow/lessons>
- EPA (US Environmental Protection Agency) (2002). *A Review of Statewide Watershed Management Approaches*. [Electronic version]. Retrieved from http://www.epa.gov/owow/watershed/approaches_fr.pdf
- EPA (US Environmental Protection Agency) (2004) EPA Water Efficiency Program (WEP) Web site: <http://www.epa.gov/owm/water-efficiency/>
- EPA (US Environmental Protection Agency) EMS (Environmental Management System) Web site: <http://www.epa.gov/owm/iso14001/ems.htm> and <http://www.epa.gov/ems/water.htm>
- EPA (US Environmental Protection Agency). MOA. [Electronic version]. Retrieved September 2004 from <http://www.epa.gov/region02/water/nycshed>
- EPA (US Environmental Protection Agency). *Revenue Guidebook*. [Electronic version]. Retrieved from <http://www.epa.gov/efinpage/guidbkpdf/tools1-5>
- EPA (US Environmental Protection Agency). *Water Conservation Plan Guidelines*. [Electronic version]. Retrieved from <http://www.epa.gov/owm/water-efficiency/webguid.html>
- EPA (US Environmental Protection Agency). *WaterStar Stakeholder List*. [Electronic version]. Retrieved from http://www.epa.gov/owm/water-efficiency/products_program.htm
- EPA. (US Environmental Protection Agency). (2001). *Environmental Management Systems and the Clean Water State Revolving Fund*. [Electronic version]. Retrieved from <http://www.epa.gov/owmitnet/cwfinance/cwsrf/emsfs.pdf>
- EPA. (US Environmental Protection Agency). (2004). *Guidelines for Water Reuse*. [Electronic version]. Retrieved from www.epa.gov/ORD/NRMRL/pubs/625r04108/625r04108.pdf
- Estrin, D. & Swaigen, J. (1978). *Environment on Trial*. Toronto: CELRF.
- Esty, Daniel C. (1999). Toward Optimal Environmental Governance. *New York University Law Review*, 74(6), 1495.
- EU Directive (2000/60/EC). Directive of the European Parliament and of the Council, October 23, 2000. Official Journal of the European Communities, 327.
- EU Ecolabel Web site: http://europa.eu.int/comm/environment/ecolabel/index_en.htm
- EUROPA Water Framework Directive (WFD). (2004). [Electronic version]. Retrieved August 2004 from http://europa.eu.int/comm/environment/water/water-framework/index_en.html
- Farid, C., Jackson, J. & Clark, K. (1997). *The Fate of the Great Lakes: Sustaining or Draining the Sweetwater Seas?* Canadian Environmental Law Association and Great Lakes Unlimited.
- Ferguson, Keith. (2004). Challenging the Intervention and Stay of an Environmental Private Prosecution. *Journal of Environmental Law and Practice*, 13, 153.
- Fidell, M. & Wong, A. (1999). Using Recycled Water for Agricultural Irrigation: City of Visalia and City of Santa Rosa. In L. Owens-Viani, A. Wong & P. Gleick. *Sustainable Use of Water California Success Stories*. Oakland: Pacific Institute for Studies in Development, Environment, and Security.
- Fiorino, Daniel J. (1999). Rethinking Environmental Regulation:

- Perspectives on Law and Governance. *Harvard Environmental Law Review*, 23, 441-449.
- Fleming, William M. & Emlen Hall, G. (2000). Water Conservation Incentives for New Mexico: Policy and Legislative Alternatives. *Natural Resources Journal*, 20, 69.
- Florida DEP (Department of Environmental Protection). Reuse Web site: <http://www.dep.state.fl.us/water/reuse>
- Flowers, John. (2004). New EPA Initiatives for Efficient Water Use. Presentation to the US Conference of Mayors, 2004 Urban Water Summit.
- Foerstel, Hans. (1994). Water Conservation Plan for Federal Government Facilities. In D. Shrubsole, & D. Tate (Eds), *Every Drop Counts*, Canadian Water Resources Association.
- Folke, Carl, Berkes, Fikret & Colding, Johan. (1998). Ecological Practices and Social Mechanisms for Building Resilience and Sustainability. In Fikret Berkes & Carl Folke (Eds), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge, UK: Cambridge University Press.
- Folke, Carl, Carpenter, S. & Elmqvist, T. (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *Ambio*, 31, 437-440.
- Foster, S.S.D. (2001). The Interdependence of Groundwater and Urbanisation in Rapidly Developing Cities. *Urban Water*, 3, 185.
- Fumero, John J. (2003). Florida Water Law and Environmental Water Supply for Everglades Restoration. *Journal of Land Use and Environmental Law*, 18(2), 379.
- Gabor, S. T., North, A.K., Ross, L.C.M., Murkin, H.R., Anderson, J.S. & Raven, M. (2005). *Natural Values: The importance of wetland and upland conservation practices in watershed management*. Barrie: Ducks Unlimited Canada.
- Gale, F. (1997). *The Greening of Political Economy: An Ecological Political Economic Approach to Production and Consumption*. Discussion Paper, D97-5. Victoria: Eco-Research Chair of Environmental Law and Policy, University of Victoria.
- Galloway, G. & Pentland, R. (2003). *Managing Groundwater Resources in the Great Lakes Basin: Securing Our Future Vision and Principles*. Toronto: Program on Water Issues — Munk Centre for International Studies, University of Toronto.
- GEO (Global Environment Outlook). (2000). Prepared for United Nations Environment Program. London: Earthscan Publications Ltd.
- Get Water Smart Web site: <http://www.getwatersmart.com/>
- GETF (Global Environment & Technology Foundation) EMS Web site: <http://www.getf.org/projects/muni.cfm>
- Gillilan, David M. & Brown, Thomas C. (1997). *Instream Flow Protection: Seeking a Balance in Western Water Use*. Washington DC Island Press.
- Gleick, P. (1996). Basic Water Requirements for Human Activities: Meeting Basic Needs. *Water International*, 21, 83-92.
- Gleick, P. (1998). Water in Crisis: Paths to Sustainable Water Use. *Ecological Applications* 8(3), 571-579.
- Gleick, P. (2000). The Changing Water Paradigm — A Look at Twenty-first Century Water Resources Development. *Water International*, 25(1), 127-138.
- Gleick, P. (2002). Water Management: Soft water paths. *Nature*, 418 (6896), 373.
- Gleick, P., Wolff, G. Chalecki, E. & Reyes, R. (2002). *The New Economy of Water: The Risks and Benefits of Globalization and Privatization of Fresh Water*. Oakland: Pacific Institute for Studies in Development, Environment, and Security.
- Gordon Foundation (2004). *Controlling Our Thirst: Managing Water Demands and Allocations in Canada*. Canadian Science Writer's Association Conference, Toronto.
- Gouldson, A. & Murphy, J. (1997). Ecological modernisation: economic restructuring and the environment. *The Political Quarterly*, 68(5), 74-86.
- Grannerman, N.G., Hunt, R.J., Nicholas, J.R., Reily, T.E. & Winter, T.C. (2000). *The Importance of Ground Water in the Great Lakes Region*. Lansing MI: USGS Water Resources Investigation Report 00-4008.
- Grobicki, A.M.W. & Cohen, B.(1999). A flow balance approach to scenarios for water reclamation. *Water South Africa*, 25(4), 473.
- Gunderson, L. & Holling, C.S. (2002). *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.
- Gunderson, L. (1999). Resilience, flexibility and adaptive management — Antidotes for spurious certitude? *Conservation Ecology*, 3(1), 7.
- Gunton, Thomas I. & Day, J.C. (2003). The Theory and Practice of Collaborative Planning in Resource and Environmental Management. *Environments*, 32(2), 5.
- Guz, K. (2004) Personal communication, Program Planner, San Antonio Water Services Conservation Department.
- Hammarby Sjostad (2004) Web sites: http://www.hammarbysjostad.se/frameset.asp?target=inenglish/inenglish_project.asp and <http://www.wateryg.org/activities/casestudies/wateryg/case2.htm>
- Hawkin, P., Lovins, A. & Lovins, H. (1999). *Natural Capitalism: Creating the Next Industrial Revolution*. New York: Little, Brown and Co.
- Hayward, T. (1994). *Ecological Thought — An Introduction*. Cambridge, UK: Polity Press.
- Hearne, R. & Easter, K.W. (1996). The economic and financial gains from water markets in Chile. *Agricultural Economics*, 15,187-199.
- Heikkila, Tanya. (2004). Institutional Boundaries and Common-Pool Resource Management: A Comparative Analysis of Water Management Programs in California. *Journal of Policy Analysis and Management*, 23(1), 97.
- Herman, Janet S., Culver, David C. & Salzman, James. (2001). Groundwater Ecosystems and the Services of Water Purification. *Stanford Environmental Law Journal*, 20, 479.
- Higgs, E. (2003). *Nature by Design: People, Natural Processes*

- and *Ecological Restoration*, MIT Press.
- Holling, C.S. (Ed) (1978). *Adaptive environmental assessment and management*. New York: John Wiley.
- Holling, C.S., Berkes, Fikret & Folke, Carl. (1998). Science, Sustainability and Resource Management. In Fikret Berkes & Carl Folke (Eds), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge, UK: Cambridge University Press.
- Horbulyk, T.M. (2004). *Markets, Policy and Allocation of Water Resources Among Sectors*. Policy Research Initiative Experts Symposium on Economic Instruments for Water Demand Management in an Integrated Water Resources Management Framework, Ottawa.
- Hughes, Denis A. & Hannart, Pauline. (2003). A Desktop Model used to Provide an Initial Estimate of the Ecological Flow Requirements of Rivers in South Africa. *Journal of Hydrology*, 270, 167.
- Hunter, David, Salzman, James & Zaelke, Durwood. (2002). *International Environmental Law and Policy*. New York: Foundation Press.
- IAMPO (International Association of Plumbing and Mechanical Officials). (2004) Web site: <http://www.iapmo.org/iapmo/>
- ICRC (Independent Competition and Regulatory Commission, ACT, Australia). (2003). *Water Abstraction Charge*. Draft report. [Electronic version]. Retrieved from <http://www.icrc.act.gov.au/water/waterandsewerage.html>
- IEAust (Institute of Engineers, Australia). (2000). *Draft Position Paper on Environmental Management Systems in the Water Services Industry*. [Electronic version]. Retrieved from <http://www.eng.newcastle.edu.au/~ncwe/ncwePosPaper/ppEMS.htm>
- IFC (Instream Flow Council). (2002). *Instream Flows for Riverine Resource Stewardship*. Retrieved from <http://www.instream-flowcouncil.org>
- IJC (International Joint Commission). (2000). *The Protection of the Waters of the Great Lakes — Final Report to the Government of Canada and the United States*. Windsor: International Joint Commission.
- IJC (International Joint Commission). (2004). Web site: www.ijc.org
- InfraGuide. (2002). *National Guide to Sustainable Municipal Infrastructure launches a stakeholder review period*. News release. [Electronic version]. Retrieved June 14, 2002 from <http://www.infraguide.ca>
- IPCC (Intergovernmental Panel on Climate Change). (1996). *Hydrology and Freshwater Ecology. Climate Change 1995: Impacts, Adaptations, and Mitigation of Climate Change*. Cambridge, UK: Cambridge University Press.
- IUCN (World Conservation Union). (2003). *The Precautionary Principle and Environmental Governance: Sustainable development, natural resource management and biodiversity conservation*, IUCN — The world conservation union.
- Jackson, M. (2000). *Systems Approaches to Management*. New York: Kluwer Academic/Plenum Publishers.
- Jacobs, Katharine L. & Holway, James M. (2004). Managing for Sustainability in an Arid Climate: Lessons Learned from 20 Years of Groundwater Management in Arizona, USA. *Hydrology Journal*, 12, 52.
- Janmaat, J. (2005). *The Race for Water: Reflections on the 1974 Okanagan Basin Study*. CWRA annual conference — Water Our Limiting Resource, Kelowna, BC.
- Jiggins, Janice & Röling, Niels. (2000). Adaptive Management, Potential and Limitations for Ecological Governance. *Int. J. Agricultural Resources, Governance and Ecology*, 1(1), 28.
- Jobin, W. (1998). *Sustainable Management for Dams and Waters*. London: Lewis Publishers.
- Johnson, B. (1999). The Role of Adaptive Management as an Operational Approach for Resource Management Agencies. *Conservation Ecology* 3(2), 8-19.
- Kallis, G. & DeGroot, H.L.F. (2002). Water for the City: Towards Sustainability. *Built Environment*, 28, 152-164.
- Karkkainen, Bradley C. (2002). Collaborative Ecosystem Governance: Scale, Complexity, and Dynamism. *Virginia Environmental Law Journal*, 21, 189.
- Kay, J.J. & Schneider, E. D. (1994). Embracing Complexity, The Challenge of the Ecosystem Approach. *Alternatives* 20(3), 32-38.
- Kay, J.J., Regier, H., Boyle, M. & Francis, G. (1999). An Ecosystem Approach for Sustainability: Addressing the Challenge of Complexity. *Futures* 31(7), 721-742.
- Kelowna. (2005). City of Kelowna Web site: <http://www.city.kelowna.bc.ca/>
- Kennett, S. (1991). *Managing Interjurisdictional Waters in Canada: A Constitutional Analysis*. Calgary: Canadian Institute of Resource Law.
- Kimmerling, Judith, et al. (2000-2001). Panel Discussion: Lessons from the Watershed Negotiations. *Fordham Environmental Law Journal*, 12, 419.
- Kornfeld, Itzhak E. (2001-2002). Groundwater Conservation: Conundrums and Solutions for the New Millennium. *Tulane Environmental Law Journal*, 15, 365.
- Kraemer, R. Andreas, Pielen, Britta M. & Leipprand, Anna. (2003). Economic Instruments for Water Management: Extra-Regional Experiences and their Applicability in Latin America and the Caribbean. In Inter-American Development Bank, *Economic Instruments for Water Management: Experiences from Europe and Implications for Latin America and the Caribbean*. Regional Policy Dialogue Study Series. [Electronic version]. Retrieved from <http://www.iadb.org/int/drp/ing/Red7/Docs/EconomicInstrumentsWater12-03eng.pdf>
- Lee, A.G. (Ed). (2002). National Guide to Sustainable Municipal Infrastructure: Defining the Problem Makes a Solution Possible. Submitted by Momentum Marketing and Creative Solutions for the NRC. In A.G. Lee (Ed.), *The Digital Pipe Digest*. Canadian Concrete Pipe Association.
- Lehtonen, Markku. (2004). The Environmental-Social Interface of Sustainable Development: Capabilities, Social Capital,

- Institutions. *Ecological Economics*, 49, 199-214.
- Lenzen, Manfred, Lundie, Sven, Bransgrove, Grant, Charet, Lisa & Sack, Fabian. (2003). Assessing the Ecological Footprint of a Large Metropolitan Water Supplier: Lessons for Water Management and Planning towards Sustainability. *Journal of Environmental Planning and Management*, 46(1), 113.
- Lévite, Hervé, Sally, Hilmy & Cour, Julien. (2003). Testing Water Demand Management Scenarios in a Water-Stressed Basin in South Africa: *Application of the WEAP Model. Physics and Chemistry of the Earth*, 28, 779.
- LHCCREMS (Lower Hunter and Central Coast Regional Environmental Management Strategy). (2003). *WaterSmart: Model Planning Provisions for the Lower Hunter and Central Coast*. Retrieved from www.hccrems.com.au/pdf_xls_zip/pdf_wsud/MPPs_May2003.pdf
- Long Peak Working Group on National Water Policy. (1994). America's Waters: A New Era of Sustainability. *Environmental Law*, 24, 125.
- Loudon, R. M. (1994). Full Cost Pricing as a Basic Need. In D. Shrubsole & D. Tate (Eds), *Every Drop Counts*. Canadian Water Resources Association.
- Loudon, R. M. (1994a). The Influence of Water/Wastewater Rates on Water Use. In D. Shrubsole & D. Tate (Eds), *Every Drop Counts*. Canadian Water Resources Association.
- Louw, D.B. & Kassier, W.E. (2002). The Costs And Benefits Of Water Demand Management. Centre for International Agricultural Marketing and Development. Project funded by the World Conservation Union (IUCN). Retrieved from www.iucn.org/places/rosa/wdm/outputs/final_report_costs.pdf
- Lovell, Chris, Mandondo, Alois & Moriarty, Patrick. (2002). The Question of Scale in Integrated Natural Resource Management. *Conservation Ecology*, 5(2), 25.
- Lucas, A. (1990). *Security of Title in Canadian Water Rights*. Calgary: Canadian Institute of Resources Law.
- Lund, Jay. (2004). Identifying Promising Integrated Solutions for California Water Management. Presentation at the Joint CWEMF/DWR California Water Plan Technical Workshop on Screening and Decision Support Tools. Retrieved from <http://cwemf.org/workshops/screeningtoolswrkshp.htm>
- Lundin, Margareta & Morrison, Gregory M. (2002). A Life Cycle Assessment Based Procedure for Development of Environmental Sustainability Indicators for Urban Water Systems. *Urban Water*, 4, 145.
- LWBC (2004). *Dealing with Drought: A Handbook for Water Suppliers in British Columbia*. Victoria: Land and Water British Columbia Inc.
- Maas, Tony. (2003). *What the Experts Think: Understanding Urban Water Demand Management in Canada*. Victoria: POLIS Project on Ecological Governance — University of Victoria.
- MacDonald, Hatton D. & Dyack, B. (2004). *Exploring the Institutional Impediments to Conservation and Water Reuse*. CSIRO Land and Water Policy and Economic Research Unit. [Electronic version]. Retrieved from www.clw.csiro.au
- Maconachie, Louise. (2004). Personal communication, Environmental Officer, North East Water, June 2004.
- Manitoba Government (2004). Retrieved July 21, 2004 from <http://www.gov.mb.ca/waterstewardship/>
- Marsalek, J, et al. (2002). Water Reuse and Recycling. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba: CCME *Linking Water Science to Policy Workshop Series, Report No. 3*. [Electronic version]. Retrieved from www.ccme.ca
- Martin, Paul. (2000). Speech to the Federation of Canadian Municipalities. London, Ontario, June 5, 2000. [Electronic version]. Retrieved from <http://www.fin.gc.ca/news00/00-044e.html>
- MCAWS (Ministry of Community, Aboriginal and Women's Services) (2004). New Requirement for Low Consumption Toilets in the Capital Regional District. [Electronic version]. Retrieved July 23, 2004 from http://www.mcaaws.gov.bc.ca/building/Low_Consumption_Toilets.htm
- McCarthy, D. (2003). Post-normal Governance: An emerging counter proposal. *Environments*, 31(1)
- McKenzie, J. (2002). *Environmental Politics in Canada: Managing the Commons into the Twenty-First Century*. Toronto: Oxford University Press.
- McKenzie-Mohr, D. (2004). Community-Based Social Marketing Web site: www.cbsm.com
- Melbourne SWF (Smart Water Fund) (2004). Web site: <http://www.smartwater.com.au>
- Melbourne WSUD (2004). Web site: <http://wsud.melbournewater.com.au>
- MELP (Ministry of Environment, Lands and Parks). (1998). *Water Conservation Strategy for British Columbia*. Victoria: Government of British Columbia.
- M'Gonigle, M. & Ramsay, P. (2004). Greening Environmental Law: From Sectoral Reform to Systemic Re-Formation. *Journal of Environmental Law and Policy*, 14(1), 331.
- M'Gonigle, M. (1989/90). Developing Sustainability: A Native/Environmentalist Prescription for Third-Level Government. *B.C. Studies*, 84(65).
- M'Gonigle, M., Jamieson, T.L., McAllister, M.K. & Peterman, R.M. (1994). Taking Uncertainty Seriously: From permissive regulation to preventative design in environmental decision making. *Osgoode Hall Law Journal*, 32(1).
- Miri, J.A. (1998). *A Snapshot of Conservation Management: 1998 Survey of State Water Conservation Programs*. AWWA Water Conservation Division.
- Mitchell, B. & Shrubsole, D. (Eds). (1997). *Practising Sustainable Water Management — Canadian and International Experiences*. Canadian Water Resources Association.
- Mitchell, Bruce. (1997). *Resource and Environmental Management*, Harlow, UK: Addison Wesley Longman Publishers.
- Morris, James P. (1999-2000). Who Controls the Waters?

- Incorporating Environmental and Social Values in Water Resources Planning. *Journal of Environmental Law and Policy*, 117.
- Moss, J., Wolff, G., Gladden, G. & Guttierrez, E. (2003). *Valuing Water for Better Governance*. Business and Industry CEO Panel. [Electronic version]. Retrieved from www.pacinst.org/reports/valuing_water/
- MDBC (Murray-Darling Basin Commission). (2004). Web site: <http://www.mdbc.gov.au/>
- Murphy, J. (2001). *Ecological Modernisation: The Environment and the Transformation of Society*. Oxford, UK: Oxford Centre for Environment, Ethics and Society (OCEES).
- NACEC. (2002). *The North American Mosaic: A State of the Environment Report*. Montreal: North American Commission for Environmental Co-operation.
- Naimen, R. J., Magnuson, J. J. & McKnight, D. M. (1995). *The freshwater imperative: A research agenda*. Washington DC: Island Press.
- National Competition Council (2004) Web site: <http://www.ncc.gov.au/index.asp>
- Natural Resources Canada (2004). *Climate Change Impacts and Adaptation: A Canadian Perspective — Water Resources*. Ottawa: Climate Change Impacts and Adaptation Directorate.
- Natural Resources Canada (2004a). *The Earth Science Sector Groundwater Program Brochure*. Ottawa, Natural Resources Canada.
- NBP (National Biosolids Partnership) Web site: <http://www.biosolids.org>
- NCC (National Competition Council) Web site: <http://www.ncc.gov.au>
- NERWA (North East Water) EMS Web site. <http://www.nerwa.vic.gov.au/environment/ems.htm>
- Newall, Prue. (2004). Manager of Sydney Water's EMS. Personal communication, June 2004.
- NIWR (National Institutes for Water Resources) Web site: <http://niwr.montana.edu> (see also <http://water.usgs.gov/wrri>)
- Nowlan, L. (2005). *Buried Treasure: Groundwater Permitting and Pricing in Canada*. Toronto, Walter and Duncan Gordon Foundation.
- NRC (National Research Council). (2000). *Watershed Management for Potable Water Supply: Assessing the New York City Strategy*. Washington, DC: National Academy Press.
- NRMMC. (2004). National Resource Management Ministerial Council, Australia Web site: <http://www.mincos.gov.au/>
- NRTEE (1996). *State of the Debate on the Environment and the Economy: Water and Wastewater Services in Canada*. Ottawa: National Round Table on the Environment and the Economy, 39.
- NRTEE (2003). *Environmental Quality in Canadian Cities: The Federal Role*. Ottawa: National Round Table on the Environment and Economy.
- NSW DEUS. (2004). *Best-Practice Management of Water Supply and Sewerage: Guidelines*. NSW Department of Energy, Utilities and Sustainability. See also: *Integrated Water Cycle Management Guidelines for NSW Local Water Utilities*. Retrieved from <http://www.deus.nsw.gov.au/Water>
- NSW Water Directorate (2004). Web site: <http://www.waterdirectoriate.asn.au/index.html>
- The National Water and Wastewater Benchmarking Initiative (2005) Web site: <http://www.nationalbenchmarking.ca/>
- O'Connor, D. (2002). *Part Two: Report of the Walkerton Inquiry — A strategy for safe water*. Toronto: Queen's Printer for Ontario.
- O'Connor, Martin.(2004). *Social Processes for Environmental Valuation: Procedures and Institutions for Social Valuations of Natural Capitals in Environmental Conservation and Sustainability Policy*. C3ED, Université de Versailles-Saint Quentin.[Electronic version]. Retrieved from <http://alba.jrc.it/valse>
- OECD (1999). *The Price of Water: trends in OECD countries*. Paris: OECD.
- OECD (2004). Environmental Performance Review of Canada. In *Water Management*, Paris: OECD.
- Orange County Grand Jury. (2004). The Groundwater Replenishment System: Providing Water for the Future. 2003-2004 Orange County Grand Jury Report. [Electronic version]. Retrieved from www.gwrsystem.com/about/background.html
- OWUE (Office of Water Use Efficiency). (2004). Department of Water Resources, California. Web site: <http://www.owue.water.ca.gov/urbanplan/index.cfm>
- Pacific Institute. (1999). *Sustainable Use of Water: California Success Stories*.
- Pardy, B. (2003). Seven Deadly Sins of Canadian Water Law. *Journal of Environmental Law and Practice*, 13, 89-107.
- Pearse, P. & Quinn, F. (1996). Recent Developments in Federal Water Policy: One Step Forward, Two Steps Back. *Canadian Water Resources Journal*, 21(4), 329-340.
- Pearse, P. & Bocking, R. (2002). Putting a Value on Water: Is Full-Cost Pricing the Answer? In *Water and the Future of Life on Earth*. Vancouver: Simon Fraser University.
- Pearse, P., Bertand, F. & MacLaren, J. (1985). *Currents of Change — Final Report: Inquiry on Federal Water Policy*. Ottawa: Inquiry on Federal Water Policy.
- Pearse, P. (2002). Pricing as an Instrument for Water Conservation. In *Water and the Future of Life on Earth*, Workshop and Think Tank, Simon Fraser University, BC, May 2002. [Electronic version]. Retrieved from <http://www.sfu.ca/cstudies/science/water.htm>
- Pederson, W. F. (1993). Protecting the Environment — What Does That Mean? *Loy. L.A. L. Rev* 27, 969.
- PEER (Public Entity EMS Resource) Web site: <http://www.peer-center.net>
- Percy, D. (1988). *The framework of water rights legislation in Canada*. Calgary: Canadian Institute of Resources Law — University of Calgary.
- Phoenix. (1998). Water Conservation Plan. [Electronic version]. Retrieved from <http://phoenix.gov/WATER/waterpln.html>
- Poff, N.L., Allan, D.J. & Bain, M.B. (1997). The natural flow

- regime: a paradigm for river conservation and restoration. *BioScience*, 47, 769-84.
- Poff, N.L., Allan, D.J., Palmer, M.A., Hart, D.D., Richter, B.D., Arthington, A.H., Rogers, K.H., Meyer, J.L. & Stanford, J.A. (2003). River flows and water wars: Emerging science for environmental decision making. *Front Ecol Environ*, 1(6), 298-306.
- Pollution Probe (2004). *The Source Water Protection Primer*. Pollution Probe: 85.
- Postel, S. (1994). A Global Perspective on Water Conservation. In D. Shrubsole & D. Tate (Eds), *Every Drop Counts*. Cambridge, UK: Canadian Water Resources Association.
- Postel, S. (1997). *Last Oasis — Facing Water Scarcity*. New York: Norton and Company.
- Postel, S. (2000). Entering an Era of Water Scarcity: The Challenges Ahead. *Ecological Applications*, 10(4), 941—948.
- Postel, S. & Richter, B. (2003). *Rivers for Life: Managing Water for People and Nature*. Washington DC: Island Press.
- Powell, S. (2003). *Overview of Water Law Reforms Across Canada*. National Symposium on Water Law, Vancouver.
- Powers, Charles W. & Chertow, Marian R. (1997). Industrial Ecology: Overcoming Policy Fragmentation. In Marian R. Chertow & Danieal C. Esty (Eds), *Thinking Ecologically: The Next Generation of Environmental Policy*. New Haven, Connecticut: Yale University Press.
- Praxis Inc. (2001). *Survey of Emerging Issues*. Prepared for Environment Canada.
- PRI (Policy Research Institute). (2004). *Fresh Look at Freshwater*. Ottawa: PRI, 4.
- Proctor, R. (1991). Individual Enforcement of Canada's Environmental Laws: The Weak-Spirited Need Not Try. *Dalhousie Law Journal*, 14, 112.
- Purdie, R.W. (2003). Case Study: The Science and Innovation System of the Murray-Darling Basin. Report prepared for the Science & Innovation Mapping Study, Department of Education, Science and Training. Australian Government. [Electronic version]. Retrieved from http://www.dest.gov.au/mapping/case_studies.htm
- Quebec Water Policy. (2002). *Water, Our Life, Our Future*. [Electronic version]. Retrieved from <http://www.menv.gouv.qc.ca/publications/2002/ENV20020310-A.htm>
- Raffensperger & Tickner, J. (1999). *Protecting public health and the environment: Implementing the precautionary principle*. Washington, DC: Island Press.
- Recycled Water Task Force. (2003). *Final Report: Recommendations of California's Recycled Water Task Force*. [Electronic version]. Retrieved from <http://www.owue.water.ca.gov/recycle/docs/TaskForceReport.htm>
- Regan, Kevin E. (2003). Balancing Public Water Supply and Adverse Environmental Impacts Under Florida Water Law: From Water Wars Towards Adaptive Management. *Journal of Land Use and Environmental Law*, 19(1), 123.
- Renzetti, S. (1999). Municipal Water Supply and Sewage Treatment: Costs, Prices and Distortions. *Canadian Journal of Economics*, 32(2), 688-704.
- Renzetti, S. (2003). Incorporating Demand-Side Information into Water Utility Operations and Planning. In J. Chenoweth & J. Bird, *The Business of Water Supply and Sustainable Development*, Greenleaf Publishing.
- Renzetti, S. & Dupont, D.P. (2002). An Assessment of the Impact of Charging for Provincial Water Use Permits. In S. Renzetti, *The Economics of Industrial Water Use*, Northampton: Edward Elgar.
- Renzetti, S. & Kushner, J. (2004). Full Cost Accounting for Water Supply and Sewage Treatment: Concepts and Case Application. *Canadian Water Resources Journal*, 29(1), 13-22.
- Reuse Coordinating Committee. (2003). Water Reuse for Florida: Strategies for Effective Use of Reclaimed Water. [Electronic version]. Retrieved from http://www.dep.state.fl.us/water/reuse/docs/valued_resource_FinalReport.pdf
- Richter, B.D, Mathews, R., Harrison, D.L. & Wigington, R. (2003). Ecologically sustainable water management: Managing river flows for ecological integrity. *Ecological Applications*, 13(1), 206-224.
- Rijswick, Marlenn Van. (2004). European Water Law in Transition: The Challenge of Integration. In H. Somsen (Ed), *Yearbook of European Environmental Law*, 3.
- Rivera, A. (2004). *Surface and groundwater, a sine qua non for Canada's development*. Canadian Science Writers' Conference — H2O?, Toronto, Canadian Science Writers' Association.
- RMI (Rocky Mountain Institute). (1991). *Water Efficiency: A Resource for Utility Managers, Community Planners, and Other Decision makers*.
- Roach, R., Huynh, V. & Dobson, S. (2004). *Drop by Drop: Urban Water Conservation Practices in Western Canada*. Edmonton: Canada West Foundation.
- Rochette (2002). Stop the Rape of the World: An Ecofeminist Critique of Sustainable Development. *U.N.B.L.J*, 51,149.
- Romano, D. & Leporati, M. (2002). The distributive impact of the water market in Chile: A case study in Limari province, 1981-1997. *Quarterly Journal of International Agriculture*, 41(1), 41-58.
- Rosencranz, Armin. (2002-03). The Origin and Emergence of International Environmental Norms. *Hastings International and Comparative Law Review*, 26,309.
- Ross & Associates Environmental Consulting Ltd. (2002). EMS Integration Project: Final Report. Sponsored by AMSA. (Association of Metropolitan Sewerage Agencies), WEF (Water Environment Federation), and EPA (US Environmental Protection Agency). Retrieved from www.wef.org/pdf/EMSfinalreport.pdf
- Ruhl, J.B. (2003). Equitable Apportionment of Ecosystem Services: New Water Law for a New Water Age. *Journal of Land Use and Environmental Law*, 19(1), 47.
- Ruhl, J.B., Lant, C., Loftas, T., Kraft, S., Adams, J. & Duram, L.

- (2003). Proposal for a Model State Watershed Management Act. *Environmental Law*, 33(4), 929.
- Saleth, M. R. & Dinar, A. (2004). *The Institutional Economics of Water: A Cross-Country Analysis of Institutions and Performance*. Northampton: Edward Elgar & The World Bank.
- Sadler, Robert. (1998). The Australian Experience: Managing a non-metropolitan urban water utility — Paradigm shifting towards a new mindset. *International Journal of Public Sector Management*, 11(7), 598.
- Sampford, Charles. (2002). Environmental Governance for Biodiversity. *Environmental Science and Policy*, 5, 79.
- SAWS (San Antonio Water Services) Season to Save (SOS) Challenge 2004 Web site:
<http://www.saws.org/conservation/seasonstosave/>
- Saunders, O. J. (1988). *Interjurisdictional Issues in Canadian Water Management*. Calgary: The Canadian Institute of Resources Law.
- Saunders, O. J. (1995). Trade Agreements and Environmental Sovereignty: Case Studies from Canada. *Santa Clara Law Review*, 35(4), 1171-1181.
- SCESD (1998). *Enforcing Canada's Pollution Laws: The Public Interest Must Come First*. Ottawa: Parliament Standing Committee — House of Commons.
- Schaefer, K., Exall, K. & Marsalek, J. (2004). Water Reuse and Recycling in Canada: A Status and Needs Assessment. *Canadian Water Resources Journal*, 29(3), 195-208.
- Schindler, D. (2001). The Cumulative Effects of Climate Warming and Other Human Stresses on Canadian Freshwaters in the New Millennium. *Canadian Journal of Fisheries and Aquatic Science*, 58, 18-29.
- Schofield, N., Burt, A. & Connell, D. (2003). *Environmental water allocation: Principles, policies and practices*. Canberra: Land and Water Australia. [Electronic version]. Retrieved from http://www.lwa.gov.au/downloads/publications_pdf/PR03054_1.pdf
- Schumacher, E. F. (1999). *Small is Beautiful: Economics as if People Mattered*. London: Hartley & Marks Publishers Inc.
- Schuyt, K. & Brander, L. (2004). *The Economic Value of the World's Wetlands*. World Wildlife Fund.
- Scientific Panel for Sustainable Forest Practices in Clayquot Sound. (1995). *Sustainable ecosystem management in Clayquot Sound: Planning and practices*. Victoria, British Columbia: Cortex Consultants.
- SFU (Simon Fraser University) BMCP (Burnaby Mountain Community Trust) Web site:
<http://www.university.ca/bmcp/swmexecutivesummary.html>
- Shrubsole, D. (2001). *Virtually Untapped: Water Demand Management in Ontario*. London: Department of Geography, University of Western Ontario.
- Shrubsole, D. & Tate, D. (1994). Paradigms for Water Management in Canada. In D. Shrubsole & D. Tate (Eds), *Every Drop Counts*. Canadian Water Resources Association.
- Song, S. & M'Gonigle, M. (2001). Science, Power, and System Dynamics: The Political Economy of Conservation Biology. *Conservation Biology*, 15(4), 980-989
- Soto, Max Valverde. (1996). General Principles of International Environmental Law. *ILSA Journal of International and Comparative Law*, 3, 193.
- Spangenberg, Joachim H. (2002). Institutional Sustainability Indicators: An Analysis of the Institutions in Agenda 21 and a Draft Set of Indicators for Monitoring their Effectiveness. *Sustainable Development*, 10, 103.
- Spangenberg, Joachim H., Pfahl, S. & Deller, K. (2002). Towards Indicators for Institutional Sustainability: Lessons from an Analysis of Agenda 21. *Ecological Indicators*, 2, 61.
- Sproule-Jones (2003). Personal communication. In Brandes & Maas (2004) 5.
- Statscan (2003). *Human Activity and the Environment — Annual Statistics 2003*. Ottawa: Statistics Canada, 86.
- Stephens, K., Karlsen, E, van der Gulik, T. & Smith, R. (2005). *Water Balance Management in the Okanagan: Now What Do We Do?* CWRA Conference Water — Our Limiting Resource , Kelowna, BC.
- Stoker, G. (1998). Governance as Theory: Five Propositions. *International Social Science Journal*, 155(1), 17-27.
- Sun, J.W. (2000). Dematerialization and Sustainable Development. *Sustainable Development*, 8, 142.
- SWC (Sydney Water Corporation) (2003). *Annual Report 2003*. [Electronic version]. Retrieved from <http://www.sydneywater.com.au>
- SWRCB (California State Water Resources Control Board). (2004). Recycling Web site: www.swrcb.ca.gov/recycling
- Sydney Water. (2004). *Ecologically Sustainable Development Policy Statement*. [Electronic version]. Retrieved from http://www.sydneywater.com.au/html/About_us/esd1.cfm
- Tate, D. (1990). *Water Demand Management in Canada: A State of the Art Review*. Ottawa: Inland Waters Directorate Water Planning and Management Branch — Environment Canada — Social Science Series, 23.
- Tate, D. (1997). Economic Aspects of Sustainable Water Management in Canada. In D. Shrubsole & B. Mitchell, *Practising Sustainable Water Management: Canadian and International Experiences*. Canadian Water Resources Association.
- Taylor, P. (2000-2002). Heads in the Sand as the Tide Rises: Environmental ethics and the Law on Climate Change. *U.C.L.A. Journal of Environmental Law and Policy*, 19, 247.
- Texas WCITF. (2004) Water Conservation Implementation Task Force: Water Conservation Best Management Practices Guide. *Texas Water Development Board Report*, 362. [Electronic version]. Retrieved from <http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf>
- Texas WCITF (2004). Water Conservation Implementation Task Force: Report to the 79th Legislature. *Texas Water Development Board Special Report*. [Electronic version]. Retrieved from http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITF_Leg_Report.pdf
- Thompson, A. (1991). *Water Allocation for the Environment —*

- The Canadian Experience*. Armidale, New England: The Centre for Water Policy Research.
- Thompson, A. (Ed). (1987). Who Controls the Aquatic Resources? Canadian Aquatic Resources. Ottawa: Department of Fisheries and Oceans. *Canadian Bulletin of Fisheries and Aquatic Sciences*, 215:
- Thompson, B. (2000). The Continuing Innovation of Citizen Enforcement. *2000 University of Illinois Law Review*, 185.
- Tingle, B. (1994). The Strange Case of the Crown Prerogative Over Private Prosecutions or Who Killed Public Interest Law Enforcement? *University of British Columbia Law Review*, 28, 309.
- UK Environment Agency. (2004a). *Review of the Water Abstraction Charges Scheme*: Consultation Document. [Electronic version]. Retrieved from <http://www.environment-agency.gov.uk>
- UK Environment Agency. (2004b). *Scheme of Abstraction Charges*. [Electronic version]. Retrieved from <http://www.environment-agency.gov.uk>
- UK Environmental Agency. (2004c). Retrieved September 2004 from. <http://www.environment-agency.gov.uk>
- US Geological Survey (2000). *Ground water in the Great Lakes Basin: The case of south-eastern Wisconsin*, US Geological Survey. [Electronic version]. Retrieved from <http://wi.water.usgs.gov/glpf/>
- USBR (US Bureau of Reclamation) Web site: <http://www.usbr.gov/waterconservation>
- Valiante, M. (2003). The Great Lakes Charter Annex 2001: Legal Dimensions of Provincial Participation. *Journal of Environmental Law and Practice*, 13(1), 47-88.
- Vance, Benjamin R. (1995-1996). Total Aquifer Management: A New Approach to Groundwater Protection. *U.S.F.L.Rev*, 30, 803.
- VanderZwaag, David. (1993). The Concept and Principles of Sustainable Development: "Reformulating" Common Law Doctrines and Environmental Laws. *Windsor Yearbook of Access to Justice*, 39.
- Vickers, A. (2001). *Handbook of Water Use and Conservation*. Amherst, Massachusetts: WaterPlow Press.
- Victoria EPA (Environmental Protection Authority) NEIP (Neighbourhood Environment Improvement Plan) Web site: <http://www.epa.vic.gov.au/Neighbourhood/default.asp>
- Wackernagel, P. & Rees, W. (1996). *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island, BC: New Society Publishers.
- Waller, D.H., & Scott, R.S. (1998). Canadian Municipal Residential Water Conservation Initiatives. *Canadian Water Resources Journal*, 23(4), 369-406.
- Washington State Watershed Management Act. (1997). [Revised Code]. (RCW §90.82.010) .
- WaterBalance Web site: <http://www.waterbalance.ca>
- WaterReuse. (2003). *A Legacy of Recycled Water Legislation: 1990-2003*. WaterReuse Association (California Section). [Electronic version]. Retrieved from <http://www.watereuse.org/Pages/calegacy.pdf>
- WATERGY Web site: http://www.eere.energy.gov/femp/information/download_watergy.cfm
- WaterWiser Web site: <http://www.waterwiser.org>
- WCC (Water Conservation Coalition). (2005) Web site: <http://www.bewatersmart.net/>
- Webb, K. (1991). Taking Matters Into Their Own Hands: The Role of Citizens in Canadian Pollution Control Enforcement. *McGill Law Journal*, 36, 770.
- Webler, T. & Tuler. S. (2001). Public Participation in Watershed Management Planning: Views on Process from People in the Field. *Human Ecology Review*, 8(2), 29.
- WELS (Water Efficiency Labelling and Standards). (2004). Web site: <http://www.deh.gov.au/water/urban/scheme.html>
- WLAP (Water, Land and Air Protection — BC). (2002). *Guide to Using the BC Aquifer Classification Maps — for the Protection and Management of Groundwater*. Victoria: Ministry of Water Land and Air Protection. [Electronic version]. Retrieved from http://wlapwww.gov.bc.ca/wat/aquifers/reports/aquifer_maps.pdf
- Wolf, A.T. (2003). The present and future of transboundary water management. In C.M. Figueres & J.Rockstrom, *Rethinking Water Management: Innovative Approaches to Contemporary Issues*. London: Earthscan.
- Wolff, G. & Gleick, P. (2002). The Soft Path for Water. In P. Gleick et al., *The World's Water 2002-2003: The Biennial Report on Freshwater Resources*. Washington, DC: Island Press.
- Wong, A. (1999). Promoting Conservation with Irvine Ranch Water District's Ascending Block Rate Structure. In L. Owens.-Viani, A. Wong, & P. Gleick, *Sustainable Use of Water California Success Stories*. Oakland: Pacific Institute for Studies in Development, Environment and Security.
- Wood, Stepan. (2002-2003). Environmental Management Systems and Public Authority in Canada: Rethinking Environmental Governance. *Buff. Envtl. L. J.*, 10, 129.
- World Resources Institute (2000). *Pilot Analysis of Global Ecosystems — Freshwater Systems*. Washington, World Resources Institute.
- WSAA (Water Services Association of Australia). (2004). *WSAA Submission to the Commonwealth Productivity Commission: Review of the Regulation Impact Statement National Competition Policy Arrangements*. [Electronic version]. Retrieved from www.pc.gov.au/inquiry/hcp/subs/sub018.pdf
- WSAA (Water Services Association of Australia). Ratings Web site: <https://www.wsaa.asn.au/ratings/ratingsabout.htm>
- Yaggi, Marc A. (2000-2001). Impervious Surfaces in the New York City Watershed. *Fordham Environmental Law Journal*, 12, 489.

POLIS Project on Ecological Governance: An Organization for Transformative Solutions

Created in 2000, The POLIS Project on Ecological Governance, seeks to discover and implement solutions to pressing issues that can build healthy and sustainable communities. Among the many research centres investigating and promoting sustainability world-wide POLIS is unique in its focus on multidisciplinary research and action and in that its work strives to blend academic research with community engagement.

The concept of ecological governance is exciting in that it offers an alternative to extractive, linear and unsustainable systems that continue to level ancient forests, displace indigenous and local communities and clog and choke our global cities. Instead ecological governance asks how we might foster circular systems in which we reduce our demands on distant (and local) ecological systems.

Whether it be through investigating the shift from supply to demand management in our use of minerals or water, re-imagining new forms of urban 'smart growth' such as the eco-innovative university campus, or reforming local land tenures for indigenous and local community, revitalization or overhauling national environmental laws, the thrust of all of our research is guided and informed by the concept of ecological governance.

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