MARBEK
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Analysis of Economic Instruments for Water Conservation

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Disclaimer

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GLOSSARY OF TERMS

Abstraction: The process of removing water from the environment for uses such as irrigation or for treatment to produce drinking water. Water withdrawal is used interchangeably in this report.

Averting behaviour: The averting behaviour approach infers a monetary value for an environmental externality by observing the expenditures individuals are prepared to make in order to avoid any inconvenience.

Diminishing returns: If one factor is increased while the others remain constant, the overall returns will relatively decrease after a certain point. Thus, for example, if prices are continually increased for water use, at some point each additional price increase will reduce water use less than the previous increase did, simply because there are fewer opportunities to achieve water use reductions.

Distributional impact: Incidence of costs and benefits by socio-economic group, stakeholder, or spatially.

Economic instrument (EI): Any economic tool or method used by an organization to achieve general developmental goals in the production of, or in the regulation of, material resources. An economic instrument tries to stimulate an economic actor to voluntarily adopt a certain behaviour. The underlying rationale is that human beings react to price incentives—when prices are high less resources will be consumed.

Environmental sustainability: Meeting the needs of the present without compromising the ability of future generations to meet their needs. Encompasses, e.g. facilitating the renewal of renewable resources, conserving and establishing priorities for the use of non-renewable resources, and keeping environmental impact below the level required to allow affected systems to recover and continue to evolve.

Elasticity: A measure of the responsiveness of one variable to another, usually expressed as a percentage change in demand due to a percentage change in price.

Negative Externalities: Damage that results from the consumption and/or production of a good or service that is not directly reflected in the price charged for the good or service or compensated for in some other, non-price way. Negative environmental externalities usually exist because relatively open access to the environment (air, water, land) means that it can be treated as a free receptacle for the wastes of production and consumption. Reduction in air quality due to vehicle emissions is an example of a negative environmental externality.

Internalization: Incorporation of an externality into the market decision-making process through pricing or regulatory interventions.

Valuation: Techniques for assessing the value of goods and services not priced and traded in markets. Most applications are to natural resources and environmental assets. Valuation process includes identifying affected benefit/cost categories, quantifying significant physical effects, estimating the values of the effects, quantification/pricing issues.

Water conservation/water efficiency: The use of any water conservation measure that results in: 1) a beneficial reduction in water loss, water waste or use; or, 2) accomplishment of a particular function, task or process using the minimum volume of water feasible, as compared to the volume of water delivered (Vickers, 2001; Tate, n.d.). The outcomes of water conservation/water efficiency include: 1) reducing demand; 2) increasing water use productivity; 3) conserving resources to maintain healthy aquatic ecosystems; 4) maintaining or enhancing water quality.

Water conservation measure: Specific tools (technologies) and practices (behaviour changes) that result in more conservative/efficient water use.

Water use productivity: Measuring the amount of water that must be expended to produce one unit of any good or service. In general, the lower the water input requirement per unit, the higher the efficiency. (Tate, n.d.).

EXECUTIVE SUMMARY

ES-1 PURPOSE, SCOPE AND DEFINITIONS

With water management a growing societal concern, much attention is being given to the potential for economic instruments (EIs) to complement traditional water management practices as part of a broader policy approach to resource conservation and protection. The **purpose** of this document is to provide a practical reference that identifies and analyzes a set of economic instruments that potentially could be implemented in Canadian jurisdictions to address water conservation. This document provides three levels of information:

- Background information on how EIs can be applied to water conservation challenges;
- A review and assessment of international and Canadian experiences; and,
- Detailed case studies on how EIs have been used to address specific water conservation challenges.

Each level of information moves the reader from a general understanding of EIs and how they can address water conservation challenges to more focused learning on the detailed implementation of EIs. The report adopts a "lessons learned" approach that provides illustrative examples of what works, doesn't work and how barriers can be overcome. *Water conservation/efficiency* is defined within this Document as a broad term that includes both quality and quantity initiatives.

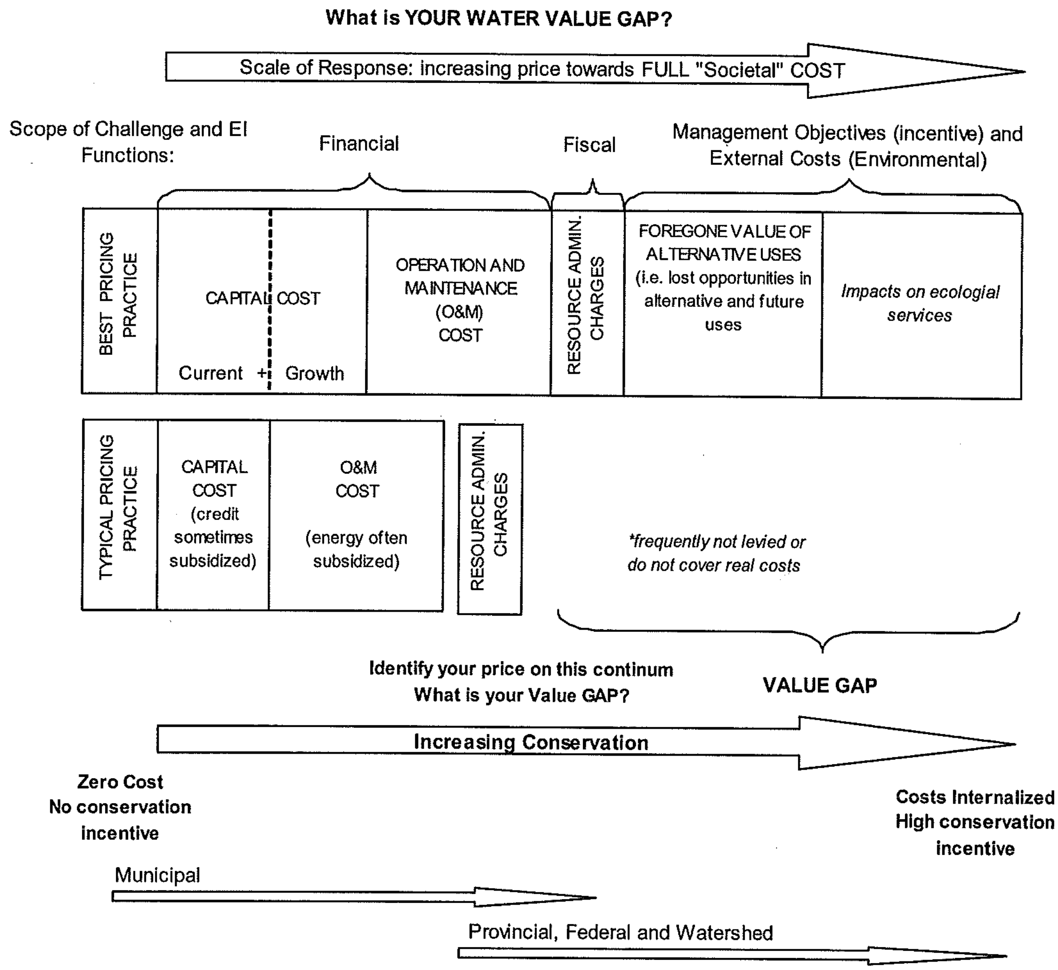
ES-2 OVERVIEW OF EI'S

Section 2 provides information on a filtering process to assist water managers to identify promising EIs for their specific water conservation challenge. This section essentially answers the questions: *How do I choose an EI and what outcomes can be expected*? This section is oriented to allow water managers to become comfortable with when and how EIs can be applied to their water conservation challenge. Interesting summary information from this section includes the following:

Generally, EIs address *water management challenges* by providing four functions (See Figure 1):

- **Financial function,** to both encourage and finance water efficiency and conservation investments
- **Fiscal function,** to increase water resource budgets or recover administrative costs.
- **Incentive function,** to change water user behaviour
- **Environmental Function,** to incent behaviour in a socially desirable direction

Figure ES-1
Thinking About the Scope of Your Problem and the Scale of Your Solution



The scale of a potential response for a given jurisdiction to a challenge (of any scope such as financial, fiscal, incentive or environmental) is illustrated in the context of the *full social value of water*, which is the continuum in ES-1. This continuum runs from a very focused solution based on a narrow definition of "costs" (such as the cost of a capital investment) to a broad based solution that encompasses water use in all its forms within a jurisdiction's authority as well as root causes of water pollution or depletion by users within the jurisdiction's influence. While the first "best practice" row in Figure ES-1 highlights the components of the full value of water, and how water should be correspondingly priced to address the full scope of water management challenges, the lower row highlights typical practices. As can be seen, typical practices price water below even basic infrastructure funding needs and do not extend into the realm of addressing management issues or externalities. The "*value gap*" reflects the gap between current pricing practices and the *full cost* or *societal value of water*. Where this value gap exists -- or a gap in any of the "funding targets" or "cost recovery" areas for that matter -- we cannot expect water prices to reflect its full value and we can therefore not expect responses to pricing signals that are socially optimal. Closing this value gap is the opportunity that EIs provide as well as the challenge that they present. The opportunity is to match the scope of challenges with an adequately scaled response, but this involves increasing the price of water, and that, coming from a region in the world where water is undervalued, will induce institutional as well as political and stakeholder opposition.

Recognizing that addressing this value gap is a first order priority to achieve water conservation leads to two-step process that serves to ultimately guide how EIs can be implemented in Canada:

- **Move prices in the right direction.** We should move pricing towards fully funding investments, as indicated in the *financial* and *fiscal* portion on the best practice line in Figure ES-1. This will generally involve moving the price of water from a low and subsidized level to a higher level reflecting current and future investment outlays.

- **Close the Value Gap.** Move beyond direct and administrative costs of services to signal water's scarcity value, as indicated in the *management objectives* and *external costs* portion of the best practice line in Figure ES-1.

Practically speaking, movement to increase the price of water is likely movement in the right direction,[1] and in fact, given institutional and other limitations, may be the most desirable path forward for water managers contemplating the usefulness of EIs.

ES-2.1 Identifying the EI Options

To promote water conservation, a broad range of EIs have been contemplated or implemented. Some focus on incentives to reduce the capital costs of water efficient technologies, such as a tax credits or subsidies. Some policies create *dis*incentives for *water use*, by pricing water through either price increases or by creating scarcity with caps in tradable permit systems. Although economists typically argue that increasing the price of water provides the most efficient incentive to achieve water conservation objectives, experience suggests that other forces are at play. Indeed, it is clear that barriers, such as political acceptance and a lack of experience, exist and impede implementation of EIs that signal the value of water and promote conservation. In Table ES-1, a number of EIs are identified. This table can be used to identify promising EIs that typically are used to address a particular water conservation challenge.

Experience suggests that EIs should complement existing administrative mechanisms, and indeed should be designed within current water management systems. (See Table ES-2).

[1] Note that in cases of municipal prices, the presence of cross-subsidization means that reforming prices might require decreased prices for some users and increases for others.

Table ES-1
Examples of EIs by Function

Function	EI Name*	Advantages	Disadvantages
Financial Function	Water prices or sewer charges (i.e. water or sewer service rates)	Follows user-pay approach, and can be used to achieve a secondary incentive function. Existing pricing can be used as the basis to move towards user-pay (full system cost) and increasing rates of conservation.	Low rates can have a minimal impact on conservation and can lead to waste of water. A progressive pricing structure that charges more for more use may incent conservation, thus diminishing the primary financial function.
	Financial Subsidies Provide positive incentives ⇒ Remove disincentive ⇒	Can be used to increase uptake of certain technologies that promote conservation. Removing adverse subsidies can promote the fiscal function while also encouraging an incentive function.	Fiscal outlays required to fund subsidy, thus adverse fiscal function. Opposition to removing subsidies, especially for important regional industries.
Fiscal Function	Subsides for capital investments Capital cost allowance or direct subsidy for water efficient technologies	Induce water efficient investments using the existing tax system, even at low subsidy rates. Also provides an incentive function.	Funds likely not earmarked to reinforce administrative capacity. Weak incentive function.
Incentive Function	Water abstraction[2] fees Takings charge linked to a permit	Adjustment of price signal to reflect actual resource cost; encourage conservation, technology and flexibility.	Low price changes can have a minimal impact unless water has a very low value to start (price of water is very low).
	Pollution charges A fee on pollutant loading	Introduces polluter-pays principle; moves towards management objectives, enables flexibility to achieve objectives.	Difficult to set the right fee. Can over charge leading to no efficient outcomes i.e. more response that is required) Low charge levels are more of a fiscal function than incentive.
	Tradable permits Permitted allocations become tradable Effluent targets or "caps" become tradable	Very effective when scarcity and water allocations conflicts exists. Provides inter-industry transfers (i.e. buy and sale permits) instead of tax payments to government. Free allocations can ensure small-scale users have access based on historical water use.	New administrative/legislative structures required; administrative and transaction costs can be high (to effect trade and make trades) Limited experience can lead to poorly designed programs that are ineffective and may ultimately be more costly or less effective than a regulatory approach.
Environmental Function	Damage assessment Assess and recover damages from spills or on-going discharges.	Can provide a strong deterrent to avoid the liability associated with funding environmental remediation and ecosystem recovery.	Requires legislative basis and expertise to value remediation and ecosystem recovery. Usually implemented with an enforcement action.

[2] The process of removing water from the environment for human use, including agricultural, municipal and industrial uses for example.

Table ES-2
Complementing Existing Mechanisms with EIs

Jurisdiction	Issue/ Problem	Scale of desired solution	Mechanism Available	EI Options	Potential Issues and Example of Application
Federal or Provincial	Undervalued water resources resulting in inefficient water use and/ or excess pollution	Broad or focused	• Pricing (as Incentive or Disincentive) • Rebates • Grants	• Tax incentive, e.g. capital cost allowance for water efficient equipment • Rebate, e.g. on high efficiency product purchases • Grants program for best practices, e.g. nutrient plans • Incentives for water re-use/ grey water technologies	• Administrative issues to establish and sustain; broker may be required for trading • Manitoba's Riparian Areas Tax Credit designed to encourage farm operators to upgrade their management of lakeshores and river and stream banks. • Netherlands Water Abstraction Tax acts as an incentive to reduce groundwater abstraction. • Québec's Politique nationale de l'eau is planning a water abstraction fee for all users.
Province	Water withdrawals exceed estimated quantity available (e.g. drought conditions)	Broad scale to capture full cost and reflect value of water (internalize external costs)	• Water Taking Permit	• Quantity limits through cap and trade permit system • Price of permit renewals raised to include earmarked funds for watershed management initiatives and education	• Administrative issues to establish and sustain; broker required for trading system • *Alberta Water for Life (planned)* • United States' California and North Colorado water markets to allow use and economic efficiency for water.
Province/ watershed	Excess nutrient load to watercourse	Broad approach to limit nutrients from all sources (source and non-point)	• Effluent Permits / licenses • Effluent Charges • Effluent/ nutrient trading	• Limit total nutrient load and allow trading among all sources • Mechanism in cap and permit system to reduce nutrients over time	• Scientific and administrative issues associated with quantification and verification • South Nation River Conservation Authority's phosphorus trading system to control phosphorus loading of watershed receiving waters. • Bay of Quinte's pilot trading scheme for phosphorus discharges
Province	Excess nutrient load to watercourse	Focused on point source discharges (industry and/or municipal)	• Effluent Permits / licenses	• Permit fee based on concentration or loading from point sources; high enough to encourage capital investments to improve treatment	• Political acceptability of fee • Low flexibility for point source owners; low technical feasibility/ high cost of treatment solutions for some sources
Municipality	Water use exceeding infrastructure	Broad approach to increase perceived value	• Water rate/ Sewer rate • Development	• Utility pricing to include full cost • Increase water rate • Development charges to	• Waterloo ON Toilet Replacement Program offers rebates for low flow toilets and dual flush systems.

Jurisdiction	Issue/ Problem	Scale of desired solution	Mechanism Available	EI Options	Potential Issues and Example of Application
	(plant) capacity, limited water supply, high peak water use	of water, to internalize costs and reduce use, to increase infrastructure capacity	charges • Rebates • Storm water utility approach • Integration of water issues (rain, grey, potable)	encourage use of existing infrastructure • Rebates on efficient water fixtures	• Victoria BC's rebates for water efficient irrigation systems and toilets and showerheads. • Toronto, ON integrates the management of water resources to include the management of streams and ditches in a watershed approach.

ES-4 EIS IN PRACTICE: JURISDICTIONAL EXPERIENCES

Section 3 provides detail on how EIs have been implemented nationally and internationally, and what lessons and observations can be drawn. This section is not technical, and draws parallels between water challenges, implementing jurisdictions, EIs implemented and lessons learned. Based on the literature review, a number of summary observations can be made:

- EIs are rarely implemented in isolation and indeed work best when they complement other approaches, such as information and communications measures for example;
- Communicating program goals and objectives to the public complements the effectiveness of EIs;
- Water pricing must be high enough to promote conservation behaviour and increase over time to account for decreasing sensitivity to a single price increase; and,
- Pollution charges need to reflect the type and impact of pollution released into the environment and the sensitivity of the receiving environment.

Lessons learned from the Canadian provincial case studies include:

- Time for public consultations is easily underestimated;
- There is often a perceived inequity when one industry is initially targeted as a first step in implementing EIs. This ultimately slows the EI implementation leading to the conclusion that a broad-based application of EIs is both more acceptable and expedient;
- Public perception of the value and abundance of water is a significant barrier. This can be alleviated somewhat by the use of identifiable water revenue funds.
- A regulatory foundation is very important for the successful implementation of EIs.
- Some provinces have fragmented regulatory systems and may not be able to implement EIs directly but instead need to work through existing regulations or codes with multiple partners.
- Fully metered systems provide good opportunities since users are accustomed to paying for water.

ES-5 USING VALUATION IN DECISION-MAKING

Section 4 presents four cases on the application of EIs and water valuation techniques. This section is more technical and provides some economic concepts and theories around EI implementation. In the first case, a municipal council must decide how to allocate its capital spending for a given year. Like most cities in Canada, there are more proposed projects than available funds. One project would identify and repair leaks in the water supply infrastructure thereby increasing the reliability of the city's water system. The challenge for the city council is to measure the value of this increase in reliability and compare it to the values of the benefits from other capital projects. In the second case, a provincial Environment Ministry must consider an application from a water bottler to withdraw water from an aquifer. The aquifer is already the primary source of water for local agricultural operations. The provincial legislation states that the Ministry must allocate water to maximize the value to the people of the province while respecting existing water uses. The challenge for the provincial Ministry is to measure and compare the value of the water withdrawn from the aquifer in its alternative applications before making a decision regarding the water bottler's application.

These cases have two things in common. First, they are concerned with different aspects of water resources management. Second, they both require a government agency to measure the value of water and use that information to make a decision. The first of these features is one with which Canadian governments at all levels have a significant amount of expertise and experience. On the other hand, the second of these features is one with which Canadian governments have relatively little expertise and experience. This observation is important because it means that government agencies will likely need to develop the institutional capacity to carry out these types of valuation exercises and incorporate them into their decision-making. That said, it is worth noting:

It is only worthwhile to estimate the value of water if that information is going to be used in the management and planning of water resources

This may seem like a blinding flash of the obvious but it is important to see that there is relatively little point in using scarce government resources to estimate the value of water unless that information is actually going to be used to support a decision-making process.

It can also be concluded that our ability to estimate the value of water has advanced substantially in recent years. Analytic techniques have become more sophisticated, experience has been gained through applying these methods in a wide variety of circumstances and comparison between models' predictions and consumers' observed behaviour have confirmed the models' validity. As a result, it is reasonable to conclude:

The theoretical properties of non-market valuation models are well understood. Furthermore, there is enough real world experience with estimating the value of water for Canadian water managers to feel confident in augmenting their watershed and water resources management regimes with an increased reliance on water valuation information. This is not to say that valuation is easy, but rather that it is technically feasible and does provide an opportunity to improve decision-making.

ES-6 LESSONS LEARNED: SUMMARY

While a number of observations and lessons learned were identified in this report, a number resonate as more important and are highlighted below. Specifically, we identify what works, doesn't work and provide some insight to overcoming barriers to EI implementation.

ES-6.1 What Works

1. Prices that reflect costs

Developing accounting and pricing rules that reflect the full-cost of water supply and sewage treatment is the single most important thing that municipal and regional governments could do to promote efficient water use. A precondition for this effort is the presence of universal water metering and having in place the management and accounting systems to accurately document water and sewage agencies' capital, operating and external costs. Provincial governments should fully consider Ontario's practice of putting in place the legislative requirements for full-cost accounting and pricing. If there is no metering (precondition), then it becomes difficult to apply economic incentives in any practical way.

2. Decentralized decision-making

Much of the innovation in water resources management has come from local and regional agencies responsible for water management. A good example of this is the phosphorous trading program developed by the South Nation Conservation Authority. These agencies perform best when their innovations and information sharing is encouraged and supported by federal and provincial governments. Furthermore, water-users who are fully informed of the costs and benefits of their water-using activities *are* in the best position to determine efficient water use levels and practices *not government decision makers*. Government simply provides the rules of the game or the framework in which the EIs are implemented, recognizing aspects of good governance including transparency, equity, and efficiency and being consistent with established policy.

Perhaps the most important implication of this perspective is that provincial governments need to adjust their approach to water taking permits/licenses and move towards a system where allocations are routinely updated to reflect use *and* conservation objectives. To make this transition, the evidence from around the world suggests that a cap and trade system of water use permits/licenses is superior to the continued use of nontradable water permits/licenses. Under these schemes, allocations are set based on historical use recognizing *all* established users and then the cap is lowered over time to reflect conservation objectives – this is often done within the existing permitting/licensing system and not through auctioning the permits to the highest bidder. Then, each allocation holder becomes a decision-maker who responds to the reduced allocation by either: reducing use to achieve the target; over complying and selling the excess allocations to others; or doing nothing and buying allocations from those who have reduced use. Within this context, it is the governments' obligation to set the rules of the game and monitor outcomes to ensure that environmental, equity and economic efficiency objectives, for example, are met.

A number of provincial governments have demonstrated a significant amount of interest in reforming or introducing fees of varying complexity for these permits/licenses while retaining control over the issuance of permits/licenses. While this is a solid step in the right direction, the provinces should also consider introducing allocation schemes that enable trading (see Horbulyk and Lo, 1998 for an example). One conservative approach is to develop experimental case studies in water-short regions to gain experience with them. However, trading may not be an issue in some provinces, such as Newfoundland and Labrador, where multiple-use is relatively rare. in that case, having a system of trading regulations may not be necessary because it will be rarely used.

3. Integration and co-ordination

There are two features that will reinforce the effectiveness of introducing EIs (particularly prices and charges) into water management in Canada. The first is integrating scientific knowledge regarding water quality and water scarcity with accounting and economic models of the costs of water and sewage agency operations. This will promote truly full-cost pricing by reflecting the social costs of water pollution, foregone recreational opportunities and even human health damages into water and sewage prices. Because research in this area is still being developed and because the development of new analytic measurement methods would benefit all Canadians, this is an ideal area for increased federal government support.

The second feature is coordinating the introduction of EIs with other measures to promote awareness of water scarcity and conservation. Experience from other jurisdictions-especially California- strongly suggests that EIs are more effective when combined with educational and advertising efforts. Thus instrument "packaging" should become imbedded in water management and conservation programs.

4. Close the Value Gap

Closing this value gap, or the gap between actual water prices and the full societal cost of water use, is the opportunity that EIs provide as well as the challenge that they present. Practically speaking, this implies that movement to *increase the price of water is likely movement in the right direction,*[3] and in fact, given institutional and other limitations, may be the most desirable path forward for water managers contemplating EIs. This lesson is an important one, since "moving in the right direction", which involves increasing the price of water, can result in expected and unanticipated outcomes (such as promoting water-conserving technological innovations).

We also observe that when the value gap is large, small changes in the price of water will likely result in significant demand responses. It can also be expected that the demand response will decrease as we approach the full societal cost of water. This notion of diminishing returns or diminishing responses to increasing water prices results because behaviour has already been altered and with each successive price increase there are fewer opportunities to reduce use. Closely allied is the "fatigue" effect where users become desensitized to price increases and therefore additional price changes are required to further stimulate conservation over time.

ES-6.2 What Doesn't Work

1. Complexity

For many agencies, the types of reforms discussed in this report are novel and represent a shift from current administrative functions. Because of this, it is suggested that the form of EIs be kept as simple as possible. This will facilitate developing methods to forecast the impacts of the EIs and lessen the chances for water users to see inequities and unequal treatment of users arising. A specific example of this approach is the following: a number of municipal councils have recently adopted multi-part, increasing block rate water price structures which are designed to promote conservation. It is very difficult to anticipate the impacts of these price structures. An alternative is to retain a simple constant price structure but adopt a summer surcharge to reflect higher supply costs and greater water scarcity.

2. Conservation for the sake of conservation

If prices, fees and charges do not reflect full measured opportunity costs of water use, then the public may perceive these measures as revenue-generating devices being disguised as environmental policy measures. Thus, when prices are raised or charges are introduced to "encourage conservation" there must be a sound case that these prices and charges really do reflect the costs of water use rather than fiscal instruments being introduced to simply reduce

[3] Note that in cases of municipal prices, the presence of cross-subsidization means that reforming prices might require decreased prices for some users and increases for others. This is especially true if move towards marginal-cost pricing

water use. As pricing moves along the water-pricing continuum (see Figure ES-1) the case made for water conservation relies increasingly on lost opportunity costs, costs of depletion of the resource and thus relies increasingly on the underlying values of the pricing agencies and their perceptions of the value and scarcity of water.

ES-6.3 Overcoming Barriers

1. Preparation of EI Programs

The U.S. Environmental Protection Agency (EPA) is arguably the world's largest and most sophisticated environmental regulator in the world. Nonetheless, when it introduced its highly successful sulfur dioxide trading system (Rico, 1995), it was almost incapable of managing the information needs of the program. An important lesson from this is that when Canadian water agencies are considering the adoption or increased reliance on EIs or water valuation they must first examine their administrative capacities and ask whether they are up to the task. Instructional limitations and the context in which EIs are implemented can be a significant barrier to the effectiveness of EIs.

2. Transparency

Engaging the public in all aspects of the decision-making regarding the adoption of EIs provides many benefits. As recent experience ranging from conservation authorities, Ontario's Remedial Action Program and the Lake Ontario-St. Lawrence Study Board of the International Joint Commission (IJC) indicates, including the public provides additional sources of experience and knowledge and often adds legitimacy to water agency proposals. As well, public perceptions about water abundance and resistance to perceived tax "grabs" are significant barriers to implementation, and consultation and communication is therefore an absolute necessity to ensure EIs are successful.

3. Inequitable Application

A major lesson from the provincial case studies is that EI programs need to be equitably applied. A narrow focus or application has significantly slowed the development and implementation of new EIs. Thus, water managers should adopt a broad-based approach to EI design from the outset.

Table of Contents

1. PURPOSE, SCOPE AND DEFINITIONS

1.1 PURPOSE OF THIS DOCUMENT

With water management a growing societal concern, much attention is being given to the potential for economic instruments (EIs) to complement traditional water management practices as part of a broader policy approach to resource conservation and protection. We note that the concept of including EIs as part of a broad approach is not new, as both the MacDonald and Pearse Royal Commissions in the 1980's urged the use of EIs for water conservation. Many Canadian jurisdictions are moving in this direction, as evidenced, for example, by Ontario's commitment to full cost accounting in the *Sustainable Water and Sewage Systems Act,* Alberta's *Water for Life Strategy,* the phosphorous trading system in the South Nation River Watershed, and water conservation programs in leading municipalities. The **purpose** of this document is to provide a practical reference that identifies and analyzes a set of economic instruments that potentially could be implemented in Canadian jurisdictions to address water conservation.

One of the challenges of developing a very practical reference for Canadian jurisdictions pertains to the wide range of relative water scarcity, public awareness and degree of institutional capacity across the country. Indeed, it is a challenge to develop guidance that is relevant and informative for a broad audience that includes municipalities and watershed authorities, provinces and the federal government. In this regard, we have developed a document that provides three levels of information:

- Background information on how EIs can be applied to water conservation challenges;
- A review and assessment of international and Canadian experiences; and,
- Detailed case studies on how EIs have been used to address specific water conservation challenges.

Each level of information presented in this report is designed to move the reader from a general understanding of EIs and how they can address water conservation challenges to more focused learning on the detailed implementation of EIs. For example, the last chapter explains how valuation can aid in sending signals to water users that water is valuable and conservation decisions should be made.

1.2 AUDIENCE AND SCOPE

Audience

The audience for this document does not need an in-depth understanding of economics. Indeed, we adopt a "lessons learned" approach that provides illustrative examples of what works, doesn't work and how barriers can be overcome. The document identifies and analyzes a set of EIs that potentially could be implemented by Canadian jurisdictions, including municipalities, watershed authorities, provincial or territorial governments, and the federal government. Thus, this document is tailored to a wide audience of water managers and interested stakeholders.

Scope

We define the scope of EIs by not just dealing with issues directly related to potable water exclusively. Jurisdictions implementing broad-based solutions to water challenges have gradually widened the scope of their programs to include all components of the water cycle. In these broad approaches, water is a resource, whether it is potable water, sewage, rainwater, groundwater, or surface water. With this broad approach, water conservation potential exists through multiple aspects of the resource, including measures addressing water services, infrastructure design and land use, and water withdrawal and access.

Water conservation is therefore defined within this Document as a broad term that includes both quality and quantity initiatives. That is, we review potential EIs that can be used to address water quantity challenges as well as water quality and resource protection challenges. Consistent with the guidance of the CCME Water Conservation and Economics Task Group, water conservation in this report is further defined as: The use of any water conservation measure that results in: 1) a beneficial reduction in water loss, water waste or use; or, 2) accomplishment of a particular function, task or process using the minimum volume of water feasible, as compared to the volume of water delivered (Vickers, 2001; Tate, n.d.). The outcomes of water conservation/water efficiency include: 1) reducing demand; 2) increasing water use productivity; 3) conserving resources to maintain healthy aquatic ecosystems; 4) maintaining or enhancing water quality.

1.3 HOW TO USE THIS DOCUMENT

Including this introductory section, this document has four sections:

- *Section 2* provides information on a filtering process to assist water managers to identify promising EIs for their specific water conservation challenge. This section essentially answers the questions: *How do I choose an EI and what outcomes can be expected*? This section is oriented to allow water managers to become comfortable with when and how EIs can be applied to their water conservation challenge;

- *Section 3* provides detail on how EIs have been implemented nationally and internationally, and what lessons and observations can be drawn. This section is not technical, and draws parallels between water challenges, implementing jurisdictions, EIs implemented and lessons learned;

- *Section 4* presents four cases on the application of EIs and water valuation techniques. This section is more technical and provides some economic concepts and theories around EI implementation.

The Document is designed to start with basic concepts familiar to water managers and then to become increasingly technical and focused on EI design, challenges and barriers and predicting outcomes. The document is meant to be a catalyst or starting point rather than an exhaustive study. The introduction of EIs will, in many cases, represent a significant change in policy orientation and, therefore, require careful planning, public consultation and research. This document is meant to facilitate this process.

Appendices also provide additional material:

- Appendix A – Provincial Case Study Results
- Appendix B – Water Valuation Techniques
- Appendix C – Methodology for Conducting Research for this Document
- Appendix D – Database Survey Jurisdictions.

2. OVERVIEW OF EIS

2.1 DID YOU BRING YOUR WATER CONSERVATION PROBLEM WITH YOU?

We start the discussion with our end point: What are we trying to achieve with EIs? As the title of the Document implies, we are investigating the application of EIs to promote water conservation -- But water conservation to what end and to what degree? Conservation "to what end?" is about the scope of your water management challenge whereas "to what degree?" is linked to the scale of the conservation response you seek. Understanding the scope and scale of the conservation challenge is a first step when investigating the applicability of EIs. Scope and scale are discussed below.

2.1.1 Scope of the Water Management Challenge

Generally, we can characterize the *scope of your water management challenge* four ways, namely (See Figure 1):

- **Financial,** where scarce financial resources limit your ability to make, or encourage, water conservation investments for:

Operational changes (both treatment and process management water);
Infrastructure upgrades (current, replacement, and planning for growth);
Changes in practices (such as cropping practices or industrial water reuse technologies or reducing perverse subsidies that promote excessive water use); and,
Information programs (for example, to increase the perceived value of water).

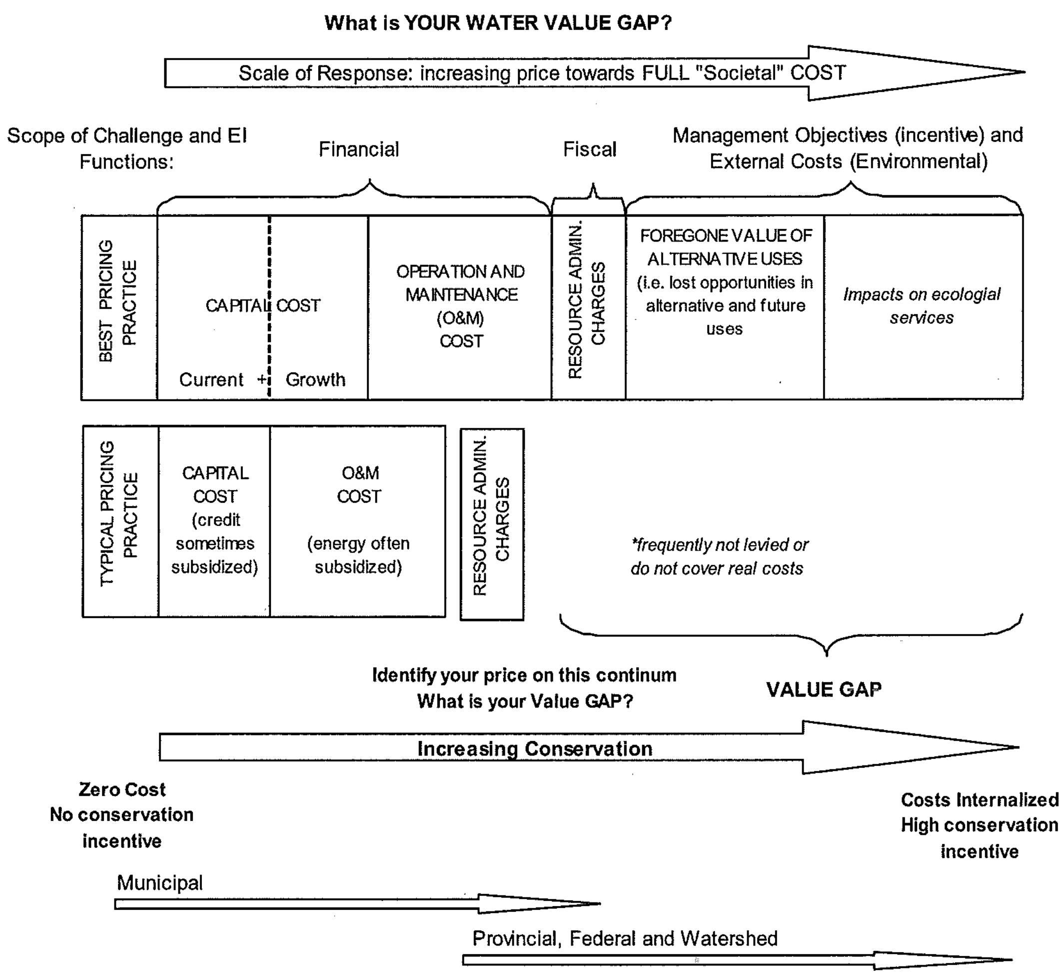
Thus, EIs often provide a **financial function** to both encourage and finance water efficiency and conservation investments.

- **Fiscal,** where institutional budget limitations or cost recovery requirements exist and water-related revenues do not recover these costs. EIs can be used to recover costs or to fund programs. Thus, EIs provide a **fiscal function** to increase water resource budgets or recover administrative costs.

- **Incentive,** where there is a need to achieve management objectives that address water conservation challenges related to water infrastructure capacity, water scarcity, allocation decision-making, source protection or pollutant control. EIs can be used to provide an incentive to conserve. Thus, EIs provide an **incentive (or "decision-making") function** to change water user behaviour to meet water management objectives and *avoid* undesirable outcomes such as additional infrastructure expenditures, water allocation requests, pollutant loading, or other adverse outcomes.

- **Environmental,** where water users have been free from experiencing the social, economic and/or environmental costs that they generate on external parties and/or the ecosystem but from which they experience benefit. Thus, EIs provide an **environmental function** to incent behaviour in a socially desirable direction so that external costs are reduced or external costs are brought into the costs of the resource use or resource access. Cost internalization[4] can also include a liability function to assess, fund actions for recovery and prevent environmental damages.

Figure 2
Thinking About the Scope of Your Problem and the Scale of Your Solution



Of course, these EI functions are not mutually exclusive. For example, the Dutch levy on surface water discharge (pollution charge) was originally designed to satisfy a financial function, but resulted in a strong pollution control response that achieved management objectives through the adoption of pollution prevention measures (such as self-funded treatment plants at large point sources). Thus, the EI also fulfilled an incentive function. Conversely, instruments designed to fulfill an incentive function, such as taxes or fees, will raise revenues. This lesson is an important one, since we observe that "moving in the right direction", which involves increasing the price of water, can result in expected and unanticipated outcomes (such as promoting water-conserving technological innovations). In the Dutch example, the unanticipated outcomes were positive in that the EI met more challenges (i.e. served more functions) than originally anticipated.

[4] Incorporation of an externality into the market decision-making process through pricing or regulatory interventions.

2.1.2 Scale of the Water Management Response and the Solution

Generally, we can characterize the *scale of your response* to a water management challenge in terms of the breath of the solution you desire. In Figure 1 above, the scale of your potential response to a challenge (of any scope such as financial, fiscal, incentive or environmental) is illustrated in the context of the *full social value of water*, which can be thought of as a continuum. This continuum runs from a very focused solution based on a narrow definition of "costs" (such as the cost of a capital investment) to a broad based solution that encompasses water use in all its forms within a jurisdiction's authority as well as root causes of water pollution or depletion by users within the jurisdiction's influence. This full scale of water's social value includes conventional costs such as capital and operating costs, as well as social opportunity costs and external environmental costs.

> **Scale - An Example of Water Pollution**
>
> In a focused solution by a province, water pollution might be addressed by targeting EIs at large industrial emitters.
>
> A broad scale solution may include all aspects of water use and multiple sectors and uses, with a suite of EIs and complementary measures, such as education and information, designed to improve water use efficiency, reduce water consumption and discharge and encourage wastewater treatment.

While the first "best practice" column in Figure 1 highlights the components of the full value of water, and how water should be correspondingly priced to address the full scope of water management challenges, the lower row highlights typical practices. As can be seen, typical practices price water below even basic infrastructure funding needs and do not extend into the realm of addressing management issues or externalities. We coin the difference between the best practice and the typical practice as the "*value gap*". That is, current pricing practices typically don't even "get the prices right" to reflect basic infrastructure costs let alone reflect the *full cost* or *societal value of water*. Where this value gap exists -- or a gap in any of the "funding targets" or "cost recovery" areas for that matter -- we can't expect water prices to reflect its full value and we can't therefore expect responses to pricing signals that are socially optimal. By "optimal" we simply mean the most efficient use of the resource where the full societal costs of use are balanced with the benefits of water use.

> We coin the difference between the best practice and the typical practice as the "*value gap*".

In principle, the concept of full cost accounting (and, by extension, full cost pricing) is fairly straightforward. The accounting of the costs for water supply (and sewage treatment) agencies should be comprehensive enough so that each consumer of water is confronted with a price that fully reflects all of the costs to society of that consumer's use of the water. These costs include not only the opportunity costs of purchased inputs (capital, labour, energy and materials) but also the opportunity cost of unpurchased inputs such as raw water supplies and any changes to water quality resulting from water use.

One implication of adopting this approach to cost accounting and pricing is that the cost of supplying different types of water could differ and that these cost differences should be reflected in prices. Different types of water could refer to surface water vs. groundwater or brackish vs. freshwater.

2.1.3 A Path Forward: Close the Value Gap

Recognizing that addressing this value gap is a first order priority to achieve water conservation leads to a two-step process that serves to ultimately guide how EIs can be implemented in your jurisdiction:

- **Move prices in the right direction.** As a society we can supply and treat water cheaply -- we treat it with chemicals and we pump it to customers or back to the environment. At the least, therefore, we should move pricing towards capturing the funding investments portion on the best practice line in Figure 1. This will generally involve moving the price of water from a low and subsidized level to a higher level reflecting current and future outlays. On the best practice row in Figure 1, this implies valuing water at a rate that encourages investments in water efficiency technologies and practices for example (in the financial and fiscal ranges). This will signal to users (water intake and pollutant discharge) that water will increasingly become a cost centre that must be managed like any other costly production input. Longer-term behavioural shifts may then start to occur. Once this first step is implemented, movement toward closing the water value gap can be made;

- **Close the Value Gap.** Move beyond direct and administrative costs of services to signal water's scarcity value. Movement in this direction, as the Dutch Levy example above illustrates, will change behaviour to reflect value in alternative uses (i.e. allocating to high value use) and movement towards achieving water management objectives, such as decreased pollutant loading or reducing water conflicts. While economic literature says that the full costs of water should be implemented (i.e. the direct and administrative costs plus value in Figure 1) in practice this is a goal that may not be attainable in the near-term (for reasons we will explore below). Thus, movement towards closing the gap may reduce undesirable outcomes but will not be socially optimal from an economic theory perspective. We observe this trade-off is acceptable in the shorter term given the current size of the water value gap in Canada.

Closing this value gap is the opportunity that EIs provide as well as the challenge that they present. The opportunity is to match the scope of challenges with an adequately scaled response, but this involves increasing the price of water, and that, coming from a region in the world where water is undervalued, will pose institutional as well as political and stakeholder opposition. Thus, we refer back to our path forward for EI implementation in Canada: Closing the water value gap.

Practically speaking, we are advocating that movement to increase the price of water is likely movement in the right direction,[5] and in fact, given institutional and other limitations, may be the most desirable path forward for water managers contemplating the usefulness of EIs. We also observe that when the value gap is large, small changes in the price of water will likely result in significant demand responses. It can also be

[5] Note that in cases of municipal prices, the presence of cross-subsidization means that reforming prices might require decreased prices for some users and increases for others. This is especially true if move towards marginal-cost pricing

expected that the demand response will decrease as we move towards the right of the full societal cost continuum. This notion of diminishing returns or diminishing responses to increasing water prices results because behaviour has already been altered and with each successive price increase there are fewer opportunities to reduce use. Closely allied is the "fatigue" effect where users become desensitized to price increases and therefore additional price changes are required to further stimulate conservation.

While the rest of this Document provides some very interesting insights and examples of how EIs have been used and can be used in the Canadian context, it is perhaps the previous discussion that is the most important lesson. With this basic lesson learned, we are better equipped to understand how EIs can be designed and implemented to promote water conservation. On the path to identify EIs that are appropriate to apply to your challenge, experience has shown that who you are, from a jurisdictional perspective, determines the types of EIs that can be implemented.

2.2 WHO YOU ARE HELPS TO DEFINE THE APPLICABLE EI

As a next step in exploring the potential to implement EIs, you need to identify who you are. This is not just a metaphysical question, but rather an important question that places you squarely in EI experience and practice. Indeed, we observe that a first step in assessing EIs is not to identify an EI that could help address a problem, but to work through a series of steps, or filters to ultimately identify the EI that best suits your particular water management challenge. Think of this as a screening process to investigate the range of EIs that could be deployed against your challenge or problem.

In Table 2.1, we start this screening process. In the table, four levels of governance are identified that would likely contemplate water conservation EIs. For each level, the typical scope of challenge is mapped to the corresponding EI function. The role played by the function at addressing the challenge is also identified as either: primary, secondary or possible. Two examples will help illustrate the table: a municipality planning for growth could use an EI whose primary function is financial (to raise revenue for new infrastructure) but could also provide a secondary incentive function so that conservation practices would reduce water demand and costly infrastructure expansion. Similarly, a province facing water allocation challenges may want a strong incentive function to reduce demand (a primary role) but also desire to strengthen its administrative capacity to promote conservation and protect the environment. In this case, the EI selected should also serve a fiscal function as a secondary role.

Table 2.1
Levels of Governance, Challenges and EI Functions

Who Are You?	Scope: What challenge do you want to address?		EI Functions and their roles	
Municipality/ Water Utility	Technical	• Water purification/ wastewater treatment plant too small • Insufficient system storage • Lack of metering • Water loss • Plant cannot treat to standard • Collection system leaks • Storm water system inadequate • Funding for research, data collection and analysis	Financial ⇒ Incentive ⇒ Fiscal ⇒	Primary role Secondary role Possible role
	Financial	• Expenditures exceed revenues for services • Escalating costs (deteriorating infrastructure; capital expansion needed; growth in demand or service areas)	Financial ⇒ Incentive ⇒ Fiscal ⇒	Primary role Secondary role Possible role Possible role
	Social	• Affordability to those with low/fixed incomes	Fiscal ⇒	Secondary role
	Environmental	• Depletion of water source • Loss of surface base flow • Greenhouse gas emission reduction goals • Pollution release resulting in degradation • Funding for research	Incentive ⇒ Fiscal ⇒	Primary role Secondary role
Watershed Authority	Environmental	• Multiple users and land uses contributing to water quality issue • Depletion of water source • Water use conflicts • Degradation of water • Minimum flows and aquifer depletion	Incentive ⇒ Fiscal ⇒	Primary role Secondary role
Province/ Territory	Technical	• Long term standing leases and special statues for single purpose use • Inefficient agricultural practices • Industry technology inadequate to meet standards for effluent • Encourage innovation • Funding for research	Incentive ⇒ Fiscal ⇒	Primary role Secondary role
	Financial	• Administrative funds and central incentive programs and infrastructure • Lack of enabling legislation for EIs • Lack of incorporating EIs in long term standing leases and special statues for single purpose use	Fiscal ⇒	Primary role
	Social	• Social cost of water use (or effluent disposal) not captured in the price of water	Internalization⇒ Incentive ⇒ Fiscal ⇒	Primary role Secondary role Possible role
	Environmental	• Water use conflicts • Degradation of water • Minimum flows • Aquifer depletion • Instream flow needs • Reporting and collection of water use data • Funding for research	Incentive ⇒ Internalization⇒ Fiscal ⇒	Primary role Secondary role Possible role

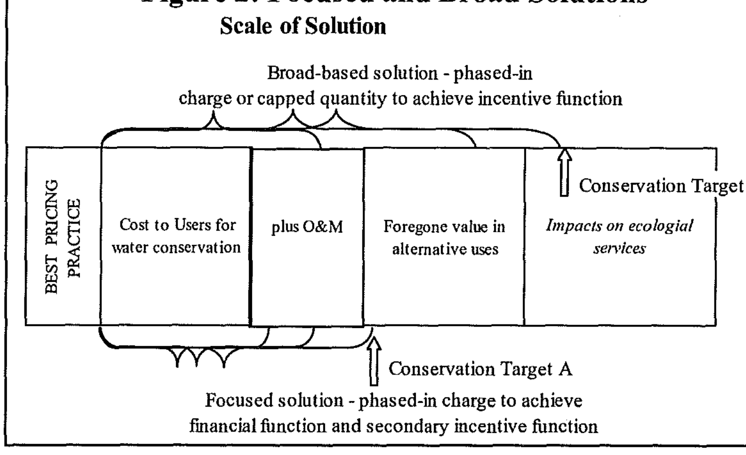
Who Are You?	Scope: What challenge do you want to address?		EI Functions and their roles	
Federal	Technical	• National innovation in technology	Incentive ⇒	Primary role
	Financial	• Affordability of infrastructure	Incentive ⇒ Internalization⇒ Fiscal ⇒	Primary role Primary role Possible role

2.3 SCALE OF THE DESIRED SOLUTION: WHO IS TARGETED AND HOW MUCH OF A CONSERVATION RESPONSE IS DESIRED?

A next step is to identify who is targeted and the desired water conservation response or solution sought. In Figure 2, the scale of the desired solution is defined two ways: first, by the stakeholders that are targeted for action, and second, as noted above, by where you want to ultimately be on the full social value continuum. In targeting stakeholders, a focused solution means that the EI (or water conservation) is targeted at a limited number of water users whereas a broad scale solution requires a broader application of the EIs to diverse users. Identifying the scale of the solution this way allows us to begin to bring definition to the boxes contained in Figure 2 and ultimately attaches numeric values to the "scale of response" on the full social value continuum (although this Document does not go into that level of detail).

In the case of the focused solution for large industrial users (See Figure 2), we ultimately want to set a charge (fee) that is approximate to the costs of the water conservation practices that reduces demand to a given conservation target, A. Because regulators don't really know the actual costs of water conservation practices for the industrial users, a phased-in charge rate can be adopted. The phase-in is desirable for two reasons: *first*, it allows the water users to more easily align their decisions to invest in water savings practices with their normal capital upgrade decision-making cycle thus reducing transition costs; and *second*, by tracking responses to the charge, the regulator can adjust the fee and more closely achieve the conservation target. This also serves to avoid unnecessary costs on the industrial users associated with over compliance, where a high charge may induce a behavioural shift that overshoots the conservation target.

Figure 2: Focused and Broad Solutions



In the broad based solution (See Figure 2,), a conservation target, B, is sought from very diverse (or heterogeneous) users and water conservation costs for each user group will likely be highly uncertain. For the broad based solution, three strategies can be employed:

1. Phase-in broad-based water pricing across all users and monitor demand responses to asses if fee increases are required to achieve the solution, or conservation target;

2. Design a number of different EIs (and other complementary approaches, such as use restrictions and education programs) targeted at different users. A similar approach to the focused solution would be employed across a number of different user groups. Sensitive groups, such as low income families, could be cross-subsidized, where fees received from some are redistributed to sensitive groups to minimize the impact of achieving the conservation target; or

3. Allocate tradeable water permits, cap overall allocations or quantities, and then reduce the cap over time.[6] This increasing stringency coupled with the trading provisions will incent those that can cheaply reduce water use to make conservation investments, subsequently freeing up some of their allocation, and then sell it to others who have relatively higher conservation costs. This trading will eventually reveal the financial costs (or price) of making conservation investments. This incentive function can also be strengthened by decreasing the overall allocation (or permitted use) over time.

   While this approach may not re-allocate water to those with the greatest societal need, it will reallocate water to those who are willing-to-pay for it, and therefore have a high value in use. It is at the time of the initial allocation that those with the greatest societal need could receive an allocation (usually based on historical use or need). They would then be free to decide if they wish to trade any surplus allocation gained through the implementation of conservation measures. The key point is choice – after the initial allocations they can sell or purchase additional allocations based on the relative cost of on-site conservation versus the market price of additional allocations.

To summarize, we started with a problem or challenge that was translated into an EI function. Each of the four EI functions – financial, fiscal, incentive and environmental – corresponds to a component of the full societal value of water. The scale of the solution to a challenge can therefore be matched with the boxes below the "full societal cost" continuum. Placing a desired solution along this continuum can help to identify whether one requires a focused or a broad solution, and the magnitude of the value signal (or pricing signal) conveyed with an EI. In the next section, we introduce the types of EIs that have been implemented, and link the EIs to the functions they are best suited to perform.

2.4 IDENTIFYING YOUR EI OPTIONS

To promote water conservation, a broad range of EIs have been contemplated or implemented. Some focus on incentives to reduce the capital costs of water efficient technologies, such as a tax credits or subsidies. Some policies create *dis*incentives for *water use*, by pricing water through either price increases or by creating scarcity with caps in tradable permit systems. Although economists typically argue that increasing the price of water provides the most efficient incentive to achieve water conservation objectives, experience suggests that other forces are at play.

[6] For now we set aside the administrative requirements of setting up a water-trading scheme, but return to this topic later in the Document.

Indeed, it is clear that barriers, such as political acceptance and a lack of experience, exist to implementing EIs that signal the value of water and promote conservation. As well, price effects sometimes decline in effectiveness, as users become desensitized to the price signal (or experience the fatigue effect). In Table 2.2, we identify a number of EIs by the function (recall these functions address challenges), such as incentive or financial function, and then explore the EI advantages and disadvantages. This table can be used to identify promising EIs that typically are used to address your challenge.

Table 2.2
Examples of EIs by Function

Function	EI Name*	Advantages	Disadvantages
Financial Function	Water prices or sewer charges (i.e. water or sewer service rates)	Follows user-pay approach, and can be used to achieve a secondary incentive function. Existing pricing can be used as the basis to move towards user-pay (full system cost) and increasing rates of conservation.	Low rates can have a minimal impact on conservation and can lead to waste of water. A progressives pricing structure that charges more for more use may incent conservation, thus diminishing the primary financial function.
	Financial subsidies provide positive incentives ⇒ Remove disincentive ⇒	Can be used to increase uptake of certain technologies that promote conservation – grants, cost-sharing etc. Removing adverse subsidies can promote the fiscal function while also encouraging an incentive function.	Fiscal outlays required to fund subsidy, thus adverse fiscal function. Subsidies provide incentive to overuse water and are a pay-the-polluter/user approach; do not encourage knowledge of the true cost of use of water. Opposition to removing subsidies, especially for important regional industries and low-income households.
Fiscal Function	Subsidies for capital investments. Capital cost allowance or direct subsidy for water efficient technologies.	Induce water efficient investments using the existing tax system, even at low subsidy rates. Also provides an incentive function.	Funds likely not earmarked to reinforce administrative capacity. Weak incentive function.
Incentive Function	Water abstraction[7] fees takings charge linked to a permit.	Adjustment of price signal to reflect actual resource cost; encourage conservation, technology and flexibility.	Low price changes can have a minimal impact unless water has a very low value to start (price of water is very low).
	Pollution charges a fee on pollutant loading	Introduces polluter-pays principle; moves towards management objectives, enables flexibility to achieve objectives	Difficult to set the right fee. Can over charge leading to no efficient outcomes i.e. more response than is required) Low charge levels are more of a fiscal function than incentive.

[7] The process of removing water from the environment for human use, including agricultural, municipal and industrial uses for example.

Function	EI Name*	Advantages	Disadvantages
	Tradable permits permitted allocations become tradable. Effluent targets or "caps" become tradable.	Very effective when scarcity and water allocations conflicts exists. Provides inter-industry transfers (i.e. buy and sale permits) instead of tax payments to government. Free allocations can ensure small-scale users have access based on historical water use.	New administrative/legislative structures required; administrative and transaction costs can be high (to effect trade and make trades). Limited experience can lead to poorly designed programs that are ineffective and may ultimately be more costly or less effective than a regulatory approach.
Environmental Function	Damage assessment Assess and recover damages from spills or on-going discharges	Can provide a strong deterrent to avoid the liability associated with funding environmental remediation and ecosystem recovery.	Requires legislative basis and expertise to value remediation and ecosystem recovery. Usually implemented with an enforcement action.

* More detail on these EIs are presented in Section 0 below.

Table 2.3 provides more detailed information on the types of EIs typically used, as well as their advantages and disadvantages.

Table 2.3
Types of EIs and Their Advantages and Disadvantages

Category of Instrument	Instrument	Definition	Advantages	Disadvantages
Water Supply and Demand				
Pricing	Flat rate per unit volume of water	Constant rates for consumption of water regardless of the quantity	• Easy to implement, meters not required	• Has a limited effect on conservation, as increasing consumption is not penalized.
	Increasing block rate	Higher rates for consumption of greater quantities of water	• Promotes conservation effectively • Greater consumption is penalized to avoid excesses by users.	• May require metering • May impact low income households
	Decreasing block rate	Lower rates for consumption of greater quantities of water	• Simple to implement. Attractive to large users	• Perverse incentive that rewards increasing use
	Abstraction (withdrawal) fee	Rate for removing water from the environment for irrigation or for treatment to produce drinking water	• Effective in obtaining water distributors (such as municipalities) to promote conservation among their users. • Easy to monitor for large users such as industry and municipalities	• Low charges have a minimal impact on conservation

Category of Instrument	Instrument	Definition	Advantages	Disadvantages
Taxes	All	Charges usually of money imposed by authority on persons or property for public purposes	• Use existing legislation and administrative structures. • Can lead to efficient conservation if rate is sufficient to change behaviour. • Way to obtain water use data.	• Politically and socially undesirable. Perception of revenue raising and not conservation oriented. • May impact relative competitiveness of industry/municipality
Improving Water Quality				
Subsidies	All	Government interventions through direct or indirect payment, price regulations and protective measures to support actions that favour a set purpose.	• Best suited to dealing with non-point source pollution. • Well suited to the residential sector, especially when combined to awareness programs.	• Should not be necessary as the system moves towards full cost recovery. • In the residential sector, efficiency program can be seen as a way to buy capacity for growth that is not welcome.
Pollution charges	All	Payments based on the measurement or estimation of the quantity and quality of a pollutant discharged into the environment.	• Can be very effective at improving water quality when charges reflect the type and impact of pollution released into the environment and the sensitivity of the receiving environment • Very useful for large point-source emitters such as industries who have control over their output.	• Low charges do not promote pollution reductions. • Net effective when charges do not reflect the type and impact of pollution released into the environment and the sensitivity of the receiving environment. • Not very effective for non-point source pollution. • Can require a significant monitoring system and information collection is necessary to ensure the charges are being applied correctly
Fees	User fees	Sum paid or charged under civil law for a service provided.	• Does not jeopardize health of lower income households.	• Less effective for water conservation as it does not reflect consumption.
	Non-compliance fees	Sum imposed under civil law on polluters who do not comply with management requirements and regulation.	• Useful to ensure that users comply with water conservation or protection regulations (e.g. pollutant discharges or lawn watering regulations)	• Can have a negative impact for low income households if service is interrupted for lack of fee payment

Category of Instrument	Instrument	Definition	Advantages	Disadvantages
Tradable permits	All	Sets a cap or target and allows trading between entities to achieve the target. Some reduce more than the target, some lees, but overall the target is achieved.	• Offers a pollutant or water consumption reduction incentive. • Can be very flexible and applied to specific pollutants. • Permits can flow towards the highest value water use. • Can be an effective conservation approach when restrictions on trading are introduced for pollution control or resource conservation	• Not well suited to the residential sector. • Less effective for non-point source pollution. • Without restrictions, can cause pollution hot spots if no provisions are made. • Permanent trades may be constrained buy concerns about future security of the entitlement due to evolutions in water policy.

2.5 HOW DO EIS CHANGE BEHAVIOUR?

Now that we introduced EIs, and provided the context in which they are best applied, we begin to explore how they work. Economic instruments applied to water conservation, so the theory goes, are relatively straightforward. The regulator introduces pricing signals so that the incentives inherent in the market economy induce behaviour in a socially desirable direction. EIs become effective when they signal to water users and suppliers that water is valuable and quantities are limited and that there is an opportunity cost associated with its use. Ultimately socially beneficial water conservation is achieved when all agents in the water market are targeted; for example, suppliers target leaks and optimize system efficiency; large volume users time shift their demand or evaluate their water use intensity and all users demand less through conservation. In the longer-run, these types of decisions by all agents in the water market become embedded in the longer-term: in cost accounting, in habit, in capital and in technology.

So, how do EIs change behaviour to promote water conservation? By function, we can identify a number of economic concepts explaining why EIs may be successful at achieving water conservation:

Financial Function

Financial resources are scarce. Measures to achieve water conservation and pollution control goals should be designed to be cost-effective, where options are selected and implemented to achieve the goal (or movement towards a goal) at the lowest cost. EIs, through flexibility and transferring decision-making to water users enable cost-effective decisions to be made which, in theory, allow conservation costs to be achieved at lower overall costs relative to other management options. As mentioned above, EIs can be used to recoup system costs and obtain reinvestment funding for future infrastructure needs.

Political and social opposition will occur. Water conservation programs will likely trigger political and social opposition due to the real or perceived financial losses or costs. In cases where this occurs, EIs can aid in designing conservation programs that lessen financial impacts and even counter the *perception* that adverse financial effects will occur. Indeed, a primary focus of EIs is to minimize overall cost while achieving a given water conservation target.

Fiscal Function

Improvements in decision-making and administrative capacity. EIs afford an opportunity to gain valuable information useful for water management decision-making. In the past, this information was typically not available through observing demand responses to water prices or government allocation rules since, with very few exceptions, water is significantly undervalued and use does not always match allocation (i.e. on permits or licence or allocation instrument). A classic example of this *"information effect"* is the German Levy system that included a fee on permitted takings that was channelled to the water management activities. When the levy was introduced, one unanticipated outcome was that it incented water users to review and manage their allocations more closely. Ultimately, this resulted in a significant renouncement of total permitted allocations (33% in one province alone).

Another immediate response to the levy was to provide German water managers with continuously updated information on takings and water use. This provided an opportunity to strengthen the information basis for management, leading to improved water modelling and monitoring, and research. As well, the levy (fee) introduced into the water management relationship many elements of control and enforcement usually associated with taxation, which provided insight on user behaviour to regulators that was not previously available. Finally, because revenue was earmarked for water management activities, the small incentive function of the fee was complemented by a strengthened administrative capacity. Thus, the effectiveness of the EI was not solely related to its behaviour response in users, but instead completed by improved administrative capacity.

Tax Shifting. EIs can be a new source of revenue and the basis for new financing mechanisms outside of the traditional tax base. Indeed, one interesting aspect of EIs is that it allows for tax shifting away from income taxes and toward user pay systems that alter behaviour in socially desirable ways.

Environmental Function

Decentralization of decision-making. EIs are a crucial part of shifting decision-making regarding water use from government to water users so that decisions can be made which improve water use efficiency or reduce pollutant discharges and are consistent with business goals. There is a temporal dimension here, where decentralized decision-making requires pricing signals to be assessed in the short-term, which then leads water users to consider longer- term alternatives.

Decision-makers respond to incentives. To achieve water conservation goals, human behaviour will need to be influenced. Experience has shown that a mix of incentives and/or regulatory requirements, otherwise known as the "carrot-and-stick" effect, can be very effective and efficient at achieving water conservation goals. Thus, EIs can be complementary to existing regulatory approaches, and can sometimes substitute for regulation. Indeed, most EIs, contrary to popular belief, have a strong regulatory basis or regulatory back-stop to ensure conservation targets or management objectives are achieved.

2.6 THE ADMINISTRATIVE CONTEXT ALSO HELPS WITH THE SELECTION OF THE EI

While the concept of EIs is straightforward, experience has shown that EIs can be complex to both design and implement. Often in a rush to implement EIs, too much faith is placed in market mechanisms on which EIs are based and too little attention is placed on the administrative and policy contexts in which they operate. The success of EIs depends on being very alert to the opportunities and limitations that follow from established systems, and being attentive to the basic properties and characteristics of a jurisdiction's system of public administration. Indeed, it is reasonable to conclude that EIs can incent behaviour so that goals are achieved in an effective and efficient manner, yet the success of EIs also depends on their design and attention to the policy, legal and administrative contexts in which they are implemented.

> The success of EIs depends on their design and attention to the policy and administrative contexts in which they are implemented.

When contemplating the suite of EI options available to water managers, it is important to distinguish between *transitional* and *transformational* EIs:

- ***Transitional* instruments are fundamentally consistent with allocation mechanisms that are currently in place such as volumetric pricing, user fees and charges, subsidization of conservation practices etc.** These instruments can be used to transition water management to new goals such as full cost pricing or peak demand management. Generally, these instruments are embedded in current water management systems or can be implemented somewhat easily where the technology (metering) and management systems are in place. Not surprisingly, transitional instruments are more palatable to government agencies since they don't require a fundamental shift in thinking or significant administrative change. Interestingly, information on the value of water contributes significantly to correct use of an EI, with the provision of information to decision-makers at the heart of transitioning towards efficient water allocation. The notion here is that an improved understanding of the value of water will lead to more informed decisions, and changes in behaviour.

  For example, in the Newfoundland Study "Assessment of the Economic Value of Water and Its Contribution to the Economy in Newfoundland", differences in the value of water to users may assist in setting water allocation guidelines, where the relative value to the user could be used to determine priority water uses. Of course, priority rights, such as water for municipalities, may take precedence over higher valued uses, and therefore allocating water based on the value in use to different users can only be employed in cases where priority rights are first satisfied and then remaining allocations occur for different users. Transitional EIs are often price-based instruments that rely on using pricing mechanisms directly to achieve the EI objectives and implement the desired EI function.

- ***Transformational* instruments are more complex and represent a larger shift from current water management systems, often requiring new systems and approaches.**

This group includes instruments such as tradeable water rights , and would likely also include pollution charges or tradable pollution permits. Implementing these instruments requires a rethinking of current water management practices and a shift, or transformation in a new direction. Accordingly, water managers and their constituents may be less receptive. That said, in places of conflict among users or water scarcity and drought, these instruments would likely provide valuable opportunities as well as the incentive for innovation to achieve conservation goals – with sellers of water being users who can achieve efficient water use reductions, including small scale farmers etc. and buyers being those who have higher conservation costs or need additional allocations. Generally, these are quantity based instruments where a quantity target is set (such as a water allocation or a pollution discharge cap) and then agents operating in the regulated sector make decisions to achieve the target through either buying or selling allocations, or by implementing conservation practices.

As a general observation, it is the transformational instruments that are more complex to implement and represent a larger risk if designed or implemented poorly. This contrasts with transitional instruments that are likely based on *existing administrative mechanism*s (such as licences or water use permits) that simply require additional "tweaking" to move pricing in the right direction to close the water value gap.

As with all programs, there are two stages to implementing EIs: program design; and, program implementation and management. Within each of these, there are a number of administrative functions that are necessary: some instruments will use existing administrative structures whereas others, especially the transformational EIs, will require new systems or a significant expansion of existing structures.

In Table 2.4 we provide a snap-shot of the types of administrative structures or mechanisms that will be required for each type of EI as well as an indication of the level of effort required by administrative structure. As can be seen, the program design requirements of the incentive and environmental function instruments are much more onerous than the financial and fiscal function instruments. As well, the administrative requirements for implementation will be greater than more traditional EIs, such as water pricing and subsidies. This increasing complexity for the instruments providing incentive functions likely explains why EIs have been slow to move from the realm of achieving financial goals towards promoting water conservation to a level that represents the full social cost of use. Regardless of whether or not the administrative structures outlined in Table 2.4 are comprehensive, the lesson is clear: EIs that seek to encourage behaviour towards increasing levels of water conservation can be complex to design and resource intensive to operate. Of course, any of the incentive function instruments can alleviate this barrier by including a secondary fiscal function aimed at cost recovery for the EI program design and operation.

> Regardless of whether or not the administrative structures outlined in Table 2.4 are comprehensive, the lesson is clear: EIs that seek to incent behaviour towards high levels of water conservation can be complex to design and resource intensive to operate.

We close this section with an important observation: the choice of instrument and its design are not the sole determinants of successful outcomes. Experience has shown that implementation is very important. Important aspects of implementation include: institutional flexibility to adjust to changing circumstances; monitoring to track success; enforcement strategy and communication.

2.6.1 Existing Mechanisms and Complementary EIs

Experience has shown that EIs that are nested within existing instructional structures or mechanisms tend to be easier to implement. The administrative aspects of introducing EIs are important and include program design and implementation (including data collection, record keeping, monitoring and enforcement, etc.). This focus on existing instructional mechanisms is important since empirical studies show that program design matters and it can't simply be assumed that EIs will lead to economically efficient outcomes or are easy to implement. International experience is illustrative here. In particular, significant components of the European Union's Water Framework Directive related to enhanced valuation and pricing of water are threatened by a lack of institutional capacity in many EU member states. This observation is consistent with our experience in Canada, where the capability to implement valuation studies is limited and due to inadequate metering, comprehensive data is simply not available. In Table 2.5, we provide a number of examples of how jurisdictional problems have typically been addressed using a mix of existing administrative mechanisms and complementary EIs. We note that data collection and analysis will be important components of each instrument and will be required in both the design phases and implementation.

Table 2.4
Administrative Structures Required by EIS

	Transitional EIs use Existing Administrative Structures						***Transformational EIs require New Administrative Structures***	
	Financial Function		**Fiscal**	**Incentive Function**				**Environmental**
	Water prices/ charges	**Financial Subsidies**	**Subsides for capital investments**	**Direct subsidy**	**Water withdrawal fees**	**Pollution charges**	**Water Markets/ Trading**	**Damage Assessment**
EI Program Design Phase								
Legislative basis and legal	✓*	✓	✓	✓	✓	✓	✓✓	✓✓
Rules and regulations	✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓
Valuation and economics					✓	✓✓	✓✓✓	✓✓✓
Consultation	✓	✓	✓	✓	✓✓	✓✓	✓✓✓	✓
Dedicated Staff	✓	✓	✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓
Technology Assessment		✓	✓	✓	✓	✓	✓	
EI Program Implementation								
Technology Assessment		✓	✓	✓				
Revenue billing and collection	✓	✓	✓	✓	✓	✓	✓	✓
Enforcement	✓	✓	✓	✓	✓✓	✓✓	✓✓	✓✓
Monitoring and Auditing	✓	✓	✓	✓	✓✓	✓✓	✓	✓✓
Communication and public outreach	✓				✓	✓✓	✓✓	
Management and Boards						✓	✓	
Dedicated Staff		✓	✓	✓	✓✓	✓✓	✓✓	✓✓✓

* administrative burden being low (✓), medium (✓✓) or high (✓✓✓)

Table 2.5
Complementing Existing Mechanisms with EIs

Jurisdiction	Issue/ Problem	Scale of desired solution	Mechanism Available	EI Options	Potential Issues and Example of Application
Federal or Provincial	Undervalued water resources resulting in inefficient water use and/ or excess pollution	Broad or focused	• Pricing (as Incentive or Disincentive) • Rebates • Grants	• Tax incentive, e.g. capital cost allowance for water efficient equipment • Rebate, e.g. on high efficiency product purchases • Grants program for best practices, e.g. nutrient plans • Incentives for water re-use/ grey water technologies	• Administrative issues to establish and sustain; broker may be required for trading system- • Manitoba's Riparian Areas Tax Credit designed to encourage farm operators to upgrade their management of lakeshores and river and stream banks. • Netherlands Water Abstraction Tax acts as an incentive to reduce groundwater abstraction. • Québec's Politique nationale de l'eau is planning a water abstraction fee for all users.
Province	Water withdrawals exceed estimated quantity available (e.g. drought conditions)	Broad scale to capture full cost and reflect value of water (internalize external costs)	• Water Taking Permit	• Quantity limits through cap and trade permit system • Price of permit renewals raised to include earmarked funds for watershed management initiatives and education	• Administrative issues to establish and sustain; broker required for trading system • *Alberta Water for Life (planned)* • United States' California and North Colorado water markets to allow use and economic efficiency for water.
Province/ watershed	Excess nutrient load to watercourse	Broad approach to limit nutrients from all sources (source and non-point)	• Effluent Permits / licenses • Effluent Charges	• Limit total nutrient load and allow trading among all sources • Mechanism in cap and permit system to reduce nutrients over time	• Scientific and administrative issues associated with quantification and verification • South Nation River Conservation Authority's phosphorus trading system to control phosphorus loading of watershed receiving waters. • Bay of Quinte's pilot trading scheme for phosphorus discharges
Province	Excess nutrient load to watercourse	Focused on point source discharges (industry and/or municipal)	• Effluent Permits / licenses	• Permit fee based on concentration or loading from point sources; high enough to encourage capital investments to improve treatment	• Political acceptability of fee • Low flexibility for point source owners; low technical feasibility/ high cost of treatment solutions for some sources

Jurisdiction	Issue/ Problem	Scale of desired solution	Mechanism Available	EI Options	Potential Issues and Example of Application
Municipality	Water use exceeding infrastructure (plant) capacity, limited water supply, high peak water use	Broad approach to increase perceived value of water, to internalize costs and reduce use, to increase infrastructure capacity	• Water rate/ Sewer rate • Development charges • Rebates • Stormwater utility approach • Integration of water issues (rain, grey, potable)	• Utility pricing to include full cost • Increase water rate • Development charges to encourage use of existing infrastructure • Rebates on efficient water fixtures	• Waterloo's Toilet Replacement Program offers rebates for low flow toilets and dual flush systems. • Victoria BC's rebates for water efficient irrigation systems and toilets and showerheads. • Toronto, ON integrates the management of water resources to include the management of streams and ditches in a watershed approach.

2.7 PREDICTING OUTCOMES: ASSESSING WHAT WILL HAPPEN ONCE IMPLEMENTED

The desirability of an instrument will depend on the relative importance placed by decision-makers on different outcomes. For example, an instrument may lead to economic savings but at the risk to water conservation effectiveness. An industrial user subject to the instrument may appreciate the cost-savings but the regulator may find the risk to the conservation objective unacceptable. Similarly, some instruments may be economically efficient, but administratively impractical or politically infeasible. To identify the merits and shortcomings of water management EIs, and to provide guidance to water managers on the possible outcomes to be expected from implementation, the following set of policy assessment criteria are useful to consider:

- *Conservation effectiveness,* where the instrument effectively achieves a given water conservation target, be it reducing demand, peak loads, use conflicts or scarcity. By definition, EIs can achieve these goals overall, but the timing of achieving the goal (speediness to target) and certainty (hitting the target or maintain a target over time) can vary.

- *Economic efficiency*, where the conservation goal is achieved at a low societal cost due to the ability of the economic instrument to allow efficient actions to be pursued. That said, it cannot simply be assumed that the instrument will lead to efficient or optimal solutions. Threats to achieving the efficiency objective and how the design of the instrument in particular impacts the efficiency outcome are of interest here.

- *Innovation*, where the EIs may promote innovation and learning-by-doing so that costs or water use is reduced over time. An example would be continuous improvement, where focusing on water conservation allows learning to occur which ultimately improves conservation practices. EIs can be assessed for their ability to promote innovation such as in water-use technologies, metering technologies, etc. Assessing this may be difficult, but nevertheless it should be considered as a desirable outcome.

- The *Distributional* impact, or the "who is impacted and by how much" is a key outcome that can be gauged when designing and implementing EIs. Although distributional impact analysis is complex, we will consider it in so far as it is important to elected officials and thus may form a basis for a barrier to implementation (e.g., increasing water prices is seen as having regressive impacts and thus politically difficult to carry out). Accounting in a general sense for the relative distributional implications on major water users is a key research question that must be addressed.

- *Administrative feasibility.* EIs can have very different implications for administrative functions. Indeed, research and empirical experience show there are fundamental differences in administrative structures required for different EIs (See Figure 2.4 above for an overview). Another aspect of administrative feasibility is technology. In recent times, technological innovation, such as so-called "smart meters", has significantly reduced the administrative costs of information acquisition, and made EIs much more administratively feasible. Transitional EIs may require less of an administrative shift than transformational EIs.

- *Political feasibility* will be a key consideration in assessing the applicability of instruments. The likely political feasibility will be tied to economic, conservation and distributional outcomes that can be expected under the different EIs.

- *Complementarity* where an EI can complement existing systems or mechanisms, and indeed may increase overall effectiveness or efficiency. EIs are rarely implemented in isolation and indeed work best when they complement other approaches, such as information and communications measures for example.

Often, a simple qualitative screen can be used to assess each potential EI for its impact on each of these areas. The qualitative screen is often implemented as an informal "brain-storming" process that requires water managers to use a consistent set of outcome criteria to assess the strengths and weakness of the instruments. Qualitative screens are also useful to identify potential barriers that may arise during design and implementation. For example, assessing the distributional aspects of the EI will identify those groups that are significantly impacted by the EIs, and therefore those stakeholders that will likely need to be consulted on design and implementation. Finally, qualitative screening assists in improving the understanding of issues and solutions for all participants, and opportunities for participants to identify and raise issues/opportunities.

In the next section, we present some information on how price changes and pricing schemes can trigger water conservation responses.

2.8 DEMAND RESPONSES TO WATER-RELATED EIS AND OTHER ISSUES

One important challenge facing water managers considering the application of economic instruments is to anticipate their impact on water use. In some cases the response of households and businesses to changes in water prices can be estimated fairly easily. In other cases, discussed below, anticipating the impact of price changes is more difficult. We consider several instances of these more difficult circumstances. This information is meant to highlight the observation that raising prices alone, or reforming pricing schemes does not always achieve the desired result. Indeed, some movement may occur in terms of water conservation, but more aggressive conservation targets may need to be achieved with differing strategies, one of which includes water pricing.

2.8.1 Single Price Change

Suppose a water agency changes a single price by a relatively small amount. The expected change in water demand can be approximated fairly accurately by taking the product of the percentage change in price and that consumer group's price elasticity of demand. A substantial body of empirical research has been carried out to estimate price elasticities in a wide range of circumstances. A consensus has been reached (Renzetti, 2002) that short-run price elasticities for residential water use are fairly small: in the range of -0.1 to -0.3. Residential water use in the long run and during peak summer periods exhibits larger demand elasticities: in the range of -0.3 to -0.6. This implies that for every 1% increase in prices, demand falls by the corresponding range. There is less information regarding the price responsiveness of non-residential water demands but the available evidence suggests that they exhibit larger price elasticities than residential consumers. As mentioned above, there is also a fatigue effect, where the initial demand response may dampen over time as people become used to the price change. In this case, price increases must be increased incrementally over time to ensure a continued demand response.

2.8.2 More Complex Cases

It is uncommon for water agencies or city councils to change only the price of water for a single user group. It is more likely that a number of features of the prices facing households and firms will be altered. We consider several possible cases here and provide guidance for anticipating the impact of these changes.

Form and level of water prices change simultaneously

A common trend amongst North American municipal councils is the shift away from flat-rate and constant unit cost water schedules. This type of change poses a challenge to analysts trying to anticipate households' and firms' responses to simultaneous changes in both the form and level of water prices. Until recently, it was believed that the appropriate approach was to account for the demand impacts of changes to both intra-marginal and marginal prices. Recent work using Canadian data shows that moving from a rate structure with a constant unit price for water to a rate structure with increasing block rates may decrease the residential demand for water by approximately 4% even if the average price between the two structures remained the same (Reynaud and Renzetti, 2004). Switching from a declining block rate structure to an increasing block rate structure (again, keeping average price constant) was predicted to decrease residential water demands by 7%. This indicates that municipal water agencies may need to anticipate how water demands react to changes in the structure of water prices separately from how they respond to changes in the level of prices.

Water and sewage prices changing

Given the financial pressures facing municipal governments and the challenges arising from any effort to alter water prices, it is also common today for municipal councils to alter water and sewage treatment prices at the same time. It can be expected that increases in sewage treatment prices will decrease households and firms' demand for this service and, as a result, also have a dampening effect on water demands. This will reinforce whatever direct effect the increase in water prices has on water demands. Unfortunately, there is very little known about the economic characteristics of sewage treatment demands including the extent to which they are sensitive to prices. Renzetti (1999), for example, examines water and sewage services pricing in a sample of Ontario cities and finds that the average residential price elasticity of water demand is -0.159 while the average residential price elasticity of water demand with respect to the price of sewage treatment prices is -0.124.

Possibility of industrial and agricultural users going to self-supply

Some industrial and agricultural water users employ technologies that provide them the opportunity to use water purchased from a municipal water agency or withdrawn directly from the natural environment (such as a lake, river or aquifer). Examples include food processors, metal foundries and greenhouse operations. This possibility implies that a municipal water agency that raises it prices to these user groups might want to take into account the possibility of some water users shifting to self-supply. Renzetti (1993) demonstrates that the decision to switch to self-supply is sensitive to economic factors and is made more likely with increases to unit prices and connection fees.

Combining price and non-price policies

Given the variety of price and non-price related measures to encourage water conservation, an important area of research has been to assess the relative efficacy of alternative water-related economic instruments. Renwick and her co-authors have recently examined the experience of Californian water utilities that employed a variety of methods ranging from requests for voluntary compliance, price increases and penalties for overusing water as methods of coping with the drought that hit that state in the 1990's (Renwick and Archibald, 1998; Renwick and Green, 2000). The authors' statistical models of water demands and household retrofit decisions demonstrate that both price and non-price measures curb demand. Non-price measures vary in their effectiveness with policies that mandate reduced water use being more effective than voluntary measures. The authors conclude, "In general, relatively moderate (5-15%) reductions in aggregate demand can be achieved through modest price increases and "voluntary" alternative DSM [demand-side management] policy instruments such as public information campaigns. However, to achieve larger reductions in demand (greater than 15%), policymakers will likely need to consider relatively large price increases, more stringent mandatory policy instruments (such as use restrictions), or a package of policy instruments." (p. 51). In his study of water conservation efforts in low-income countries, Brooks (1997) echoes this conclusion, asserting "Although regulations have a bad name, they are often both appropriate and efficient for managing water demand. Exhortation is also more effective than generally believed, particularly in times of drought. The range of options is wide enough to preclude generalization, but one can say that they should be chosen to support, and if possible reinforce, the effects of market-based measures" (p. 4).

Pricing Water

There are two main advantages to pricing water. The first is that doing so is consistent with many international developments in water resources management. The second is that doing so facilitates reform of cost accounting and pricing rules. There are disadvantages, however, to this approach. These include the potential for understating the cultural, social and even spiritual importance that many Canadians assign to water. In addition, unless adequate protective measures are put in place, increasing the emphasis on the pricing and rational allocation of water may run the risk of promoting environmental damage. These outcomes are already occurring because water is not being valued and exchanged properly. A full economic valuation would take into account these dimensions of water's value either quantitatively or qualitatively. Finally, there is an ongoing debate amongst policy analysts and legal experts as to whether a move towards a greater use of market-based measures for water allocation may have implications for water's status under NAFTA. There is an equal risk that if water not priced properly, subsidization allegations could become an issue. This last point is a legal issue and, as such, is outside the scope of this report. Interested readers should refer to Environment Canada's Freshwater website (http://www.ec.gc.ca/water_e.html) for the government of Canada's position on this issue and to see a dissenting opinion see Chalecki (2000).

Alternatives to Water Taking Permits

A fundamental feature of the government's water management policy is its approach towards water allocation. A water allocation framework is a set of laws, institutions and policies that determines the distribution of water across users. If water is plentiful relative to demands, then water allocation is largely an administrative task. Conversely, if reliable water supplies are inadequate to meet all competing water demands (including in-stream and other ecological demands) then water allocation is a more difficult task. In the latter case, government must either decide who receives water and who does not or it must designate that task to some other institution such as a water market. In general, the greater is the degree of relative water scarcity, the greater the need for a well-articulated water allocation framework to distribute water, resolve conflicts and enforce decisions.

One dimension of a water management framework refers to how water allocation decisions are made. The current practice in Canada is to have a provincial government agency making these decisions based on set of water management objectives. There is usually a set of criteria applied to each abstraction permit to ensure that they are consistent with government's water management objectives. This approach ensures government control over the allocation of water and those factors such as ecosystem integrity and in-stream water needs may be considered in allocation decisions. On the other hand, these administrative decision-making processes have been criticized for lacking transparency and accountability and for failing to adapt to changing economic conditions and water-use patterns.

One alternative to administrative decision-making processes is to retain control for decision-making within a government agency but to introduce fees for the right to abstract water. This approach has the benefit of encouraging efficient water use and conservation. Further, prices may be set to recover government's program costs and/or to reflect the opportunity costs of an applicant's water use. The principle shortcoming of this approach is the difficulty most agencies experience in changing abstraction fees to reflect changes in water supply and demand. The possible forms of these fees are described in our report.

Another alternative to administrative decision-making is to adopt a more market-orientated approach to water allocations. In this type of situation, once water permits have been issued (or sold) by government, water users such as irrigation associations, municipalities and large industrial concerns may buy and sell the right to use water. These transfers may be permanent or they may be temporary. The latter situation involves the leasing of water-use rights without actually transferring ownership to those rights. These market-based approaches have the potential to allocate water in a more flexible and efficient manner than what is possible under a more administrative approach. A significant feature in their favour is that these market-based arrangements allow water prices to varying freely according to changing circumstances regarding water supplies and demands. These changing prices provide valuable information needed by water users in making decisions regarding production levels, business locations and capital investments. Nonetheless, any market-based allocation framework requires government oversight in order to ensure that instream needs are met and other environmental policy goals are satisfied.

3. EIs IN PRACTICE: JURISDICTIONAL EXPERIENCES

In this section, we provide an overview of a literature search that systematically reviewed and assessed domestic and international experiences with EIs for water conservation. This section moves the document from the general to the more specific with respect to EI implementation. Additional information from the Canadian provinces concerning current and planned EIs is provided in Appendix A as well as information pertaining to the assessed case studies in Appendices D and E. Based on the literature review, a number of summery observations are evident:

- EIs are rarely implemented in isolation and indeed work best when they complement other approaches, such as information and communications measures for example;
- Communicating program goals and objectives to the public complements the effectiveness of EIs;
- Water pricing must be high enough to promote conservation behaviour and increase over time to account for decreasing sensitivity to a single price increase;
- Pollution charges need to reflect the type and impact of pollution released into the environment and the sensitivity of the receiving environment.

Lessons learned from the Canadian provincial case studies include:

- Time for public consultations is easily underestimated;
- There is often a perceived inequity when one industry is initially targeted as a first step in implementing EIs. This ultimately slows the EI implementation leading to the conclusion that a broad-based application of EIs is both more acceptable and expedient;
- Public perception of the value and abundance is a significant barrier. This can be alleviated somewhat by the use of identifiable water revenue funds;
- A regulatory foundation is very important for the successful implementation of EIs.
- Some provinces have fragmented regulatory systems, and may not be able to implement EIs directly but instead need to work through existing regulations or codes and with multiple partners;
- Fully metered systems provide good opportunities since users are accustomed to paying for water.

Much more detail is provided below.

3.1 OVERVIEW OF JURISDICTIONAL EXPERIENCES

A review of use of economic instruments for water around the world and here in Canada reveals a variety of approaches and experiences. An overview of these approaches and experiences is an important first step in understanding the possible approaches and the issues related to implementing EIs in Canada. The following section presents the results of a literature review on international and Canadian initiatives involving economic instruments for water management. In this section, we present a broad overview of how EIs have been implemented and weave in some lessons learned. We first start with a discussion of the method used to document the jurisdictional experiences. This is followed by on overview of international, Canadian and then Canadian provincial experience.

3.2 METHOD

To obtain the information necessary to conduct the literature review and produce the lessons learned, a general Internet and literature[8] search for relevant documents was performed. This search focused on Canadian examples where economic instruments have been used for water and International examples of such uses. The search also intended to uncover literature on the general aspects of the use of economic instruments for water. A number of case studies were identified and information from these case studies was introduced into a database. The aspects that the database focused on were: the responsible jurisdiction, the problem addressed by the instrument (financial, technical, social, environmental), the target or goal, the sectors of focus, exemptions for sectors, the type of economic instrument used, the complimentary instruments used, problems encountered in relation to the instrument, and successes obtained from its use. Appendices D and E provide the database fields and the case study results. In addition, a number of interviews with key informants at the provincial level were completed for the Canadian provinces to obtain an overview of the situation regarding water and the use of economic instruments.

The 27 international case studies were analyzed separately from the 26 Canadian case studies to highlight the differences between Canada and the international examples. The data and other documents were then used to extract a number of trends concerning the use of economic instruments for water. Lessons learned were developed from this information and are provided below. The provincial case study overviews are presented independently below. The following section presents the result from the literature search, highlighting the main characteristics, issues, and lessons learned for each aspect covered in the literature search and interviews.

3.3 INTERNATIONAL EXPERIENCES WITH EIs

The international community considered in this literature review included countries from Europe, America, Africa, and Australia and New Zealand for a total of 27 case studies at the national, regional, watershed, and municipal levels. These case studies offered extensive or particular experience with EIs for water management, which allowed the development of some observations concerning the use of such instruments to manage water resources. These observations and other lessons learned are structured here according to the aspects of EIs to which they are connected.

3.3.1 Who Has Implemented EIs?

Internationally, water EIs are mostly used at the national level or at the provincial/regional level. A total of 27 international cases were analysed and, of these, 10 instruments were used at the national level and 10 at the provincial/regional level, 2 at the watershed level, and 6 were municipal cases. The literature suggests that, for some instruments, a national or provincial/regional approach is better suited as is the case for tradable water permits.

In many cases, the State environmental agency administers the economic instrument, while in other cases, the regional/provincial governments may be in charge of the water

[8] Reports and other materials printed for distribution outside commercial publishing channels. These may include reports (technical reports, statistical reports, market research reports, etc.), theses, conference proceedings, technical and commercial documentation, and official documents not published commercially (primarily government reports and documents).

resources. In some situations, as in the Netherlands, there are state waters and regional waters and their management is shared accordingly. Water boards often manage the water resource, as in France water boards are responsible for entire watersheds. Where instruments are used at the municipal level, the charges can be collected by an agency or department in charge of municipal services while some have agencies or departments in charge of water services exclusively. Although there are not many cases of watershed management in our review (Australia, England, France), France shows a very functional approach where the water agencies and basin communities manage most aspects of water including use charges for pollution.

3.3.2 The Challenge Addressed by the EI

> Experience shows that EIs can simultaneously address a financial function, a fiscal function, and achieve conservation goals.

Most EIs are used to cover the costs of water services (financial function) and some extend cost recovery to full cost accounting where environmental costs are included in the charge (internalizing the externalities). Of the 27 case studies reviewed, 11 instruments were used to internalize externalities (incentive and environmental functions) and 3 instruments for system cost recovery (financial function). Most of the remaining examples used the instrument as a funding tool for the jurisdiction or to invest in their water infrastructure (financial function). European countries use water EIs mostly for pollution prevention and for financial reasons. Resource conservation is supported by EIs is cases of water scarcity but also for those countries using EIs to address environmental concerns. The instruments, by their nature, tend to address both an economic issue, such as funding or cost recovery, while striving for conservation opportunities and infrastructure improvements.

3.3.3 The Scale of the Solution – Sectors of Focus

> Internationally, the commercial, industrial, and agricultural sectors were the first areas of focus for EIs.

The scale of the solution is affected by jurisdictional aspects guiding the choice of instrument (i.e. municipalities do not use withdrawal fees and most national governments do not have the power to charge individuals for water consumption). Internationally, pollution charges tend to target industries, and the agricultural sector as well as municipalities and all sectors within them. On the other hand, water prices target households and industries, often the commercial sector as well. Subsidies tend to focus on the residential sector and some industrial sectors within municipalities. In many cases, the presence of compensatory subsidies or exemptions affects the goal of full cost recovery.

Overall, the industrial sector was the first sector of focus when addressing water consumption and management. In some cases, water charges are only concerned with industrial water use and include no other sector, as is sometimes the case for pollution charges; however there were examples of situations where the residential or commercial sector were targeted while the industrial sector was not. In the international examples, few problems were noted concerning the sector focus of the water EIs and this may be due, as is the case in Europe, to the age of some programs.

An exception is the Columbian Water Tax, which highlighted the difficulties experienced by poorer countries. The implementation of such instruments in the residential sector may be difficult because of the precarious economic situation of these countries. Municipalities and their consumers in most cases cannot afford the pollution charges imposed on municipalities. In some countries, the issue of targeting the residential sector with EIs has raised some discomfort in that the social value of basic water services may be threatened by some EIs. This aspect will be discussed further when we address water prices in the types of EIs section below.

For developed countries, some questions remain concerning the residential sector where, for equal charges, people living in a suburb will consume more water than those living in the city centre, even for the unmetered customers in the city centre (Hamel et al., 1997). This suggests that some characteristics of the residential sector may need consideration in the implementation of EIs and complementary initiatives for water conservation.

3.3.4 Types of EIs Implemented

> As a general observation for all instruments, prices that are too low fail to affect behaviour to reduce consumption.

A number of aspects may limit the ability of EIs and their rate system to reduce water consumption. As a general rule for all instruments, charges that are too low fail to affect behaviour to reduce consumption – other issues include small cost shares for water as a cost of production and small price elasticities (i.e. demand responses to price changes). In the case of Austria, government subsidies are designed to keep the sewerage charges per household below a politically significant amount thus affecting the charge's ability to influence water consumption. In a graduated charge system, when a minimum flat rate is used combined with a consumption-based charge, as is the case in the Netherlands, the flat rate may cover most of the consumption and thus limit the charge's effect on consumption. Other countries like Finland offer a fixed basic charge to cover a small portion of consumption for all, (20% in Finland), and the remaining use is subject to a consumption-based charge.

Water Abstraction/Withdrawal Fees

Water abstraction fees are primarily used at the national and provincial/regional/watershed level. They are often used in European countries where they are imposed on direct users of the national water resource, whether they are municipalities, industries, or agricultural users. These charges in turn, are passed on by municipalities to water users through drinking water and wastewater treatment charges. In fact, the use of water charges at the municipal level is often in response to charges for water abstraction at the national or provincial/regional level. Other instruments such as water prices, taxes, and pollution charges are often used by national or provincial/regional jurisdiction in the same manner as an abstraction fee, based on water withdrawal. In Europe, these fees are used to control pollution, to conserve the resource, and as a source of funding for the maintenance and improvement of water service infrastructures.

For water abstraction, a number of exemptions were found. In Finland, industries often abstract water directly from the water sources and are exempt from the fee but responsible for treatment of their own wastewater. In the Netherlands, exemptions exist for skating rinks, emergency extractions (ex. for fires), rinsing reusable packaging, companies extracting less than 40 000 m^3 per year and pumping less than $10m^3$ per hour, the draining of building sites if less than 50,000 m^3 per month, and draining and mining capacities at depths greater than 500m. In the German State of Baden-Württemberg, extractions of less than 2000 m^3 per year are exempt and there is a 50% exemption for abstractions between 2000 and $3000m^3$. Further, in Germany, rebates of up to 90% of the fee are available for water intensive agriculture and industries for which the charge may threaten their competitive position. However the rebate is conditional on the undertaking of water efficiency measures. Denmark also presents a number of sector exceptions including the agriculture sector and some industry sectors.

Water Pricing

Water pricing schemes are used at all jurisdictional levels but, as mentioned previously, are often very similar to abstraction fees when used at the national level. Water pricing is very common in municipalities and often combined with pollution charges. They are most often used to cover system costs while not taking into account full cost accounting. Pricing schemes may use consumption-based charges, graduated charges, fixed charges, or a combination of these, and they are often combined with administrative fees. A subsidy system can be introduced to cover sufficient services to allow all users to have a healthy standard of living regardless of ability to pay. If it is to be based on consumption, this instrument may be socially safer if it uses a graduated charge system where a minimum price for a basic healthy quantity is identified and followed by a consumption-based charge.

Pollution Charges

Most European countries use pollution charges targeted at the regional and municipal levels. They are most often used to cover system costs while controlling pollution and preserving the resource. Greater charges are often imposed on industries compared to households. The charges may be consumption-based, graduated, fixed, or a combination of these and may vary according to pollutant type and/or concentration. As is the case for water prices, they are often combined with administrative fees. However, pollution charges are most often consumption-based. For the industrial sector, where the pollutant content of the discharge is taken into consideration, a monitoring program determines the presence and quantity of particular pollutants in the discharge to allow the adjustment of the charge to reflect the effect of the pollutants on the receiving environment. Charges can also be partly based on other characteristics (size of the home, number of toilets in a home, size of the property, per irrigated acre, or population equivalents). Some water prices, although set by other entities such as water companies, may be limited by a national body as is the case in the United Kingdom where a maximum water price cap is set for the entire country.

A number of exemptions are found in the international examples of pollution charges. In Denmark, discharges from mussel plants, fish farms, and overflows from combined sewage collection systems and stormwater discharges are exempt from the charge. In addition, rate reductions are found for entire sectors: fishing, cellulose, vitamin and pigment industries. In France, municipalities of less than 400 inhabitants and discharges from sewerage treatment plants into natural waters are exempt while in Austria, a 75% connection rate to municipal water systems limits the application of the charge.

Pollution charges need to reflect the type and impact of pollution released into the environment and the sensitivity of the receiving environment

A shortcoming of the pollution charges system is that the level of pollution reduction to be obtained in response to charges can be uncertain given uncertainty about demand responses to fees. In addition, effluent charges in some cases are only levied on direct discharges to natural waters. Since non-point pollution is hard to monitor directly, it may be better to estimate the pollution from a proxy input, such as water use data that is correlated with pollutant loading. When trying to take into consideration the receiving environment, considering the type of pollutants and quantity discharged into the receiving waters is a start. However, adjusting the charges for determined impact zones of variable sensitivity may also be desirable.

Tradable Water Permits/Allocations

Tradable water permit schemes can be used to promote the efficient allocation and use of water while preserving the resource at the provincial/regional or river basin level. The schemes studied are established in the United States, Chile, and Australia. They are rarely pure market systems without restrictions and the restrictions found are most often introduced due to environmental concerns. In Australia (New South Wales, South Australia, Victoria, Queensland), there are restrictions on the spatial transfer of water use, volume controls, and restrictions from environmental considerations such as the preservation of river flows, control of salinity, and the protection of wetlands and river ecosystems. In Colorado, United States, buyers of allotments are required to demonstrate a beneficial need and ability to use the water, and water can only be used within the district boundaries to prevent speculation in water or the development of a monopoly position in the ownership of contractual rights.

Water rights and trades may be constrained by concerns about future security of the entitlement due to evolutions in water policy.

Although still in its early stages, water trading market experience has suggested a number of potential administrative challenges. In particular, some systems involve a very long time frame to approve trades. This is can lead to an inefficient use of water by users as some users may need rapid access to water resources (ex. the agricultural sector). In the case where permanent and temporary trades are allowed, long time frames for approval of permanent trades can promote temporary trading of permits or licenses. In Australia, this situation is mostly due to lack of prior approval mechanisms and cumbersome arrangement. In cases where temporary trades do not require environmental evaluations, an incentive to buy water temporarily is created and thus causes an inadequate scrutiny of the environmental impacts of the water use. Another issue raised by permit trading schemes concerns security. Permanent trades may be constrained by concerns about future security of the entitlement due to evolutions in water policy. As is also the case for other EIs, exemptions, requirement, or thresholds for participation may limit participation and thus the effectiveness of the system. This is true in the Netherlands where the threshold for participation limits to 50% the number of livestock farms included in the scheme.

Restrictions may be welcome in situations where water conservation, pollution prevention, in-stream demands, or 3rd party impacts are to be addressed by the tradable permit scheme.

Lessons from Colorado suggest that, for a market system to work well, there is a need for a clear overall program framework for the market to function. The system also needs to be open and transparent with a clear administrative framework and user-based management. Finally, water does not necessarily need to be privately owned but the owner of the rights must believe the system provides a level of security. Regarding restrictions in the market system, although some restrictions may impede the efficiency of the market scheme, they may be welcome in situations where water conservation, pollution prevention, in-stream demands, or 3rd party impacts are to be addressed by the tradable permit scheme.

Incentives and Subsidies

Incentive programs work best when combined to educational and informational initiatives as stakeholder support is key.

Incentives are often used to reduce water consumption in North America. The City of San Diego is a prime example of a jurisdiction where the incentive programs are the basis for water consumption reduction efforts. In the City of San Diego, partnerships were established with states, municipalities, and energy companies to fund their incentives programs. Incentives are often used by the water service provider who is also in charge of wastewater treatment, mostly for municipalities. However, programs are also used at the national or provincial/regional level as is the case in the United States where the agricultural sector receives subsidies as a reward for types of land management that preserve water. In this case, incentives are used to address diffuse sources of water pollution by providing monetary incentive for the implementation of agricultural best practices.

Incentives can be used to address diffuse sources of water pollution by providing monetary incentive for the implementation of best practices.

Incentive programs require some amount of cooperation by the public, as only a change in behaviour is rewarded but not mandatory. A common issue encountered by such programs, and educational efforts, is the concern that conservation is to support growth. This being an issue of discomfort, incentive programs may find some reluctance from the public. One way to improve the effectiveness of incentive programs is by involving the various stakeholders in the initiative. This can help focus the effort, convey the message of reduced water consumption, convince the stakeholders, and also help fund the initiative. Political and public support for the measures is crucial to their success, and taking the time to convince and educate the stakeholders is key. Another lesson learned from incentive programs suggests that industry be allowed to find their own way to reduce water use or pollution through targets. However, although incentive programs can be effective in reducing promoting desirable water related behaviours, it may be more important to remove existing subsidies which create adverse incentives and promote undesirable water behaviours, as was done for the agricultural sector in New Zealand. It remains that subsidies may be provided for actions that would have been undertaken in the absence of the subsidy although this can hardly be avoided.

3.3.6 Complementary Instruments

> Different types of water related behaviours may require different approaches and instruments for greatest efficiency (e.g. incentives for low flow devices combined to regulation for undesirable behaviours)

Most EIs are used in association with a number of other initiatives, this especially at the municipal level. Many EIs are best used with some level of monitoring, including metering of water consumption. Initiatives aimed at maintaining water infrastructure are often additional to other conservation efforts, such as education, leak detection and repair programs. Leak detection can account for a significant amount of reduced water use and is an important complement to other initiatives. In addition, consumer education and information programs are often entertained to promote changes in behaviour and to help users understand the aspects of the water resource including the state of the water resources, the cost of the water services, the value of water for both the human environment and its functions in the natural environment. Education and information programs also help improve compliance without increasing administrative costs. Regulatory tools are also used to ensure compliance with the requirements of the EI or to discourage types of undesirable water behaviour (such as lawn watering during certain periods of the year). These non-economic approaches are most often used to reduce water pollution or preserve water resources.

An example of the use of complementary instruments at the international level can be found in the Netherlands. The Dutch introduced a groundwater abstraction tax (GAT) in addition to their pollution charge to better address water protection. Their approach addresses two aspects of water use. While the pollution charge addresses water quality control, the abstraction tax responds to the need to protect the groundwater resources of the Netherlands (70% of the country's water supply) by making groundwater less attractive to users in comparison to surface water.

3.3.7 Administrative Structures

The most frequent administrative function for regulators discussed in the literature is the need for an effective monitoring system. Water consumption and wastewater discharges need to be monitored to determine charges and assess reductions and thus the success of the initiative. A monitoring system that considers the pollutant content of the wastewater released into the aquatic environment is also necessary for pollution charges. The monitoring system could be the user's responsibility as is sometimes the case for recycle bins. As for the revenues, they are most often collected by the environmental agency of the jurisdiction although they are not necessarily earmarked for water related initiatives.

3.4 CANADIAN EXPERIENCES WITH EIS

The Canadian case studies included a total of 26 at the provincial and municipal levels. The results of the literature review is presented following; more elaborate overviews of the provincial situation for British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Québec, and Saskatchewan are provided in Appendix A. The case studies provide insight into the Canadian situation regarding the management of water resources and the use of EIs for water conservation and management.

3.4.1 Who Has Implemented an EI?

In Canada, most EIs used for water management are found in municipalities. In some cases, EIs are being considered for water management and conservation at the provincial level (see interviews for more detail). Municipalities are mostly using the instruments as they have the regulatory powers, which allow them to implement water related pricing, and charges. These legal restrictions are one of the main reasons why provincial governments have not introduced such instruments. One other case of note is the South Nation River Conservation Authority of the South Nation River Watershed, which adopted a watershed approach to water management, and tradeable effluent permits scheme through a community-based watershed organization.

> Public perception of water issues may be the first barrier to overcome when considering EIs for water conservation.

The use of economic instruments by Canadian provinces is still nascent; however, provinces early in the process of developing EIs have learnt a number of lessons. Firstly, the length of time required for public consultations on water conservation is easily underestimated. Secondly, provinces have encountered difficulties in terms of perceived inequity when one specific industry is targeted as an initial step. A broad-based approach to reach multiple water users appears more acceptable to stakeholders.

Thirdly, the public perception of the value and abundance of water in Canada can be a significant barrier to instituting EIs. Water is generally viewed by the Canadian public to be abundant, and so resistance can be high when attempting to introduce increased water rates and charges for water, permit restrictions or conditions, limited access, and pollution or disposal conditions. Of course, what municipal water pricing is doing is conserving scarce capital and ecological health. This concern can be alleviated somewhat by the use of identifiable water revenue funds associated with specific goals when collecting revenue increases.

The fourth key lesson learned through the provincial experience is the importance of a regulatory foundation to undertake water conservation. Provinces with fragmented systems may not be able to implement EIs directly or without partners, but rather need to work through existing regulations or codes (such as the building code) and with multiple partners, such as municipalities and crown corporations, to access water users to meet water conservation objectives. Finally, fully metered systems provide good opportunities for EIs since users are accustomed to paying for water used. Refer to Appendix A for more detail on the experience of nine provinces.

3.4.2 Challenges Addressed

At the Canadian municipal level, there are two main approaches to the use of EIs. Some municipalities collect the funds through their municipal services department and include them into the general revenue to be used by the city for any intent. Others have created departments or agencies dealing exclusively with water management issues. Their mandate allows them to collect and use the funds for water management initiatives to improve and maintain the quality of service and the resource. Some considered the latter a preferential approach, which limited political influence on water management issues.

Arms length agencies allowed the introduction of EIs, which were more representative of the cost of water services without influence from the political office.

The financial collection scheme introduced along with EIs can vary. In the case of Provincial governments, potential EIs would generate funds, which are often collected by the corresponding environmental department or water-specific group or agency. These have sometimes been transferred to other agencies, such as watershed or conservation authorities. They can be collected in a separate fund reserved for water related initiatives from water body rehabilitation to educational initiatives. Although this is Québec's intention, these plans are still very hypothetical and should be viewed as intentions rather than commitments.

Regarding privatization, a study of municipal water management and privatization showed that the political inability to introduce substantial water rates to maintain the service is the main reason why the service is allowed to be privatized rather than the municipality's inability to manage the service (Hamel et al., 1997).

A major function addressed by water EIs in Canadian municipalities is fiscal. Delaying and/or funding future infrastructure expansions while reducing total water consumption and consumption peaks appears to be the norm. Although less frequent for the present time, some municipalities like Victoria, BC, and Waterloo, ON, are using EIs for water conservation. The provinces are, at different levels, approaching the use of EIs for water conservation. Although only three provinces have implemented or are implementing some form of EIs, many others are considering them or intend to develop other instruments to complement the existing ones.

3.4.3 The Scope of the Solution – Sectors of Focus

> Targeting all users is considered the most equitable approach.

Many municipalities address primarily the residential sector when introducing EIs. Of the 18 municipalities covered by our literature review, 7 municipalities focused solely on the residential sector. The remaining 11 municipal case studies focused on all sectors within the municipality, including the residential sector. However, although none were encountered in our sample did so, some municipalities, as suggested by the PEI case study, focus on the commercial and industrial sectors. At the provincial level, some provinces initially intended to focus on a particular sector of industry. In the case of Québec, the first intent was to focus on the water-bottling sector and, in Nova Scotia, the original licensing scheme focused on the hydro-electric power sector. Both provinces adjusted the focus to target all water users, which is seen by the public and stakeholders as the most equitable approach. Although no instrument has been finalized, the experience of Ontario, Quebec and New Brunswick with water bottlers and similar users has also confirmed the importance of an equitable approach.

Some exemptions were identified in the Canadian examples considered. These include British Columbia's pollution charge for the industrial sector where only 20% of industries which discharge waste will require government approval to do so. In addition, for some cities in British Columbia and the town of Okotoks in Alberta, the existing water pricing schemes are only applied to residential and commercial customers. Other exemptions include Saskatchewan where the agricultural sector is exempt from the industrial water use charge. Nova Scotia also offers a temporary exemption from their water permit charge for farmers and, temporarily, a partial exemption has been granted to the aquaculture industry.

3.4.4 Types of EIs Implemented

> Public perception of water issue can be an impediment to the success of water efficiency programs and the adoption of water efficient behaviours

As mentioned previously, the introduction of EIs in Canadian municipalities and provincial governments revealed that efficiency programs are often seen by the public as a way to buy capacity for growth, which is not welcome. This perception was often combined with the perception that Canada does not have a water problem. These perceptions can be an impediment to the success of water efficiency programs and the adoption of water efficient behaviours. One frequent solution adopted by the implementing jurisdiction was the development and delivery of extensive educational and informational programs, which convey the state of water resources, the value of those resources, the impact of water use on the environment, and the costs associated with the water services. This approach has been considered especially important, as some municipalities have recognized the importance of obtaining the support of the city council and other stakeholders for the programs to be successful.

Larger municipalities using EIs for water management have primarily adopted water pricing. This most prevalent measure is used at different levels: some municipalities are using water pricing to send strong economic signals to convey the value of water and water related services with consumption-based charges and graduated charges; others are using smaller water prices with the intent of recovering system costs. Sewer charges are also an evolving area of application, where water conservation goals (demand and pollutant loading) have been forwarded with the use of sewer charges. Overall, municipalities using water instruments to manage water consumption have found significant success. One must be careful when assessing success the effectiveness of EIs however. In the case of Yellowknife, the water reductions attained since the introduction of the charge were attributed to the leak detection and repair programs launched with the charge. Since Québec is still in the early stages of the development of an abstraction fee scheme, no additional information is available. The South Nation River Conservation Authority in Ontario should be noted as an interesting case of tradable permits system. The program, targeting municipalities and the agricultural sector, addresses phosphorus loading of receiving waters of the watershed.

Beyond the instruments used presently, some concern has been raised relating to consumption-based charges. Charges based on consumption are considered efficient for large users such as industrial, agricultural and commercial enterprises. However, charges based on consumption are considered by some to be less efficient for residential customers where consumption is more structurally dependant on the presence of a garden, grass yard, a pool or a car to wash (Hamel, 1997). These are users whose consumption you want to target – water use is not exactly a basic need in these cases.

3.4.5 Complimentary Instruments

Most municipalities addressing water consumption, be it to delay future expansion or for water conservation, combine a number of instruments and initiatives to better ensure compliance. Metering is necessary for consumption-based charges but also for other types of charges to monitor consumption over time and gain information on consumption patterns. Informational and educational materials are also used extensively to promote proper behaviour and inform consumers of the water situation and its impacts. In some municipalities, information and incentives are the main drivers of successful water management initiatives. Informational and educational initiatives are also seen as fundamental in obtaining the participation and approval of the public and political authorities. Many provinces and municipalities have been involved in such programs before even considering the use of EIs for water. Leak detection programs are also very common and, as suggested previously, can account for considerable water savings. Overall, municipalities and provinces believe the use of complimentary instruments to be crucial to the success of water consumption management and conservation.

Informational and educational materials are also used extensively to promote proper behaviour and inform consumers of the water situation and its impacts.

3.4.6 Administrative Structures

Most municipalities have implemented some form of monitoring program to monitor water consumption in households and to gather data on consumption patterns. Leak detection and repair programs are also present in many municipalities. Regarding the management of water issues and rates, a variety of approaches are found at the municipal and provincial levels, often dependant on the legal and jurisdictional arrangements concerning water. For some, arms-length water boards are responsible for water management initiatives and the funds collected while others include water management with the general public services. For provinces especially, initiatives and funds are sometimes managed by the related department of environment through a particular group and the funds generated by a potential EI may be earmarked or directed to support water conservation programs. This approach is seen as advantageous in obtaining public approval for the use of EIs, as observed in Manitoba in relation to its environmental levies for drinking cartons and cans. The South Nation River Conservation Authority program is also noteworthy in the fact that it is run by a multi-stakeholder committee and uses farmers, considered well versed in farming practices, to conduct all project field visits and evaluations.

4. HOW DOES IT WORK: USING VALUATION IN DECISION-MAKING

In this section, we narrow the focus to explore how EIs and valuation have been used to achieve or promote water conservation. These cases are designed to provide the reader with a flavour for how to implement EIs and indicate the type of analysis and thinking that will be required. Indeed, you will see from these case studies that EIs can be complex to design and implement, and attention to detail matters.

4.1 INTRODUCTION

Consider the following situations. In the first case, a municipal council must decide how to allocate its capital spending for a given year. Like most cities in Canada, there are more proposed projects than available funds. One project would identify and repair leaks in the water supply infrastructure thereby increasing the reliability of the city's water system. The challenge for the city council is to measure the value of this increase in reliability and compare it to the values of the benefits from other capital projects. In the second case, a provincial Environment Ministry must consider an application from a water bottler to withdraw water from an aquifer. The aquifer is already the primary source of water for local agricultural operations. The provincial legislation states that the Ministry must allocate water to maximize the value to the people of the province while respecting existing water uses. The challenge for the provincial Ministry is to measure and compare the value of the water withdrawn from the aquifer in its alternative applications before making a decision regarding the water bottler's application.

These cases have two things in common. First, they are concerned with different aspects of water resources management. Second, they both require a government agency to measure the value of water and use that information to make a decision. The first of these features is one with which Canadian governments at all levels have a significant amount of expertise and experience. On the other hand, the second of these features is one with which Canadian governments have relatively little expertise and experience. This observation is important because it means that government agencies will likely need to develop the institutional capacity to carry out these types of valuation exercises and incorporate them into their decision-making.

The purpose of this section is to highlight some of the aspects of water resource and watershed planning where it would be most appropriate to estimate the value of water. Before proceeding, it is worthwhile pointing out the following:

It is only worthwhile estimating the value of water if that information is going to used in the management and planning of water resources

This may seem like a blinding flash of the obvious but it is important to see that there is relatively little point in using scarce government resources to estimate the value of water unless that information is actually going to be used to support decision-making process.

The next section presents four case studies related to the valuation of water and the use of this information in water resource management and watershed planning.

Based on the overview in Appendix B, it can be concluded that our ability to estimate the value of water has advanced substantially in recent years. Analytic techniques have become more sophisticated, experience has been gained through applying these methods in a wide variety of circumstances and comparison between models' predictions and consumers' observed behaviour have confirmed the models' validity. As a result, it is reasonable to conclude the following:

> **The theoretical properties of non-market valuation models are well understood. Furthermore, there is enough real world experience with estimating the value of water for Canadian water managers to feel confident in augmenting their watershed and water resources management regimes with an increased reliance on water valuation information. This is not to say that valuation is easy, but rather that it is technically feasible and does provide an opportunity to improve decision-making.**

4.2 CASE STUDIES

The purpose of these case studies is to demonstrate the application of water valuation information to the management and planning for water resources. Furthermore, the order in which the case studies is presented is important since it highlights the areas that water valuation can aid in decision-making:

- *Valuation and allocation decision-making.* The first case study reports on an ongoing Study Board, which is using valuation information to assist in its development of recommendations regarding the allocation of water in the Great Lakes.
- *Cost accounting.* The second case study discusses the valuation methods that will likely be employed shortly by Ontario water and sewage utilities in their efforts to comply with recent legislation regarding their cost accounting and pricing practices.
- *Valuation for utility planning and operation.* The third case study is somewhat more speculative as it presents additional types of valuation methods that could also be used by water and sewage utilities to enhance their planning and operations. The valuation 'tools' exist to carry out these calculations but there is no institutional requirement that they be used. Nonetheless, the third case study demonstrates that there are potentially substantial benefits to their adoption.
- *Valuation and Provincial Water Withdrawal Permits/Licenses.* This case study provides an example of how valuation can be used to assist provinces to attach fees to their existing water permits/licenses.

To complement these case studies, Appendix B provides information on the technical aspects of valuing water. This appendix provides a nice overview of the theory and practice of water valuation and how it is used in decision-making.

4.2.1 Case Study #1: The International Joint Commission's Lake Ontario St. Lawrence River Study Board[9]

The International Lake Ontario-St. Lawrence River Study Board was appointed by the International Joint Commission in 2000. The Board's mission is to consider, develop, evaluate and recommend updates and changes to the 1958 Control Orders for Lake Ontario-St. Lawrence River water levels and flow regulation, taking into account how

[9] Steven Renzetti is a member of the LOSLR Study Board.

water level fluctuations affect all interests and changing conditions in the system including climate change, all within the terms of the Boundary Waters Treaty. The interests being considered include the following: hydroelectric power, commercial navigation, shoreline property owners, recreational boating, municipal and industrial water users and the natural environment[10]. In essence, the IJC has asked the Board to make recommendations regarding how to allocate water amongst these interests (that are sometimes competing and sometimes complementary).

The Board has supported a substantial amount of research that has allowed it to build a large and sophisticated computer model that captures the hydrologic and economic features of the Lake Ontario-St. Lawrence River system. The model employs a large number of "performance indicator" (PI) functions. These show the impact of changes in lake levels and river flows on specific interests. For example, one set of PI functions relates the cost of shipping various cargoes through the lower Great Lakes system as a function of water levels. These costs can rise from the need to reduce boat loads and the possibility of delays in the case of lowered water levels. All of the PI functions are denominated in dollars with the exception of those PI's reflecting the environmental impacts of changing water levels (the Study Board chose not to denominate the measures of environmental impacts in dollars).

A variety of methods are being used to evaluate impacts of water level changes and develop the PI functions. A contingent valuation survey provided estimates of recreational boaters' willingness to pay to avoid low water levels. A review of electricity prices formed the basis for estimating the benefits to hydropower producers of higher water levels. Furthermore, the Study Board is examining whether these electricity market prices must be adjusted to reflect the environmental damages that would be avoided if increased hydropower production displaces 'dirtier' fossil-fuelled generating facilities. A computer model predicts riparian erosion and flooding and provides dollar estimates of shoreline and property damages from high water levels. Another computer model assesses the costs and likelihood of investments being required to augment the water intakes of municipal water systems and industrial water users in the case of low water levels.

While the work of the Study Board is not yet complete (it is currently in the fourth year of its five-year mandate), the direction in which it is moving is clear (International Lake Ontario-St. Lawrence River Study Board, 2004). The Study Board has assembled a significant amount of information regarding the economic and ecological implications of alternative water management plans for Lake Ontario and the St. Lawrence River. The economic and environmental Performance Indicators will serve as the basis for assessing and comparing alternative Regulation Plans. In turn, the PI's will ultimately inform and support whatever recommendations the Study Board makes to the International Joint Commission. Thus, the LOSLR Study Board provides an excellent example of how a public agency can make use of valuation (and other) information to make decisions regarding water allocations within a large and complex watershed.

There are two noteworthy items regarding the working of the Study Board. First, the Study Board is a relatively small group of experts. Its work is supported by academic

[10] The Board's Plan of study and related documents can be found at www.losl.org.

researchers, private sector consultants and a public oversight committee. Thus, the work of the Study Board is subjected to two different types of review: the rigor of academic peer review as well as the oversight of public scrutiny. At the same time, it should be remembered that the Study Board has a five-year mandate and a total budget close to $25 million. The scale of resources available to the Study Board has allowed it to carry out large and sophisticated studies of the economic and ecological features of the lower lakes system.

It is reasonable to conclude that the technical and resource intensive demands required to accurately define the full societal value of water may be beyond the administrative capacity of most jurisdictions. Therefore water valuation as a technique is better used as a concept where the *value gap* is addressed but not necessarily fully defined.

4.2.2 Case # 2: An Example of Full Cost Accounting - Moving Prices in the Right Direction by Closing the Value Gap

When consideration of how economic instruments and measurement methods can be applied to promote the conservation of water, the role of local water and sewage agencies immediately comes to mind. With the possible exception of the provincial regulations regarding permits (or licenses) to withdraw water, the single most important area for policy and operational reform concerns the way in which water and sewage agencies account for their costs and set their prices. This is true for two reasons. The first is that the price of municipal water supply and sewage treatment services is the most important policy instrument available to influence water use by most Canadian households and small businesses. The second is that there is a substantial body of evidence that demonstrates that cost accounting and price setting by Canadian water and sewage treatment agencies are inadequate[11]. The accounting and price-setting practices of most water and sewage treatment agencies lead to consumers being confronted with prices that understate the full cost of their consumption by a wide margin. For example, in a study of Ontario municipal agencies, Renzetti (1999) estimated that prices charged to residential and commercial customers were only a third and a sixth of the estimated marginal cost for water supply and sewage treatment, respectively.

The purpose of this case study is to discuss how market and non-market valuation methods can be used to move water and sewage treatment agencies towards a more complete accounting of the costs imposed on society from their operations. In what follows we review the potentially most important sources of incomplete cost accounting. We then demonstrate the application of these ideas and methods with a case study of a representative water and sewage treatment agency.

Defining the cost of a productive activity is, in principle, fairly straightforward. The opportunity cost of employing an input is the highest net benefit generated had it been employed elsewhere. For example, if a utility borrows $1 million to invest in its infrastructure, the opportunity cost is the rate of return it could have earned over the life of the investment. The full cost of a productive activity is the sum of the opportunity

[11] It is worthwhile noting that these problems were highlighted in the report of the Inquiry on Federal Policy in 1985 (Pearse, Bertrand and MacLaren, 1985).

costs of all inputs[12]. While most of these inputs are purchased or leased by the firm (as in the case of capital or electricity), other inputs may be used without being purchased or leased (as in the case of raw water supplies and water bodies used as a sink for the disposal of sewage outflows).

For a variety of reasons, a government agency or firm's private accounting of costs may differ from the full economic cost of those activities. First, the price paid for an input may not reflect its opportunity cost to society. For example, the generation of electricity causes a variety of environmental damages, which are not included in the accounting of power utilities and thus not reflected in electricity prices. An extreme case of this situation occurs when a firm has access to an input for free. For example, firms in Canada may emit certain substances into the air and water (rather than trap and dispose of them) for free so long as they do not violate emissions regulations. Similarly, sewage treatment plants may dispose of certain substances into lakes and rivers without cost to themselves so long as effluent regulations are met. In each of these cases, the market price of the input does not accurately reflect the cost to society of its use. Thus private accounting of costs understates the full costs of production. Second, there may be accounting document lines set out in government regulations, which dictate the way in which costs are recorded. For example, water supply and sewage treatment agencies may be prevented from assigning a competitive rate of return as part of the opportunity cost of its capital goods. Third, a water utility may receive subsidies from other agencies.[13] These could include direct subsidies such as capital grants from senior levels of government or indirect subsidies as might occur if a municipal water supplier were to receive services from the city's legal department without charge.

Despite there being a fairly strong consensus amongst analysts regarding the theoretical definition of full-cost accounting, applying the concept may not be so simple. The first reason is that analysts and utility regulators differ in how completely they wish to see an agency move to full cost accounting. Some would argue that is sufficient to see that operating and maintenance costs are fully accounted for whereas others would also include capital costs. The latter stance appears to be the position taken by the Walkerton Inquiry and Ontario's new legislation (Government of Ontario, 2002). Still others would argue that all external costs such as environmental damages and the opportunity cost of raw water supplies must be included. This is the position reflected in the European Union's Water Framework Directive. A second factor that inhibits implementation is a lack of standardized document lines for full cost accounting (Government Finance Officers Association, 2001. Finally, because of the novelty of this approach to water and sewage utility accounting, there may be difficulties in obtaining the data needed to estimate some cost components.

To illustrate these issues, we summarize a recent effort to estimate the full cost of service for a representative water supply and sewage treatment agency. Renzetti and Kushner (2004) consider the operations of the Region of Niagara's water supply and sewage treatment systems. The service delivery model in Niagara is split between the Regional Municipality of Niagara and its twelve member municipalities. The Region is responsible for water and sewage treatment plants, trunk water distribution facilities and major

[12] A more complete description of full cost accounting may be found in Cadmus Group et al (2002).

[13] Water Utility Boards may hinder the setting of appropriate water prices.

sewage collection systems including pumping stations while the municipalities are responsible for water distribution and local sewage collection. The total rated normal capacity for the Region's potable water systems is 0.614 M cubic meters/day. A total of 80,717,236 cubic metres of potable water were supplied in 1998. The sewage treatment plants in the Region treated a total of 84,083,335 cubic metres and typically provided primary and secondary levels of treatment.

Renzetti and Kushner examine the reported operating costs of the regional water and sewage agency and then estimate the extent to which those reported costs understate the full social costs of the agencies' activities. The results of that analysis are provided in Table 4.1. There are several entries in Table 4.1 that are noteworthy. First, both market and non-market valuation methods were used to assess the opportunity costs of inputs. Market valuation methods-which are already quite familiar to managers and regulators of water supply and sewage treatment agencies-were used to impute a competitive rate of return on the agency's invested capital. Furthermore, because of the capital-intensive nature of water suppliers and sewage treatment facilities, any underestimation of the cost of capital is going to have significant consequences for the recorded costs of supply. Second, the non-market estimates of water-related inputs suggest that the two most important sources of cost-underreporting stem from the failure to incorporate the value of raw water input to the water supplier and the costs arising from sewage treatment facilities' effluents which lead to diminished water quality and its attendant lost recreational opportunities[14]. Of equal importance, perhaps, is the relatively large range on the estimates of these two values reported in Table 4.1. This reflects the small number of extant studies from which the authors could transfer value estimates.

4.2.3 Case Study #3: Using EIs to Improve the Level of Service

It is well understood that water supply and sewage treatment agencies are highly capital-intensive operations. One of the implications of this is that it is very important for these agencies to get the level of capital investment 'right'. This is because any investment in enhanced water supplies or sewage treatment has an opportunity cost- that is, it could have always been used elsewhere for road improvements, local schools or other public services. From an economic perspective, getting the level of capital investment (and the degree of service reliability or level of water quality implied by it) 'right' means balancing the costs of the investment with the benefits.

Water and sewage agencies, however, have historically viewed these benefits in terms of statistical measures of the likelihood of system failure or the likelihood of not meeting some water quality document line. These are important measures and water and sewage agencies are sometimes mandated by legislation or insurance underwriters to make these types of calculations. Unfortunately, these ways of measuring benefits makes it very difficult to compare them to investment costs and to compare them to the benefits of capital investments for the provision of other public services. As a result, it would be very useful if water and sewage agencies were able to ascertain the level of benefits from capital investments in a way that made them comparable to costs and to the benefits of other investments. One solution is to measure benefits by estimating consumers'

[14] Renzetti and Kushner did not consider the possibility that there may be negative health consequences arising either from exposure to chlorinated byproducts in drinking water or from exposure to sewage treatment plants' effluents.

valuation or willingness to pay for those improvements in system reliability or water quality. Adamowicz et al's work (cited above) on valuing reductions in the risks of waterborne toxins is an example of this approach. In what follows we discuss how water and sewage agencies could use willingness to pay information to assist them in their decision-making with respect to infrastructure investments.

Reliability[15]

A crucial feature of the design and operations of any water supplier is its targeted level of reliability. Demands can at certain periods threaten to exceed system capacity and unexpected breakages can inhibit supply reliability. Thus, no system is one hundred percent reliable. On the other hand, increasing system reliability can often be very expensive. Traditionally, engineers have designed water utilities to meet targets of arbitrarily set reliability (such as meeting peak demands ninety five percent of the time). However, in choosing to meet an arbitrarily defined target, designers do not know whether these targets are the ones desired by consumers and taxpayers. The absence of information regarding consumers' valuation of different levels of reliability means that there can be no assurance that the efficient level of reliability (i.e., that one that equates the marginal costs and benefits of an incremental change in the level of reliability) is achieved.

It may be valuable for water supply agencies to complement their decision-making with respect to capital investments related to system reliability with information on consumers' valuation of improvements in reliability. In this way, water agencies would be in a better position to identify and compare the costs and benefits of differing levels of reliability. This approach recognizes that households and other water users value increased reliability but that the investments needed to achieve this have their own opportunity cost. Municipal councils recognize that any funds allocated to improving water system reliability could have been invested in improved roads, schools and hospitals-these are all things that households value. In order to assess these benefits and costs, however, information regarding households' (and other customers') valuation of differing levels of reliability must be ascertained.

A recent nation-wide survey asked Canadians if they would be willing to pay more for their water supply if the added payments were directed at repairing water distribution and sewage treatment systems. The survey of 1500 households found that the average household willingness to pay for improved water system reliability was approximately \$26.00/month over and above current water supply payments (Rollins, Frehs, Tate and Zachariah, 1996). This is a fairly remarkable finding since, at the time of the survey, the average household monthly water bill was approximately \$22. This survey is important for several reasons. First, it demonstrates the usefulness of the contingent valuation methodology (CVM, a survey based approach to elicit the value people place on changing water and air quality) method of eliciting consumers' preferences regarding water prices and the quality of water supply. Second, it should help to lay to rest one of the most often heard criticisms of proposals to raise water and sewage rates in support of infrastructure rehabilitation. Critics (perhaps on local city councils) have often argued that households would not support this type of development. This survey strongly

[15] This section is based on Renzetti (2004).

suggests that this line of argument is not supported by real world evidence and it hints to the reason why this is the case. It has been found in many CVM studies that consumers have much more confidence in a proposal to improve environmental quality (and, as a result, are more willing to pay for it) if the survey indicates that the respondents' hypothetical payment would be earmarked for the stated purpose rather than going into government's general revenues. Thus, most CVM studies related to water quality improvements state that households' payments will be done through higher water and sewage prices rather than an increase in the level of sales or income taxes.

One shortcoming of the Rollins study is that the wording of the question regarding improvements to water and sewage systems was somewhat ambiguous. As a result, water and sewage agency managers might be hard pressed to use its results directly to support increased infrastructure spending. This shortcoming can be addressed by making the survey questions much more specific. For example, Howe and Griffin Smith (1993) conducted a CVM survey of U.S. households and found that Colorado residential water users were willing to pay approximately $60 US annually beyond their current water bills in order halve the likelihood of a major system failure[16]. Once aggregated, these willingness to pay estimates could be compared to the costs of achieving this increase in reliability in order to determine if the investment is merited.

Water Quality Improvements

The quality of publicly supplied drinking water is of critical importance to water supply agencies and consumers and to Canadian households. In a series of public opinion surveys (Environics, 2000) Canadian families expressed serious reservations about the quality of their tap water. A remarkable 12 % of respondents said that tap water poses a high health risk to Canadians, while 38% of respondents said it poses a moderate health risk. With these kinds of sentiments being expressed it is not surprising that a growing number of Canadian households are switching to bottled water as their primary source of drinking water (Dupont, Renzetti and Roik, 2003). These changes, however, come at a cost. While the average cost of tap water in Canada is approximately $\$1.25/m^3$, bottled and delivered water often costs tens and hundreds of times more than this. This is clear market evidence that many Canadian households are willing to pay significant amounts for what they perceive to be higher quality water.

There is also a large body of research that documents households' willingness to pay for improvements in the quality of public water supplies. The development of the contingent valuation method provides researchers with a powerful tool to examine households' perceptions of the risks associated with water consumption and the value they place on addressing those risks. Representative of CVM–based research is the work of Jordan and Elnagheeb (1993). The authors conduct a CVM survey of households in Georgia, U.S.A, in order to determine their valuation of an improvement in drinking water supplies from a reduction in nitrate levels. In the survey, publicly supplied households were told that the water agency "will make sure that your water is safe for drinking but will increase your monthly water bill". While the researchers are unable to test whether households all have

[16] Specifically, respondents were asked their WTP to reduce the risk of a situation where outdoor water use would be restricted to 3 hours every third day for July, August and September from 1 in 300 to 1 in 600 for Boulder, Colorado and from 1 in 10 to 1 in 30 for Aurora, Colorado.

the same perception of what is 'safe', average WTP is $10.07US/month for publicly supplied households. Aggregating over Georgia's population yields an estimate of $153.8 million as the aggregate annual benefit for water quality improvement.

This case study has considered the application of specific types of demand-side information to a number of facets of water and sewage agency planning and operations. For many of these agencies, the idea of gathering and analyzing data on features such as consumers' willingness to pay for infrastructure improvements is unfamiliar. Nonetheless, many other utilities (including Los Angeles, Seattle and Toronto) have experimented with price and non-price measures to conserve water use and have used information regarding water demands to assess the costs and benefits of major infrastructure projects.

4.2.4 Case Study #4: Valuation and Provincial Water Withdrawal Permits/Licenses

Federal and provincial governments have the responsibility for deciding how to allocate the waters under their respective jurisdictions. As a result, each government must choose between two options: it may retain direct control over the allocation of water through a permitting system or it may establish some other mechanism to allocate water-the most common of which is a market-like mechanism. If a government chooses the first option it is deciding that it will set the **price of water** and allow potential water users to decide the quantity of water to be withdrawn (subject to government approval). Alternatively, if a government chooses the second option, it is deciding that it will set the aggregate **quantity of water** that may be withdrawn and allow the selected mechanism to determine the price of water.

With the exception of Alberta's recent interest in employing water markets to allocate water (i.e. Water for Life Strategy), provincial governments have chosen to retain direct control over the allocation of water-that is, the first option. Thus, water may be withdrawn only after the government has approved an application and issued a permit or license to withdraw a specified quantity of water. In some provinces, a fee is charged for the permitted water withdrawal. In some cases only an application fee is charged for all non-domestic uses (Newfoundland and Labrador) while in others (notably British Columbia, Nova Scotia, and Saskatchewan) an annual fee based on volume of water used is added to application fee. Also, Newfoundland and Labrador collects annual water power rentals for water use licences issued for water power uses.

The nature of provincial water permit application processes (including any fees charged) provides little reason to believe that they result in the efficient allocation of water. There are several reasons for this (see the discussion in Dupont and Renzetti, 1999), but perhaps the most important concern is the fee that is charged for permits/licenses to withdraw water. Specifically, the basis for these fees has never been clear. They do not appear to be aimed at recovering program costs. They are too low to be considered as a serious effort to tax the rents arising from water use. Finally, there is no reason to think that they signal the opportunity cost of water use. This last point is crucial because it is a necessary condition for the efficient allocation of water. If potential water users are not confronted with the information regarding the opportunity cost of their desired level of water withdrawal, there is little reason to believe that they will choose the efficient level of water use.

Thus, if provincial governments are going to continue to rely on the direct control of the allocation of water through a permit system and if those permits/licenses are to have fees assigned to them, governments should decide what purpose(s) the fees are to have. Note: there is a difference between permit/licence fee and water rental and the objective of each.

For example, the Government of Ontario announced recently its interest in levying a fee in association with its Permit to Take Water program and argued that such a fee could (1) promote efficient water use and conservation and (2) ensure that water users pay their fair share towards the upkeep of government programs aimed at protecting water resources (Ontario Ministry of the Environment, 2004). The challenge is that these two goals may have different implications for the form of the fees to be charged. If the purpose is to recover program costs, fairness in the sharing of costs is paramount. Furthermore, it suggests that the government is not expecting a behavioural response in the way of reduced water use. In this case, the government may want to tie the fee either to the structure of its programs costs or to the benefits derived by the application from the government programs that fees support (e.g. the protection of water quality). On the other hand, if fees are to promote efficient water use, then they need to reflect opportunity costs of water use. This would suggest fees possibly differentiated by season, location and type of water withdrawn (groundwater vs. surface).

Reminder on Variables
A = annual licence fee ($/year)
t = volumetric charge ($/m3/year)
s = spatial characteristic variable
T = temporal characteristic variable
Qin = quantity of intake water
Con = proportion of water consumed to water intake
Z = characteristic variable that differentiates water users (eg., SIC, annual revenue).

Table 4.1 provides a summary of some of the alternative forms for the water use fee.[17] In general, there may be two components to the charge: an annual fee of $A/year and a volumetric charge of $t/m^3/year. As Table 4.1 indicates both A and t can be fixed constants that are the same for all users or they could be differentiated across users. In general, if a permit holder is anticipated to have an annual post-charge intake of X m^3 /year, then its total liability under the fee structure would equal $(A +tX) per year. It is also possible that a fee could be based, in part, on the consumptive aspects of industrial and agricultural water use. Water consumption is different from water intake and is generally measured as the difference between water intake and water discharge. In the case of irrigation, consumption may be measured as the difference between withdrawals and estimated return flows. If the fee were to include an additional charge on annual water consumption of $c/m^3/year then the plant's or farm's liability would be $(A + tX + cY) where Y is the anticipated post-charge level of water consumption.

As one moves down the rows of Table 4.1, the fee structure becomes more sophisticated in its ability to promote efficient water use while earning revenue for the government. It also becomes more complex and, as a result, more costly to administer. Part of these costs would result from the valuation work needed to estimate (and regularly monitor) the appropriate level for the parameters A, t and c. For example, many observers have

[17] This discussion is based on Renzetti and Dupont, 1997.

applauded the use of economic instruments by European countries to promote water conservation and to enhance water quality and have acknowledged the sophistication of those charges (they are often differentiated according to waterbasin and industrial classification of water user). On the other hand, researchers have criticized the level of withdrawal charges and effluent fees used in European countries for being too low to alter water users' decision-making (Brown and Johnson, 1984, Roth, 2001).

The different levels of complexity of the fee structure in Table 4.1 and the experience of European countries with water-related economic instruments suggest a potentially important conclusion. In most matters of public policy, the law of diminishing returns holds true. In the context of the choice of the structure of a water use fee, this suggests that if a province wishes to introduce fees to complement its water permit system, it needn't look to the last row of the table for the optimal fee structure. Rather, a relatively simple fee structure backed with a reasonable amount of research regarding the opportunity cost of water is likely to yield almost as much benefit as a more complex fee structure that does not motivate users to alter their decision-making with respect to water, water-using technologies and future capital investments.

Table 4.1
Alternative Forms for the Water Use Fee

Forms	Advantages	Disadvantages/Challenges
1. $A=A_0$, $t=0$ Uniform licence fee, no volumetric charge	a. simplest to administer b. collects revenue with no distortion to firms level decision-making c. does not require metering	a. little or no efficiency gain b. does not differentiate between Fixed and Variable costs of water supply c. inefficient if opportunity costs vary in space, time, or with quantity d. does not differentiate A_0 across users, if appropriate
2. $A=g(Z)$, $t=0$ Sector specific licence fee, no volumetric charge	a. simple to administer b. little distortion c. no metering needed d. improved equity over 1.	a. little or no efficiency gain b. problems choosing and defining Z variable c. does not differentiate between Fixed and Variable costs of water supply d. inefficient if opportunity costs vary in time or with quantity
3. $A=0$, $t=t_0$ No licence fee, volumetric charge	a. still fairly simple to administer b. some efficiency gain	a. inefficient if opportunity costs vary in space or time b. confuses Fixed and Variable costs of water supply c. increased level of monitoring required
4. $A=A_0$, $t=t_0$ Licence fee and volumetric charge	a. allows Administration and Variable costs to be collected separately	a. does not differentiate A_0 across users, if appropriate b. inefficient if opportunity costs vary in space or time c. increased level of monitoring required
5. $A=A_0$, $t=f(s, T)$ Licence fee and volumetric charge based on spatial and temporal differences	a. improved efficiency features if volume charge varies in time and space b. allows Administration and Variable costs to be collected separately	a. does not differentiate A_0 across users, if appropriate b. substantially more complicated than (1.-4.) c. increased level of monitoring required d. valuation required
6. $A=g(Z)$, $t=f(s, T)$ Sector specific licence fee and volumetric charge based on spatial and temporal differences	a. improved equity over (1.-4.) b. allows Administration and Variable costs to be collected separately	a. problems choosing and defining Z variable b. substantially more complicated than (1.-4.) c. increased level of monitoring required d. valuation required
7. $A=g(Z)$, $t=f(s, T, Con)$ Sector specific licence fee and volumetric charge based on spatial, temporal and consumption differences	a. most sophisticated, allows volume charge to vary also by degree of consumptive use. b. improved equity over (1.-4.) c. allows Administration and Variable costs to be collected separately	a. problems choosing and defining Z variable b. requires a lot of monitoring c. substantially more complicated than (1.-4.) d. valuation required

Definitions of the variables in Table 4.1:

A= annual licence fee (\$/year); t= volumetric charge (\$/m^3/year); s= spatial characteristic variable; T= temporal characteristic variable; Con= proportion of water consumed to water intake; Z= characteristic variable that differentiates water users (e.g., SIC, annual revenue).

5. LESSONS LEARNED: SUMMARY

In this section, we provide summary observations for moving EIs forward in Canada We identify what works, doesn't work and provide some insight on overcoming barriers.

5.1 WHAT WORKS

1. Prices that reflect costs

Developing accounting and pricing rules that reflect the full-cost of water supply and sewage treatment is the single most important thing that municipal and regional governments could do to promote efficient water use. A precondition for this effort is the presence of universal water metering and having in place the management and accounting systems to accurately document water and sewage agencies' capital, operating and external costs. Provincial governments should strongly consider fully Ontario's example of putting in place the legislative requirements for full-cost accounting and pricing.

2. Decentralized decision-making

Much of the innovation in water resources management has come from local and regional agencies responsible for water management. A good example of this is the phosphorous trading program developed by the South Nation Conservation Authority. These agencies perform best when their innovations and information-sharing is encouraged and supported by federal and provincial governments. Furthermore, water-users who are fully informed of the costs and benefits of their water-using activities *are* in the best position to determine efficient water use levels and practices *not government decision makers*. Government simply provides the rules of the game or the framework in which the EIs are implemented, recognizing aspects of good governance including transparency, equity, and efficiency and being consistent with established policy.

Perhaps the most important implication of this perspective is that provincial governments need to adjust their approach to water taking permits/licenses and move towards a system where allocations are routinely updated to reflect use *and* conservation objectives. To make this transition, the evidence from around the world suggests that a cap and trade system of water use permits/licenses is superior to the continued use of nontradable water permits/licenses. Under these schemes, allocations are set based on historical use recognizing *all* established users and then the cap is lowered over time to reflect conservation objectives – this is often done within the existing permitting/licensing system and not through auctioning the permits to the highest bidder. Then, each allocation holder becomes a decision-maker who responds to the reduced allocation by either: reducing use to achieve the target; over complying and selling the excess allocations to others; or doing nothing and buying allocations from those who have reduced use. Within this context, it is the governments' obligation to set the rules of the game and monitor outcomes to ensure that environmental, equity and economic efficiency objectives, for example, are met.

A number of provincial governments have demonstrated a significant amount of interest in reforming or introducing fees of varying complexity for these permits/licenses while retaining control over the issuance of permits/licenses. While this is a solid step in the right direction, the provinces should also consider introducing allocation schemes that enable trading (see Horbulyk and Lo, 1998 for an example). One conservative approach is develop experimental case studies in water-short regions to gain experience with them. However, trading may not be an issue in some provinces, such as Newfoundland and Labrador, where multiple-use is relatively rare. In that case, having a system of trading regulations may not be necessary because it will be rarely used.

3. Integration and co-ordination

There are two features that will reinforce the effectiveness of introducing EIs (particularly prices and charges) into water management in Canada. The first is integrating scientific knowledge regarding water quality and water scarcity with accounting and economic models of the costs of water and sewage agency operations. This will promote truly full-cost pricing by reflecting the social costs of water pollution, foregone recreational opportunities and even human health damages in water and sewage prices. Because research in this area is still being developed and because the development of new analytic measurement methods would benefit all Canadians, this is an ideal area for increased federal government support.

The second feature is coordinating the introduction of EIs with other measures to promote awareness of water scarcity and conservation. Experience from other jurisdictions-especially California- strongly suggests that EIs are more effective when combined with educational and advertising efforts. Thus instrument "packaging" should become imbedded in water management and conservation programs.

4. Close the Value Gap

Closing this value gap, or the gap between actual water prices and the full societal cost of water use, is the opportunity that EIs provide, as well as the challenge that they present. Practically speaking, movement to *increase the price of water is likely movement in the right direction,*[18] and in fact, given institutional and other limitations, may be the most desirable path forward for water managers contemplating EIs. This lesson is an important one, since "moving in the right direction", and specifically, increasing the price of water, can result in expected and unanticipated but positive outcomes (such as promoting water-conserving technological innovations).

When the value gap is large, small changes in the price of water will likely result in significant demand responses. It can also be expected that the demand response will decrease as we approach the full societal cost of water. This notion of diminishing returns or diminishing responses to increasing water prices results because behaviour has already been altered and with each successive price increase there are fewer opportunities to reduce use. Closely allied is the "fatigue" effect where users become desensitized to price increases and therefore additional price changes are required to further stimulate conservation over time.

5.2 WHAT DOESN'T WORK

1. Complexity

[18] Note that in cases of municipal prices, the presence of cross-subsidization means that reforming prices might require decreased prices for some users and increases for others.

For many agencies, the types of reforms discussed in this report are novel and represent a shift from current administrative functions. Because of this, it is suggested that the form of EIs be kept as simple as possible. This will facilitate developing methods to forecast the impacts of the EIs and lessen the chances for water users to see inequities and unequal treatment of users arising. A specific example of this approach is the following: a number of municipal councils have recently adopted multi-part, increasing block rate water price structures which are designed to promote conservation. It is very difficult to anticipate the impacts of these price structures. An alternative is to retain a simple constant price structure but adopt a summer surcharge to reflect higher supply costs and greater water scarcity during dry summer months.

2. Conservation for the sake of conservation

If prices, fees and charges do not reflect full measured opportunity costs of water use, then they may be perceived by the public to be revenue-generating devices disguised as environmental policy measures. Thus, when prices are raised or charges are introduced to "encourage conservation" there must be a sound case that these prices and charges really do reflect the costs of water use rather than fiscal instruments being introduced to simply reduce water use.

5.3 OVERCOMING BARRIERS

1. Preparation of EI Programs

The U.S. EPA is arguably the world's largest and most sophisticated environmental regulator in the world. Nonetheless, when it introduced its highly successful sulfur dioxide trading system (Rico, 1995), it was almost incapable of managing the information needs of the program. An important lesson from this is that when Canadian water agencies are considering the adoption or increased reliance on EIs or water valuation they must first examine their administrative capacities and ask whether they are up to the task. Instructional limitations and the context in which EIs are implemented can be a significant barrier to the effectiveness of EIs.

2. Transparency

Engaging the public in all aspects of the decision-making regarding the adoption of EIs provides many benefits. As recent experience indicates, ranging from conservation authorities, Ontario's Remedial Action Program and the Lake Ontario-St. Lawrence Study Board of the IJC, including the public provides additional sources of experience and knowledge and often adds legitimacy to water agency proposals. As well, public perceptions about water abundance and resistance to perceived tax "grabs" are significant barriers to implementation, and consultation and communication is therefore an absolute necessity to ensure EIs are successful.

3. Equitable Application

A major lesson from the provincial case studies is that EI programs need to be equitably applied. A narrow focus or application has significantly slowed the development and implementation of new EIs. Thus, water managers should adopt a broad-based approach to EI design from the outset.

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APPENDIX A

Canadian Provincial Experiences with Economic Instruments

British Columbia Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

In 1997, the MWLAP brought together a Working Group of representatives from all three levels of government, as well as industry, professional associations and interest groups to develop a *Water Conservation Strategy for British Columbia.* The strategy is to promote supply and demand-side management for water users. Other goals of the strategy are to encourage a more comprehensive approach to managing water supply systems and an evaluation and reporting program was created to assess program progress towards the goals.

B.C. has water abstraction permit fees and charges administered by Land and Water British Columbia to recover the costs of water management. Water responsibilities are fragmented, making direct measures by the province difficult. A Crown corporation is responsible for water licensing and allocation. The provincial Plumbing Code is being used for water conservation, through municipalities.

INSTRUMENTS AND TARGETED GROUPS

In British Columbia, the provincial government has no direct regulatory authority to institute charges for water conservation and so such measures to address this issue must be carried out through amendments to other regulations. The Ministry of Water, Land, and Air Protection (MWLAP) is involved in the promotion of water efficiency programs to municipalities. Municipalities have authority over the provision of drinking water. A number of municipalities have been looking at metering and higher rates for water. The provincial government is providing enabling regulations to allow municipalities to introduce water efficiency devices. Low flow water fixtures are required in new construction or renovations in BC through the *Water Conservation Plumbing Regulation.* Eventually, municipalities applying for infrastructure grants may be required to demonstrate water efficiency, and that water audit and leak detection programs are in place. BC is also developing a *Waste Discharge Regulation* that would focus on high-risk and medium-risk activities.

Land and Water British Columbia Inc., a Crown Corporation, is responsible for water resources allocations, regulating water utilities and developing water-use policies under the *Water Utility Act.* The Corporation is also involved in protection activities and provides information and incentives for water conservation. As a result of a recent drought in some regions the Corporation developed a *Provincial Drought Management Action Plan.* The plan includes measures to improve drought preparedness and water conservation in communities as well as raising funds for public information campaigns. Water is still allocated on a first come, first served basis.

BARRIERS AND LESSONS LEARNED

The issue of regulatory authority is a considerable impediment to provincial introduction of economic instruments for water conservation and protection in British Columbia.

Provincial authorities stated that the public perception of the value of water is expected to be a strong determinant in the effectiveness of economic instruments and other conservation activities.

Manitoba Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

The province of Manitoba adopted the *Water Strategy for Manitoba* in April 2003. The provincial government is planning to continue to develop other instruments to encourage conservation including licensing fees and use-based charges.

The *Water Strategy for Manitoba*'s goal is to ensure the availability of province's water resources to meet priority needs and to support sustainable economic development and environmental quality.

INSTRUMENTS AND TARGETED GROUPS

The conservation policies of the *Strategy* are to be achieved through regulations, incentives, education, and watershed-based integrated management of resources. Manitoba is looking into using economic instruments for water to serve a number of purposes such as demand side management, generating revenue, rewarding water efficient behaviour (through incentives) and discouraging inefficient behaviour (through disincentives).

In Manitoba, the volumetric charges in place, focused on irrigators and industry, are no longer reflecting the cost of providing the water service. Nominal fees for water right licenses allow the extraction of water but the cost of these only represents about one third of the administration cost of the license itself, and none of the cost of the water services. The province is also involved in a number of educational initiatives to promote greater water efficiency.

Charges for water services already exist in most municipalities in Manitoba. Most municipalities are metered and some level of charge for water consumption and wastewater services is present on a system cost recovery basis. Municipalities supplement water conservation with education materials.

Manitoba Water Stewardship is currently partnering with others in North American to conduct water efficiency related research. This coordinates research to ensure maximum effectiveness for expenditures, and enables expertise from across North America to collaborate in design and completion of research. Partnering with other agencies within Manitoba is also on-going.

BARRIERS AND LESSONS LEARNED

Public consultations and workshops have helped guide Manitoba's water strategy development. Further public consultations concerning the implementation of the Strategy are planned.

The province has observed that the public has a tendency to view economic instruments as just another tax and thus are resistant to their adoption. However, as was the case for the introduction of environmental levies for drinking cartons and cans in Manitoba, the instruments are much more easily adopted when the revenues created are earmarked in a specific fund for protection and conservation efforts. Manitoba also promotes a suite of instruments, from incentives to education, to attain more efficient water use in the province.

New Brunswick Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

New Brunswick has not established EIs for water but is currently drafting the Water for Life Strategy to address the issue of water use in the Province. A consultation document regarding the Water for Life Strategy is currently expected to be released towards 2006.

Thirty different watersheds supplying municipal drinking water have been identified in New Brunswick. These designated watersheds cover only four percent of the province's total land area, but service 21 communities and more than 300,000 residents. Experience has shown that it is far more cost effective to protect a watershed properly, than to clean a contaminated watershed or to find an alternate water supply. For this reason, the New Brunswick Government has developed the Watershed Protected Area Designation Order as a pro-active approach to watershed protection. Relevant acts and regulations governing water use and supply include:

- **Clean Water Act.** The *Act* details the order-making powers of the Minister, which provide a means of controlling or stopping the discharge of contaminants into water, or of requiring the clean-up of contaminated sites. Regulations and Orders under the *Act* include:
  - *Watercourse and Wetland Alteration Regulation.* Requires individuals planning a project that alters or diverts a watercourse (surface water) or wetland to obtain a permit from the Minister. The Minister may impose terms and conditions on a permit, including those restricting the extraction of water
  - *Wellfield Protected Area Designation Order.* Protects municipal wellfields by providing standards for chemical storage and land use activities around designated wellfields. Activities that adversely affect the quantity or quality of water in a public ground water supply system are not permitted.
  - *Watershed Protected Area Designation Order.* Protects municipal watersheds by providing standards for chemical storage and activities in and around designated watersheds. Places restrictions on the amount of water that may be extracted from a designated watershed.
  - *Water Classification Regulation.* Used to classify inland surface waters. The regulation sets goals for water quality on a watershed basis. It establishes water quality classes, and the associated water quality standards, and outlines the administrative processes and requirements related to the classification of water. The regulation has been developed to help watershed and other community-based groups to plan and set goals for surface water quality and watershed management.

- **Environmental Impact Assessment Regulation under the Clean Environment Act.** Requires individuals proposing certain projects to register with the Minister. Waterworks that extract greater than 50 m3/day must be registered. Minister may place restrictions on the amount of water extracted from surface and ground water sources by persons operating a registered waterworks.

- **Water Quality Regulation under the Clean Environment Act.** Establishes an approval process for the construction, modification and operation of a source of contaminant, sewage works or waterworks. Only "waterworks" that extract greater than 50 m3/day are regulated. The Department has occasionally used the regulation to control water extraction by industry, however, the general intent of the regulation is to protect the quality, not quantity, of public water supplies in New Brunswick.

INSTRUMENTS AND TARGETED GROUPS

Options being considered for economic instruments for water include: the use of royalties per unit of water used; and a permitting scheme with fees. However, the provincial government currently lacks regulatory authority to charge fees directly to users. Although this situation may be resolved in the future, the means available to regulate water extraction lies in the Environmental Impact Assessment policy. Through the policy, anyone extracting more than a certain amount of water per day may be required to register the project with the Minister who, in turn, will assess whether an environmental impact assessment is required or if a certificate of determination will be issued with conditions attached.

BARRIERS AND LESSONS LEARNED

The Department of the Environment and Local Government feels that the development of an economic instruments strategy at the Provincial level requires consideration of equity, the state of the resource and the costs associated with its delivery. In addition a significant amount of time must be allotted to this type of undertaking.

Newfoundland and Labrador Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

The province of Newfoundland and Labrador has a comprehensive water use allocation system under the *Water Resources Act*. The province ensures that the water resources will be protected, conserved and enhanced to provide the greatest possible sustainable benefits to the province's inhabitants. To accomplish this, the province sets water management priorities, continue monitoring of chemical, physical, hydrological and ecosystems parameters, enforce existing and new legislation, sets standards and disseminate information, all in partnership with all stakeholders. Of interest is that the *Water Resources Act* enables economic measures such as incentives, royalties, subsidies, administrative and other fees and water use charges, for the purposes of ensuring the conservation and proper utilization of water resources, and for the financing of programs and other measures. This enabling mechanism, which ultimately allows EI based regulations to be developed, significantly reduces the legislative and jurisdictional barrier to EI implementation that likely exists in other provinces. As well, the *Water Power Rental Regulations* enables the application of water power rentals for water power generation in the order of $0.80 per megawatt hour generated. The water power rentals are oriented to capture some of the value in use of water to generate water power.

INSTRUMENTS AND TARGETED GROUPS

The major water users in the province are thermal and power generation, and the municipalities and the pulp and paper. Fish processing, agriculture, aquaculture, water bottling and other commercial and industrial water users are not as significant. Priorities concerning water use are given primarily to domestic and municipal uses, followed by agricultural, commercial and institutional, industrial, thermal and power generation, and finally other purposes. Under the *Water Resources Act*, water use licenses will be required for any non-domestic uses. Provisions for the use of economic instruments are found in the *Water Resources Act*, however these are not presently implemented with the exception of water power uses. The province implemented water power rental regulations that provide for the collection of rentals from water power developments subject to the regulation. There are also application fees for all uses, which have been implemented since 1996, and are collected by the Water Rights Section of the Department of Environment and Conservation. Licences are not needed for domestic uses and cases where existing rights apply. However, the *Act* states a right to the permanent diversion or to the exclusive use of water shall not be acquired by a riparian owner or another person by length of use or otherwise than in accordance with the *Act*. Unlike most provinces the *Act* has no minimum amount for water withdrawal that exempts non-domestic uses from obtaining licences which is considered to be a distinguish measure for water conservation in that province.

BARRIERS AND LESSONS LEARNED

The involvement of all stakeholders in the process of developing a water resource use system to protect and conserve the water resources was a priority. The province was involved in numerous consultations during the development of the *Water Resources Act,* as was the case for the *Environmental Protection Act*. The province also deemed important that, when concurrent applications for water use were provided, priority be given to certain types of uses. An interesting lesson is that a blanket provision to enable EIs was included in the *Water Resources Act,* thus making it easier to ultimately develop and implement EIs.

Nova Scotia Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

Charges are based on the amount of water withdrawn with an increasing block rate to promote water conservation. However, the charges do not reflect the cost of the service or its additional impacts and charges a fee for the licence.

The government of Nova Scotia released a *Drinking Water Strategy* in 2002. The focus of the Strategy is water quality and safety but it also addresses aspects of water conservation. The *Strategy* offers consideration for financial tools to address water issues. The strategy also mentions that the cost of sourcing, treating, and delivering safe drinking water should be included in the cost conveyed to the user. Nova Scotia has required licenses for water withdrawals since 1919.

INSTRUMENTS AND TARGETED GROUPS

Some economic measures are considered in the *Strategy;* specific financial tools are to be assessed and reviewed at the local level to adopt the most appropriate approach to water cost recovery.

The original intent of the licence and associated fee was fundraising for general government initiatives and the focus, until 1970, was on hydro-electrical facilities. The licence was based on the horsepower capacity of the turbines. Beginning in 1970, all other types of water withdrawals from any user were subject to obtaining a licence for water withdrawal. Licenses are now based on the amount of water withdrawn and are granted for a maximum of ten years. Exemptions have been given to farmers who are required to obtain a water withdrawal licence but are not required to pay the fee. A partial exemption has also been given to the aquaculture industry but both these exemptions are considered temporary. An increasing block rate was introduced in 1991 for the water withdrawal license to promote water conservation, however, most users are small municipalities who pay on average about $200 annually for their water withdrawal licence. The fee for the license is accompanied by an annual administration fee of $532.50 for hydro-electrical facilities and $213 for all other users. The licence fees are used as general revenue and the administrative fees are used to finance the approval system.

BARRIERS AND LESSONS LEARNED

Charges that do not reflect the true cost of water use are not effective in reducing consumption.
Targeting all water users is seen by the public and stakeholders as the most equitable approach.
A monitoring system is key to proper management of economic instruments.

One main problem with the present system is the lack of monitoring and reporting on water use by users. The users are required to report on water use but few have been fulfilling this requirement and monitoring has been lacking. The importance of such functions is clear when full cost recovery or water conservation become goals.

An advantage of the Nova Scotia situation lies in the long-standing history of water fees.

Ontario Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

Water and Sewage Service Rates: Full Cost Pricing. The *Sustainable Water and Sewage Systems Act, 2002*, once proclaimed, will require that the full cost of providing water and sewage services, including capital and operating costs, as well as source protection costs associated with providing these services, be accounted for and recovered by municipalities. For the *Act* to be proclaimed, regulations need to be developed that specify requirements for reports and plans that municipalities will be required to prepare.

Permits To Take Water. In December 2003, the Government of Ontario imposed a year-long moratorium regulation that was intended to ensure that no new permits would be issued for specific highly consumptive uses (e.g. water bottlers, soft drink producers, aggregate processing) that would remove water from the watershed, in any watershed in southern Ontario and watersheds in northern Ontario where a conservation authority exists, while new rules governing water takings in the province were being developed. The moratorium did not apply to municipalities or farmers. A new Water Taking and Transfer Regulation (Ontario Regulation 387/04), that came into effect on January 1, 2005, requires the ministry to refuse applications for new and expanded takings for these specific highly consumptive uses that remove water only from watersheds that already have a high level of use. In addition to defining ecosystem impacts that the Ministry of the Environment considers when reviewing permit applications, the new regulation specifies the factors the Ministry considers when reviewing permit applications, including water conservation.

INSTRUMENTS AND TARGETED GROUPS

Water Taking Fees and Charges. On December 23, 2004, the government announced administrative fees for permits to take water. Effective April 1, 2005, permit applicants will be required to pay an administrative fee for permit applications. The fee will recover the ministry's costs to review these applications. Water takings for irrigation and frost protection for agricultural purposes, including vegetable crops, fruit orchards, flowers, nurseries, tree and sod farms, tender fruit and aquaculture (fish farming) are exempt from permit fees. The Ministry intends to bring forward a proposed framework for water taking (abstraction) charges in 2005 that may include volume-based charges for water takings that remove water from the watershed for commercial purposes, to contribute to the costs of managing a sustainable and healthy supply of water in Ontario. The Ministry is reviewing options for a volume-based water taking charge as a result of comments received from stakeholders during consultations on the Source Protection Planning White Paper (released February 12, 2004), and the recommendations of the Source Protection Planning Implementation Committee (released December 14, 2004). Water bottlers, for example, would not be opposed to a water taking charge if it was imposed on all users.

South Nation River Total Phosphorus Management Program

Considering the use of other instruments, Ontario has been monitoring the South Nation River watershed and its regulated water quality trading program. The program, started in 1999 and known as Total Phosphorus Management (TPM), requires that wastewater dischargers control their phosphorus loadings into the receiving waters of the watershed. The approach taken provides new and expanding wastewater systems the choice of either employing a higher level of treatment technology to maintain current phosphorus loadings or investing in best management projects to offset their loading by a ratio of 4 to 1, i.e. 4 kilograms for every 1 kg in increase in phosphorus load. The latter is accomplished through the purchase of phosphorus credits from rural landowners, primarily farmers, by wastewater dischargers. The program is run by a multi-stakeholder committee, and all project field visits are done by farmers rather than paid professionals. South Nation Conservation, a community- based watershed organization, provides administration of TPM monies.

BARRIERS AND LESSONS LEARNED

A number of lessons learned were identified through the South Nation Watershed water quality trading efforts and the water abstraction considerations. In the trading program, clearly defined water quality enhancement goals and targets are essential, as is a good understanding of both point and non-point sources of pollution and their contributions to the phosphorus loading. In addition, a written management agreement between the point source discharger who will be participating and the body responsible for administering the trading program is an important element. In the case of potential water abstraction charges, targeting all commercial and industrial users shows to be an important aspect in finding support for such an instrument. Involvement of all potential stakeholders in the process is a crucial enabling factor for economic instruments. In addition, it must be acknowledged that trading and other economic instruments complement but do not replace the more traditional government regulatory process.

PEI Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

Prince Edward Island's (PEI) *Drinking Water Strategy* is an action plan to ensure the safety and quality of PEI's drinking water. In PEI, no provincial policy introducing economic instruments for water is intended in the near future. Water charges are present at the municipal level but the rates are too low to provide an economic incentive to reduce water use or recover service costs.

PEI's drinking water is obtained from groundwater supplies, which are not expected to reach their limit soon.

INSTRUMENTS AND TARGETED GROUPS

The *Strategy* uses a multi-barrier approach to protecting drinking water, focusing on source protection, system design and operation, and monitoring and reporting. Water fees in PEI are a municipal jurisdiction and water rates are set by the city councils and must be approved by the Island Regulatory and Appeals Commission. Municipalities that have approved water rates include some of the largest municipalities in PEI such as Charlottetown, Cornwall, Summerside and Stratford. Combined drinking water and sewer rates are charged to the metered commercial and industrial sectors of the municipalities and total about $300 per year. The residential sector is not metered or charged. The charges presently collected do not provide full cost recovery for the water services provided by the municipalities.

The generated funds are not earmarked for specific uses as the rates were established for the purpose of raising general municipal funding. These rates are too low to provide an economic incentive to reduce water use and municipalities are typically not combining these charges with educational/informational programs to reduce water demand. In some municipalities, the water authorities, previously called water boards, were a separate body within the municipality with a separately elected council. This is no longer the case since the amalgamation of a number of cities in Prince Edward Island led to the absorption of the water boards into the municipal structure.

The provincial government does have educational/informational programs promoting water conservation. The Province gathers information on the water extractions and discharges and is in the process of accumulating information and expertise on the science behind Prince Edward Island's water resources. Some thought has been given to water extraction fees but no concrete work has yet been done towards developing such a fee.

BARRIERS AND LESSONS LEARNED

The province recognizes the need for economic instruments to reflect the value of the resource however, and the value of water services. The difficulties in introducing economic instruments or charges lie partly in the fact that the public does not believe there is a water supply problem.

Québec Case Study

STATUS OF THE WATER STRATEGY AND RELATED ECONOMIC INSTRUMENTS

A comprehensive water policy, which includes intentions to introduce economic instruments for water, has been developed and is being implemented. The objectives of the *Politique nationale de l'eau*, adopted in 2002, involve the protection, restoration, and the promotion of Québec's water resource through sustainable water management while ensuring better protection of public health.

The province has started to undertake EI development with a water use charge or abstraction fee being considered. The objective of economic instruments is to make water users accountable for the costs of protecting, restoring, and developing water and aware of the value of this resource.

Municipalities are, and will remain, responsible for their water policy; the Province will suggest and promote approaches to water management.

INSTRUMENTS AND TARGETED GROUPS

The initial focus of economic instruments for water was on the water bottling industry however, this was not viewed as equitable by the industry. Targeted sectors now include the water bottling industry as well as municipalities and all industries, institutions and commercial enterprises not serviced by the municipal systems. Planned EIs will promote reductions in water demand to better preserve the resource. EIs will also raise funds for environmental initiatives and finance administrative aspects of the policy. Public consultations on the charge and charge system are expected to be held in 2005. The EI charges being considered would be collected and deposited into a water-fund managed by the province.

The Water Governance Reform Orientation of the strategy intends to increase participation by users in both decision-making and actions on water conservation through revision of the legal framework for water, implementation of watershed-based management, acquisition of knowledge and information about water, strengthening of partnerships, and introduction of EIs.

Other commitments of the policy include education and promotional efforts in municipalities, a number of actions to support and influence agricultural practices in Québec, and ensuring the participation of Québec's partners such as the Aboriginal nations and international organizations.

Wastewater charges are also planned, likely based on consumption and effluent pollutants.

BARRIERS AND LESSONS LEARNED

While the policy was adopted in 2002, the introduction of the instrument was initially expected in 2003 and is now expected nearer 2005. This highlights the need to plan for a long time frame in the development of such instruments partly due to the number of stakeholders. The initial focus on a single industry also increased consultation time. Discussions with the bottling sector contributed to the delay in implementation and an adjustment to the targeted sectors. As a result, the government changed focus to include all water users in the proposed instrument.

Saskatchewan Case Study

Status of the Water Strategy and Related Economic Instruments

The government of Saskatchewan is currently developing a *Water Conservation Plan.* The *Water Conservation Plan* is intended to protect and conserve Saskatchewan water resources. The *Plan* considers the use of economic instruments for water conservation in the province using a user-pay philosophy, addressing the demand-side of water use. The existing *Manitoba Water Policies* introduced in 1990 includes in its Water Management objective intentions to price water to adequately reflect the true cost of water supply and wastewater disposal.

The *Plan* considers the environmental, social and economic value of water beyond consumption. It intends to apply this perspective to water conservation and management initiatives and is expected to be introduced and begin its implementation in mid-2005. Public meetings are planned for November 2004 to present the *Water Conservation Plan* and its intentions.

Volumetric water abstraction charges for self-supplied water users are in place. The Saskatchewan Watershed Authority maintains a schedule of charges for the use of water by industries to reflect and emphasize the value of water, promote wise water usage and help offset the costs of managing our water resources. Charges are applied to industries using water for processing; mineral exploration and mining; oil exploration and recovery; manufacturing; gravel washing; hydraulic pressure testing; thermal power generation and other purposes the Saskatchewan Watershed Authority may designate. The level of charge applied considers the use of the water and the source of the water.

Instruments and Targeted Groups

The *Water Plan* considers the use of economic instruments such as provincial tax rebates for the purchase of water efficient appliances and cost-sharing incentives for agricultural equipment upgrades for low water consumption equipment. Through metering, Saskatchewan municipalities have the necessary data to assess the type of economic instrument and level of charge that could be introduced. Although no economic instrument has yet been selected, the potential instrument would target all sectors of water users, with a specific focus on the municipal and agricultural sectors.

In the presence of new regulations associated with the potential economic instrument, the province intends to create new administrative functions responsible for the enforcement activities. No plans have been made as to the management and use of the funds collected from a potential economic instrument.

Barriers and Lessons Learned

The province believes that the involvement of stakeholders is an important part of the development and implementation of the *Plan* and its instruments. Full metering across the province is an advantage when considering economic instruments for water as it allows proper assessment of current use, the setting of targets and the assessment of the level of the charge to be implemented to reach the targets.

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APPENDIX B

Evaluation Techniques and Approaches

Valuation Methods[19]

The development of methods to estimate the value of 'non-marketed' goods such as environmental quality has been one of the most active areas of applied economic research over the last decade. The earliest efforts can be traced back to Hotelling's proposal in the 1930's for the travel cost method to value recreational opportunities. More recently, the need in the United States to assess the costs and benefits of government regulations and the Exxon Valdez disaster spurred the development of methods such as the averting behaviour and contingent valuation survey. In addition, the interest in extending countries' National Income Accounting frameworks to better account for resource depletion and changes in environmental quality have promoted efforts to develop macroeconomic measures of environmental quality changes. Today, the field of non-market valuation is well established. There are literally hundreds of specific studies available valuing a wide variety of environmental goods including many of the recreational, ecological, residential and industrial uses of water[20].

In approaching the valuation of water, the analyst may adopt one of three possible perspectives. The first is to employ valuation methods derived from microeconomic theories of value. This is by far the most commonly adopted approach. Alternatively, the analyst may estimate the contribution of water to a country's aggregate level of economic activity (or aggregate level of wealth). This can be done by using macroeconomic measures of the value of water (see the excellent discussion in Nordhaus and Kokkelenberg, 1999). The third approach is not so much a method of estimating the value of water as it is a set of procedures for taking existing values (available perhaps from research conducted in other jurisdictions) and transferring it to the case in study. This set of procedures is known as 'benefit transfer' and is treated as a separate approach because it is used frequently by governments and consultants when they do not have the time or resources to conduct original research.

Microeconomic valuation methods may be grouped into indirect techniques (those which rely on observed market behaviour to infer users' value of water) and direct techniques (those that use survey methods to obtain valuation information directly from households. Examples of indirect valuation techniques include residual imputation, averting behaviour and hedonic price models. Residual imputation is used most commonly when examining the value of water in agriculture and industry. The value of water is calculated as a residual by subtracting the costs of all non-water inputs from revenues. Averting Behaviour measures the costs of actions taken to reduce or remove a risk associated with exposure to environmental contaminants such as pesticides found in groundwater. Hedonic pricing is based on the assumption that consumers' preferences regarding a commodity (such as housing) can be represented by their attitudes towards characteristics of the good (for example, lot size, number of rooms and local environmental quality). Statistical models can then be used to infer the value assigned to changes in the environmental characteristic when all other characteristics are held constant.

[19] This section draws on chapter 8 of Renzetti (2002).

[20] For example, entering the search string "water value" into Environment Canada's *Environmental Valuation Reference Inventory* (EVRI) yields 457 records. EVRI is available at www.evri.ca

Examples of direct microeconomic valuation methods include contingent valuation (CVM) and the more recently developed choice experiment surveys. In the CVM approach, individuals are presented with information concerning a hypothetical or constructed market and asked to indicate their willingness to pay to achieve a desired good or service. For example, a respondent might be asked to value a potential improve in water treatment that reduces the risk of illness. Choice experiment surveys are closely related to CVM surveys. In choice experiments, consumers are surveyed and asked to rank different combinations of environmental quality and costs. The responses are then combined with information regarding the agent's characteristics in order to determine his/her willingness to pay for environmental quality improvements.

Representative Water Valuation Studies

Smith, Desvousges and McGivney (1983) employ a travel cost model to address the change in the valuation of sport fishing associated with changes in water quality. The principle finding of the Smith study is that increases in water quality are found to increase the demand for water-based recreation and to increase users' valuation of recreational experiences. For example, when applied to data derived from users of the Monongahela River, the average consumer surplus for water quality improvements (from boatable to game fishing condition) of $9.96 per household per season ($1992 Canadian). Furthermore, the average consumer surplus associated with improving water quality from boatable to swimmable is $20.91 per household per season ($1992 Canadian).

Mahan, Polasky and Adams (2000) employ a hedonic pricing approach to assess the impact of the proximity, shape and type of wetland on residential property values in Portland, Oregon. The sales price of the property is regressed against a set of structural, neighbourhood and environmental characteristics. Its estimated coefficients indicate that increasing the size of the nearest wetland by 1 acre raises mean property values by $24 and that reducing the distance to the nearest wetland by 1,000 feet raises the mean house value by $436 ($1994 U.S.).

Adamowicz, Dupont and Krupnick (2004) conduct sophisticated Internet-based CVM and CE surveys to estimate Canadian households' valuation of improvements to water quality that lead to a reduction in risks associated with cancer and microbial illnesses. The authors find that household willingness to pay for risk reductions equivalent to 10 fewer cancer deaths and 50 fewer cancer cases (over 10 years in a community of 100,000) is between $152-$298 for CVM models and $88-$142 from CE models ($2004 Canadian).

An alternative perspective uses macroeconomic measurement methods to examine the relationship between water use and aggregate economic activity. These measures can be used, in turn, to infer the value of water to an economy as a whole. A number of countries have sought to extend their system of National Accounts to include some natural resources in the definition of their stock of economic assets. The most common approach is to develop 'satellite' accounts that parallel the main set of accounts. The countries that are attempting this integration are, however, are not ready to integrate fully measures of natural resource stocks and flows into the national accounts. This is due to a variety of unresolved conceptual issues, lack of comprehensive data and difficulties over resource valuation. The approach being adopted by Statistics Canada is described in the following quotation (McComb and Gravel, 2000, 10-11):

"The approach that we intend to take is to consider nature as a factor of production. The value of nature that would be measured is the value of economic activity that can be attributed to natural inputs. The boundary of economic activity would be extended to include the consumption of non-market goods and services produced by nature. The cost of environmental degradation would be measured as the value of lost production, again broadly defined, that is attributable to the degradation. A fully developed set of accounts would track the value of natural inputs in production and show the cost of depletion and degradation both where they are implicit on the level of output and where they are not. Corresponding asset accounts would show the value of natural assets and changes in the value of natural assets due to depletion or degradation, as well as the changes in the value of other assets due to degradation."

The benefit transfer method is the third perspective available to the analyst wishing to investigate the value of water. It does not itself generate original estimates but rather calculates water values by transferring existing benefit estimates from studies that have been already completed for other sites. This technique may be used when existing studies are related to a site or an issue that closely resembles the water use to be valued or because the analyst does not have the resources to conduct a full evaluation exercise. Despite the apparent cost-effectiveness of this approach, there exist significant concerns regarding its application (Brouwer, 2000). These concerns derive from the need to rely on studies whose methods, assumptions, sites or issues may not closely resemble those under study. Nonetheless, increased experience with conducting benefit transfer and the trend towards transferring benefit functions (rather than point estimates) and using meta-analysis have increased the confidence with which this technique can be used.

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APPENDIX C

Methodology for this Study

Methodology for this Study

Our Approach is conceptually straight forward and consists of five steps:

- *First*, we will first identify the suite of EIs applicable to water conservation. This will be accomplished through a literature review of Canadian and international experience. We will develop a common reporting framework for each EI so that they can be consistently compared. This will include background information such as the theoretical underpinnings, how it is applied and how it induces behavioural shifts. Where instruments are similar, we will group then so that commonalities can be highlighted.

- Next, we will develop case studies that are representative of the grouped instruments. These case studies will highlight hot spots or best practices as mentioned above. A key approach here will be to convey solutions to assist water managers with their particular water conservation challenges or goals.

- Then we will assess the instruments presented in the case studies using the common set of criteria (i.e., section 2.3 above). This assessment will make clear the tradeoffs associated the different instruments with respect to societal outcomes. This will be equivalent to a tool that allows water managers to assess how EIs can be expected to perform. Water valuation for watershed management will be treated in a similar fashion.

- We will develop a lessons learned or executive summary document that explores the use and potential of EIs for water conservation. This will also act as a tool to facilitate the implementation and administration of EIs for water managers.

- Finally, we will communicate the results in an easy to understand "document" format. This format will be oriented to water managers and other stakeholders who will not necessarily have a background in economics.

Task 2: Analysis of economic instruments implemented in Canadian and International jurisdictions. In this task we will first conduct a literature review of recent information, reports and studies of EIs used for water conservation in Canada and internationally. The review will focus on major water use sectors (i.e., municipal, agricultural, commercial, institutional, industrial, and water and thermal power generation) and on government agencies with responsibility over water use and allocation. Examination of instruments in other countries will focus only on instruments that have significant potential for adaptation in Canadian conditions. Important criteria will include: the rationale for the selection of the featured economic instruments for sustainable water use and conservation; the process used to implement the instrument and the distribution of the related responsibilities; the effectiveness of the instrument in stimulating sustainable water use and conservation and in what conditions; and the transferability of the instrument from a major water use sector to another. The deliverable here will be a number of case studies that illustrate hot spots or best practices as well as a general survey of EIs applied to water conservation.

Task 3: Applying Valuation to Watershed Management and Planning. Specific areas of watershed management will be identified to show, using examples, where and how water valuation can enhance watershed management and planning. The research will build on our valuation techniques/methodologies work that has already been done as per the "Monitoring the Value of Natural Capital: Water" document and the Renzetti and Kushner report mentioned in the RFP Appendix. An important consideration here will be to demonstrate how water valuation can be used to transform existing water allocation regimes to efficient allocation schemes. The deliverable here will be a number of case studies that illustrate hot spots or best practices as well as a discussion of important issues.

Task 4: Evaluating the Merits and Barriers of Using EIs. The merits, successes and barriers of implementing EIs for water conservation will be evaluated in relation to the sustainable use of water, while recognizing the full value of water conservation and the valuation technique/approach that could be employed to calculate or reach that value. This evaluation will include: a description of specific merits, successes and barriers; strategies and actions for overcoming barriers and implementing economic instruments; the identification of the most promising opportunities for the implementation of economic instruments within major water use sectors of the Canadian context; a decision tool for assessing economic instruments for implementation; and, the identification of other areas of water management and use planning where EIs may be implemented effectively to achieve management and use planning goals.

Task 5: Executive Summary/Comprehensive Analysis of Tasks 2-5. We will provide a summary of the research findings and key learning in a 10-page document. A summary table of findings will form part of the executive summary. This will be a succinct section in the final report that will act as an executive brief suitable for decision-makers and other interested in EIs for water conservation. The report will contain the research findings and a summary table covering Tasks 1 to 5.

Appendix 1: Estimation of Revenues generated by a Provincial Water Use Fee

Assume that a government adopts a relatively simple form for a provincial water use fee: no annual fee and a constant, sector-specific, volumetric charge. The following formula provides a 'first-order' estimate of the revenues that could be earned from the introduction of the WUF. The term t_i is the fee levied per cubic metre of water in sector i. Q_i° is the quantity of water that sector i is licensed to abstract prior to the introduction of the WUF. Finally, the term s_i is a factor that takes into account the reduction in water use that would likely arise following the introduction of the fee (the term η_i is the ith sector's price elasticity of water demand):

$$rev = \sum_i t_i \cdot (1 - s_i) Q_i^{\circ}$$

$$where \quad s_i = \left(\frac{\Delta Q}{Q^{\circ}}\right)$$

$$and \quad \Delta Q = Q^{\circ} \cdot \eta_i \cdot (\% \Delta P)$$

Appendix 2: Approximation of the Impact of the provincial water use fee on users' Costs

As indicated above, one concern regarding the introduction of a WUF is its impact on users' costs of production and, as a result, their international competitiveness. The approximate percentage increase in the industry's total costs of operation (ΔC) may be given by the following formula (derived in Dupont and Renzetti, 1999):

$$\Delta C = S_w \cdot (1 + \eta_w) \cdot \Delta p_w$$

For example, suppose that we know the following for a specific industry:

- Water's share in total costs (S_W) = 0.01 (that is, 1.0%)
- Price elasticity of water demand (η_W) = -0.25
- Increase in water-related costs due to introduction of fee (Δp_W) = 10%

Applying the assumed values indicates that if the introduction of the fee implied a 10% increase in water-related costs, then water users would experience an increase in total costs of approximately 0.075%.

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APPENDIX D

Database Survey Jurisdictions

Database Survey Jurisdictions

Canadian	International
Canada, British Columbia (water conservation strategy)	Australia, NSW-SA-Vic-Qu (transferable water use rights)
Canada, Manitoba (water conservation strategy)	Australia, Victoria (zone based salinity charge)
Canada, New Brunswick (water conservation strategy)	Austria (municipal sewerage charges)
Canada, Nova Scotia	Benin
Canada, Prince Edward Island	Chile (tradable water permits)
Canada, Québec (politique nationale de l'eau)	Columbia (environmental tax – pollution charge)
Canada, Saskatchewan (water conservation strategy)	Denmark (effluent charges)
Canada, Barrie (water conservation program)	Denmark (sewerage charges)
Canada, Calgary (water pricing)	Denmark (tap water tax)
Canada, Edmonton (water pricing)	Finland (water charges)
Canada, Kelowna (water pricing)	France (effluent charging system)
Canada, London (water pricing)	Germany (municipal sewer discharge charges)
Canada, New Glasgow (water pricing)	Germany (municipal water service charges)
Canada, Okotoks (water pricing)	Germany, Baden-Württemberg (water abstraction tax)
Canada, Ottawa-Carleton (water pricing)	Mexico (irrigation water fee)
Canada, Regina (water pricing)	Netherlands (effluent charges)
Canada, Rosemère (water pricing)	Netherlands (groundwater abstraction tax)
Canada, Sudbury (water pricing)	Netherlands (MINAS Program)
Canada, Toronto (water pricing)	New Zealand, New South Wales (load base licensing program)
Canada, Vancouver (water pricing)	Slovak Republic (water abstraction charge)
Canada, Vernon (water pricing)	South Africa
Canada, Victoria (water pricing)	United Kingdom (water pricing – price caps)
Canada, Waterloo (water conservation programs)	United States (agricultural subsidies restrictions)
Canada, Winnipeg (water pricing)	United States, California (water market)
Canada, Yellowknife (water pricing)	United States, Idaho (drinking water program)
	United States, North-Colorado (water market)
	United States, San Diego County (incentives)

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APPENDIX E

EI Database

Canadian Examples

*See section 3.2 for details concerning each field

Jurisdiction	Program	Implementing Jurisdiction	Problem	Sector	Instrument Name	Complimentary Instrument Used
Canada, British Columbia	Water Conservation Strategy	Provincial	Pollution Control	Industrial	(planning)	
Canada, Manitoba	Water Conservation Strategy	Provincial	Conservation of Resource	Agricultural	Subsidy	√
Canada, New Brunswick	Water for Life Strategy	Provincial	Conservation of Resource	-	(planning)	
Canada, Nova Scotia	Drinking Water Strategy	Provincial	Funding	All	Permit Charge	√
Canada, Prince Edward Island	Drinking Water Strategy	Provincial	Conservation of Resource	-	-	
Canada, Québec	Politique Nationale de l'eau	Provincial	Internalize Externalities	All	Abstraction Fee	√
Canada, Saskatchewan	Water Conservation Strategy	Provincial	Conservation of Resource	All	(planning)	
Canada, Newfoundland and Labrador	Comprehensive Allocation System along with EI provisions and regulations under the *Water Resources Act*	Provincial	Economic measures	All non-domestic uses	Application fees and rentals for water power uses	√
Canada, Barrie	Water Conservation Program	Municipal	Prevention Funding	Municipal – Residential	Subsidy	√
Canada, Calgary	Water Pricing	Municipal	Prevention Conservation of Resource	Municipal	Water Price	√
Canada, Edmonton	Water Pricing	Municipal	Prevention Reduce Peak Use	Municipal – Residential	Water Price	√
Canada, Kelowna	Water Pricing	Municipal	Prevention System Cost Recovery	Municipal	Water Price	√
Canada, London	Water Pricing	Municipal	Prevention	Municipal – Residential	Water Price	√
Canada, New Glasgow	Water Pricing	Municipal	Prevention	Municipal	Subsidy	√
Canada, Okotoks	Water Pricing	Municipal	Full Cost Recovery	Municipal	Water Price	√
Canada, Ottawa-Carleton	Water Pricing	Municipal	Insufficient Capacity	Municipal	Water Price	√

Jurisdiction	Program	Implementing Jurisdiction	Problem	Sector	Instrument Name	Complimentary Instrument Used
Canada, Regina	Water Pricing	Municipal	Reduce Peak Use System Cost Recovery	Municipal	Water Price	√
Canada, Rosemère	Water Pricing	Municipal	Reduce Peak Use System Cost Recovery	Municipal – Residential	Water Price	√
Canada, Sudbury	Water Pricing	Municipal	Funding	Municipal	Water Price	√
Canada, Toronto	Water Use Rate	Municipal	Prevention Full Cost Recovery	Municipal	Water Price	√
Canada, Vancouver	Water Use Rate	Municipal	Prevention Reduce Peak Use	Municipal	Water Price	√
Canada, Vernon	Water Use Rate	Municipal	Prevention Reduce Peak Use	Municipal – Residential	Water Price	√
Canada, Victoria	Water Pricing	Municipal	Prevention Funding Expectations - social pressure Conservation of Resource	Municipal	Water Price	√
Canada, Waterloo	Toilet Replacement Programs Rain Barrel Distribution Program	Municipal	Prevention Conservation of Resource Pollution Control	Municipal	Subsidy	√
Canada, Winnipeg	Water Use Rate	Municipal	Prevention	Municipal – Residential	Water Price	√

International Examples

Jurisdiction	Program	Implementing Jurisdiction	Problem	Sector	Instrument Name	Complimentary Instrument Used
Australia, NSW-SA-Vic-QU	Transferable Water Use Rights	Provincial	Insufficient Capacity	Agricultural	Tradable Permits	√
Australia, Victoria	Zone Based Salinity Charge	Watershed	Internalize Externalities Pollution Control	Agricultural	Pollution Charge	
Austria	Municipal Sewerage Charges	Regional	Full Cost Recovery	Municipal - Residential	Pollution Charge	√
Bernin	Water Charges	National	System Cost Recovery	Municipal	Water Price	
Chile	Tradable Water Permits	National	Strengthening Property Rights Conservation of Resource	All	Tradable Permits	
Columbia	Environmental Tax – pollution charge	National	Internalize Externalities	All	Pollution Charge	
Denmark	Effluent Charges	Municipal	Pollution Control	Municipal	Pollution Charge	√
Denmark	Sewerage Charges	Municipal	Full Cost Recovery Pollution Control	Municipal	Pollution Charges	√
Denmark	Tap Water Charges	National	Funding Conservation of Resource	All	Abstraction Fee	√
Finland	Water Charges	Municipal	Full Cost Recovery Administrative Cost	Municipal	Water Pricing	√
France	Effluent Charging System	Watershed	Internalize Externalities Pollution Control	All	Pollution Charge	√
Germany	Municipal Sewer Discharge Charges	Municipal	Full Cost Recovery Pollution Control	Municipal – Residential	Pollution Charge	√
Germany	Municipal Water Service Charges	Municipal	System Cost Recovery	Municipal	Water Price	√
Germany, Baden-Württemberg	Water Abstraction Tax	Watershed	Funding	All	Abstraction Fee	√

Jurisdiction	Program	Implementing Jurisdiction	Problem	Sector	Instrument Name	Complimentary Instrument Used
Mexico	Irrigation Water Fees	Regional	System Cost Recovery	Agricultural	Water Price	√
Netherlands	Effluent Charging System	Regional	Internalize Externalities Pollution Control	All	Pollution Charge	√
Netherlands	Ground Water Abstraction Tax	National	Funding Conservation of Resource	All	Abstraction Fee	√
Netherlands	MINAS Trading Program	National	Internalize Externalities Pollution Control	Agricultural	Tradable Permits	√
New Zealand, New South Wales	Load Base Licensing Program	Provincial	Internalize Externalities Pollution Control	Industrial	Pollution Charge	√
Slovak Republic	Water Abstraction Charge	National	Internalize Externalities Pollution Control	All	Abstraction Fee	√
South Africa	Enhanced Water Tariffs	National	System Cost Recovery	Municipal	Water Price	
United Kingdom	Water Pricing – Price Cap System	National	Full Cost Recovery	Municipal	Water Price	√
United States	Agricultural Subsidies	National	Pollution Control	Agricultural	Subsidy	√
United States, California	Water Markets	Regional	Internalize Externalities	All	Tradable Permits	√
United States, Idaho	Drinking Water Program	Provincial	Administrative Cost Funding	Municipal	Water Price	√
United States, North-Colorado	Water Markets	Regional	Efficient Economic Use	All	Tradable Permits	√
United States, San Diego	Incentives	Municipal	Insufficient Capacity Conservation of Resource	Municipal	Subsidy	√