RESOURCE VALUATION AND PUBLIC POLICY: CONSUMERS' WILLINGNESS TO PAY FOR IMPROVING WATER SERVICING INFRASTRUCTURE

Submitted October 1996; accepted April 1997
Written comments on this paper will be accepted until December 1997

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Abstract

In many Canadian municipalities the infrastructure that helps to deliver quality water to households, and transports the waste water produced is in need of major capital re-investment. Estimates made by Environment Canada show that some $4.59 billion per year, over the next 10 years, will be required in order to maintain existing levels of water supply and quality, and to meet future needs. Governments at all levels will have to make decisions concerning the funding of such undertakings. One of the options available to municipal officials will be to pass on some or all of these costs to the consumer. One interesting question concerning this policy alternative relates to the willingness of consumers to pay increased water charges. This paper reports on the results of a study to probe this question, carried out jointly by Environment Canada and the University of Guelph. The study, which employed a contingent valuation methodology, found that the average willingness-to-pay to ensure adequate water servicing was just over $26.00 per month above current water servicing prices. At this level, the municipal water industry would generate an additional $3.5 billion annually, a large portion of the extra revenue required. The public policy implications of this finding are discussed in the paper.

Résumé

À l'heure actuelle, l'infrastructure qui sert à distribuer de l'eau de qualité aux ménages de nombreuses municipalités canadiennes et, par la suite, à transporter les eaux usées produites requiert un réinvestissement important de capitaux. Selon les estimations d'Environnement Canada, il faudrait disposer d'une somme de 4,59 milliards de dollars par année pour maintenir l'approvisionnement en eau et sa qualité au niveau actuel et pour répondre aux besoins des dix prochaines années. Tous les paliers de gouvernement devront prendre des décisions sur la façon de financer de telles entreprises. Une des options qui s'offre aux élus municipaux est de répercuter au consommateur des services une partie ou la totalité des coûts inhérents à ces entreprises. Une question intéressante qui se pose relativement à cette option est la volonté du consommateur de payer plus de taxes pour l'eau. Nous présentons ici les résultats d'une étude réalisée conjointement par Environnement Canada et l'Université de Guelph sur cette question. L'étude, effectuée à l'aide d'une méthode des enchères, a permis d'établir que la volonté de payer pour assurer des services adéquats d'eau était en moyenne d'un peu plus de 26 $ par mois, sans compter le coût actuel des services d'eau. Un tel financement rapporterait

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3,5 milliards de dollars annuellement à l'industrie municipale de l'eau, soit une large part des recettes supplémentaires requises. Nous examinons, dans la dernière section de ce document, les répercussions de cette constatation sur la gestion des affaires publiques.

Introduction

The provision of safe, clean water and adequate waste water treatment is one of the most important of municipal functions. Water provision and waste water treatment are considered here as an integrated function, identified in the paper as 'water servicing'. Not only do most activities in municipalities depend on adequate levels of water servicing, the state of public health is also directly related to such servicing. The paper examines the concept of willingness-to-pay for water services in view of the financial constraints facing public services in general, and public water services in particular.

We begin with an overview of an industry in financial crisis, the main characteristic of which is the current inability to raise sufficient revenues to ensure adequate service. This overview, based on recent work by Tate and Lacelle (1995), defines the nature of this financial crisis, and examines the application of full-cost, user-pay pricing as a means of solving the crisis. Next, we examine consumers' willingness to pay (WTP) to ensure that the current levels of public water services do not deteriorate. This WTP is couched in terms of the additional amount consumers state they are willing to pay, over and above their current payments for water services. The findings are based on data gathered in a nation-wide survey of 1511 Canadian households in January 1996. The empirical section of the paper summarizes the contingent valuation methodology (CVM) underlying the survey, the CVM techniques used in the study, and the results obtained. The paper concludes with a commentary on the usefulness of the CV methodology in the context of municipal water pricing, and the implications of the present experiment for public policy in the municipal water infrastructure field.

The Water Infrastructure Financing Problem

By Canadian standards, the municipal water servicing industry is a large one. Its in-ground assets were valued at more than $100 billion in 1984 (MacLaren, 1985), located in over 1,500 municipalities of over 1,000 persons. Its annual revenues were estimated at $3.3 billion nationally (Tate and Lacelle, 1995) . The industry pumped a total of 13.8 million cubic metres of water per day in 1994, supplying 21.7 million persons, and treated the sewage of 19.6 million persons.

The parameters of the financial problem were described in detail most recently by the Federation of Canadian Municipalities (FCM, 1985). The important parameters were: revenues that failed to cover the full costs of operation; substantial cross-subsidies both from other levels of government and among user groups; a declining base of support from municipal public works budgets; and an increasing unwillingness by senior governments to transfer money to water utilities. Underlying these trends were many unmetered water service connections, very low water prices to consumers, and an excessive level of water usage. These characteristics persist currently, and, if anything, are more serious. For example, the national average monthly charge per residential connection is $21.50, with the charge for many municipalities as low as $10.00 (Tate and Lacelle, 1995). The facts that charges are low and that only about 50% of connections are metered have produced a per capita water use that is among the highest in the world. This, in turn, has escalated both capital and operation and maintenance (O&M) costs with a significant waste of public funds.

Maintaining, renovating, and upgrading water infrastructure poses at least two vital economic questions: how much will it cost to achieve an adequate level of water servicing, and given the current trends to decreasing expenditures from public sources, where will adequate funding be found?

The Magnitude of the Financing Problem

Compiling comprehensive estimates of the potential costs of adequate municipal water services on a Canada-wide basis is a challenging exercise under any circumstances. Costs are specific to individual municipalities and analysts. Municipalities have a tendency to overestimate costs in the hope of larger grants from elsewhere. Similarly, consulting analysts tend to overestimate costs to justify large contracts. The overall effect is a tendency to overcapitalize water systems. The most recent effort to estimate cross-Canada costs for water and wastewater system adequacy is contained in Tate and Lacelle (1995). This report estimated the total *marginal* capital plus O&M costs at $4.6 billion ($1991) annually over a 10-year 'catch-up' period and $ 1.8 billion thereafter. The term 'marginal cost' here means the costs to be incurred above current and planned expenditures. This amount of money could be raised by means of user charges using a three-fold action plan: a doubling of average monthly charges per connection for all users, the addition of an 80% sewer surcharge, and the complete metering of all connections to municipal systems. For an average residential connection, such a program would add about $35.00 to a monthly water bill. (This is a national average with wide variations. Many municipalities, such as Edmonton and Ottawa-Carlton, may already be paying full costs). The question posed in this paper is whether the estimated WTP approximates this amount. The answer has important public policy implications.

Estimating the Benefits of Maintaining Water Services

CVM Applied to Water Services

The economic value of most traded goods, such as cars or houses, is represented by the prices consumers are willing to pay for them in competitive markets. Since environmental goods such as water quality are not traded commodities, market prices are not available for use as measures of the economic value of improvements to these amenities. Many Canadians do pay a fee for municipal water services. But since these fees are not determined via competitive markets, but are set by municipalities to help cover costs of water services, they are not indicative of demand (willingness to pay). Thus, in the absence of competitive markets, we turn to alternative methods to estimate economic value.

The contingent valuation method elicits an economic valuation of a non-marketed good, based on the response of a relevant sample population to a carefully-designed questionnaire. The questionnaire defines the precise nature of the good that is to be offered via a hypothetical market. Respondents are offered the opportunity to 'purchase' the good using a cash-valued payment vehicle, such as increased taxes, user fees, or some other payment method. Ranges of offers are used in the survey sample to develop a data set from which a statistical estimate of individual maximum WTP can be derived. Individual WTP can then be aggregated to approximate measures of welfare changes of the relevant population, due to provision of the non-marketed good. Freeman (1993) provides a good review of the economic theory regarding the use of WTP to measure individual and aggregate benefits of non-market goods and services. Mitchell and Carson (1989) give a thorough discussion of CVM.

Recent applications of CVM to ground water quality issues include the determination of option prices for ground water protection in Cape Cod, Massachusetts (Edwards, 1988), and Dougherty County, Georgia (Sun, 1992); WTP for improvements in drinking water quality in Georgia (Jordan and Elnagheeb, 1993) and the determination of the WTP for ground water protection in Dover, New Hampshire (Shultz and Lindsay, 1990). Mean values for this group of studies range from $121 to $641 ($U.S.) per household per annum. In Australia, the CVM has been used to measure Yass District ratepayers' willingness to pay for improvements to the quality of domestic drinking water (Carlos, 1991) and to maintain drinking water quality in Sydney now and in the future (Dwyer, 1991). Mean values reported for these studies range from $24 to $67 ($A) per annum. Differences in WTP in these studies reflect, among other things, different definitions of the marginal improvements offered and differing existing levels of water charges.

CVM Techniques Used in This Study

This study was designed to investigate the dollar amount the Canadian public would be prepared to support, through a user-pay approach, a water infrastructure improvement program that would prevent an otherwise inevitable decline in water services. The survey was administered by phone by professional interviewers at the well-known Canadian polling firm Angus Reid. The study used a referendum as a hypothetical market, in which a majority rule criterion applied. Respondents were told that a majority 'yes' vote would cost their household a given dollar amount ($ B per month) in increased user fees for water services. A majority 'no' vote meant that the program would not be implemented, and no one would be charged. Respondents were asked to cast their votes based on the value of the program relative to the amount they would be charged in the event of a majority 'yes' vote. Other socio-demographic information was obtained from each respondent. (A copy of the questionnaire is available from the authors upon request.) The question as stated by the interviewer to the respondent was:

> *Would you be willing to support a program to conserve water by repairing water distribution and sewage treatment systems in Canada, if it cost your household an additional $B each month?*

This type of binary response CVM question format is known as dichotomous choice (DC). The DC referendum format is preferred by many practitioners because strategic response bias is mitigated. In addition, this study used a double-bounded technique, as described below, to increase the statistical efficiency of the resulting WTP estimates.

Consistent with utility maximization theory, WTP corresponds with the expected benefit the consumer would receive from the purchase of the good or service (Hanemann, 1984). It is assumed that a 'yes' response to an offer amount $ B indicates that $ B $\leq$ the consumer's maximum WTP. We would also expect that the respondents would support any other bid less than $ B if they support $ B.

This study used a double-bounded logit model, in the manner outlined in Hanemann *et al* (1991). This means that a second question was asked of each respondent, conditional on their response to the first. In the case of a 'yes' response to the first question, the individuals were then asked if they would pay a second, higher amount, $ B^h for the program. If the response to $ B^h is 'no', we can conclude that $ B^h > maximum WTP. If the response to $ B^h is 'yes' then it is assumed that $ B^h $\leq$ maximum WTP. In the case of a 'no' response to the initial offer amount, a second lower amount, $ B^L is offered. If the second response is 'yes', then it is concluded that $ B $\geq$ maximum WTP > $ B^L. If the second response is 'no', then it is concluded that $ B^L > maximum WTP.

WTP is generally assumed to be distributed logistically. If $ B is close to zero, fewer people are likely to respond 'no' and the probability of a 'yes' response is high. As $ B gets larger, the probability of a 'yes' response declines, and asymptotically approaches a lower bound. Since it is assumed that a 'yes' to any amount implies that an individual would vote 'yes' to any lower amount, the probability distribution of a 'yes' traces out a cumulative density function (cdf). A property of a cdf is that its expected value is the area under it. Thus, the mean WTP for the water conservation program is measured as the area under the estimated cumulative density function for WTP. The mean WTP can then be aggregated over the population of households in Canada for an estimate of the total value of the proposed water quality preservation program.

Survey Development, Pretesting and Piloting

Survey development proceeded interactively through the course of several rounds of pretesting. During early stages, the description of the water infrastructure program was developed to ensure that respondents understood the good and the payment vehicle. The first phase of the experiment included an open-ended pre-test which yielded a prior estimate of the WTP distribution. This distribution was used to generate bid amounts for a double-bounded dichotomous choice pilot survey. The results of the pilot survey were used to refine bid amounts for a second pilot survey. The final version of the water survey was incorporated into an omnibus survey administered during January 1996. 1511 Canadian households were selected via random-digit dialling techniques, stratified by census subdivision, to be representative of the Canadian population. There was some concern about including the CVM as part of an omnibus survey, in which we had no control over other questions. However, the mean WTP for the second pilot survey, carried out in April 1995, was $27 per household per month, which compares remarkably well to those values reported in this paper for the final survey. Inclusion on the omnibus survey generated a much larger sample than would normally have been possible, given the same cost, and appeared to have caused no bias.

Estimating Willingness-to-Pay

The logistic cumulative density function of individuals' WTP is written:

$$G(B) = [\, 1 + e^{-(\alpha+\Sigma\beta X)}]^{-1} \qquad (1)$$

where α and β are parameters to be estimated, and X is a matrix of bids and socio-demographic characteristics of the surveyed population, such as education, income, location and type of water supply.

The initial bid amount for each interview was selected randomly from the set of values S = [$5, $10, $15, $20, $30, $40]. This set of values was used because it spans the mean of the distribution for WTP, as determined through open-ended pretesting and pilot studies (Cooper, 1993; Kanninen, 1995). If the individual responded 'yes' to $ B, a second higher bid B^h was selected from S. If the individual responded 'no' to B, a second, lower bid from B^L, was selected from S. The process yielded a set of qualitative dependent variables:

- yes-yes: if the respondent said 'yes' to B and B^h,
- yes-no: if the respondent supported B but rejected B^h,
- no-no: if the respondent rejected B and B^L, and
- no-yes: if the respondent rejected B but supported B^L.

Using this vector of dependent variables and the matrix of bid amounts and other socio-demographic variables (X), the parameters of equation (1) were estimated with the maximum likelihood estimator, using the algorithm developed by Cooper (1993).

Willingness to pay is determined by the resulting distribution of positive responses to the bids. Socio-demographic variables that show significant variation with WTP indicate that people who share those characteristics may be more or less likely to have voted 'yes'.

Summary of Results

Table 1 summarizes the WTP point estimates and confidence intervals for six regional areas of Canada: British Columbia; Alberta; Manitoba and Saskatchewan;

Table 1: Estimates of Average WTP ($/month) per Household for Water by Region, 1996

Variable	British Columbia	Alberta	Manitoba and Saskatchewan	Ontario	Québec	Atlantic Provinces
Constant	2.3904*** (.8212)	2.7746*** (.9312)	2.7224*** (1.049)	3.1452*** (.4291)	2.0261*** (.5083)	2.3799** (1.002)
Bid	-.0772*** (.0064)	-.1097*** (.0106)	-.0939*** (.0096)	-.0917*** (.0044)	-.0793*** (.0046)	-.0910*** (.0093)
Age	-.0196** (.0095)	-.0253** (.0129)	-.0901* (.0134)	-.0200*** (.0059)	-.0140* (.0079)	-.0162 (.0146)
Income	.0025 (.0051)	.0043 (.0066)	.0021 (.0065)	.0048* (.003)	.0039 (.0040)	.0062 (.0085)
# in house	-.0938 (.1586)	.3124* (.2244)	-.0622 (.1889)	-.0293 (.0749)	1271 (.101)	.2699* (.1757)
Children	.6368* (.4287)	-.3537 (.5328)	-.3080 (.5111)	.0123 (.2226)	.0061 (.2699)	-.9019* (.4652)
Education	-.0516 (.0990)	-.1832* (.1229)	-.1975* (.1274)	.0381 (.0609)	.0214 (.0725)	.0282 (.1384)
Awareness	.7240** (.3413)	-.0586 (.3851)	.7151* (.459)	.1067 (.1784)	.2475 (.1974)	.4052 (.377)
Agr. Activities	-.7856* (.4606)	-.0472 (.8431)	.1168 (.6313)	.5216* (.3895)	-.0300 (.3984)	-.6464 (.5978)
Single Family Home	.2850 (.3396)	-.4327 (.524)	.4379 (.5042)	.5370** (.2339)	-.2538 (.2313)	.1777 (.4999)
Wtr bill	-.0848 (.3484)	.3918 (.9008)	1.3001 (1.05)	-.3718 (.3348)	.7953** (.3998)	-1.0348* (.5453)
Pay for treatment	-3018 (.3801)	.7760* (.5132)	-.7319* (.4479)	-.0196 (.2234)	-.3920* (.245)	.2000 (.5869)
Metered	-.2403 (.4913)	-.3753 (.847)	.1883 (1.034)	.3153 (.3156)	-.7206* (.489)	.9765* (.728)
N =	199	134	127	523	399	121
Log likelihood	-237.36	-155.10	-147.29	-668.47	-503.27	-156.95
WTP	27.82	20.86	28.13	25.24	26.97	28.85
99% C.I.	23.44 to 32.24	17.20 to 25.13	23.92 to 32.84	22.86 to 27.61	24.17 to 29.79	24.28 to 34.25

*** Indicates significant at or above the .01 level, $\alpha = 2.576$.
** Indicates significant at the .05 level, $\alpha = 1.96$.
* Indicates significant at the .10 level, $\alpha = 1.3$.
Numbers in parentheses are standard errors

Ontario; Québec; and the Atlantic Provinces. This result was compared with a restricted model in which all coefficients for each region were equated. Using the maximum likelihood ratio test, we rejected the hypothesis that the restricted model was no different from estimating separate coefficients for each geographic region.

Willingness to pay estimates for the water infrastructure program described in the survey ranged from a low of $20.86 per household per month in Alberta to a high of $28.85 per household per month in the Atlantic Provinces. Confidence intervals for the 99% level were estimated using the method of Krinsky and Robb (Park *et al.*, 1991) and are reported in Table 1 along with mean WTP estimates. Because WTP for Alberta is significantly lower than that for the other regions, Alberta was identified as a possible special case.

A number of explanatory socio-economic variables were included to account for systematic differences among individual respondents, which would potentially affect their willingness to pay for the water infrastructure improvement program. These variables are listed in Table 2.

In all cases, age negatively affected the value of the program. This is unremarkable since the description of the program clearly stated that the consequences of a majority 'no' vote would be a future decline in the quality of water services.

In almost all cases, household income did not significantly influence the probability that a respondent would vote for the program. The effects of household size on the coefficient for income were accounted for by including the number of people in the household as a separate variable.

Table 2: Explanatory Variables Used In The Logit Model

Variable	Definition
Bid	Dollar value offered to respondents
Age	Age in years of respondents
Income	Household income in $1,000's
# in house	Number of people in household
Children	Dummy variable indicating that children live in household
Education	Categorical variable that is increasing with increasing number of years of formal education
Awareness	A dummy that indicates the respondent replied that she/he was previously aware of Canada's water infrastructure problems
Agr. activities	A dummy variable that indicates that the household uses water for irrigation or livestock
Single family home	A dummy variable that indicates respondent lives in a single family home
Water bill	A dummy variable that indicates that the household receives a bill for water services
Pay for treatment	A dummy variable that indicates the household receives a bill for waste water treatment
Metered	A dummy variable that indicates that water charges are on a volume basis

A dummy variable for children was expected to indicate an increased willingness to pay for a program that would reduce costs to future generations. The coefficient on children was positive and significant at the 90% level in British Columbia, and at the 90% level in the Atlantic Provinces, but with a negative sign. It is likely that in this region, which had the lowest household income, the presence of dependents has a negative effect on WTP due to effect on per capita household income.

Level of education had no effect on WTP except in Alberta and Manitoba/ Saskatchewan where higher levels of education had a negative impact on WTP. There may be some correlation between educational level and prior awareness of potential water infrastructure problems, as represented by the dummy variable 'awareness'. For regions other than Alberta, 'awareness' took on a positive value, indicating that prior awareness of the issue meant a greater WTP for the infrastructure program.

The dummy variable for agricultural activities is a proxy for rural residents on the one hand and reflects that water is used as a productive input to a farm operation on the other. 'Agricultural activities' is positive and significant at the 90% level for Ontario, and is negative and significant at the 90% level for British Columbia. Nowhere else is agricultural activity a significant predictor of WTP for the water infrastructure program.

'Family homes' was included as a dummy variable because it was thought that home owners or renters would be more likely to receive a water bill than apartment dwellers. Residence in a single family home had a positive influence on WTP at the 90% level in Ontario, and was not significant elsewhere.

Bills for water services and for waste water treatment were included as dummy variables to distinguish those respondents who already pay directly for water services from those who do not. It could be argued that because these respondents already pay fees for the service, the amount they would be willing to pay to support the program would be lower than that of people who are not presently paying specifically for water services. In most cases these variables are not very significant. A few cases warrant comment however. The Atlantic Provinces and Québec have much higher coefficients on the dummy for current water billing, and have positive values significant at the 95% level and just below the 90% level, respectively. Both variables are positive in sign for Alberta, but with only water treatment charges being significant at the 90% level.

'Metered' is a dummy variable that accounted for households whose water charges were based on volume used. It was assumed that because volumetric billing induces consumers to conserve water, this variable would have a positive sign, and would indicate, all else being equal, those people who are already aware of conserving water. The variable is only significant above the 90% level for the Atlantic Provinces and Québec; in the latter, it has a negative sign.

A separate set of questions was asked to gain an understanding of why the response was 'yes' or 'no' to either of the offered bid amounts. Of the two bid amounts , 15% (220) rejected both bid amounts, while 85% (1254) accepted either one or both of the bids (N=1474 because of missing values for a few of the observations). Of those individuals who responded 'yes' to either bid (Table 3), the majority of responses centred around the fact that water is essential (31%). There was also a definite concern for future costs associated with a degraded water supply (20%) and a concern for future generations (18%). Of the 'no - no' responses (Table 4), over 25% felt that they already paid enough for water or that they could not afford the increased price (18%). Of the 220 'no - no' responses, 29 indicated that they either objected to how the question was asked or that they did not believe that if they voted 'yes' the money would actually be used by government for the purpose it was intended.

Table 3: Reasons for 'Yes' Response to Either Bid Offer

	Count	%
Water is essential/I have no other choice	390	31.1
Avoid higher future costs	243	19.4
Should not leave to future/ my responsibility	225	17.9
Preserve/improve water supply	170	13.6
Concern about health/ quality of life	137	11.0
Raise awareness	24	1.9
Other	28	2.3
Don't know	36	2.8
TOTAL	1254	100.0

Table 4: Reasons for 'No' Response to Both Bid Offers

	Count	%
Pay too much/ pay enough taxes	57	25.8
Can't afford it	38	17.4
Object to question/money will not go to program	29	13.0
Not a problem/ already conservation	23	10.4
Not applicable/ not a municipal system	23	10.4
Let city pay	15	7.0
Own responsibility/I don't waste/ family size	9	4.1
More important problems	7	3.4
Other	15	7.0
Don't know	4	1.7
TOTAL	220	100.0

Twenty-three of the 'no - no' respondents indicated that they did not believe that there was a real problem.

In all cases, the bid amount is a highly significant predictor of WTP for the water infrastructure program. The annual value of a project to improve infrastructure to maintain water quality at current levels can be estimated by aggregating over the monthly household mean WTP estimates. In 1995, there were 11,243,000 Canadian households (Statistics Canada, 1996). This number, if multiplied by mean monthly WTP over twelve months, would yield an annual willingness to pay for a water infrastructure improvement program in Canada of approximately $3.5 billion.

Conclusions

The CVM methodology appears effective in analysing problems of public policy similar to the one addressed in this paper. The large number of respondents answering 'yes' to either the first or second bid amounts indicates a willingness among households to pay increased prices to maintain current levels of water services. The monthly WTP values reported here represent a substantial increase in charges over and above current water charges (about $21.50 per month). This WTP value is surprisingly similar to the estimated marginal cost of the infrastructure program ($35.00 per household per month) in the Tate and Lacelle (1995) study. Most respondents (about 1250) appeared to believe that there was no choice but to pay higher prices for water servicing, or that water was essential for their activities, or that there was a need to preserve water for the future.

A slight difference in WTP emerged among regions, as shown in Table 1. We can speculate about the causes of these differences, although these speculations should be treated tentatively.

- In Atlantic Canada, the higher than average WTP values may result from a predominance of flat rate billing methods in relation to many other provinces, which incorporate generally low water charges to consumers. Consumers, in this case, have little or no indication of either the charges being paid for water services, or the real cost of the resource. This would result in a tendency to overvalue a good not paid for directly.

- A similar explanation pertains to the higher than average WTP in British Columbia, with the additional factor of a generally high level of environmental awareness in that province.

- The differences in average WTP between Ontario and Québec are interesting. Ontario has a higher proportion of meters, and many municipalities are billed monthly, whereas in Québec billing is not as regular. Individuals in Québec may not fully realize how much they are already paying for their water. An alternative explanation deals with the fact that Québecers consume more bottled water per capita than the rest of the country (Griswold-Woodsworth, 1997). This is an indication that Québec residents are already paying more for good quality water.

- In the Prairie provinces, intensive water conservation programs are currently underway in many municipalities such as Winnipeg. These programs are heightening water awareness, and a realization of the problems associated with inadequate water systems. This increased level of awareness would lead to a higher than average WTP value. This explanation does not appear to pertain to Alberta, where there are clearly other factors involved that give WTP values substantial below those of other regions. We cannot explain this anomaly.

We can conclude that there exists substantial support for increased water charges. Public education may be a significant factor in fostering this support, since the WTP is higher in areas where there have been significant efforts made to establish water awareness programs. It would appear possible to foster further support for full cost pricing through the establishment of more water awareness programs.

From a public policy viewpoint, it appears possible to address the problems of water infrastructure financing using substantially increased water charges. This study shows that the cumulative WTP amounts approach those needed for infrastructure upgrading. It should be emphasized that this conclusion is based on national averages and that individual cases may vary widely. It is worth noting that, for water charges to be effective in promoting water conservation, they must be volume-based, as documented by Tate and Lacelle (1995). In addition to meeting much of the current financial shortfall, increased water charges on the magnitude suggested would provide a significant incentive for conservation of both Canada's water resources and scarce public capital.

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