CONSERVATION WATER RATE STUDY

FINAL REPORT

Prepared for

Capital Regional District

by

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with

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EXECUTIVE SUMMARY

OBJECTIVE

The Capital Regional District (CRD) engaged New East Consulting Services Ltd to undertake a study of conservation-oriented water rate structures. The study was required to help the CRD pursue water demand management objectives within the Greater Victoria Service Area. Demand management objectives, defined in 1999 in the "Strategic Plan for Water Management" include reductions in peak summer demands, base demands and non-revenue water. Conservation rate structures, used primarily at the retail level, can help achieve these objectives. Water supply issues that motivate CRD's interest in demand management include: (1) growing water demands, (2) system reliability under drought conditions, (3) water quality problems when water levels in the Sooke Reservoir are low, (4) the high cost of future capacity expansion options, and (5) the limited success of past demand management efforts in the CRD.

APPROACH

The evaluation of alternative rate structures focused on the retail rates since only these rates have a direct impact on the water demand of end users. It commenced with an assessment of opportunities for reform using existing rates and then moved on to an assessment of alternative rate structures. The following rate structures were evaluated (all of these options save the last one include a fixed charge based on meter size):

Uniform	Constant volumetric charge (the existing rate structure and the most common one in North America)
Declining block	Volumetric charge that falls as water use increases
Increasing block	Volumetric charge that increases as water use increases
Humpback	Volumetric charge that increases first then decreases as water use increases
Seasonal	Volumetric charge that is higher for all water used in the summer
Excess use	Volumetric charge that is higher only for excessive water use in the summer
Demand charge	Uniform volumetric charge (as above) plus a fixed charge that is based on the customer's maximum water demand (replaces the fixed meter charge)

Some of the water retailers now recover a portion of their costs using parcel taxes or other charges that do not appear on the water bill. In evaluating existing and alternative rate structures, consideration was therefore given to the recovery of all costs for both water and sewer systems from the water bill. This has the effect of increasing the water bill and as a consequence the incentive for conservation. This option therefore involves dropping these other charges where possible and shifting associated costs onto the retail water bills.

A screening exercise was used to evaluate the rate options. The exercise involved considerable input and commentary from staff of the CRD and local municipalities and from the Water Advisory Committee. Criteria used in the evaluation included: (1) achieving significant water use reductions, (2) distributing costs among water consumers in a fair manner, (3) assuring affordability of water supply, (4) full cost recovery, (5) minimising adverse impact on the local economy, and (6) minimising financial risk to the water suppliers. Case study analysis was completed for three local municipalities to assess changes in water demands and impacts on water rates, customer bills and the stability of water sale revenues.

Throughout the analysis, all rate reforms were assumed to be revenue neutral. That is each alternative rate was set to meet the same revenue target. This was particularly important for options that looked at adjustments to existing rates without changing the rate structure. One of these options involved an increase in the volumetric charge, which was offset by a reduction in the fixed charge. Another involved using the water bill to recover all water supply and sewer service costs, including those now recovered on the property tax bill. In this case, the increase in the water bill is offset by a reduction in property taxes.

FINDINGS

Wholesale water supply costs are recovered by the CRD using a uniform volumetric charge for water sold to local municipalities. The local municipalities recover retail water supply costs through retail water sales as well as with parcel and property taxes. The retail water rates are a combination of fixed charges plus uniform consumption charges. Where fixed charges are used on the water bill, they represent from 16% to 56% of the typical domestic water bill. In two municipalities, fixed charges for water appear on the property tax bill rather than the water bill. Some municipalities use the water bill to recover a portion of their sanitary sewer service costs, but most of these costs are recovered through fixed charges on the property tax bill.

The wholesale water rate is currently $0.198/m^3 and volumetric retail water rates for the 8 local water supply retailers range from $0.292/m^3 to $0.727/m^3. When fixed charges and charges for sewer services are factored in, the cost of water for the average household in the CRD ranges from $0.53/m^3 to $1.54/m^3. At these levels, the cost of water in the CRD is low relative to costs elsewhere in North America. Conversely, levels of water consumption are relatively high at 550 litres per capita per day. Domestic water use is a large share of this demand, with the average household water use at about 30 m^3 per month. Demands are also highly seasonal. Average daily summer water sales are more than double the average daily winter sales in some local municipalities due to lawn and garden watering.

CONCLUSIONS

The principal conclusions from this assessment are as follows:

- Increases in the water rates resulting from the transfer of water supply and sewer service costs from the property tax bill to the water bill will have the greatest impact on water use. Reductions in demand caused by this transfer are expected to be significant.
- None of the alternative rate structures is expected to have a significant impact on water demand if only the format of the rate structure is changed without shifting sewer costs onto the water bill.
- The seasonal and excess use rate structures will cause a significant increase in the cost of water for the average residential customer while the increasing block and seasonal options will have a significant impact on water bills of large non-residential customers.
- Rate structures that increase the volumetric rates on water used in the summer will increase the reliance on summer water sales for water revenues. This increases revenue instability. The seasonal rate structure causes the greatest increase in revenue instability.
- Due to the current 4-month billing cycles, customer billings for water services are infrequent. Customers are billed in the late fall or winter for water used in the summer. Long delays like this in customer billing weaken the economic incentive created by volumetric rates.

RECOMMENDATIONS

Recommendation	Discussion
Retain the uniform rate structure at the retail level.	Alternative rate structures will result in relatively modest reductions in water demand
Use the retail water bill, where possible, to recover all water and sewer costs including costs now recovered using property and parcel taxes.	Transferring costs now recovered using parcel or property taxes to volumetric charges on the water bill will increase these charges and provide a strong economic incentive to conserve water.
Fixed charges in the retail rate structure should be set to recover no more than about 15% of total water bill revenues.	When fixed charges are too high the volumetric charges are correspondingly lower and the incentive to conserve water is diminished.
Municipalities should increase the frequency of retail meter reading and billing to a quarterly schedule for residential customers (i.e. every 3 months) and a bimonthly schedule for large ICI customers.	A quarterly schedule has several advantages: (1) more frequent billing reinforces the economic incentive to conserve water, (2) quarterly data on water use allows more equitable billing for sewer services based on indoor usage alone which is estimated using winter water use data, (3) it is easier for low income households to budget for smaller quarterly bills.
Retain the existing wholesale rate structure.	This structure is compatible with the proposed rate structure at the retail level.
Continue to lobby the Lieutenant Governor in Council to allow CRD municipalities to recover trunk sewer and sewage disposal costs by way of fees and charges set independently within each municipality.	Current Provincial legislation requires CRD trunk sewer charges to be recovered from property taxes. This impedes the ability of local municipalities to recover sewer costs on a user pay basis in the water bill and prevents the adoption of full-cost water and sewer rates.
Continue the existing demand management program to promote efficient water use.	Programs that combine promotions such as rebates for installing low flush toilets with economic incentives created by rate structures are more effective in controlling water demand.
Complete more detailed studies at the retail level to develop implementation plans for rate reform and to address a number of outstanding issues.	Examples of outstanding issues include the recovery of sewer and water costs from unserviced properties, the allocation of costs among residential and ICI customers, and administrative requirements for rate reform.
Phase in rate reforms over a two-year period.	A two-year phase in period allows customers some time to adjust to the new rates but is not so gradual that the reforms will pass unnoticed.
Develop and implement an effective communication plan to promote rate reforms.	The public will often oppose any type of rate reform. An effective communication plan will do much to overcome this opposition.

BENEFITS

A number of benefits will be realised with the implementation of recommendations made above:

Rate reform is an important tool for water demand management that will help the CRD and its member municipalities achieve their strategic water conservation objectives. The recommended reforms to retail water rates are expected to reduce overall water demand by up to 10%. This reduction will increase the effective water supply capacity and thus improve system reliability in times of drought. It will also allow additional growth to be serviced without expanding capacity and thus will allow the CRD to defer future capacity investments.

The recommended reforms adhere to the user pay principal by shifting cost recover from property taxes to charges on the water bill. This shift will assure that water bills will more fairly reflect the cost of both large and small servicing customers. Rate reform will thus lead to a more equitable distribution of costs among customers.

With more frequent readings of customer meters, water utility staff develop a better understanding of water use patterns and are in a better position to manage water demand.

The effort and cost required to implement the recommended reforms are lower than would be required to adopt an entirely new conservation-oriented rate structure. Increases in metering and billing costs are minimised and existing billing systems should readily accommodate the proposed changes.

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ABBREVIATIONS

ADF	average daily flow
admin.	administrative
cf	cubic feet
cfs	cubic feet per second
CRD	Capital Regional District
DB-FX	decreasing block rate
EU-FX	excess use rate
FX	fixed charge
gal.	gallon
gpcd	imperial gallons per capita per day
IB-FX	increasing block rate
ICI	industrial/commercial/institutional
IRWD	Irvine Ranch Water District
MF	multi-family
m^3	Cubic meters
mgd	Million US gallons per day
migd	Million imperial gallons per day
mo.	month
MTLC	Municipal Technical Liaison Committee
MWD	Metropolitan Water District
na	not applicable
OM&A	operating, maintenance and administration
PUC	Public Utility Commission
RFP	request for proposal
SF	single family
SPWM	Strategic Plan for Water Management prepared by Reid Crowther and Partners Ltd.
SR-FX	seasonal rate
UFW	unaccounted for water
UR	uniform rate
WAC	Water Advisory Committee

CONVERSION FACTORS

To Convert From:	To:	Multiply by:
Foot	Meter	0.3048
Square foot	Square meters	0.0929
Acre	Square meters	4,046
Acre foot	cubic meters	1,233.5
100 cubic feet	cubic meters	2.832
100 cubic feet	1,000 imperial gallons	0.623
1,000 imperial gallons	cubic meters	4.546
1,000 US gallons	cubic meters	3.785
Meter	feet	3.28
Square meter	Square feet	10.764
Cubic meters	imperial gallons	220.0
Cubic meters	100 cubic feet	0.353
Cubic meters	acre feet	0.000811
1,000 imperial gallons	100 cubic feet	1.605
Imperial gallons	US gallons	1.201
US gallons	imperial gallons	0.833
Acres	square feet	43,560
Square feet	acres	0.00002296
Acre foot	imperial gallons	271,379
Cdn $/acre foot	Cdn $/cubic meters	0.000811
Cdn $/100 cubic feet	Cdn $/cubic meters	0.353
Cdn $/1,000 imperial gallons	Cdn $/cubic meters	0.220
Cdn $/1,000 US gallons	Cdn $/cubic meters	0.264
US $/1,000 US gallons	Cdn $/cubic meters	0.396
US $	Cdn $	1.5

1 INTRODUCTION

1.1 PURPOSE

As part of ongoing water conservation program efforts, the Capital Regional District (CRD) engaged New East Consulting Services Ltd. to examine opportunities for conservation-based pricing of water in the Greater Victoria service area. The impetus for the study came from the "Strategic Plan for Water Management" completed in 1999, which recommended a comprehensive study of conservation-oriented water rates (page 5-93). The purpose of the assignment was to prepare a water rate study that was tailored to the needs of Greater Victoria. This report describes the work completed for this assignment and documents recommendations for an appropriate rate structure and its implementation.

1.2 BACKGROUND

The Capital Regional District (CRD) is responsible for the supply of potable water in the CRD area. The CRD supplies water on a wholesale basis to municipalities in the Saanich peninsula and central area, which in turn retail the water to individual users. The CRD charges for water sold to the local municipalities using a full-cost volumetric rate based on the utility method for rate setting. The wholesale customers are Saanich, Victoria and Esquimalt, Oak Bay, the Saanich Peninsula Water Commission and the Juan de Fuca Water Commission. The CRD also retails water to customers in the Western Communities and charges these customers local retail rates.

The retail rates are a combination of fixed charges plus uniform consumption charges. These rate structures are the most common structures for larger municipalities across Canada. In terms of water conservation, they represent a significant improvement over earlier rate structures used throughout Canada such as the flat rate and the decreasing block rate structures. But they do not provide as much financial incentive for water conservation as more recent conservation rate structures such as seasonal charges and increasing block rates.

A number of issues underlie CRD's interest in a water conservation rate structure, including:

- concerns with system reliability stemming from the reliance on a finite volume of water stored in the Sooke Reservoir to meet high summer water demands
- the need to meet growing water demands while maintaining targets for system reliability
- water quality problems that occur at low water levels in the Sooke Reservoir
- the costs of future capacity expansion options such as the diversion of flows from Goldstream Reservoir ($10M)
- the limited success of past demand management efforts in the CRD.

Water conservation efforts in the CRD began in 1993. A Water Conservation Policy was adopted in 1995 with the objective of a reducing total per capita consumption to 477 litres per day by 2004. In 1999, demand management objectives were further clarified in the report, "Strategic Plan for Water Management." They now include reductions in peak summer demands, base demands and non-revenue water. The Water Department's current demand management efforts include public information, audits, rebates, meter replacement and lawn watering restrictions. Through the strategic planning exercise, demand management objectives have been defined to include reductions in peak summer demands, base demands and non-revenue water consumption. Conservation rate structures can be used to help achieve these objectives.

The terms of reference for this study endorse the following key principles in setting a conservation water rate structure:

- equity among water consumers,
- affordability to all customers regardless of economic circumstances,
- full recovery of water supply costs, and
- minimum impact on the local economy.

1.3 APPROACH TO THE STUDY

The main tasks for this assignment include:

- Review of historical and current water utility data of CRD and its member communities.
- Establishment of water rates setting principles and evaluation criteria in consultation with CRD Water Department staff, the Water Advisory Committee (WAC) and the Municipal Technical Liaison Committee (MTLC).
- Identification of alternative conservation rate structures and assessment of their impacts in terms of meeting conservation objectives, impacts on revenue and expenditures, administrative practicality, economic impact on different consumer groups, etc.
- Evaluation of alternatives using approved criteria including compliance to rate setting principles.
- Identification of the most viable rate structure and development of an implementation strategy.

These tasks were undertaken with the full co-operation of Regional and municipal staff. As the work progressed, working papers were prepared for review by staff and members of WAC. Information was thereby provided for review on an ongoing basis and the consultants received feedback that helped guide the work.

An iterative process was used to evaluate the alternative conservation rate structures. In this process, the WAC and the MTLC played a key role by commenting on working papers and completing evaluation exercises.

1.4 ORGANISATION OF THE REPORT

The following chapter of this report reviews existing conditions in the CRD. The next two chapters identify, describe and evaluate alternative conservation rate structures. The evaluation includes an assessment of the impacts of alternative rate structures on water demands, rates, customer bills and revenue stability. Recommendations for rate reform are developed based on the evaluation. Chapter 4 describes how conservation-oriented rates will affect capital works and Chapter 5 discusses matters relating to the implementation of rate reforms. Conclusions and recommendations are presented in the final chapter.

2 EXISTING SITUATION

2.1 OVERVIEW OF WATER SUPPLY SYSTEMS

The CRD is responsible for water supply sources, intake, treatment, transmission and distribution. The water supply is obtained from catchments to the west. Primary supply comes from the Sooke Reservoir, with Goldstream Reservoirs held in reserve as emergency backup. Water flows by gravity. There is no treatment apart from disinfection. This combination of factors results in low supply costs.

The CRD conveys the treated water to its member municipalities and unincorporated areas on a wholesale basis except to the Western Communities and Sooke where the treated water is distributed to individual properties on a retail basis with the wholesale rate imbedded in the retail rate.

Water is supplied and transmitted by the CRD to the central and peninsular municipalities of Victoria, Oak Bay, Saanich, Central Saanich, North Saanich and Sidney. Victoria operates the Esquimalt water system. In the case of Central Saanich, North Saanich and Sidney, CRD sells water to the Saanich Peninsula Water Commission. This Commission, administered by the CRD Environmental Services Department, maintains local distribution and storage facilities and re-sells the water to local municipalities. Local municipalities provide local infrastructure and bill individual customers for water. Their billings include the wholesale and retail costs. The CRD does not bill individual customers in these municipalities.

The local water systems in the Western Communities are operated by the CRD and retail billings to them are at a uniform retail water rate. The Juan de Fuca Water Distribution Commission, the governing body for CRD's retail water operations, reviews and approves the retail rate for the Western Communities. The Western communities include Colwood, View Royal, Langford, Metchosin, Sooke, and the Juan de Fuca Electoral Area.

Service connections at the retail level in 1998 were as follows:

TABLE 1: SERVICE CONNECTIONS - 1998

	Water service connections	Sewer % of water (1)	Sewer service connections (2)
Victoria	17,824	100%	17,800
Oak Bay	6,072	100%	6,100
Saanich	28,860	60%	17,300
North Saanich (3)	3,649	33%	1,200
Central Saanich	4,412	60%	2,600
W. Communities	14,561	17%	2,500
Sidney	3,140	100%	3,100
Total	78,518	65%	50,600

NOTES: (1) Figures reported by members of MTLC

(2) Estimated from % data and water connections

(3) % sewer servicing includes an expansion scheduled to occur in 2001.

2.2 CURRENT RATES

2.2.1 RETAIL RATES

All customers are billed a volumetric rate on the water bill (see Table 2). All local municipalities have two-part rates with a fixed and a volumetric component. This is a standard approach to water tariffs and is generally accepted as a reasonable way to allocate costs. All retailers pay the same wholesale rate for water but local retail rates vary due to differences in local system costs and different degrees of reliance on other sources of funds such as parcel and property taxes. Most of the fixed charges appear in the water bill, but two municipalities bill the fixed charge with the property tax.

TABLE 2: RETAIL 2000 WATER RATES IN CRD SERVICE AREA

Municipality	Water Rates		Wholesale Portion of Volumetric Charge (1)	Parcel Tax for Water System
	Fixed charge	Volumetric charge (rate in original units in brackets)		
Victoria (2)	$28.05/4 mo	29.2¢/m^3 (82.6¢/100cf)	68%	-
Esquimalt	$28.05/4 mo	29.2¢/m^3 (82.6¢/100cf)	68%	-
Oak Bay	$42.60/4 mo	29.3¢/m^3 (83¢/100 cf)	68%	-
Saanich	$11.20/4 mo	41.0¢/m^3 ($1.86/1000 gal)	49%	-
Central Saanich (3)	$36.00/4 mo	36.4¢/m^3	54%	-
North Saanich (4)	On tax bill	55.1¢/m^3 ($2.50/1000gal)	36%	$220/yr
Sidney (2)	On tax bill	72.7¢/m^3 ($3.30/1000 gal)	27%	$131/yr
Western Communities	$15.83/4 mo	67.96¢/m^3	29%	-

NOTES: 1) The wholesale rate is 19.8¢ /m^3. 2) Victoria and Sidney add a garbage charge to utility bill.
3) Also there is a farm water rate of $0.1978/m3. If farm home also served, the first 151 m^3 is at urban rate.
4) Dean Park is the only area serviced with sanitary sewers.

Only three of the municipalities have a sewer charge on the water bill (Table 3). Most municipalities use parcel taxes (a flat rate for all properties) or property taxes (based on assessed property value) to recover all or part of their sewer system costs. These taxes are applied to all properties whether or not they are serviced. Property taxes are not however collected from government buildings and service charges such as the water bill may at times provide the only means of recovering costs from these customers.

Typical residential water bills range from $15 to $46 per month or $189 to $553 per year (water plus sewer charges – Table 4). Costs on a typical residential water bill for wholesale supply are not high, varying between 13% and 40% of the total water bill. The majority of costs are for the local system. This is not surprising since treatment and pumping costs are minimal. Fixed charges on the typical residential water bill range from 0% to 56% of the total bill. Where they are 0%, fixed charges are levied as parcel taxes that do not appear on the water bill.

TABLE 3: CHARGES FOR SANITARY SEWER SERVICES

Municipality	Sewer Charges on the Water Bill	Annual Parcel Tax or Sewer Bill	Other Charges
Victoria	50% of water bill	-	Frontage charge
Esquimalt	-	-	General mill rate
Oak Bay	-	-	General mill rate
Saanich	-	Res. - \$112 ICI - (\$42 + \$10/fixture)	-
Central Saanich (1)	80% of water bill	-	-
North Saanich	-	\$410	-
Sidney (2)	81.1¢/m^3	\$150	-
Langford	-	22.0¢/m^3 x 3 x (metered water use from Sept. to Dec.)	Mill rate or frontage tax to pay for debt
Colwood	-	Fixed charge per household, ICI charges are based on equivalent residential units (3)	-
View Royal	-	\$82.50	-

NOTES: 1) Sewer charge is based on water consumption from September to December.

2) Sidney has minimum bills of \$15/qtr for water and \$18/qtr for sewer. Sewer billed in 3rd quarter (July to September) based on lower of actual water consumption or average water used in the prior three quarters.

3) Equivalent residential units for an ICI customer is a number that represents the customer's water use as a multiple of the water use of a standard residential unit.

TABLE 4: TYPICAL RESIDENTIAL WATER BILL

	Residential Water Bill – Typical Charges (1)				Fixed Portion of the Total Water Bill	Wholesale Water Cost in the Total Bill
	Water Charges (\$/mo)	Sewer Charges (\$/mo)	Total Bill (\$/mo)	Unit Cost, Water and Sewer (\$/m^3)		
Victoria	15.77	7.91	23.69	0.79	44%	25%
Esquimalt	15.77	-	15.77	0.53	44%	38%
Oak Bay	18.96	-	18.96	0.63	56%	31%
Saanich	14.83	-	14.83	0.49	19%	40%
Central Saanich	19.92	15.94	35.86	1.20	45%	17%
North Saanich	16.50	-	16.50	0.55	0% (3)	36%
Sidney	21.78	24.33	46.11	1.54	0% (3)	13%
Western Communities	24.36	-	24.36	0.81	16%	24%

NOTES: 1) Assumes water use of 30 m^3 per month and servicing with both water and sewers. Estimated bills include fixed and volumetric charges.

2) Fixed charges for water are on the property tax bill.

2.2.2 FARM RATES

As a matter of social policy, water is provided to farms within the CRD at a subsidized rate. The retailers charge the wholesale rate for water used for agricultural purposes including for greenhouse operations. The CRD compensates the retailers for all revenue losses associated with this subsidy.

2.2.3 WHOLESALE RATES

The wholesale water rate is reviewed annually by the Regional Water Supply Commission, which is the governing body for wholesale water operations. The same wholesale rate is applied to all water sold to the water retailers. Wholesale rates have more than doubled since 1992 as can be seen in the following table:

TABLE 5: WHOLESALE CRD WATER RATES

Year	Wholesale Rate $/m^3 ($/1000 gallons)
1992	0.088 (0.40)
1993	0.121 (0.55)
1994	0.132 (0.60)
1995	0.145 (0.66)
1996	0.150 (0.68)
1997	0.176 (0.80)
1998	0.176 (0.80)
1999	0.185 (0.84)
2000	0.198 (0.90)

2.2.4 COMPARISON WITH CUSTOMER COSTS ACROSS NORTH AMERICA

Customer costs for water and sewer services in Canada and the US are shown in Tables 6 to 8. Costs are expressed in terms of the cost per cubic meter of water used by the customer—the unit cost. Data are provided for volumetric charges and for volumetric plus fixed charges that appear on the customer's water bill. These costs are compared to CRD unit costs for residential customers. The comparisons are based on the total costs for both water and sewer services since it is these costs that residential customers see and respond to on their water bill. Total costs include both the volumetric and fixed charges.

TABLE 6: CUSTOMER COSTS FOR WATER AND SEWER SERVICES – CANADA

	Volumetric Charges		Volumetric plus Fixed Charges	
	Res.	ICI	Res.	ICI
Median Cost ($/m^3)	0.79	0.68	1.11	1.10
Average Cost ($/m^3)	0.89	0.81	1.18	1.19
No. of municipalities	332	449	332	449

Source: Based on an analysis of data in the Environment Canada database, "MUP-D" for 1996.

Notes: Consumption level = 35 m^3/month. Total costs include the fixed charge.

Unit costs for residential customers in the CRD range from $0.49 to $1.54 per m^3 (see "Unit cost, water and sewer" in Table 4 above). All but 2 of the unit costs in the CRD are below the average and median residential costs for Canada (see Table 6) and all fall below the average and median US unit costs (total water bill costs in Table 7). Considering the distribution of costs for water and sewer services in Canada (Table 8), the CRD unit costs fall into the low end of the distribution.

TABLE 7: RESIDENTIAL WATER AND SEWER COSTS IN THE US

	Volumetric Charges	Volumetric plus Fixed Charges
Water		
Median Cost ($/m^3)	0.55	0.84
Average Cost ($/m^3)	0.58	0.91
No. of municipalities	172	172
Sewer		
Median Cost ($/m^3)	0.64	0.94
Average Cost ($/m^3)	0.69	1.01
No. of municipalities	128	128
Total water Bill (Water + Sewer)		
Median Cost ($/m^3)	1.19	1.78
Average Cost ($/m^3)	1.27	1.92

Source: Based on an analysis of data in "1998 Water and Wastewater Rate Survey" (Raftelis Environmental Group).

Notes: Sample size = 137 US municipalities. Consumption level = 28 m^3/month. Total water bill cost includes the volumetric charge and the fixed charge.

TABLE 8: DISTRIBUTION OF WATER AND SEWER COSTS IN CANADA – 1996

	Volumetric Charges				Volumetric plus Fixed Charges			
	ICI		Residential		ICI		Residential	
Price range ($/m^3)	no.	%	no.	%	no.	%	no.	%
Less than $0.25	70	15.6%	19	5.7%	11	2.4%	3	0.9%
$0.26 to $0.50	117	26.1%	86	25.9%	53	11.8%	37	11.1%
$0.51 to $0.75	77	17.1%	60	18.1%	75	16.7%	50	15.1%
$0.76 to $1.00	83	18.5%	74	22.3%	66	14.7%	62	18.7%
$1.01 to $1.25	45	10.0%	46	13.9%	74	16.5%	70	21.1%
$1.26 to $1.50	30	6.7%	22	6.6%	67	14.9%	51	15.4%
$1.51 to $1.75	14	3.1%	15	4.5%	49	10.9%	39	11.7%
$1.76 to $2.00	8	1.8%	7	2.1%	13	2.9%	12	3.6%
$2.01 to $2.25	1	0.2%	0	0.0%	17	3.8%	4	1.2%
$2.26 to $2.50	1	0.2%	1	0.3%	14	3.1%	1	0.3%
$2.51 to $2.75	1	0.2%	1	0.3%	6	1.3%	2	0.6%
$2.76 to $3.00	0	0.0%	0	0.0%	3	0.7%	0	0.0%
More than $3.00	2	0.4%	1	0.3%	1	0.2%	1	0.3%

Source: Based on an analysis of data in the Environment Canada database, "MUP-D" for 1996.

Notes: Consumption level = 35 m^3/month. Total cost includes the fixed charge. See Table for sample sizes.

The comparisons made above suggest that the cost of water and sewer services on the water bills of residential customers in the CRD are low. Low costs for water in the CRD are to be expected since conventional treatment is not required and pumping costs are low. In addition, overall customer costs on the water bill are low in the CRD because many of the sewer system costs do not appear on the water bill and are recovered using the tax bill instead. Under this method of cost recovery, customers have less opportunity to manage the size of the water bill by using less water.

Several Canadian municipalities that have two-tier water systems like the system of the CRD were contacted to compile information on their wholesale water rates as well as special rate features and local tariffs. Data for these municipalities are shown in Table 9.

TABLE 9: WHOLESALE WATER RATES IN CANADIAN MUNICIPALITIES

Municipality	Tariff Format	Tariff	Water Source	Local Municipalities[1]
Victoria CRD	Single, uniform	19.8¢/m^3 water	Protected surface, no treatment	6 municipalities and CRD retail
Vancouver GVRD	Single, uniform	17.8¢/m^3 water	Gravity flow from reservoirs, no treatment	18 municipalities, unmetered flat rate
Niagara Region, Ont.	Single, uniform	30.0¢/m^3 water 48.9¢/m^3 sewer	Lake Ontario, conventional treatment	11 municipalities all using two part rates: 5 declining block and 6 uniform rate. 55% of charges are for wholesale supply
Waterloo Region, Ont.	Single, uniform	44.5¢/m^3 water 31.7¢/m^3 sewer	Groundwater & river water, conventional treatment	7 municipalities. 65% of charges are for wholesale supply
York Region, Ont.	Single, uniform	43.7¢/m^3 water 42.0¢/m^3 sewer	Lake Ontario & groundwater, conventional treatment	9 municipalities using mostly 2-part rates. 72% of charges are for wholesale supply.

All of these upper tier municipalities sell water at single uniform rates to the local municipalities. They have not adopted rate formats that are differentiated based on the water usage patterns of individual local utilities nor do they use rates that are expressly designed promote conservation.

The three Ontario regional municipalities have a mixture of large and small local municipalities, and each has more than one supply system to operate. York Region does not have direct access to sufficient water resources and buys most of its water from the City of Toronto. Virtually all customers are metered at the retail level. Most retail municipalities utilise 2-part rates with a uniform volumetric rate. Although conservation programs are a high priority in two of the Regions (Waterloo and York), the local municipalities have not pursued conservation style rates. Vancouver does not meter retail customers. As a result, there is no opportunity to use economic incentives to control water use. The low cost of water is used as a reason for not metering.

Only Vancouver has rates that are comparable to those in the CRD. The proportion of cost related to supply in other parts of Canada varies from 55% to 72%. This is considerably higher than in the CRD. The difference is to a great extent due to the fact that the CRD has access to very high quality raw water that meets USEPA requirements for an unfiltered water source. The treatment facilities normally used for surface water are not required in the CRD and pumping costs are also very low.

2.3 REVENUE REQUIREMENTS

Municipal financial records for the retail water supply operations were reviewed in order to determine the revenues that are recovered from water rates. Revenue requirements for 1998 and 1999 are provided in Table 10. The 1999 revenue data were used in the analysis of alternative rate structures in Chapter 4.

TABLE 10: WATER SYSTEM REVENUES ($1,000'S)

	REVENUES				EXPEN-DITURES
	User Charges (1)	Taxes (2)	Other (3)	Total	
1998					
Victoria + Esquimalt	5,052.8	1,810.0	521.9	7,384.7	7,501.9
Oak Bay	1,683.6	-	62.7	1,746.3	1,744.3
Saanich	7,824.5	10.2	719.4	8,554.1	8,164.4
Central Saanich	1,675.8	866.7	1,123.3	3,665.8	3,527.8
North Saanich	1,093.6	982.4	935.9	3,011.9	2,959.4
Sidney	1,045.0	662.9	345.4	2,053.3	1,955.8
Western Communities	6,185.3	-	1,489.8	7,675.1	5,519.3
1999					
Victoria + Esquimalt	5,255.6	1,829.1	409.4	7,494.1	7,402.1
Oak Bay	1,688.6	-	42.2	1,730.8	1,692.8
Saanich	7,976.6	10.2	153.4	8,140.2	7,698.1
Central Saanich	1,744.8	909.0	751.2	3,405.0	3,216.2
North Saanich	1,061.9	987.2	555.2	2,604.3	2,527.5
Sidney	1,068.0	658.5	347.2	2,073.7	1,982.8
Western Communities	not avail.	not avail.	not avail.	not avail.	not avail.

Source: Financial statements of the retail water departments.

Notes: (1) Revenues from sale of water.

(2) Transfers from general revenue including parcel taxes, property tax revenue, frontage taxes, etc.

(3) Includes revenues from penalties, connection fees, other fees, reserve fund transfers, grants, etc.

2.4 METERING AND BILLING

Currently, retail meters are read every 4 months in all communities except Sidney where they are read every 3 months. Municipal staff are responsible for meter reading tasks.

Most of the water retailers use Tempest software for their financial systems, including water customer billing. This software can accommodate increased billing frequencies, and volumetric charges that vary by customer class or by season.

2.5 WATER DEMAND

2.5.1 ANNUAL WATER PRODUCTION AND SALE

Figures for annual water production and bulk water use are provided in Table 11, while retail sales data are provided in Table 12. Bulk water use is the volume of water provided to water retailers by the CRD. Retail water sales represent water used by the end user.

Total water production in 1999 was almost 60,000,000 m^3 or 164,000 m^3 per day. Daily water production per retail account is about 2.1 m^3 and per capita water production is approximately 550 litres per day. Single family residential demand accounts for 83% of total demand in Saanich but only 51% of demand in Victoria. Water sales data from Sidney for 1999 indicate that residential demand makes up 76% of the total sales in that community.

TABLE 11: WATER PRODUCTION AND BULK WATER USE

	Total Production	BULK WATER USE (wholesale water)				
		Total	Victoria	Saanich	Oak Bay	Saanich Pen.
MIGD/yr						
1997	12,337	10,217	4,298	3,763	782	1,375
1998	13,519	10,962	4,283	4,276	895	1,509
1999	13,145	10,637	4,218	4,072	836	1,511
1000 m^3/yr						
1997	56,079	46,439	19,535	17,103	3,553	6,248
1998	61,450	49,827	19,466	19,436	4,067	6,858
1999	59,751	48,350	19,172	18,508	3,801	6,869

Source: Based on an analysis of data from CRD

NOTE: Water is not provided to Western communities on a wholesale basis.

TABLE 12: RETAIL WATER SALES IN 1998

	Total	Victoria/Esq	Saanich	Oak Bay	Other*
Retail Water Sales					
1000 m^3/yr	48,960	17,759	17,513	3,560	10,129
MIGD/yr	10,771	3,907	3,853	783	2,228
Distribution of sales					
Single Family Res.	50.7%	32.5%	61.6%	82.8%	52.3%
Multi-Family Res.	19.0%	25.6%	14.5%	6.2%	19.9%
ICI	29.0%	41.2%	21.8%	11.0%	26.2%
Agriculture	1.3%	0.7%	2.1%	0.0%	1.6%

Source: Based on an analysis of data from CRD

* Includes Western communities, North Saanich, Central Saanich and Sidney.

2.5.2 SEASONAL WATER SALES

Water sales records were also analysed to determine the seasonal distribution of sales. Information on the seasonal distribution of water sales is used in the design of seasonal rate structures. For the CRD communities, high seasonal use can commence in May and continue through to September. The current billing frequency, mostly every 4 months, is not suitable for billing seasonal water rates.

Assuming bimonthly billing commencing in January, the year is divided into two periods for purposes of rate design. The summer season spans 6 months extending from May to October.

Seasonal bulk water sales for 1999 are summarised for four municipalities in Table 13. Summer sales represent from 58% to 70% of total sales. The ratio of average summer to average winter sales is lowest in Victoria at 1.39 and highest in Oak Bay at 2.36. A high ratio corresponds to a high proportion of residential customers as well as a cultural background and lifestyle that assigns great importance to green lawns and fine gardens. In the case of Oak Bay, the high seasonal demand also reflects higher income levels. Residential water demand typically has a greater seasonal variation than ICI demand.

TABLE 13: SEASONAL DISTRIBUTION OF BULK WATER CONSUMPTION - 1999

	Victoria	Saanich	Oak Bay	Saanich Pen.	Total
% in the Summer	58.2%	66.2%	70.3%	65.0%	63.2%
%in the Winter	41.8%	33.8%	29.7%	35.0%	36.8%
Average Summer	409,092	449,076	97,946	163,781	1,119,895
Average Winter	293,864	229,553	41,437	88,095	652,949
Summer/Winter	1.39	1.96	2.36	1.86	1.72

Source: Based on an analysis of data from CRD

Notes: Summer = May, June, July, August, September, October

Winter = November, December, January, February, March, April

2.5.3 RETAIL CUSTOMER PROFILES IN CASE STUDY CITIES

Billing records were reviewed in order to develop profiles of the residential customers and the industrial, commercial and institutional (ICI) customers. Residential customers are households that are individually metered. ICI customers include households in apartment buildings and multiplexes that are bulk metered and do not receive individual water bills. Customer profiles provide the basis for determining customer water bills and estimating changes in water demand.

The 1999 water billing records for Saanich and Victoria were sorted by type of customer and by size of water demand. The sorted records were then divided up into 5 groups, each representing about one fifth of the total volumetric demand. The numbers of customers in each of these groups and the average monthly water use of customers within each group are reported in Table 14.

The distributions in Table 14 are typical of retail water sales. A relatively small number of customers use a disproportionately large volume of water. For example, average residential water use is about 30 m^3 per month in both communities, but the average consumption of the largest customers, representing less than 10% of all customers is more than twice this amount. Modifications to the rate structure to achieve water conservation will often have very little impact on the small- to medium-size customers but a large impact on the water bill of these large customers. Water use by smaller customers is generally for essential needs (sanitation and cooking) while excess use often includes a large discretionary element.

TABLE 14: RETAIL CUSTOMER WATER USE PROFILES – 1999

	Residential Customers (single family)			ICI Customers		
	Number of Customers in Group	Total Water Use of Group (m^3/year)	Water Use per Customer (m^3/mo)	Number of Customers in Group	Total Water Use of Group (m^3/year)	Water Use per Customer (m^3/mo)
Victoria						
1st 20% of use	5,562	916,719	14	2,872	2,658,015	77
2nd 20% of use	3,125	914,482	24	508	2,646,631	434
3rd 20% of use	2,386	914,708	32	270	2,647,371	817
4th 20% of use	1,775	914,278	43	125	2,639,119	1,759
5th 20% of use	1,017	912,712	75	42	2,667,015	5,292
Total use	13,865	4,572,899	28	3,817	13,258,151	290
Saanich						
1st 20% of use	10,291	2,121,907	17	1,169	1,472,982	105
2nd 20% of use	6,050	2,116,782	29	223	1,463,969	547
3rd 20% of use	4,691	2,116,795	38	113	1,459,085	1,076
4th 20% of use	3,635	2,117,039	49	43	1,401,516	2,716
5th 20% of use	2,209	2,111,930	80	4	1,553,405	32,363
Total use	26,876	10,584,453	33	1,552	7,350,956	395

2.5.4 PRICE ELASTICITY OF WATER DEMAND FOR BRITISH COLUMBIA

2.5.4.1 What is Elasticity

The basic premise of conservation water rates is that the demand for water falls as the volumetric price of water increases. The volumetric price is used to give the water customer an incentive to conserve water. The strength of the relationship between the price of water and the demand for water is measured using a value called the price elasticity of demand or just elasticity.[1]

To understand elasticity, first consider the probable response of an individual household to the increases in the price of water shown in Figure 1. The demand curve in Figure 1 is the thin line that steps down as price increases—this shape is called a "step function".[2] But elasticity describes a smooth continuous relationship between price and water demand, not an uneven step function. The demand relationship or curve is smoothed out because it describes the aggregate demand of many customers. For instance, Figure 2 might be what the demand of 20 households looks like while Figure 3 might be for 1,000 households. The smoothing happens because different households use different amounts of water and respond in different ways to price. Elasticity is a number that describes the downward slope of the smooth curve in Figure 3. Because the slope is downward sloping, elasticity is a negative number.

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[1] There are also elasticities to measure the response of demand to increases in household income, population growth, etc. Here, the term is only used to refer to price elasticity.

[2] In mathematics, a function is a relationship between two variables like price and demand. An equation is used to describe a function. A simple function for water demand might be the following:

Monthly household demand = 30 cu.meters – 0.2 x (price per cu. meter)

Economists use a statistical analysis of demand and price data to estimate the price elasticity of demand. The price used in this analysis is the total volumetric price including the water rate plus any wastewater rate or surcharge. Estimates of price elasticity usually lie in the range of -0.05 to -1.0. This number is a ratio of the percentage change in demand and the percentage change in price that causes the change in demand.

The mathematical expression for elasticity is:

(Price elasticity of demand) = (Percent change in demand) ÷ (Percent change in price)

$$= \frac{\text{(Change in water demand after the price change)} \div \text{(Water demand before the price change)}}{\text{(Change in price)} \div \text{(Original price)}}$$

The calculation using elasticity to estimate a change in demand when price changes is therefore:

(Percent change in demand) = (Price elasticity of demand) x (Percent change in price)

For example, assume the elasticity for demand in a community is -1.0. If the price of water increases by 10%, then the change in demand is:

(-1.0) x (10%) = -10%

If elasticity is -0.2, demand changes by:

(-0.2) x (10%) = -2% .

FIGURE 1 : AN INDIVIDUAL HOUSEHOLD'S DEMAND FOR WATER

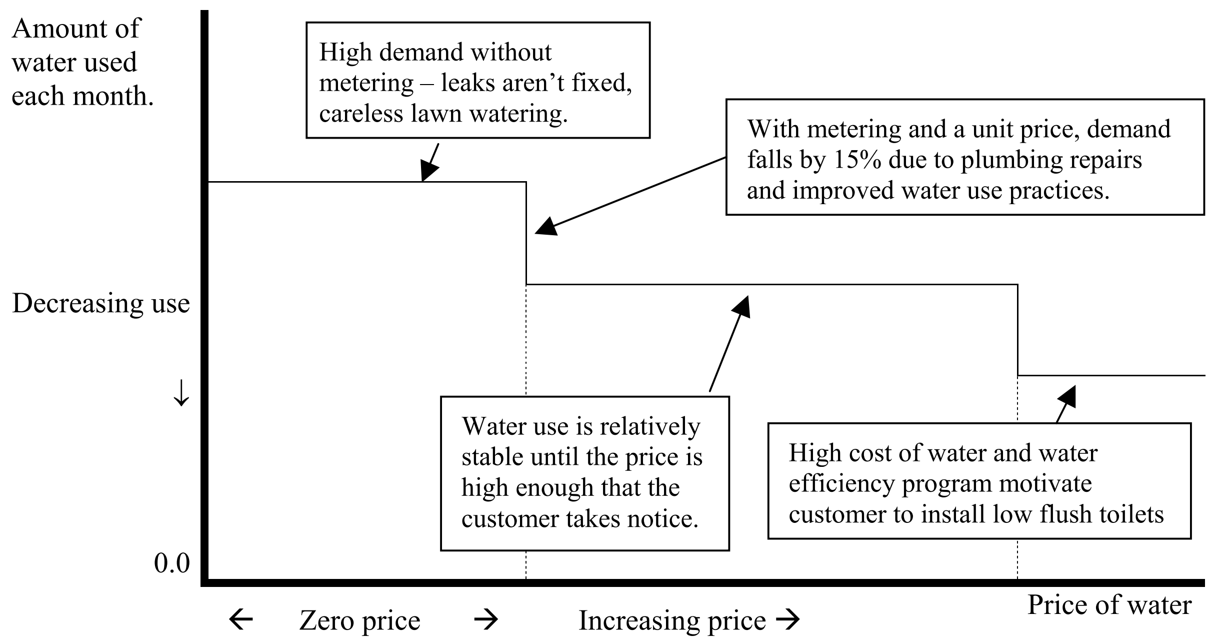


FIGURE 2 : DEMAND FOR WATER – 20 HOUSEHOLDS

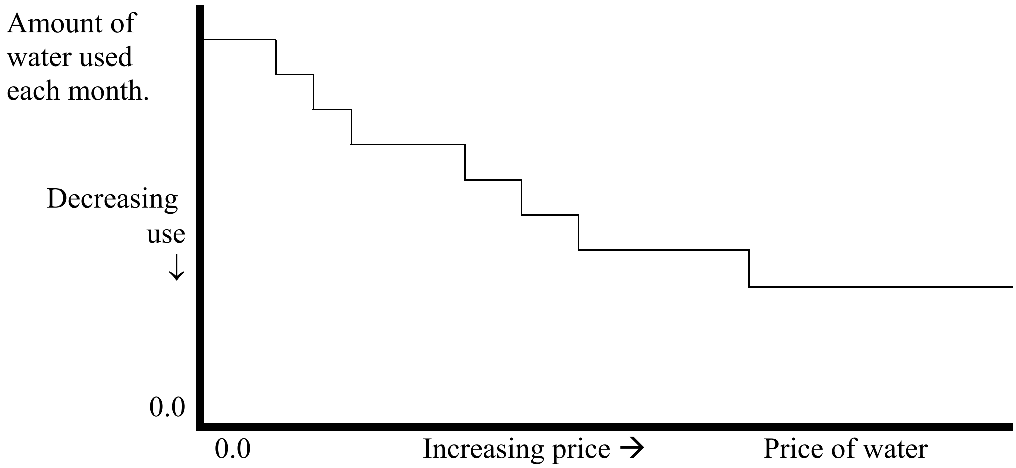
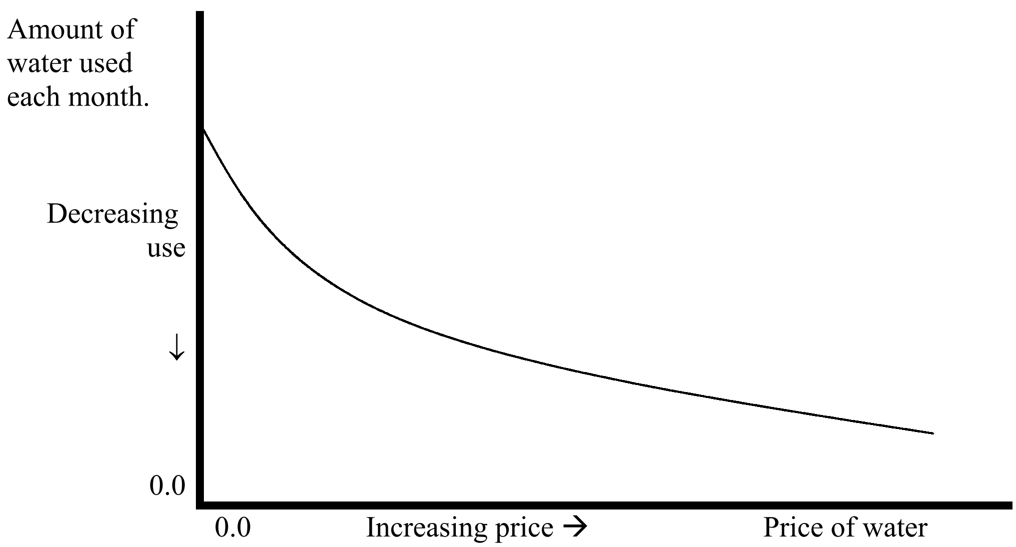


FIGURE 3 : DEMAND FOR WATER – 1,000 HOUSEHOLDS



2.5.4.2 Interpreting Price Elasticity Calculations

Price elasticity calculations are used to forecast water demand. Such calculations should be interpreted with care for a number of reasons. Estimates of elasticity are usually borrowed from the research literature and do not necessarily reflect conditions prevailing in the community for which forecasts are being made. Literature numbers are often presented as point estimates with little or no contextual information. But context is very important in understanding the response of demand to price. At the very least, it is important to recognise key attributes:

1. Elasticity varies by type of customer. Large industrial water users may be very sensitive to the price of water, while commercial customers and residential customers in individually metered

dwellings will be less sensitive. Zero elasticity is generally appropriate for flat rate customers or water users who are not individually metered (e.g. tenants in a bulk-metered building)

2. Elasticity of residential demand will vary by type of use—indoor demand is generally less elastic than outdoor demand for lawn and garden irrigation.
3. Elasticity may vary as price increases. Initially, at very low prices, the cost of water is negligible for most customers and elasticity is low. As the price increases, the water bill becomes more prominent and elasticity increases (i.e. demand becomes more responsive to price).
4. Over time, the cost of water to customers will fall in terms of real or non-inflating dollar values if increases in the price of water do not keep up with inflation. If this has been happening, then demand may not respond as expected to increases in the price of water since the increases just serve to offset inflation.
5. As price becomes very high, water demand may "harden" or become less responsive to subsequent price increases. This can happen when customers have exhausted all of their cost-effective options for reducing water demand. For example discretionary demand may be minimised while basic needs must continue to be met.

To select a value for elasticity for a community, it is therefore necessary to evaluate the mix of customer types receiving water service, the relative proportions of indoor and outdoor water use, the existing price levels and the history of water efficiency programming and water rate adjustments.

Time scale is a further complicating factor in the interpretation of price elasticity. Demand studies provide both short run and long run estimates of the elasticity of demand to price. Short run elasticity measures changes in demand that occur within a year, whereas long run elasticities measure responses that occur over a longer period of time. Long run elasticities are generally higher than short run elasticities since certain water efficiency measures that a customer adopts in response to a price change may take more than one year to implement.[3] In water efficiency planning studies, long run price elasticities are of greatest interest.

In estimating elasticity, it is often difficult to discern the impact of pricing when other forces are influencing demand such as weather and population growth. The same problem exists when forecasting demand with models that include price elasticity. The impact of price changes may be overwhelmed by the impact of other factors. Moreover, if the impact of a water efficiency program is built into the forecast, then it is easy to double count or overestimate the impact of price changes since the water efficiency measures promoted by the program are the same measures that customers use in responding to price increases.

2.5.4.3 Estimates of Price Elasticity of Water Demand

The research literature contains hundreds of papers analysing the demand for water. Two studies from BC are considered here. In addition, a number of reports summarise findings from water demand studies and recommend ranges of elasticities for planning work. These reports are also reviewed here. Finally, a statistical analysis of water demand data for 1996 from municipalities in BC is presented.

An early study of water demand in Victoria by Sewell and Roueche[4], one of the first such studies in Canada, analysed aggregate municipal water demand data for the period 1954 – 1970. They analysed the response of water demand per customer to changes in the price of water over time. Other variables

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[3] The long run response of demand may of course be greater or less than the short run response due to factors such as general price inflation and weather that can affect demand.

[4] W.R. Sewell and L. Roueche, 1974. "Peak Load Pricing and Urban Water Management: Victoria, B.C., a Case Study." Natural Resources Journal, 14(3), pages 383-399.

that they considered were summer weather conditions and average income levels. Variables such as changes in customer mix or levels of economic activity over time were not considered. Demand data were aggregated to the level of the Greater Victoria Water District and the water price data was also aggregated up to this level by calculating an average retail price for the District. Price elasticities estimated in this study were -0.40 for annual water demand, -0.065 for peak season demand and -0.58 for off-peak season demand. The peak and off-peak season elasticities are the reverse of what is normally expected (peak season demand should be more responsive than off-peak season demand, not less). Moreover, these estimates are constant over the full range of prices although we would expect elasticity to increase as price gets higher.

Another example of water demand analysis for BC is the work of Renzetti on industrial demand.[5] Using 1982 industrial survey data for BC firms, Renzetti developed demand curves for four broad industrial sectors—petrochemicals, heavy industry, forest products and light industry. Only the light industry sector in the form of manufacturing, construction and food processing is represented in study area and these customer groups account for less than 2% of total demand. The estimated elasticity for this sector was – 0.53.

Several reports on rate setting and financial planning for water supply provide information on demand elasticities. This information is summarised in Table 15. The more recent documents cited in Table 15 favour lower estimates of price elasticity.

TABLE 15: COMPILATION OF PRICE ELASTICITY INFORMATION

Source	Summary of Elasticity Information
<u>Cost Allocation and Rate Design for Water Utilities</u>, 1991, National Regulatory Research Institute	Residential: -0.20 to -0.40 Industrial: -0.50 to -0.80
<u>Evaluating Urban Water Conservation Programs, a Procedures Manual</u>, 1992, California Urban Water Agencies	Single-family residential: Winter: -0.10 to -0.20; Summer: -0.20 to –0.40 Multi-family residential: Winter: -0.05 to -0.20; Summer: 0.00 to -0.20 Commercial/ Industrial: -0.10 to -0.30
<u>Municipal Water and Wastewater Rate Manual</u>, 1994, Canadian Water and Wastewater Asc and Rawson Academy of Aquatic Science.	In-house residential: -0.2 to -0.4 Outdoor residential: up to –1.0 Non-residential: -0.5 to -0.8 (These numbers are based on the same source as those given in the first reference cited in this table)
<u>Designing, Evaluating and Implementing Conservation Rate Structures</u>, 1997, California Urban Water Conservation Council	Long run elasticities SF residential: Winter: -0.10 to -0.30: Summer; -0.20 to –0.50 MF residential: Winter: 0.00 to -0.15; Summer: -0.05 to -0.20 Short run elasticities SFresidential: Winter: 0.00 to -0.10; Summer: -0.10 to -0.20 MF residential: Winter: 0.00 to -0.05; Summer: -0.05 to -0.10

[5] S. Renzetti, 1988. "An econometric Study of Industrial Water Demands in British Columbia, Canada." Water Resources Research, 24(10), pages 1569-1575.

TABLE 15: COMPILATION OF PRICE ELASTICITY INFORMATION

Revenue Effects of Water Conservation and Conservation Pricing, 1994, National Regulatory Research Institute and Urban Water Demand Management and Planning, 1998, Bauman, Boland and Hanemann. Mcgraw-Hill.	These two publications summarise findings from dozens of water demand studies spanning 5 decades. Only a handful of the studies are either continental in scope or specific to the Pacific NW region. Elasticity estimates from these are as follows: In-house residential: -0.1 to -0.2 Outdoor residential: -0.4 to -0.7 Commercial: -0.1 to -0.4 Industrial: -0.4 to -1.0 Total municipal: -0.1 to -0.7

2.5.4.4 Elasticity Assumptions for the CRD

Direct estimates of price elasticity were made for this study using 1996 water demand data for municipalities in BC. This data was part of the Environment Canada's national Municipal Utility Price Database (MUP DB) for 1996. Elasticity is a component of a mathematical expression called a demand curve that describes how the demand for water changes as various underlying factors such as price and population change. The general form of the estimated demand curves is:

$$\ln(Q) = a + b \times (\text{persons/household}) + c \times [\ln(\text{population})] - m \times (\text{price})$$

where:
- Q = total annual demand of all users
- ln(Q) = natural logarithm of Q
- price = average price
  - = (water bill)/(monthly water use) for metered customers
  - = 0.0 for flat rate customers
- a, b, c and m are fixed parameters.

This form of the demand function is referred to as a semi-log curve. It allows price elasticity to increase as price increases. The water demand curves estimated for municipalities in BC are as follows:

Dependent variable = ln(total ADF)	Regression variable: Persons per Household	ln(Pop. served)	Average Price/m^3	Constant term
Coefficient	-0.499	0.976	-0.194	1.183
Standard error	0.162	0.028	0.067	0.484
t scores	-3.087	34.865	-2.916	2.445
R2	0.903	F score	411.703	
Degrees of freedom	133			
Dependent variable = ln(residential ADF)	**Regression variable: Persons per Household**	**ln(Pop. served)**	**Average Price/m^3**	**Constant term**
Coefficient	-0.484	0.945	-0.173	1.100
Standard error	0.156	0.027	0.064	0.467
t scores	-3.100	34.959	-2.686	2.355
R2	0.903	F score	414.560	
Degrees of freedom	133			

For the range of retail water prices in the CRD in 1996, estimated elasticities are as follows:

Residential demand: -0.09 for low prices to –0.23 for high prices, -0.12 for average price
Total demand: -0.10 for low prices to –0.26 for high prices, -0.14 for average price

These estimates are consistent with the values shown in Table 14 above.[6]

[6] Using this type of demand curve, elasticity is estimated as (m x price) and changes in water demand are estimated as follows: $Q_{new} = Q_{old} [1 - m (price_{new} – price_{old})]$

For total demand, the value for m is 0.194 using prices expressed in 1996 dollars. After adjustment for inflation from 1996 to 2000, the appropriate value for m is 0.180.

3 ALTERNATIVE RATE STRUCTURES

3.1 RETAIL RATE STRUCTURES

Opportunities to promote water conservation using the water rates at the retail level are explored in this section. The fixed and volumetric charges that can be used in a rate structure are first described. Following this, opportunities to promote conservation using the existing rates are identified, alternative rate structures are described, and the experience with rate structures in other municipalities is reviewed.

3.1.1 COMPONENTS OF THE RETAIL RATE STRUCTURE

Components of the retail rate structure are described in this section. This information provides background information that is used in the discussion of alternative retail rate structures.

Retail rate structures can include fixed charges that remain constant from one billing period to the next and/or volumetric charges that vary with the amount of water consumed. The fixed charge is independent of the volume of water actually used by the customer. Two-part tariffs use both types of charges and the customer pays the fixed charge plus a volumetric charge for the water volume used. One-part tariffs use only a fixed flat rate charge or a volumetric charge.

3.1.1.1 Types of Fixed Charge

The fixed charge can be a single charge applying to all customers or a charge that varies across classes of customer. When the rate structure is a one-part tariff using a fixed charge it is called a flat rate. Flat rates usually only apply to residential customers. Flat rate charges may be the same for all customers or they may vary based on some attribute of the customer such as household size, assessed property value or the number of water using fixtures in a house. The fixed charge in a two-part tariff can be a uniform charge for all customers, or can vary. The formats for a fixed charge in a two-part tariff are described below:

- **Single or uniform fixed charge** – This is a fixed charge to each customer that is levied in every bill and that is independent of the amount of water used. Many water system costs do not vary with volume and a fixed charge is a fair way of recovering a portion of such costs. It is usually used to recover costs directly related to customers such as billing, collecting and metering costs. A single fixed charge is easy to calculate and less trouble to apply compared to a variable charge (see below) since tracking of a customer's meter size is not needed. It is generally used in small municipalities where larger meters are few and resources for keeping updated billing records less.
- **Meter charge** – This is a fixed charge per month for each customer that varies by the size of a customer's meter or water service. This charge is used by most lower tier municipalities in the CRD. The meter size is normally used rather than the customer's service size because the meter is an indicator of the supply capacity provided to the customer. The charge varies because some of the cost components that are recovered through the fixed charge vary with meter size. For example, meter and service pipes within the road allowance and meter reading costs increase with meter size. Other costs such as billing costs vary less with meter size. Water system fire protection capacity costs are also often included in the fixed charge. The charge for large industrial meters are typically over a hundred times greater than the charge for a residential meter. Generally charges that vary by meter size are the fairest type of fixed charge.

- **Demand Charge** – A fixed charge per billing period that is based on the customer's peak demand. Different approaches may be used to measure peak demand, but for a retail rate, maximum month demand in the previous year is appropriate. The measure of peak demand for a customer remains constant for the billing year. The demand charge can replace the meter charge as a fixed charge (this is assumed to be the case in this analysis). This charge is common for electricity sales but not for water, especially at the retail level.
- **Minimum Bill** - The fixed charge may or may not include a minimum consumption allowance. Where it does it is referred to as a minimum bill. The minimum bill provides the customer with a specified consumption allowance at no additional cost. The customer pays the minimum charge plus the volumetric consumption charge on any water used in excess of the consumption allowance. The minimum bill can be justified as a means of covering some fixed costs that are ongoing whether a customer uses water or not. It provides a municipality with a revenue cushion that is unaffected by annual variations in use (usually related to seasonal use fluctuation for cooling and irrigation). The consumption allowance with a minimum bill should be sufficiently low that only a small percentage of customers pay only the minimum bill. Otherwise, the minimum bill starts to function like a flat rate charge.

Since the costs that are truly variable over the short term represent less than 10% of total costs, it is not practical to set fixed charges to recover the 90% or more of costs that are fixed. To do so would remove the incentive to meter. Fixed charges in the two-part tariff are primarily used to recover customer-related costs for meters, services, billing and collecting. They may also be used to recover certain capital costs such as those associated with the provision of capacity for fire protection.

3.1.1.2 Types of Volumetric Charge

Volumetric charges are levied for the amount of water consumed by a customer. Volumetric charges include uniform charges, declining blocks, increasing blocks, the inverted "U" or humpback blocks, the seasonal charge and the excess use charge.

Uniform Charge - The uniform charge applies a single volumetric charge to all usage. It is simple to calculate and apply and easy for customers to understand. In the simplest case, tariff calculations for the single block tariff involve dividing total budgeted costs that are to be recovered from the water tariff by total expected water sales. This charge does not attempt to refine the allocation of costs to customers in proportion to their peak demands, which are a factor in the cost of providing water system capacity.

Declining Blocks - The declining block volumetric charge decreases in steps as usage increases. Traditionally the consumption limits for the first block were set to encompass the largest amount that a customer in a single-family dwelling might use. The upper consumption limits for the 2nd block would encompass the consumption of most medium to large commercial customers, and the 3rd and subsequent blocks covered larger industrial users. A typical declining block volumetric charge structure therefore had at least 3 blocks. But declining block volumetric charge with only 2 blocks are frequently used now. This reflects an ongoing shift away from this type of charge due to their poor reputation for water conservation. It is argued that they do not promote water conservation since the price of water declines as more water is used. But this reputation is more a matter of optics than reality. Like any other volumetric tariff structure, the declining block volumetric charge always provides the customer with an economic incentive to conserve water since the water bill always increases as the amount of water used increases. The key issue with respect to conservation concerns the size of the price incentive. The declining block volumetric charge may be an appropriate tool for water conservation if small customers are responsible for the inefficient water use in a system since it charges a higher price to the small customer and therefore gives that customer a greater incentive to conserve water.

Declining block charges were originally designed to achieve an equitable allocation of costs among customers. Costs for building and operating the excess system capacity that is used to satisfy peak demands are recovered primarily from residential customers who, as a customer class, are the main cause of peaks demands. The rate design is cost-based and is not meant to favour industry in order to promote economic development.

The most common approach is called the base-extra capacity method. This method requires that all costs be first allocated to the following functional cost categories: base demand, maximum day extra capacity demand, maximum hour extra capacity demand, customer meters and services, customer billing and collecting and fire protection services. These allocated costs are then assigned to domestic, commercial and industrial customer classes based on the contribution that each class of customer makes to costs in each cost category. Costs for customer meters, services, billing and collecting and possibly fire protection are recovered through the meter charge. Costs allocated to maximum hour, maximum day and average day demands are recovered through the volumetric charge. Detailed data on customer counts and water demand profiles are required to set these tariffs properly.

Increasing Blocks - With increasing blocks the price of water increases with increasing use. This structure is designed to encourage water conservation. The first block for a customer class would be designed to cover the normal use of an average customer in that class. For subsequent blocks, the differential in the charge level should be designed to give a clear and strong economic incentive to the customer to conserve water; for example, rate differentials between the blocks of 5%, 10% or even 25% are not enough for domestic customers. This type of charge is most appropriate for residential customers. It would be suitable for industrial customers where water availability limitations outweigh the disadvantages of shifting the cost burden to the largest users.

Humpback Block - A hybrid of the increasing and decreasing blocks is called the humpback or inverted "U" block. Calculation of humpback blocks requires an analysis of costs similar to the analysis used to set declining blocks. Costs are allocated to the same functional cost categories. The subsequent assignment of allocated costs to component blocks then creates a peak charge for the consumption block that captures most of the seasonal demand of residential customers. This format encourages conservation by residential customers by using the increasing block limits to encompass residential usage, while at the same time offering large industrial users declining charges which reflect the economies of scale of providing such customers with water.

Seasonal Charge - Seasonal charges are high volumetric charges on all water used during the peak water demand season. The off-peak season or base charge applies to water consumed during the remainder of the year. Seasonal charges promote water conservation where seasonal demands are the target of conservation efforts. The rationale for a seasonal charge is that peak demands require over sizing of supply facilities relative to the capacity required to meet demand for most of the year. With a seasonal charge, the extra costs of this excess capacity are recovered directly from that component of demand that causes those costs.

Excess Use Charge – The excess use charge is a high volumetric charge that applies to all demand during the peak water demand season in excess of a threshold. The threshold is set equal to average off-peak season consumption or a modest multiple of this amount, for example 1.3 times winter demand. A base charge applies to all of a customer's off-peak season consumption and to the portion of peak season consumption that is below the threshold.

For both the seasonal charge and the excess use charge, the differential between the peak season and off peak season charge must be large so customers notice the difference and have a strong incentive to save water. One way to achieve this is to recover all capital costs for expansion from the peak season charge. This approach will generally produce a large seasonal charge but it also increases the risk of inadequate cost recovery since the utility relies on more variable seasonal demands to recover a major portion of its costs. Sound judgement must therefore be exercised in designing seasonal charges.

3.1.2 PROMOTING CONSERVATION WITH EXISTING RATES

3.1.2.1 Increasing Volumetric Water Charges

The starting point in a water conservation rate study should always be a consideration of how existing rates might be reformed to promote water conservation without actually changing the rate structure. This can be accomplished either by: (1) increasing the existing volumetric charges while reducing the fixed charges to maintain the same level of cost recovery; or (2) increasing the volumetric rates by increasing the total costs that are recovered on the water bill.

Most of the existing rate structures are two-part rates with a fixed charge and a uniform volumetric charge (Table 16). Two municipalities have fixed charges that appear on the tax bill rather than the water bill. Fixed charges on the water bill represent from 16% to 56% of the typical residential bill. These charges are relatively high and could be reduced to 15%. By doing this, greater emphasis is placed on the volumetric charge for cost recovery. With a smaller fixed charge, small customers pay a lower water bill while customers using a lot of water will pay a higher bill and thus have more incentive to conserve water.

As noted on Section 2.2.1, property taxes are used to recover part of the water system costs in two lower tier municipalities and all or part of their sewer system costs in all municipalities except Central Saanich. Three of the six eastern municipalities have a sewer surcharge and only one community in the Western Communities has a sewer surcharge. Reliance on the property tax to recover water or sewer system costs reduces the size of the water bill, which in turn diminishes the incentive to conserve water. Recovering the cost of the sewer system entirely from the water bill will typically double the water bill. This simple measure greatly increases the incentive to conserve water while being revenue neutral since water and sewer costs are taken off of the property tax bill.

TABLE 16: TYPICAL RESIDENTIAL WATER AND SEWER BILL

	Typical Residential Bill - $/mo (1)	Fixed Portion of the Total Bill	Volumetric Portion of the Total Bill
Victoria	23.69	44%	56%
Esquimalt	15.77	44%	56%
Oak Bay	18.96	56%	44%
Saanich	14.83	19%	81%
Central Saanich	35.86	45%	55%
North Saanich (2)	16.50	0%	100%
Sidney (2)	46.11	0%	100%
Western Communities	24.36	16%	84%

Notes: (1) Assumes water use of 30 m^3 per month (see page 5). (2) Volumetric portion is 100% since the fixed charges are on the property tax bill.

3.1.2.2 Sanitary Sewer Surcharge

A sanitary sewer surcharge uses a customer's metered water consumption as a basis for calculating a sewer charge. The reason that water consumption is used is that the water meter reading is the most feasible way of determining the approximate volume of sewage discharged by a customer. Since it is not feasible to install sewage meters on each service due to cost, maintenance and meter accuracy issues, water meters readings are used as a proxy.

The use of water meter reading does not precisely reflect actual sewage volumes. Some water does not enter sanitary sewers directly, such as lawn watering in the case of residential customers and cooling water in the case of non-residential customers. On the other hand, there is flow entering the sewer system from inflow and infiltration that is not reflected in the water meter readings. Generally water meter readings are used without adjustment in calculating sewer surcharges. The justifications for this are that non-sanitary water use is balanced by inflow and infiltration and that water meter readings are a good way of apportioning sewer costs to customers.

Some sewer utilities adjust the residential sewer surcharge to address customer concerns about billing sewer based on water meter readings that include outdoor use in the summer:

- **Winter Consumption as Base For Summer Sewer Billing** – Since there is no outdoor use in the winter, some utilities bill sewer in the summer based on each customer's winter water meter readings. This approach has good acceptance from customers, but requires complete meter readings and a billing system that can accommodate this rather cumbersome approach.
- **Summer Discount** – The sewer bill in the summer is based on water meter readings discounted by 15% to 20% to adjust for outdoor use. This approach is rather simple to apply.
- **Maximum Summer Sewer Bill** – Sewer bills have a threshold in the summer based on what an average family sanitary sewage discharge level. Once the charge reaches this predetermined level, no additional sewer charges are levied. This has a disadvantage of not helping small, careful customers while benefiting larger families and those who are wasteful water users.

Note that all of these approaches require the sewer rates to be increased to offset the loss in revenue resulting from reducing the volume used to calculate the sewer bills. As a result, they do not change the average sewer bill paid. Except for the first approach that differentiates between customers, they are essentially a public relations gesture.

If conservation is a priority, an adjustment for summer usage is not normally made for sewer charges since applying the sewer charge to the entire summer water use increases the incentive to use less water. In the case of non-residential customers, some utilities will make special adjustments where significant non-sanitary water use can be demonstrated. Plastics manufacturing with its heavy cooling load would be an example (as long as the waste cooling water is not discharged to the sanitary sewer).

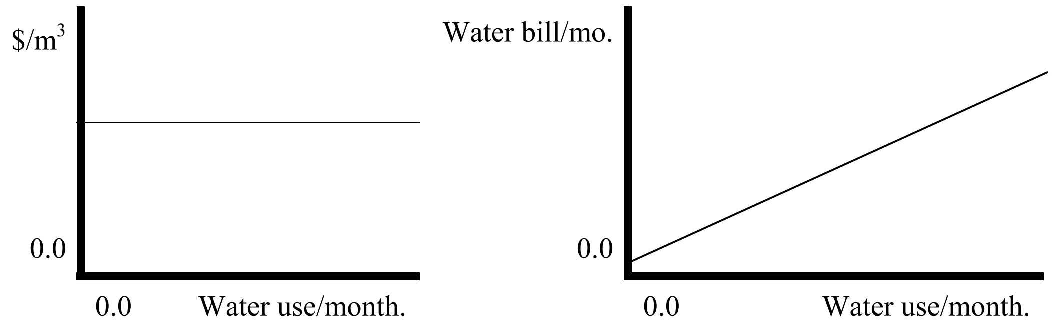
3.1.3 ALTERNATIVE RETAIL RATE STRUCTURES

3.1.3.1 The Uniform Rate Structure

The uniform rate (UR) structure has no fixed charge and a constant volumetric rate is applied to all water used in the billing period (see figure 3.1). All customers therefore pay the same amount for each unit of water used. This is the simplest format for a volumetric rate structure.

While a UR structure is commonly used in a two-tier municipal government system to sell water at the wholesale level, a UR structure is not common at the retail level.

FIGURE 4 : UNIFORM RATE STRUCTURE



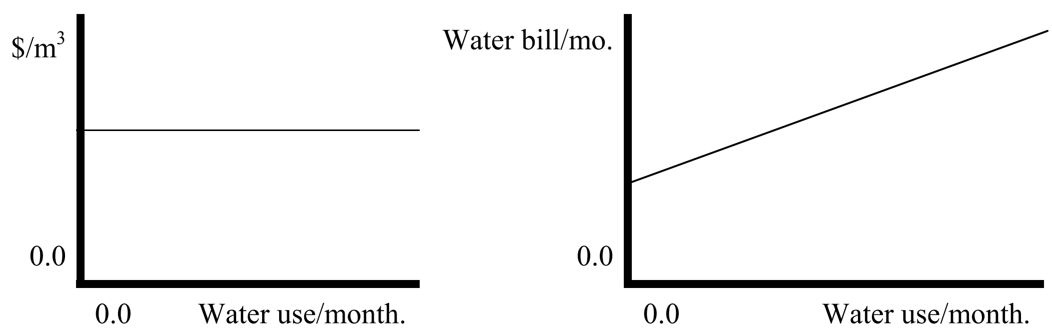
Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the UR structure: Volumetric charge = \$1.50/m^3 Customer water use in one month = 24 m^3 ➔ Monthly water bill = 1.50/m^3 x 24 m^3 = \$36

3.1.3.2 Uniform Rate Structure with a Fixed Charge

A uniform rate structure with a fixed charge (UR-FX) has a constant volumetric charge applied to all consumption plus a fixed charge based on meter size.

FIGURE 5 : UNIFORM RATE STRUCTURE WITH A FIXED CHARGE



Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the UR-FX structure:

Volumetric charge: $1.200/m3;

Monthly meter charge: 18 mm - $6.00

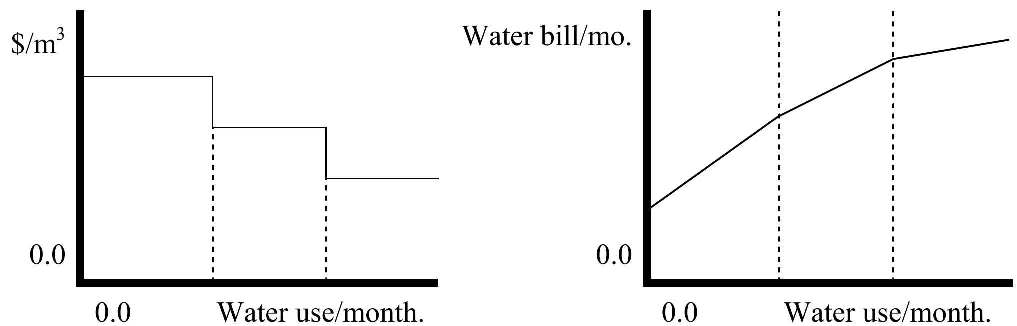
Customer water use in one month = 24 m^3

➔ Monthly water bill = $6.00 + $1.20/$m^3$ x 24 m^3 = $34.80

3.1.3.3 Declining Block Rate Structure

The declining block rate (DB-FX) combines a meter charge with a declining block volumetric charge.

FIGURE 6 : DECLINING BLOCK RATE



Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the DB-FX structure:

Sample calculation for a customer using 28 m^3/month:

Volumetric charge: 0 to 24 m^3/month at $1.207/$m^3$,

24.1 to 200 m^3/month at $1.000/$m^3$,

200.1+ m^3/month at $0.700/$m^3$

Monthly meter charge: 18 mm - $6.00

Customer water use in one month = 28 m^3

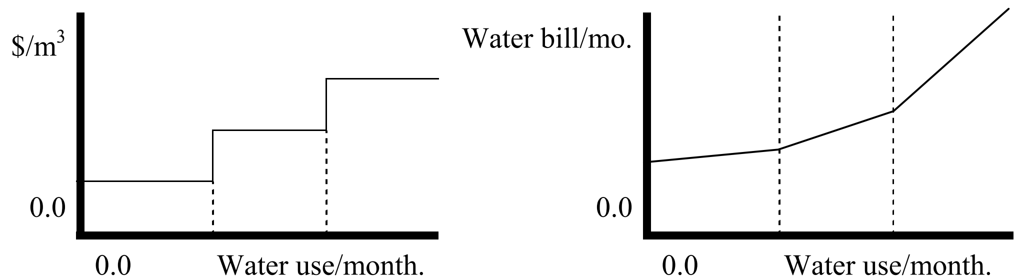
➔ Monthly water bill = $6.00 + ($1.207/m^3 x 24 m^3) + ($1.000/$m^3$ x (28 m^3 - 24 m^3))

= $38.97

3.1.3.4 Increasing Block Rate Structure

The increasing block rate structure (IB-FX) combines a meter charge with an increasing block volumetric charge. This structure is often only used for residential customers since the high rate of the final block can not be justified for large non-residential customers.

FIGURE 7 : INCREASING BLOCK RATE



Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the IB-FX structure:

Volumetric charge: 0 to 10 m^3/month at $0.350/$m^3$,

10 to 25 m^3/month at $0.700/$m^3$,

25.1+ m^3/month at $1.400/$m^3$;

Monthly meter charge: 18 mm - $6.00

Customer water use in one month = 35 m^3

➔ Monthly water bill = $6.000 + ($0.350/m^3 x 10 m^3) + ($0.700/$m^3$ x (25 m^3 - 10 m^3))

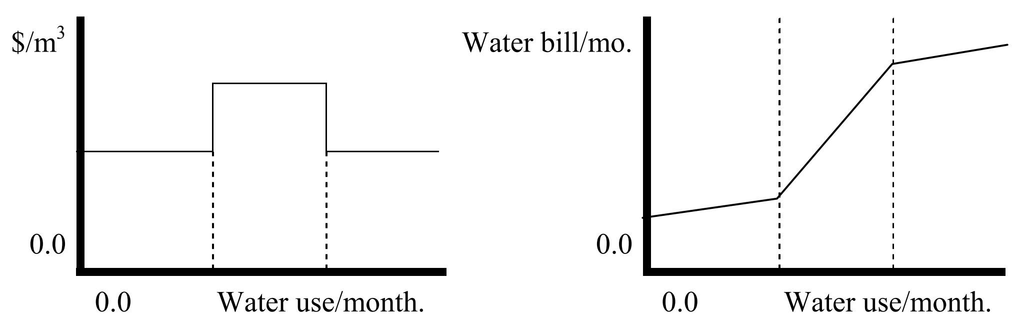
+ ($1.400/$m^3$ x (35 m^3 - 25 m^3))

= $34.00

3.1.3.5 Inverted U or "Hump-backed" Rate Structure

The humpback rate structure (HB-FX) combines a meter charge with a humpback volumetric charge

FIGURE 8 : HUMP-BACKED RATE



Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the HB-FX structure:

Volumetric charge: 0 to 25 m^3/month at \$0.600/m^3,

25.1 to 75 m^3/month at \$1.400/m^3,

35.1+ m^3/month at \$0.600/m^3

Monthly meter charge: 18 mm - \$6.00

Customer water use in one month = 35 m^3

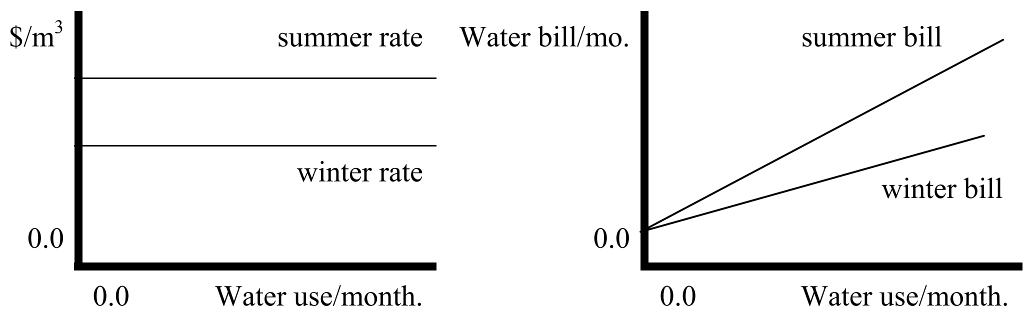
➔ Monthly water bill = \$6.000 + (\$0.600/m^3 x 25 m^3) + (\$1.400/m^3 x (35m^3 - 25 m^3))

= \$32.40

3.1.3.6 Seasonal Rate Structures

Seasonal rate structures (SR-FX) are any rate structure with a seasonal volumetric charge. Seasonal volumetric charges can be added to other rate structures. In this report, we consider a SR-FX rate featuring a uniform volumetric charge and a fixed charge.

FIGURE 9 : SEASONAL RATES



Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the SR-FX structure:

Volumetric charge: Base charge: \$1.000/m^3,

peak season volumetric charge: \$1.462/m^3;

Monthly meter charge: 18 mm - \$6.00

Customer water use in one month = 28 m^3 in the summer and 16 m^3 in the winter

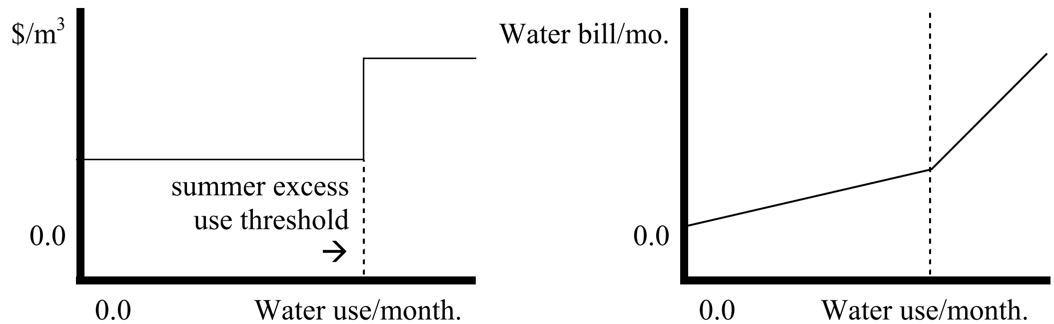
➔ Monthly water bill = \$6.00 + \$1.462/m^3 x 28 m^3 = \$46.94 in the summer

= \$6.00 + \$1.000/m^3 x 16 m^3 = \$22.00 in the winter

3.1.3.7 Excess Use Rate Structures

Excess use rate structures (EU-FX) are any rate structure with an excess use volumetric charge. Excess use rates can be added to other rate structures. In this report, we consider a EU-FX rate featuring a uniform volumetric charge and a fixed charge.

FIGURE 10 : EXCESS USE RATE



Structure of the Volumetric Rate **Monthly Water Bill**

Sample calculation of a customer bill with the EU-FX structure:

Volumetric charge: Base charge: $1.000/m^3,
excess use charge: $3.145/m^3
(applied to demand above 120% of winter demand);

Monthly meter charge: 18 mm - $6.00

Customer water use in one month = 28 m^3 in the summer and 16 m^3 in the winter

➔ Monthly water bill = $6.00 + $1.000/m^3 x (1.2 x 16 m^3)
+ $3.145/m^3 x (28 m^3 – 1.2 x 16 m^3)
= $52.88 in the summer
= $6.00 + $1.000/m^3 x 16 m^3 = $22.00 in the winter

3.1.3.8 Demand Charge Rate Structure

Demand charge rates (DC-FX) are any rate structure featuring a demand charge based on the customer's peak demand. Different approaches may be used to measure peak demand, but for a retail rate, maximum month demand in the previous year is appropriate. The demand charge replaces the meter charge as a fixed charge. This charge is common for electricity sales but not for water, especially at the retail level.

Sample calculation of a customer bill with the DC-FX structure:

Volumetric charge: $1.199/m^3;

Demand charge on peak month use: $0.172/(m^3/month)

Customer water use in one month = 28 m^3, maximum demand of 40 m^3/month last year

➔ Monthly water bill = ($1.199/m^3 x 28 m^3) + ($0.172/(m^3/month) x 40 m^3/month)

= $40.45

3.1.3.9 Lifeline Rate Structure

Lifeline rate structures (LR-FX) are any rate structure featuring a subsidised volumetric charge on a minimum volume of water for basic residential needs. They are designed to assist low-income households. Lifeline rates can be incorporated into increasing or decreasing block rate structures.

Sample calculation of a customer bill with the LR-FX structure:

Volumetric charge: 0 to 5 m^3/month - $0.750/m^3

5+ m^3/month - $1.350/m^3

Monthly meter charge: 18 mm: $6.00

Customer water use in one month = 28 m^3,

➔ Monthly water bill = $6.00 + $0.750/m^3 x 5 m^3 + $1.350/m^3 x (28 m^3 – 5 m^3)

= $40.80

3.1.3.10 Drought Rate Structure

A drought rate structure (DR-FX) is any rate structure with volumetric charges that are higher during a drought. This is an emergency rate that is used to reinforce bans on water use and to mitigate the revenue loss caused by a watering ban.

Sample calculation of a customer bill with the DR-FX structure:

Normal volumetric charge: $1.200/m^3,

Volumetric charge in drought: $1.836/m^3 (only charged during a drought)

Monthly meter charge: 18 mm - $6.00

Customer water use in one month = 28 m^3 in the summer and 16 in the winter, customer is limited to 16 m^3 during drought

➔ Normal summer water bill = $6.00 + $1.200/m^3 x 28 m^3 = $39.60

Drought summer water bill = $6.00 + $1.836/m^3 x 16 m^3 = $35.38

Winter water bill = $6.00 + $1.200/m^3 x 16 m^3 = $25.20

3.2 EXPERIENCE WITH CONSERVATION RATES

3.2.1 TARIFF STRUCTURES USED IN CANADA AND THE US

The UR-FX rate structure was the most common structure found in Canadian municipalities in 1996 followed by the DB-FX structure (Table 17). IB-FX and EU-FX rate structures are not popular in Canada. These structures accounted for 10% or less of the tariff structures reported by larger municipalities in 1996 and 1991 (Table 17). US rate surveys in 1996 and 1998 indicate a much higher use of IB structures—representing about 1/3 of the block rate structures (Table 18).

TABLE 17: DISTRIBUTION OF RATE STRUCTURES IN CANADA

Type of rate structure	Non-residential		Residential	
	No.	%	No.	%
UR-FX, UR	263	40.9%	188	29.1%
DB-FX	141	21.9%	99	15.3%
IB-FX	35	5.4%	38	5.9%
Complex (includes HB-FX, EU-FX)	10	1.6%	7	1.1%
Flat Rate	179	27.8%	288	44.7%
Property Tax	15	2.3%	25	3.9%
TOTAL	643	100.0%	645	100.0%

Source: Based on an analysis of the 1996 MUP data from Environment Canada

Note: Includes all reporting municipalities with service populations of 5,000 or more.

TABLE 18: DISTRIBUTION OF RATE STRUCTURES IN US MUNICIPALITIES

	UR-FX	DB-FX	IB-FX	TOTAL
1996	32%	36%	32%	100%
1998	34%	35%	31%	100%

Source: Raftelis Environmental Consulting Group, 1998 Water and wastewater rate survey and 1996 Water and wastewater rate survey, Charlotte, N.C.

Just over a quarter of larger Canadian municipalities still used only a fixed charge to recover costs from residential customers in 1996. This charge was either a flat rate water bill or a charge against the property tax. The percentage was much lower for commercial customers. Flat rate charges are however more prevalent than these figures suggest, since many municipalities with volumetric tariff structures also retain a flat rate charge for customers who are not yet metered. In the 1996 Environment Canada rate survey this was true for 27% of the non-residential tariffs and 45% of the residential tariffs.

At times, a municipality wishing to adopt a certain tariff structure in order to achieve one objective finds that other objectives will be sacrificed if the preferred structure is used. For instance, the IB-FX structure may help with water conservation but it is not based on the cost of providing service to customers and may not achieve an equitable allocation of costs among customers. When this type of conflict arises, communities may choose to differentiate tariffs by customer class. Examples of Ontario communities that have differentiated tariff structures are provided in Table 19.

TABLE 19: TARIFF STRUCTURES DIFFERENTIATED BY CUSTOMER CLASS

	Residential Tariffs	Non-residential Tariffs
Chatham	IB-FX	DB-FX
Cobourg	IB-FX	DB-FX
Kingston Township	UR-FX	DB-FX
London	IB-FX	HB-FX

3.2.2 CASE HISTORIES

3.2.2.1 Seattle – Increasing Block Rates

The Seattle Water Department replaced its UR-FX rate structure with a two step IB-FX structure in 1989. At this time it also initiated an active water conservation program. The second step of the IB-FX structure was set equal to the marginal cost of new water supplies as determined in cost of service studies.

Between 1975 and 1995, the average cost for residential water use increased in real or constant dollar terms by 77% for summer demand and by 15% for winter demand. Over this period average summer water use declined by 4.5% and winter demand declined by 7.9%. Much of this change is attributed to the combined effect of the increase in cost of water and the water conservation program.[7]

3.2.2.2 Phoenix – Increasing Block Rates

The Phoenix Water and Wastewater Utility initiated changes in its rate structure as early as 1977 when it switched from a UR-FX structure to an IB-FX structure for residential customers. In 1990, after a series of rate structure reforms, it finally settled on a three-season SR-FX structure that applied to all customer classes. This rate structure featured a minimum bill, which provided an allowance of 28 m^3 per month in the summer.

The cost of water in the summer increased in real terms by 29% from 1975 to 1995 but fell by 12% for water used in the winter season. Average residential water use fell by 30% in the summer and by 25% in the winter over this period. These changes in demand are attributed to various factors, one of which, the adoption of a seasonal rate structure, was estimated to have reduced demand by 1.0 to 1.6%.[8]

3.2.2.3 Irvine Ranch – Modified Increasing Block Rates

The Irvine Ranch Water District (IRWD) uses its own wells to supply about half its water demands and the remainder is purchased from the Metropolitan Water District (MWD).[9] In the face of drought conditions in 1991 the IRWD introduced IB-FX water rates to recovery penalty charges imposed by

[7] R.W. Cuthbert and P.R. Lemoine, "Conservation-oriented Water Rates", Journal of the American Water Works Association, Vol. 88 (11), Nov. 1996

[8] Ibid

[9] Based on Tom Ash, "How An Effective Rate Structure Makes Conservation Work for You—Irving Ranch Water Conservation District," (1999, AWWA, Conserve 99). Information was also gathered from IRWD staff by telephone interview.

the MWD. At the same time it also introduced an aggressive water conservation program with annual funding of $1.25 million.[10]

The rate structure has evolved to the current modified IB-FX structure in which each customer has a consumption allotment (Table 20). The residential customer allotment is based on number of residents and lot area. There is a standard allotment of water based on the following assumptions:

- Detached homes with 4 people and a 1300 square foot yard
- Attached homes with 3 people and a 435 square foot yard
- Apartments with 2 people and no lot

Customers can apply for increased allotments, for example each additional person increases the allotment by 7.1 m^3 (250 cf) while a more complex calculation is used to calculate the allotment for yard area. Business customer allotments are calculated on an individual basis. This approach requires considerable administrative effort since detailed information must be compiled and maintained for each customer.

TABLE 20: IRWD 2000 WATER AND SEWER TARIFFS

Description	Rate ($/$m^3$)	Residential		Business, Landscape	
		Tier	Use vs. Allocation	Tier	Use vs. Allocation
¾ Base Rate	$0.25	Low volume discount	0 – 40%		
Base Rate	$0.34	Conservation base rate	41 – 100%	Conservation	0 – 100%
2 x Base Rate	$0.68	Inefficient	101- 150%	Penalty	101 – 110%
4 x Base Rate	$1.36	Excessive	151 – 200%	Excessive	111 – 120%
8 x Base Rate	$2.71	Wasteful	201% & above	Abusive	121% & above
Fixed Charge	Varies by meter size, 5/8” and ¾” meter charge is $4.35 / month (US$2.90)				
Sewer Charge	Flat rate of $8.85 monthly (US$5.90)				

The volumetric charge is used to pay for the MWD supply charges and the variable local charges such as power for pumping. The MWD charges $0.53 /$m^3$ (US$435 per acre-foot) and the local well costs are much less at about $0.24 /$m^3$ (US$200 per acre-foot). The base cost is based on the average variable cost and the higher block rates are based on the more expensive water purchased from MWD. The service charge is used to pay for the remainder of the costs – essentially the “fixed” costs. The rate should be about $7.35 per month (US$4.90), but they have surplus funds that subsidise this rate down to the current level of $4.35 per month (US$2.90).

Limited information was provided on the impact of these rates on water use. It is noted that there was a 19% reduction in 1991 – 1992 on residential usage. The impact on business customers was unclear. Over the period 1990 to 1992 when the new rates were introduced, outdoor water use decreased from about 4.4 acre-feet per acre to 3.5. By 1998 the figure was about 2.3 acre-feet per acre. For a lot measuring 60 feet by 100 feet, 4.4 and 2.3 acre-feet per acre represent about 55 and 30 m^3/month respectively over a 12-month period.

The IRWD is satisfied with the effectiveness of their program. They are very strong on customer service and the program is well received by customers. By basing volumetric charges on their variable costs, reductions in water usage do not result in the need to increase rates if there is conservation.

[10] Unless otherwise noted, all currency units are in Canadian dollars.

3.2.2.4 City of Oshawa - Sewer Surcharge

The Region of Durham is located to the east of the City of Toronto. It was formed in 1974 and assumed full responsibility for the local municipal water and wastewater systems in the area, including the City of Oshawa. Over the period 1976 to 1980 the Region implemented uniform Regional water rates and in Oshawa moved the wastewater cost recovery from the property tax to a surcharge on the water bill.

The current water and wastewater tariffs for all Regional customers are provided in Table 21.

TABLE 21: DURHAM REGION WATER & WASTEWATER TARIFFS – 2000

Description	Water	Wastewater
Fixed Charge - $/month (1)	$6.29 to $1059	All customers $2.27
1st block	$0.38	$0.58
2nd block	$0.32	$0.51
3rd block	$0.29	$0.43
Residential bill for 22.7 m^3	$14.83	$15.33
Portion of bill for the volumetric charge	59%	85%

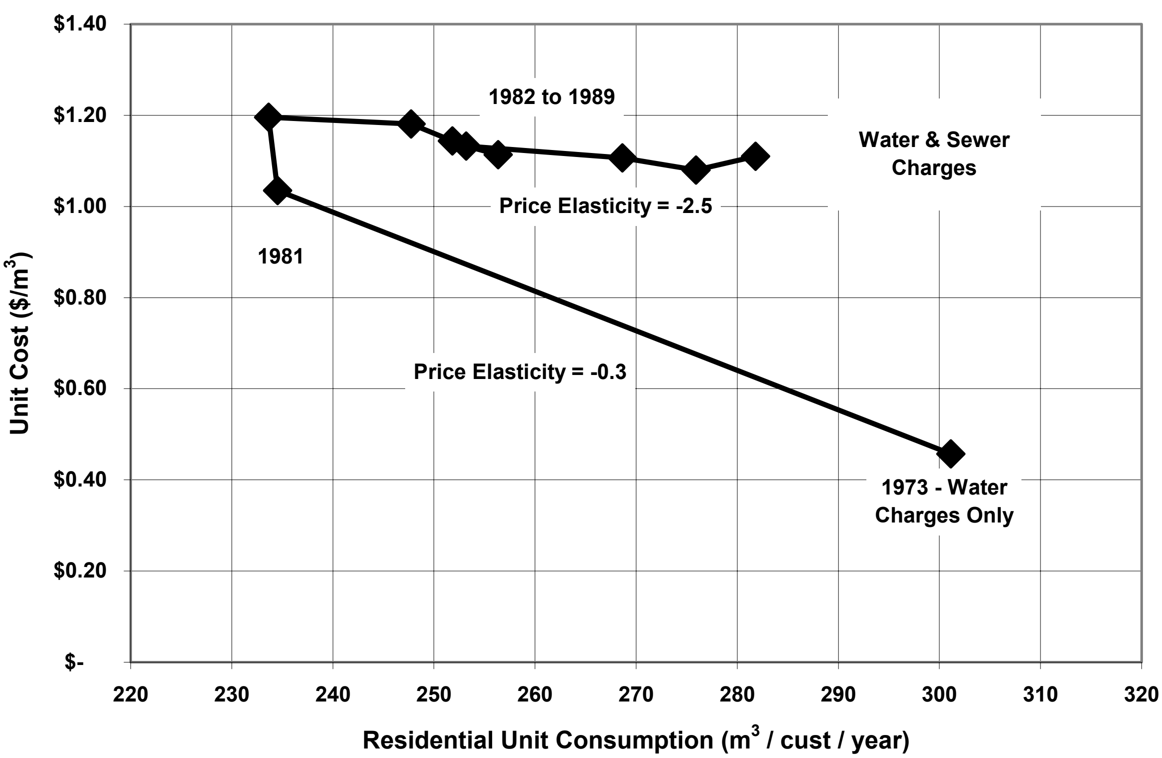
(1) Varies by meter size

Currently, an average customer using 22.7 m^3 per month pays a combined water and sewer bill of $30.17, of which 72% is based on the volume of water used.

The impact of adding a sewer surcharge to the water is illustrated below. Water consumption dropped from just over 300 m^3 per customer per year in 1973 to about 235 m^3 in 1981. During this period uniform Regional rates were phased in and the average unit cost more than doubled.

It is interesting to note that water consumption has steadily rebounded since 1982. This is thought to be due to the fact that unit water costs in constant dollars have actually decreased. In addition, the total cost of water and sewer bills is actually less than most other services, so customers have become less concerned about the water and sewer charges.

FIGURE 11 : RESIDENTIAL WATER CONSUMPTION - OSHAWA


$1.40
$1.20
$1.00
$0.80
$0.60
$0.40
$0.20
$-
220
230
240
250
260
270
280
290
300
310
320
Unit Cost ($/m3)
Residential Unit Consumption (m3 / cust / year)
1982 to 1989
Water & Sewer
Charges
Price Elasticity = -2.5
1981
Price Elasticity = -0.3
1973 - Water
Charges Only

3.2.2.5 Windsor - Excess Use Charge

The City of Windsor in Ontario experienced very high maximum day flows in 1987 during a dry period. As a result the Windsor Public Utilities Commission has proceeded both with a water treatment plant expansion and the implementation in 1989 of seasonal water rates.

The excess use charges are applied to the bimonthly billings issued from June 1 to November 30. The excess use charge is levied on the portion of a customer's usage that exceeds the customer's usage during the prior December 1 to May 31. The base tariff is applied during the winter and for a customer's summer usage up to the prior winter usage level. There is also a service charge variable by meter size. Volumetric tariffs are reported in Table 22.

Average day and maximum day ratios over the 1980 to 1995 period are graphed below. Average day demand has dropped about 2% and maximum day demand about 7%.

The impact of the excess use charge combined with the additional influence of precipitation can be seen in the second graph on the following page. Note that the dry year in 1990 deferred the apparent impact of the excess use charge, which is more obvious in following years.

TABLE 22: WINDSOR PUC VOLUMETRIC WATER TARIFFS 1987 TO 1996

Year	Base Rate	Summer Excess Use Rate	Base vs. Excess Use
1987	0.111	0.111	100%
1988	0.127	0.127	100%
1989	0.141	0.249	177%
1990	0.157	0.277	176%
1991	0.194	0.335	173%
1992	0.213	0.369	173%
1993	0.216	0.380	176%
1994	0.222	0.386	174%
1995	0.224	0.390	174%

FIGURE 12 : AVERAGE DAY PUMPAGE & MAX DAY RATIOS – WINDSOR

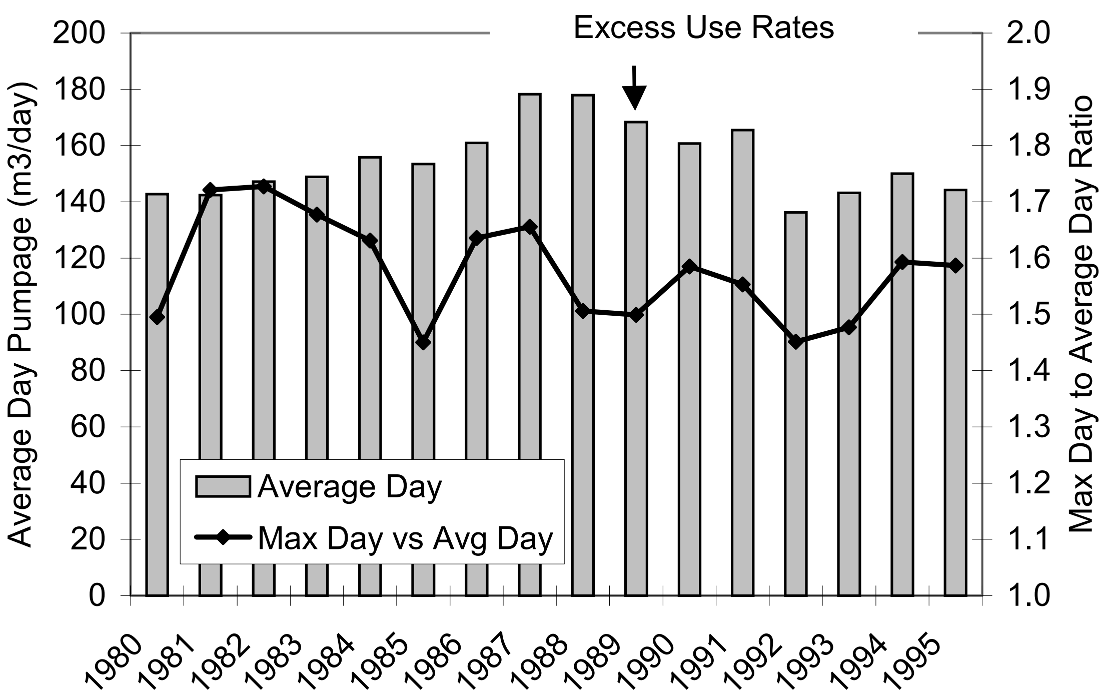
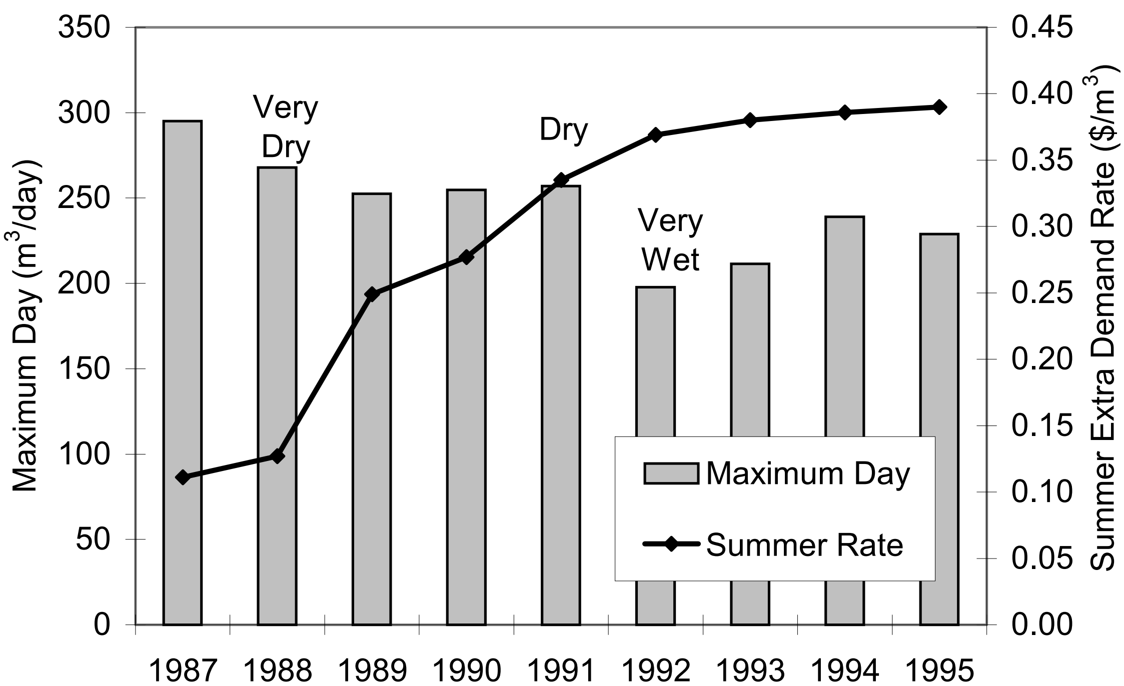


FIGURE 13 : WINDSOR MAXIMUM DAY VERSUS SUMMER PRICE


Maximum Day (m3/day)
Summer Extra Demand Rate ($/m3)
Very Dry
Dry
Very Wet
Maximum Day
Summer Rate
350
300
250
200
150
100
50
0
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1987
1988
1989
1990
1991
1992
1993
1994
1995

3.2.2.6 Belleville - Seasonal Rates

The Belleville, Ontario Public Utilities Commission introduced seasonal water tariffs in 1993. Higher rates are applied during June to September. Bills are monthly. The differential was +1.1¢/m^3 in 1993, +2.6¢/m^3 in 1994 and +4.0¢/m^3 in 1995. The 1995 and 1996 tariffs were as follows:

TABLE 23: BELLEVILLE PUC WATER TARIFFS 1995 & 1996 – MONTHLY

Charge	October to May	June to September
Fixed Charges	Varies by meter size from $7.69 to $151.11 per month	
First 450 m3	$0.55 /m3	$0.59 /m3
Balance	$0.42 /m3	$0.46 /m3
Sewer Surcharge	Residential flat rate $12.60 and general service 165%	

The water supply data prior to and after the introduction of the seasonal rates is provided in Table 24.

TABLE 24: BELLEVILLE PUC WATER SUPPLY PUMPAGE STATISTICS

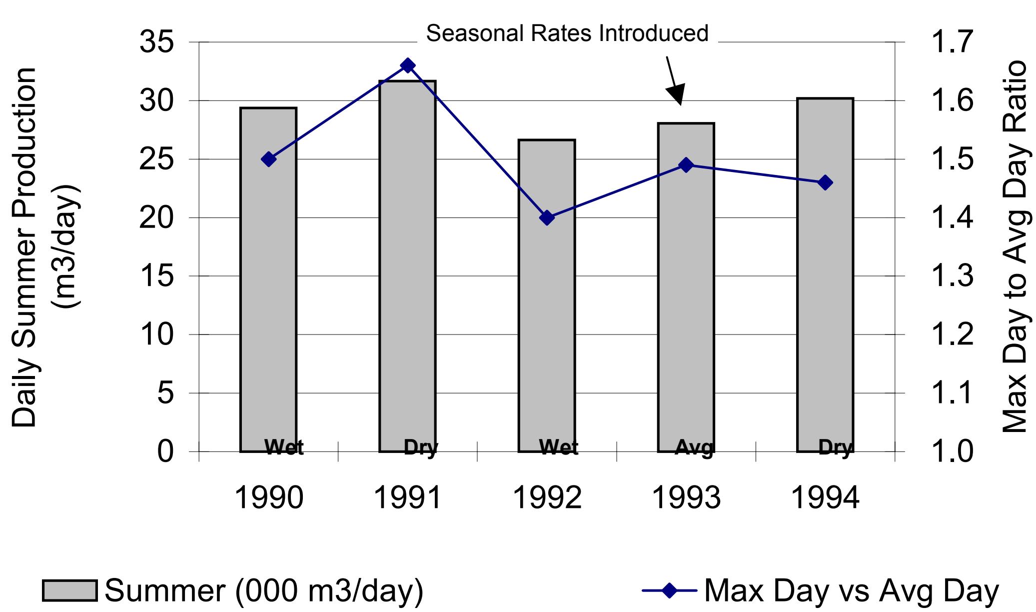
Description	1990	1991	1992	1993	1994
Total Pumpage (mig)	2,129	2,181	2,053	2,041	2,175
June-Sept Pumpage (mig)	788	850	715	753	810
Summer vs. Total	37%	39%	35%	37%	37%
Precipitation Pattern	Wet	Dry	Wet	Average	Dry
Average Day (migd)	5.83	5.97	5.62	5.59	5.96
Maximum Day (migd)	8.74	9.89	7.89	8.33	8.71
Max Day vs. Avg. Day	150%	166%	140%	149%	146%

The impact of these seasonal rates is not readily discerned in the demand statistics. The ratio of summer to average annual pumpage fell by about 2 percentage points following the change (Table 25), but, in light of the small seasonal differential in rates, a more detailed analysis is required to confirm that this change was in fact caused by the new rates.

TABLE 25: IMPACT OF SEASONAL RATES

	Percentage Exceedance of Summer over Annual Pumpage	
Period	Dry Years	Wet Years
Before seasonal rates	39% (1991)	37% (1990)
After seasonal rates	37% (1994)	35% (1993)
Difference	-2%	-2%

FIGURE 14 : SUMMER PRODUCTION & MAX DAY RATIOS - BELLEVILLE



3.2.2.7 Summary of the Retail Rate Case Studies

Case studies have been presented representing IB-FX, SR-FX, EU-FX rate structures as well as an example involving the transfer of sewer system costs to charges on the water bill. Most estimates of reductions in demand corresponding to the adoption of conservation-oriented rate structures are relatively small and are often attributed to a combination of factors including rate reform and water conservation program efforts. It is not always clear how much impact rate reform alone has had. The Irvine Ranch case study seemed to achieve good success with a modified IB-FX rate structure and a well financed conservation program. The rate structure in this case was very aggressive, the highest volumetric rate being more than 10 times greater than the lowest. Where differentials were modest, as in Belleville, impacts on demand were negligible.

Significant impacts on demand were seen in Oshawa when sewer costs were shifted to the water bill—the water bill doubled and demand fell by over 20% in response. Over time demand has climbed back up for a variety of reasons including a decline in the inflation-adjusted cost of water.

3.3 WHOLESALE RATE STRUCTURES

Wholesale water rate structures resemble retail rate structures. They can be one or two part structures. One-part structures featuring a volumetric tariff are the most common wholesale rate in Canada. Two-part wholesale structures consist of a volumetric charge and a fixed charge. Alternative wholesale rate structures are described in the table below. These all resemble the retail rate structures described above. The main exception is that the block rate structures are not suitable at the wholesale level since block rate structures are designed to target the demand of relatively homogeneous classes of customers such as residential customers. Generally there are only a few wholesale customers and they do not fall into standard groups having similar demand characteristics.

TABLE 26: ALTERNATIVE WHOLESALE RATE STRUCTURES

The Uniform Rate Structure (UR)	The UR structure has no fixed charge and a constant volumetric rate is applied to all water used in the billing period. This is the simplest and most common format for the wholesale rate structure.
Uniform Rate Structure with a Fixed Charge (UR-FX)	A UR-FX has a constant volumetric charge applied to all consumption plus a fixed charge. It is not usually found at the wholesale level, but resembles the situation where a UR structure is used and additional charges are levied on local water retailers in the form of assessments against property or parcel taxes. This approach is used for wholesale sewer services by the CRD.
Seasonal Rate Structures (SR)	SR structures impose a higher volumetric charge on all water sold during the peak demand season.
Excess Use Rate Structures (EU)	EU structures impose a high volumetric charge on water sold during the peak demand season that exceeds a threshold based on off-peak season use.
Demand Charge Rate Structure (DC-FX)	DC rate structures feature a volumetric charge and a charge based on the customer's peak demand. Peak demand measured over a short period of time is the usual basis for the peak demand charge. The appropriate measure will depend on the objective of the charge. For instance a peak demand charge that is used to allocate peak demand capacity costs to customers might use a daily or hourly measure of peak demand.

3.3.1 CASE STUDIES OF WHOLESALE RATE STRUCTURES [11]

3.3.1.1 Seattle

Seattle Public Utilities operates a three-tier system providing water and sewer services. It supplies water to 27 wholesale customers charging these customers using the complex two-part rate structure featuring a seasonal charge, a growth charge and a demand charge (Table 27). At the retail level, a two-part seasonal rate structure is used (see page 31).

TABLE 27: WHOLESALE WATER SERVICE CHARGES IN SEATTLE – 2000

WHOLESALE VOLUMETRIC CHARGES		
Off-peak Use	$0.39/m^3 (US$0.73/cf)	Sept. 16 to May 15
Peak Usage	$0.59/m^3 (US$1.12/cf)	May 16 to Sept15
Growth Charge	$0.24/m^3 (US$0.46/cf)	usage over base allowance
Demand Charge	$8.71/m^3 (US$22.0/1000 gal)	applied to excess demand
SERVICE CHARGES (monthly charge based on meter size)		
Smallest meter: 1" meter	$81/month (US$54/month)	
Largest meter: 24" meter	$1,854/month (US$1,236/month)	

Source: www.cityofseattle.net/seattle/util/services/rates/

Wholesale and retail charges in Seattle are based on cost of service studies completed every 2 years. Charges are set to achieve full cost recovery while components of the rate structures are based on marginal cost. The seasonal wholesale volumetric charges apply to a base allowance stipulated in wholesale contracts with each wholesale customer. The growth charge is added to these charges for water used in excess of the base allowance. It acts like an excess use charge and is used to recover the cost to meet growing demand.

The demand charge in Seattle's rate structure applies to deficient storage and is designed to discourage reliance on the wholesale supply system to provide peak hour demands. Customer storage requirements are calculated based on their maximum demand over a 10-day period. The demand charge is only levied if the wholesale customer's maximum 15 minute demand exceeds the daily flow by more than 30%. The demand charge itself is calculated as the marginal cost of additional storage. This charge has been effective in controlling peak demands since wholesale customers manage their demands carefully and the charge therefore generates little revenue.

3.3.1.2 Dallas

The Dallas Water Utilities operates a three-tier water and sewer system. It supplies retail water to customers within the City boundaries and wholesales water under contract to 20 municipalities outside the City limits. Two rate structures are employed at the wholesale level:

- a UR structure with all water sold at $0.44/m^3 (US$1.1097/1,000 US gallons)
- a DC structure with the following rates

  volumetric charge = $0.13/m^3 (US$0.3355/1,000 US gallons)

  demand charge rate = $49,060 per 1,000 m^3 per day of demand (US$123,886/MGD)

[11] Information in this section is based on the report, "Water Efficiency Rate Study, Phase 1 Report" prepared by the Water Services Division of the Regional Municipality of Waterloo as well as searches of web sites of the case study cities and interviews with staff of the wholesale water departments of these cities.

Demand is a maximum rate of flow established in the supply contract between the utility and the wholesale customer. This level of demand is set as a physical limit on maximum supply to the customer using a rate of flow controller at the customer's meter. The annual demand charge is reduced if Dallas fails to meet the contractual maximum daily flow rate. The customer may select to reduce its demand but pays a demand charge based on the highest demand in existence over the past five years. This feature assures that the utility receives revenue to cover imbedded capital costs.

Wholesale customers are free to select the structure that best suits their needs, but the DC structure is generally cheaper for customers requiring more than 1 MGD of capacity. The demand charge provides customers with a strong incentive to control peak demands. Additional incentive is provided through the supply contract, which stipulates that the buyer must establish a water conservation program for its retail customers. An IB-FX rate structure is used at the retail level in Dallas City.

3.3.1.3 Metropolitan Water District, Southern California

The Metropolitan Water District (MWD) operates a two-tier water supply system serving 27 wholesale customers. Wholesale water supplies are used to supplement local sources of supply in this system. A complex rate structure is used to sell water to members of the MWD. The structure has the following components:

- full service volumetric charges

  treated water = \$0.53/m^3 (US\$435/acre foot)

  untreated water = \$0.42/m^3 (US\$349/acre foot)

- Agriculture - discounted volumetric charges for agriculture (32% discount)
- Seasonal storage service charges - discounted volumetric charges where water is purchased during the winter is sequestered in short or long term storage for use during the summer peak demand season (approximately 20% discount for short term storage, 33% discount for long term storage)
- Connection maintenance charge - assessed on the highest average week demand over the previous five years:

  connection maintenance charge

  = \$26.48 per m^3/second (US\$50/cfs) up to a maximum of 2.832 m^3 per second (100 cfs)

- Readiness to serve charge based on annual volume
- Peak demand charge for treated water - levied on peak week demand between May and September if that demand exceeds 130% of average flow for the May to September period.

Staff with MWD indicated that the peak demand charge has not in fact been used.

The seasonal storage service charge is the most interesting conservation feature of this rate structure. It resembles the seasonal charge in function but is structured as a discount and is set up to reallocate seasonal demand using local storage potential rather than to reduce seasonal demand.

3.3.1.4 Water Service Beyond the Municipal Boundary

Larger municipalities often provide water service to adjacent municipalities beyond their boundaries. These services are provided by wholesale or retail purveyors and may be offered at a discount or at a mark up on the local service charge. A mark-up of 150% to 200% is common in Ontario (Table 28). Various arguments are used to justify a mark-up:

- Outside customers may not have contributed to the historical cost of facilities
- The cost of servicing outside customers may be higher
- A return on investments is warranted in the case of sales to customers who are not residents of the municipality that owns the facilities.

TABLE 28: SUPPLY CHARGE TO OTHER MUNICIPALITIES (% of local rate)

	Average	Median	Maximum	Minimum
Wholesale Supplier	135%	110%	200%	87%
Retail Supplier	152%	150%	200%	100%

Source: OWWA, 1997, Survey of municipal water rates and operations benchmarking in Ontario
(Includes municipalities with at least 5,000 water service accounts.)

3.3.1.5 Summary of the Wholesale Rate Case Studies

Existing conservation-oriented wholesale rate structures tend to use complex charges that target very specific elements of demand. Examples were found of demand charges that were designed to encourage water retailers to build their own storage to meet peak demands as well as a rate designed to encourage inter-seasonal storage of water supplies. These rates were based on careful analyses of system costs. Metering technology at the wholesale level allows the use of these complex rates.

4 EVALUATION OF ALTERNATIVE RETAIL RATES

4.1 APPROACH TO EVALUATION OF RATE STRUCTURES

The formal evaluation of rate structures focussed on rate structures at the retail level since it is these rates that will influence the water demand of end users. Wholesale rates were considered after a decision on retail rates was made, with emphasis on selecting a wholesale rate that was compatible with the preferred retail rate structure. The comparative evaluation focused on the following retail rate structures:

UR	Uniform rate
UR-FX	Uniform rate with a fixed charge
DB-FX	Declining block rate
IB-FX	Increasing block rate
HB-FX	Humpback rate
SR-FX	Seasonal rate
EU-FX	Excess use rate
DC-FX	Demand charge rate

The lifeline rate and the drought rate were not included since these two rate structures represent modifications that can be made to the other structures. Moreover, they fall somewhat outside the scope of a comparative evaluation of conservation rates. The lifeline rate is more appropriately compared to other measures to assist low-income families. The drought rate is an emergency measure unlike the other rate structures. These two options are discussed separately below.

An iterative three-step screening process was used in the evaluation of retail rate structures. Members of two committees, the Water Advisory Committee (WAC) and the Municipal Technical Liaison Committee (MTLC) participated in all three steps. The first step involved the use of explicit evaluation criteria that were weighted based on feedback from the two committees. The second step was a simple rating exercise by committee members that was completed once they had reviewed the outcome of the first screening and were familiar with the alternative rate structures. These two steps were based on qualitative information and focussed on the structure of the retail water rates and not the level charges in the rate structure. The purpose of the first two steps was to eliminate inferior rate structures. The final screening involved a quantitative assessment of the impacts of alternative rate structures. Results of the impact assessment were used in discussions to select a preferred rate structure based on a consensus process.

4.2 STEP ONE – RANKING BASED ON CRITERIA

The first step involved a ranking of the alternative rate structures based on an explicit set of evaluation criteria and qualitative information describing the performance of each rate structure with respect to each criterion. This evaluation focussed on the rate structure and not the level of charges in each rate structure. For this reason, the first step did not consider options involving shifting water and sewer costs that are currently recovered through property taxes to the water bill.

Evaluation criteria were first developed based on explicit rate setting principles that are defined in Table 29. Members of WAC and MTLC completed an assessment of the significance of the evaluation criteria using the following rating: 0 = out, 1 = low significance to 5 = high significance. A summary of this assessment is provided in Table 30. Overall, water efficiency and full cost recovery received the highest average ratings while affordability was lowest. These ratings were used to develop 2 alternative sets of weights for the criteria in the comparative evaluation analysis.

TABLE 29: PRINCIPLES FOR RATE SETTING

PRINCIPLE	DEFINITION
Water efficiency	The level of water use should be compatible with available resources and the cost-effective delivery of water services.
Equity	Recover costs from each customer in proportion to the cost of servicing that customer.
Affordability	Assure that all customers can afford the water required for basic living regardless of economic circumstance.
Full cost recovery	Recover all of the costs of the water system (operations, maintenance, administration and capital finance) from rates and other user charges.
Economic impact	Do not discourage economic growth that is compatible with the long-term capacity of resources to service growth.
Public acceptance	Avoid widespread public disapproval and gain the general approval of most customers.
Technical feasibility	Implementation and administration of a new rate structure must be achievable.
Administrative ease	Implementation and administration should not place an inordinate burden on administrative resources.
Security of supply	Improve the capacity to meet water demands in drought conditions.
Minimum financial risk	Avoid or reduce financial risk associated with revenue variability and revenue loss.

TABLE 30: RATINGS OF SIGNIFICANCE FOR THE EVALUATION CRITERIA

PRINCIPLE	No. at 0	No. at 1	No. at 2	No. at 3	No. at 4	No. at 5	**Average rating**	**Minimum rating**
Water efficiency	0	0	0	1	3	6	4.5	3
Equity	0	3	0	1	2	4	3.4	1
Affordability	1	4	0	2	2	1	2.3	0
Full cost recovery	0	0	0	1	4	5	4.4	3
Economic impact	1	1	0	4	1	3	3.2	0
Public acceptance	0	1	1	3	1	4	3.6	1
Technical feasibility	0	0	1	4	2	3	3.7	2
Administrative ease	0	0	1	3	3	3	3.8	2
Minimum financial risk	1	2	0	2	1	4	3.2	0
Security of Supply	1	0	0	4	2	3	3.5	0

NOTE: Rating is as follows: 0 = drop from the analysis, 1 = low significance, 5 = high significance

The performance of each of the alternative rate structures was assessed and scored with respect to each of the evaluation criteria. A verbal evaluation was provided along with a score from -3 for very poor to +3 for very good. The rationale or basis for the evaluations is provided in Table 31 while assessments and scores are provided in Table 32.

TABLE 31: RATIONALE FOR PERFORMANCE ASSESSMENTS

CRITERIA	BASIS FOR A HIGH SCORE	BASIS FOR A LOW SCORE
Water efficiency	Increases the economic incentive to reduce annual and/or seasonal volumes of water	Diminishes the existing economic incentives for water conservation
Equity	Improves equity for example by: Allocating peak demands costs to customers who cause those demands Recovering metering and billing costs through a fixed charge	Equity is diminished by changes in the rate structure that are not based on the cost of servicing customers, e.g. dropping a fixed service charge.
Affordability	The rate structure assures that the water bill for poor households is quite low.	The rate structure increases the water bill for poor households.
Full cost recovery	Recovers current costs and helps maintain reserve requirements for contingencies and future capital finance.	Fails to recovers current costs and helps maintain reserve requirements for contingencies and future capital finance.
Economic impact	Volumetric rates for large commercial customers do not increase significantly.	Volumetric rates for large commercial customers increase significantly.
Public acceptance	Changes to the rate structure are minor, most customers do not see an impact on their bills.	Major changes are made. Many customers have significantly higher bills.
Technical feasibility	Existing customer meters are appropriate.	Existing customer meters are not suitable.
Admin. ease	New rates are relatively easy to calculate in house. Minor changes to meter reading procedures and billing systems.	New rates are difficult to calculate in house. Major changes to meter reading procedures and billing systems.
Security of Supply	Targets peak season demand with a high volumetric rate.	Lowers the volumetric rate for peak season demand.
Minimum financial risk	Increases the revenue share derived from fixed charges and/or indoor water use.	Reduces the revenue share derived from fixed charges and/or indoor water use.

TABLE 32: ASSESSMENT AND SCORING OF RATE STRUCTURES

CRITERIA	UR	UR-FX	DB-FX	IB-FX
Water efficiency	all water use is subject to a volumetric charge, but fails to target peak or seasonal use 2	represents status quo, fails to target peak or seasonal use, lower volumetric charge since the fixed charge recovers some costs 0	targets SF residential class which has a high seasonal use but fails to target seasonal use, lower volumetric charge for larger commercial and bulk metered MF residential customers -1	targets seasonal use of residential customers with a higher rate 2
Equity	customer costs and capacity costs are poorly allocated based on total volume -2	uses a fixed charge to recover customer costs, capacity costs poorly allocated based on total volume -1	uses a fixed charge to recover customer costs, capacity costs are allocated based on peak demand characteristics by customer class 1	uses a fixed charge to recover customer costs, capacity costs are allocated based on both customer size and peak demand -1
Affordability	elimination of existing fixed charge will likely reduce the bill of low income families 1	water bill may be higher for low income families that use little water due to fixed charge 0	higher water bill for low income families due to fixed charge and higher volumetric charge -2	higher water bill for larger low income families that use a lot of water 0
Full cost recovery	full cost recovery achieved with proper rate design 3	full cost recovery achieved with proper rate design 3	full cost recovery achieved with proper rate design 3	full cost recovery achieved with proper rate design 3
Economic impact	small increase in volumetric charge will increase bills of large customers -1	no positive or negative impact, represents status quo 0	lower water bills for large customers 1	increase in top rate for large customers -2
Public acceptance	minor change from status quo 2	readily accepted, represents status quo 3	residential customers end up paying more -2	high volume residential customers pay more, complex rate -2
Tech. Feas.	feasible 3	Feasible 3	feasible 3	feasible 3
Admin. ease	minor change from status quo 1	represents status quo 3	minor change from status quo, DB rate was used previously 1	minor change from status quo 1
Minimum financial risk	variability of rate revenues is high since there are no fixed charges -1	Meter revenues are fixed so revenues are less variable. 2	meter revenues are fixed but financial dependence on residential sales is higher, this increases or reduces revenue risk depending on the design of blocks 0	meter revenues are fixed, financial dependence on the seasonal residential sales is higher but revenues from stable ICI demand also increase 0
Security of supply	small increase from the status quo in the incentive to conserve water 1	no change from status quo 0	charge for excess seasonal use may fall depending on the size of the first block -1	targets seasonal demand and large users 1

TABLE 32: ASSESSMENT AND SCORING OF RATE STRUCTURES (continued)

CRITERIA	HB-FX		SR-FX		EU-FX		DC-FX	
Water efficiency	targets seasonal use of average residential customers with a higher rate	2	targets all seasonal use with a somewhat higher rate	3	targets seasonal use in excess of base consumption with a much higher rate	2	targets seasonal use with a high fixed charge	3
Equity	uses a fixed charge to recover customer costs, capacity costs can be reasonably allocated with the block rates	1	uses a fixed charge to recover customer costs, capacity costs allocated based on seasonal volume	1	uses a fixed charge to recover customer costs, peak capacity costs are allocated based on excess seasonal volume	3	capacity costs allocated based on capacity requirement	3
Affordability	higher water bill for larger low income families that use a lot of water	0	higher summer water bill for low income families	0	with a fixed charge, the water bill may be higher for low income families that use little water	0	demand charge will be low for low income families that use little water	1
Full cost recovery	full cost recovery achieved with proper rate design	3	full cost recovery achieved with proper rate design	3	full cost recovery achieved with proper rate design	3	full cost recovery achieved with proper rate design	3
Economic impact	small reduction of large volume customers	1	high summer cost for businesses depending on seasonal tourist traffic	-1	negligible if allowances are made for seasonal businesses	0	higher cost for businesses depending on seasonal tourist traffic	-1
Public acceptance	high volume residential customers pay more, large customers seen to be favoured, complex rate	-2	customers with low seasonal water use pay less, high seasonal use customers pay more	-2	impact of the high rate applied to high usage will affect a small number of customers whose demand exceeds the threshold	-1	complex rate structure, adverse impacts probably affect a small number of customers	-2
Tech. Feas.	feasible	3	Feasible	3	feasible	3	depends on needs for metering	0
Admin. Ease	complex rate, may be more difficult to adjust	-1	more complex, will require more frequent meter reading	-2	more complex rate, will require more frequent meter reading	-2	more complex rate, will require more frequent meter reading, may be difficult to calculate	-3
Minimum financial risk	meter revenues are fixed but financial dependence on the seasonal part of residential sales is higher	-2	meter revenues are fixed but financial dependence on variable summer sales is higher	-2	financial dependence on excess summer sales increases	-1	demand charge revenues are fixed, revenues are less variable.	2
Security of supply	targets seasonal residential demand	1	targets all seasonal demand	2	targets excess summer use	1	targets all seasonal demand	2

Scores and criteria weights were combined to develop overall scores for each of the rate structures. A numerical analysis was completed to assist in the comparative evaluation. This analysis, summarised in Table 33, uses the significance ratings of the evaluation criteria shown in Table 30 above. Three sets of overall scores are developed from these inputs and all of the rate structures are then ranked based on their overall scores.

TABLE 33: SCREENING TABLE FOR ALTERNATIVE RATE STRUCTURES

Criteria Scores	UR	UR-FX	DB-FX	IB-FX	HB-FX	SR-FX	EU-FX	DC-FX
Water efficiency	2	0	-1	2	2	3	2	3
Equity	-2	-1	1	-1	1	1	3	3
Affordability	1	0	-2	0	0	0	0	1
Full cost recovery	3	3	3	3	3	3	3	3
Economic impact	-1	0	1	-1	1	-1	-1	-1
Public acceptance	2	3	-2	-2	-2	-2	-1	-2
Technical feasibility	3	3	3	3	3	3	3	0
Administrative ease	1	3	1	1	-1	-2	-2	-3
Minimum financial risk	-1	2	0	0	-2	-2	-1	2
Security of Supply	1	0	-1	1	1	2	1	2
Overall scores								
No weighting	0.9	1.3	0.3	0.6	0.6	0.5	0.7	0.8
Average weighting	1.3	1.6	0.6	1.0	1.0	1.0	1.0	1.0
Minimum weighting	1.9	1.9	1.1	1.7	1.5	1.6	1.6	1.1
Ranking								
No weighting	2	1	8	5	5	7	4	3
Average weighting	2	1	8	4	7	5	3	5
Minimum weighting	1	1	7	3	6	4	4	7

The unweighted overall scores are calculated assuming that all of the evaluation criteria are equally important. Average weighting represents a "democratic" weighting scheme in which each persons vote is given equal weight. The minimum weighting scheme is a "pessimistic" weighting in that it only considers the worst or lowest ratings assigned to each criterion. This last weighting identifies a preferred rate structure under a worst case scenario. Using three sets of weights tells us whether the choice of a rate structure is sensitive to different weightings.

The three resulting rankings of the rate structures were examined to identify three rate structures that could be dropped. In all three cases the DB-FX rate structure ranked eighth or last and HB-FX structure ranked 2nd or 3rd last. The top rate structures in all cases were UR and UR-FX. Weighting with the average and minimum significance ratings causes DC-FX to fall in rank and SR-FX to rise. DC-FX falls primarily because of its poor performance under administrative ease and technical feasibility. Structures with the top rankings under the minimum weighting scheme are, in descending order: UR-FX and UR tied for 1st place, and EU-FX in 3rd place. The IB-FX rate structure follows close behind in scoring based on minimum weights and it switches rank with EU-FX when average weighting is used.

At this stage in the analysis it is more important to understand and agree with the rationale for dropping certain rate structures than to focus on the rate structures that are carried forward into the second step. The numerical analysis must therefore be interpreted to identify deciding factors that weigh against each excluded rate structure. We have already identified that poor scores for administrative ease and technical feasibility are pushing the DC-FX structure out. The DB-FX structure is out because it performs relatively poorly on a number of criteria, especially water efficiency, security of supply and public acceptance. The lower ranking of the HB-FX structure occurs because this rate structure performs poorly on public acceptance and minimum financial risk, and has relatively lower scores for water efficiency and security of supply.

4.3 STEP TWO – SIMPLE RATING

After reviewing results of the first step in the evaluation of retail rate structures, members of WAC and MTLC were asked to rank the alternative rate structures in order of preference indicating, at the same time, rate structures that should be dropped from further consideration. The purpose of this exercise was to develop a short list of conservation rate structures for further analysis.

The following structures were rated by members of WAC and MTLC:

UR	Uniform rate
UR-FX	Uniform rate with a fixed charge
DB-FX	Declining block rate
IB-FX	Increasing block rate
HB-FX	Humpback rate
SR-FX	Seasonal rate
EU-FX	Excess use rate
DC-FX	Demand charge rate

Respondent ratings for the alternative rate structures are provided in Table 34 below. Certain respondents provided separate ratings for residential and non-residential rate structures while others gave only one set of ratings for the rate structures.

Overall ratings were developed from individual responses by summing the individual ratings.[12] Overall ratings shown for residential and non-residential rate structures in Table 34 suggest that the following rate structures should be retained for further analysis: UR, UR-FX, IB-FX, SR-FX, EU-FX. Of these, the IB-FX and UR-FX structures were rated highest.

The UR-FX structure represents the status quo. It was preferred over the UR structure that drops the fixed charge. Since the two structures are similar in form, these 2 options are combined and are interpreted as a UR-FX structure with a fixed charge that is considerably lower than the charges currently used in the existing retail rate structures.

Based on the first two steps of the evaluation exercise, the rate structure options described in Table 35 were carried into the next phase of the analysis.

[12] The analysis of rating data was also done using three alternative methods, which treated the ratings as votes. Results from the three voting methods were in agreement with the simple approach based on summations.

TABLE 34: RATINGS OF ALTERNATIVE RATE STRUCTURES

	UR	UR-FX	DB-FX	IB-FX	HB-FX	SR-FX	EU-FX	DC-FX
Rating for a residential rate structure								
WAC member # 1	5	1	8	4	3	2	8	8
WAC member # 2	1	5	8	3	8	4	2	8
WAC member # 3	8	1	8	5	4	3	2	8
WAC member # 4	1	2	8	3	8	4	8	2
WAC member # 5	3	4	8	2	5	1	6	8
WAC member # 6	2	1	8	4	8	3	8	8
WAC member # 7	8	8	8	1	8	2	3	8
MTLC member # 1	3	3	8	5	8	2	1	4
MTLC member # 2	8	1	8	2	8	5	8	8
MTLC member # 3	2	1	8	5	8	8	3	4
MTLC member # 4	8	4	8	3	8	2	1	8
MTLC member # 5	8	1	8	2	4	8	3	8
MTLC member # 6	8	1	8	2	8	8	4	2
MTLC member # 7	4	8	8	2	8	8	1	8
MTLC member # 8	1	2	8	2	8	8	2	8
MTLC member # 9	8	5	8	1	8	4	2	3
Sum of ratings	78	48	128	46	112	72	62	103
Overall Score	5	2	8	1	7	4	3	6
Rating for a non-residential rate structure								
WAC member # 1	5	1	8	4	3	8	8	8
WAC member # 2	1	5	8	2	8	8	3	8
WAC member # 3	8	1	8	5	3	4	2	8
WAC member # 4	2	1	8	4	8	8	8	3
WAC member # 5	1	2	8	8	4	3	5	8
WAC member # 6	2	1	8	4	8	3	8	8
WAC member # 7	8	8	8	1	8	2	3	8
MTLC member # 1	3	3	8	5	8	2	1	4
MTLC member # 2	8	1	8	2	8	5	8	8
MTLC member # 3	2	1	8	5	8	8	3	4
MTLC member # 4	8	4	8	3	8	2	1	8
MTLC member # 5	8	1	8	8	8	8	8	8
MTLC member # 6	8	1	8	8	8	8	4	2
MTLC member # 7	4	8	8	2	8	8	1	3
MTLC member # 8	1	2	8	8	8	8	8	8
MTLC member # 9	8	5	8	1	8	4	2	3
Sum of ratings	77	45	128	70	114	89	73	99
Overall Score	4	1	8	2	7	5	3	6

Note: The most preferred rate structure is assigned a rating of 1, the next in line is assigned 2, and so on. A rating of 8 was assigned to any rate structure that the respondent thought should be dropped.

TABLE 35: SHORT LIST OF RATE STRUCTURES

Option	Residential	Non-residential	Comment
1. Existing	UR-FX	UR-FX	Status quo based on existing rates. Other options are compared to this one. Billing for existing rates is every 3 or 4 months.
2. UR-FX	UR-FX	UR-FX	Fixed charge is set to recover 15% of revenues from the water bill. Assumes bimonthly billing.
3. IB-FX1	IB-FX (3 blocks)	IB-FX (3 blocks)	Fixed charge is set to recover 15% of revenues from the water bill. An IB-FX structure is used for all customers. The last block has a moderate charge to assure that revenues do not exceed costs in municipalities with a large non-residential water demand. Assumes bimonthly billing.
4. IB-FX2	IB-FX (3 blocks)	UR-FX	Fixed charge is set to recover 15% of revenues from the water bill. Blocks in the residential IB-FX rates are based on residential demand. The charge for the 3rd block is a high charge to encourage conservation. Assumes bimonthly billing.
5. SR-FX	SR-FX	SR-FX	Fixed charge is set to recover 15% of revenues from the water bill. All summer demand is charged at a higher rate. Assumes bimonthly billing.
6. EU-FX	EU-FX	EU-FX	Fixed charge is set to recover 15% of revenues from the water bill. The threshold for summer water use beyond which the high EU-FX charge kicks in varies from 125% to 175% of the winter demand. Assumes bimonthly billing.

Note: Options 1 to 6 are each repeated using two alternative assumptions about revenue targets: (a) The revenue target for existing rates with certain sewer an water costs recovered from the property tax bill. (b) An increased revenue target that results when sewer or water costs currently in the property tax are recovered from the water rate instead (revenues from the sewer charge go back to the sewer department).

4.4 STEP THREE - IMPACT ASSESSMENT

This section summarises the analysis that has been completed to assess the impacts of alternative conservation water rate structures on water rates, the demand for water, customer bills and revenue. The assessment was based on financial and operating data for 1999. Costs were be adjusted to reflect higher meter reading costs for options 3 to 6 and all rate calculations assumed full cost recovery and incorporated adjustments of demand based on price elasticity.

The analysis was carried out for three municipalities: Victoria, Saanich and Sidney. These communities were selected because they represent a range of different opportunities for rate reform. All three use a uniform volumetric rate to charge for water. Both Saanich and Victoria also use a fixed charge on the water bill while Sidney recovers certain water supply costs through the property tax. Both Sidney and Victoria use a volumetric charge to recover costs for sewer operations. Saanich recovers these costs using the property tax and Sidney also recovers a portion of its sewer costs through property taxes. The alternative rate structures can be applied to all three municipalities. In addition, costs that are currently recovered with the property tax in Sidney and Saanich can be moved over to the water bill, causing the water rates to increase.

The analysis summarised below was completed using the information presented in Chapters 2 and 3 of this report. It is based on cost allocations, rate setting and price elasticity calculations. The approach to the analysis was developed with a single purpose in mind—to examine the potential impacts of the alternative conservation rate structures so that they can be compared and evaluated. These results can not be used as a basis for setting rates, a task requiring a more detailed scrutiny of existing costs and demands.

4.4.1 COST INCREASES FOR METER READING AND BILLING

The current billing cycles are too infrequent to allow the water retailers to clearly identify summer water use—a requirement of several of the conservation rate structures. Moreover, the infrequent customer billings mean that the customer is most likely billed in the late fall or winter for water used in the summer. **Long delays in billing weaken the economic incentive created by a conservation rate structure**. To effectively implement conservation rate structures, the meter reading and billing frequency should be increased to six cycles per year from the existing frequencies of 3 or 4 per year. Estimates of the costs to increase the meter reading and billing frequency to six cycles per year are as follows:

Victoria	$130,000
Saanich	$160,000
Sidney	$25,000

Additional costs associated with the new rate structures represent about 2% of the existing revenue requirements. The new costs pay for new staff for meter reading and administration as well as overhead costs for benefits, mailing, stationary and transportation.

Most of the water retailers use Tempest software for customer billing. This software can accommodate increased billing frequencies, and volumetric charges that vary by customer class or by season. A change will however be required in the Tempest billing software to accommodate the EU-FX rate structure since Tempest is not equipped to use an excess use charge. The costs of modifications that are needed for EU-FX billing are not known at this time. There are no changes required in retail metering technology for the new rate structures.

4.4.2 WATER AND SEWER COSTS ADDED TO THE WATER BILL

Sidney is the only case study municipality recovering water costs from the property tax. The amount involved in 1999, estimated at $445,400, is assumed to be shifted to the water bill.

Sewer costs that are shifted from the property tax to the water bill are reported in Table 36 in terms of the unit charge rate that is used to estimate the customer's water bill. Any revenue collected on the water bill for sewer services is remitted to the sewer department.[13]

TABLE 36: SEWER CHARGES ON THE WATER BILL – 1999 ($/m^3)

	Victoria	Saanich	Sidney
Sewer costs currently recovered from water bill	$0.416	$0.00	$0.811
Sewer Costs shifted from the property tax to the water bill	$0.00	$0.416*	$0.350**
Total	$0.416	$0.416	$1.161

* Value based on costs for Victoria.

** Value based on the charge for sewer services in the property tax.

[13] Data in Table 36 differs somewhat from data in Section 2.2.1, which was obtained after the screening analysis was completed. New data on sewer costs does not alter the analysis in a substantial way.

4.4.3 RATE STRUCTURE DESIGN – METER CHARGES

Meter charges for the alternative rate structures are set to recover 15% of the total revenue requirement. The remaining 85% are recovered from the volumetric charges. Bimonthly charges for the small household meter are shown in Table 37. Charges for large meters are higher. These are calculated as a multiple of the small meter charge using the following ratios based on existing meter charges in Victoria and Saanich (Saanich ratios are used for Sidney):

Meter Size (mm)	15	18	25	37	50	75	100	150	200
Meter Charge Ratio – Victoria	1.0	1.0	1.4	1.8	2.9	5.4	8.6	16.1	35.9
Meter Charge Ratio – Saanich	1.0	1.3	2.5	4.8	7.6	14.3	23.8	47.5	76.1

TABLE 37: METER CHARGES FOR THE RESIDENTIAL METER (15mm)

	Existing	UR-FX	IB-FX1	IB-FX2	SR-FX	EU-FX
Victoria	$14.025	$8.316	$8.316	$8.316	$8.316	$8.316
Saanich	$7.490	$6.011	$6.011	$6.011	$6.011	$6.011
Sidney	-	$11.312	$11.312	$11.312	$11.312	$11.312

Note: All meter charges are for a 2-month billing period. Existing charges in Victoria and Saanich are actually based on a 4-month period and are twice the amounts shown, i.e. $28.05 and $14.98 respectively.

4.4.4 RATE STRUCTURE DESIGN – VOLUMETRIC CHARGES

Volumetric charges for the UR-FX rate structures do not vary by block or season and are simply calculated as the average rate required to recover 85% of the revenue requirement for a given level of water sales. The calculation of volumetric charges for the other rate structures is complicated by the use of block or seasonal differentials.

In the case of the two block rate structures, IB-FX1 and IB-FX2, design parameters include the volumetric limits for the first two blocks and the rate differentials for the block charges. The same design parameters were used in all three municipalities and these are provided in Table 38. The charge rate for the second block rate is assumed to be the base rate and has a rate multiplier of 100%. For a residential customer, this charge applies to all of the water that a customer uses during the month in the second block, i.e. between 20 m^3 and 30 m^3. Below 20 m^3, the first block charge rate applies. This charge is 50% of the base rate. Above 30 m^3 (300 m^3 in the case of the ICI customer), the third block charge rate applies; it is 166% of the base rate.

TABLE 38: INCREASING BLOCK RATE DESIGN PARAMETERS

		RESIDENTIAL			ICI		
Option	Design Parameter	1st block	2nd bock	3rdblock	1st block	2nd bock	3rd block
IB-FX1	Upper limit (m^3/month)	20	30	not app.	20	300	not app.
	Rate multiplier	50%	100%	160%	50%	100%	160%
IB-FX2	Upper limit (m^3/month)	20	30	not app.	not app.	not app.	not app.
	Rate multiplier	50%	100%	250%	100%	100%	100%

The base rate for the SR-FX structure is the winter rate. The seasonal rate is set at 3 times the base rate (a rate multiplier of 300%). Thus, the customer pays the base rate for water from November to April and 3 times the base rate for all of the water used from May to October inclusive.

The base rate for the EU-FX structure is also the winter rate. In the summer the base rate is charged for any water used within each customer's EU-FX summer allowance and excess usage over the allowance is charged at 4 times the base rate (a rate multiplier of 400%) . The summer allowance is expressed as a multiple of each customer's average monthly water use in the winter. For example, in Victoria the allowance is set at 125%; so each customer pays the base rate during the summer for all water use below 125% of their average winter use and 4 times the base rate for water in excess of this. The EU-FX allowances in Saanich and Sidney are set at 175% and 140% respectively. In all three municipalities, the allowances apply to both residential and ICI customers.

Volumetric charges for the existing and alternative rate structures are shown in Table 39. The total volumetric charges for these rate structures include the volumetric charges for water plus those used to recover sewer costs.

TABLE 39: VOLUMETRIC CHARGES ($/m^3)

	Existing	UR-FX	IB-FX1	IB-FX2	SR-FX	EU-FX
Victoria						
Year Round Rate	$0.292	$0.345	-	-	-	$0.302
Rate on Excess Use	-	-	-	-	-	$1.208
Summer Rate	-	-	-	-	$0.488	-
Winter Rate	-	-	-	-	$0.163	-
Residential - 1st block	-	-	$0.146	$0.173	-	-
Residential - 2nd bock	-	-	$0.292	$0.345	-	-
Residential - 3rd block	-	-	$0.467	$0.863	-	-
ICI - 1st block	-	-	$0.146	$0.345	-	-
ICI - 2nd bock	-	-	$0.292	$0.345	-	-
ICI - 3rd block	-	-	$0.467	$0.345	-	-
Saanich						
Year Round Rate	$0.377	$0.440	-	-	-	$0.377
Rate on Excess Use	-	-	-	-	-	$1.508
Summer Rate	-	-	-	-	$0.577	-
Winter Rate	-	-	-	-	$0.192	-
Residential - 1st block	-	-	$0.212	$0.221	-	-
Residential - 2nd bock	-	-	$0.423	$0.442	-	-
Residential - 3rd block	-	-	$0.702	$1.105	-	-
ICI - 1st block	-	-	$0.212	$0.442	-	-
ICI - 2nd bock	-	-	$0.423	$0.442	-	-
ICI - 3rd block	-	-	$0.702	$0.442	-	-
Sidney						
Year Round Rate	$0.727	$1.050	-	-	-	$0.855
Rate on Excess Use	-	-	-	-	-	$3.420
Summer Rate	-	-	-	-	$1.435	-
Winter Rate	-	-	-	-	$0.478	-
Residential - 1st block	-	-	$0.655	$0.680	-	-
Residential - 2nd bock	-	-	$1.310	$1.360	-	-
Residential - 3rd block	-	-	$2.175	$3.400	-	-
ICI - 1st block	-	-	$0.655	$1.360	-	-
ICI - 2nd bock	-	-	$1.310	$1.360	-	-
ICI - 3rd block	-	-	$2.175	$1.360	-	-

4.4.5 IMPACT ON WATER DEMAND

As the water rates increase, customers are expected to respond by reducing their use of water. This response is estimated for each of the 5 customer groups described in Table 14 above (page 12). The base case analysis assumes that all costs for water and sewer services that are now recovered through the property tax bill are shifted to the water bill. With this assumption, the reduction in water demand is dramatic in Saanich and Sidney when water and sewer costs are included in the property tax bill but they are modest in Victoria where they are not now on the tax bill (see Table 40). Most of the impact on water demand therefore seems to be caused by the increase in costs and not the rate structure.

A supplementary analysis was completed for Saanich and Sidney that estimated impacts on water demand without shifting costs onto the water bill—impacts on water demand in this case were comparable to those in Victoria (Table 40). This suggests that the decision about a rate structure and the decision about what costs to recover from the water bill should be made separately. Obviously, increasing the costs that are recovered through the water bill will have the greatest impact on demand and the greatest benefit in terms of water conservation. This benefit can be achieved without changing the rate structure.

TABLE 40: IMPACT ON WATER DEMAND (% CHANGE)

Rate Option	UR-FX	IB-FX1	IB-FX2	SR-FX	EU-FX
Victoria					
Summer	-0.30%	-0.98%	-0.90%	-2.71%	-1.44%
Winter	-0.34%	-0.90%	-0.44%	0.00%	-0.01%
All year	-0.32%	-0.95%	-0.71%	-1.57%	-0.84%
Saanich (costs from the property tax bill are shifted to the water bill)					
Summer	-8.23%	-9.17%	-9.67%	-10.70%	-9.47%
Winter	-8.06%	-7.25%	-6.91%	-3.60%	-7.23%
All year	-8.17%	-8.52%	-8.73%	-8.30%	-8.71%
Saanich* (the property tax bill is not changed)					
Summer	-0.14%	-1.41%	-1.59%	-2.40%	-1.10%
Winter	-0.09%	-0.81%	-0.32%	0.00%	0.00%
All year	-0.12%	-1.21%	-1.16%	-1.59%	-0.73%
Sidney (costs from the property tax bill are shifted to the water bill)					
Summer	-14.17%	-19.44%	-25.71%	-21.10%	-22.08%
Winter	-15.92%	-15.20%	-17.09%	-5.63%	-12.65%
All year	-14.78%	-17.95%	-22.69%	-15.67%	-18.77%
Sidney* (the property tax bill is not changed)					
Summer	-0.33%	-1.89%	-2.95%	-3.76%	-3.35%
Winter	-1.41%	-0.69%	-0.61%	0.00%	-0.24%
All year	-0.71%	-1.47%	-2.13%	-2.44%	-2.26%

* When water and sewer costs are not shifted to the water bill, water rates are lower than those shown in Table 38.

When we consider the cases where only the rate structure changes and costs are not shifted onto the water bill, a number of observations can be made about the relative impact of the alternative rate structures:

- The least effective option for water conservation is UR-FX. This is the case because the volumetric tariff does not increase very much.

- The two increasing block rate structures (IB-FX1, IB-FX2) have quite similar impacts. IB-FX2 where the increasing block rate is applied only to the residential customer generally has a greater impact on summer demand than IB-FX1 since it targets the residential customer with a higher third block rate; but this is not the case in Victoria which has a large ICI sector.
- Impacts of both the SR-FX option and the EU-FX option are concentrated in the summer when water conservation is of greatest value. Generally, the SR-FX option had the greatest impact on summer water use. This happens because all of the summer demand is subject to a high volumetric charge. The high rates of the EU-FX option only affect customers when they use more than their summer allowance of water.

The results that are summarised in Table 40 must be interpreted with caution, especially in cases showing large reductions in demand. Estimates such as these based on elasticity calculations are subject to error for a variety of reasons, some of which are documented in Section 2.5.4. The actual magnitude of a reduction in demand following a change in the water rates will depend on a variety of factors, which are not necessarily reflected in an elasticity calculation. For instance, 35% of retail water customers in the CRD are not connected to the sewer services (see Table 14 on page 3) and these customers will therefore not be affected by a shift of sewer costs onto the water bill. In addition, general price inflation may erode the impact of an increase in rates if these do not keep pace with inflation.

4.4.6 IMPACT ON CUSTOMER WATER BILLS

Estimates of the total annual cost of water bills for representative customers are provided in Table 41 for the existing and alternative rate structures. The upper portion of this table shows the cost for the entire bill including sewer charges included in the water bill while the lower portion of the table shows just that portion of the water bill corresponding to the charges for water supply.

An assessment of these results leads to the following observations:

- Considering only the water supply portion of the bills, customer costs for the existing and UR-FX options are very similar in Victoria and Saanich because the UR-FX option does not entail a large change from the status quo. The UR-FX option is more expensive for customers in Sidney because some water supply costs are shifted from the property tax to the water bill in that community.
- The SR-FX and EU-FX options cause a significant increase in the cost of water for the average residential customer. For other options, the water bills are roughly constant or may even fall unless costs recovered with the water bill have been increased. The highly seasonal water use of the average residential customer explains the greater impact of the SR-FX and EU-FX options.
- The impact of the two IB-FX options depends critically on the design of the rate and the customer profiles. IB-FX2 has a greater impact on the large residential customer because it is designed to specifically target this customer with a high rate. IB-FX1 has a very significant impact on water costs of the largest ICI customers since most of their water demand will fall into the high cost third block.
- The EU-FX option tends to have a less significant impact on most ICI customers because they generally have a less pronounced seasonal demand for water. This is not however true of seasonal ICI customers such as golf courses and nurseries.

4.4.7 IMPACT ON FINANCIAL RISK

All of the rate structure options are designed to fully recover required revenues and include the impact of reduced water use in the calculation of the rates. Cost recovery is therefore not an issue since the rates are set to fully recover the revenue requirements. But there is an issue associated with the year-to-year variability of revenues caused by variations in demand. Summer weather conditions are the principal cause of variations in demand. **Any rate structure that increases the volumetric rates on water used in the summer will increase the reliance on summer water sales for water revenues and this will increase the variability of revenues.** Over the course of time, revenue instability is not usually a significant problem since deficits are offset by surpluses. But an increase in revenue variability makes it more difficult to manage cash flow and it can increase the short-term cost of financing operations. This problem is less pronounced at the local level since a decrease in demand will also have a direct decrease in the volume of water purchased from the CRD. The impact will be felt more at the CRD level since there will be a direct decrease in revenues in proportion to the decrease in demand, with very little in the way of associated reductions in variable costs.

The share of revenues derived from summer water sales is used to measure the risk of increased revenue instability (Table 42). Based on this measure, the SR-FX option clearly entails the greatest risk since it places greatest emphasis on summer sales for revenue. Other options all have a similar impact on the share of revenue derived from summer water sales and represent a moderate increase in revenue instability. Several rate structure options appear to reduce the revenue risk for Sidney by introducing a fixed charge on the water bill but this result is misleading since the fixed charge on the water bill replaces a charge on the property tax bill, which is also fixed.

TABLE 41: IMPACT ON CUSTOMER Water BILLS ($/year)

	Existing	UR-FX	IB-FX1	IB-FX2	SR-FX	EU-FX
TOTAL CUSTOMER BILL - WATER + SEWER						
Victoria						
Residential – Average Use	$360	$340	$300	$340	$390	$390
Residential – high use	$720	$730	$740	$910	$850	$840
Large ICI Customer	$48,000	$48,300	$54,200	$48,300	$56,600	$47,380
Saanich						
Residential – Average Use	$210	$370	$340	$370	$430	$380
Residential – high use	$400	$750	$800	$930	$870	$770
Large ICI Customer	$143,100	$290,400	$359,000	$291,000	$336,600	$287,920
Sidney						
Residential – Average Use	$670	$890	$850	$810	$1,020	$880
Residential – high use	$1,430	$1,840	$1,930	$1,780	$2,120	$1,820
Large ICI Customer	$26,000	$32,900	$36,800	$35,100	$38,600	$31,600
WATER PORTION OF CUSTOMER BILL						
Victoria						
Residential – Average Use	$200	$180	$140	$180	$230	$240
Residential – high use	$350	$360	$370	$560	$480	$480
Large ICI Customer	$21,600	$21,900	$28,400	$21,900	$30,600	$20,960
Saanich						
Residential – Average Use	$210	$210	$170	$210	$270	$220
Residential – high use	$400	$400	$460	$600	$520	$420
Large ICI Customer	$143,100	$149,300	$225,100	$149,900	$195,600	$146,930
Sidney						
Residential – Average Use	$320	$460	$430	$420	$590	$480
Residential – high use	$680	$910	$1,120	$1,120	$1,200	$950
Large ICI Customer	$12,300	$15,700	$22,900	$19,000	$21,400	$14,000

TABLE 42: IMPACT ON THE SEASONAL DISTRIBUTION OF REVENUES

Rate Option	Existing*	UR-FX	IB-FX1	IB-FX2	SR-FX	EU-FX
Victoria						
Volumetric Charge – Summer	43%	49%	50%	52%	68%	54%
Volumetric Charge – Winter	31%	36%	35%	33%	17%	31%
Fixed Meter Charge	26%	15%	15%	15%	15%	15%
Saanich						
Volumetric Charge – Summer	54%	56%	60%	61%	72%	60%
Volumetric Charge – Winter	27%	29%	25%	24%	13%	25%
Fixed Meter Charge	19%	15%	15%	15%	15%	15%
Sidney						
Volumetric Charge – Summer	65%	56%	59%	58%	70%	60%
Volumetric Charge – Winter	35%	29%	26%	27%	15%	25%
Fixed Meter Charge	0%	15%	15%	15%	15%	15%

* Revenue shares for the existing rate structure are based on water bill revenues and do not account for fixed revenues from charges on the property tax bill.

4.4.8 SUMMARY OF THE EVALUATION OF RETAIL RATE STRUCTURES

Five alternative retail rate structures were analysed to determine the impact that each would have on water demand, customer water bills and revenue stability. The principal conclusions following from this analysis are:

- Increases in the water rates associated with the transfer of water and sewer costs from the property tax bill to the water bill have the greatest impact on water use. Reductions in demand caused by this transfer are expected to be significant.
- In most cases, the SR-FX option followed by the EU-FX option had the greatest impacts on summer water sales. However none of the rate structure options had a significant impact on water sales on their own.
- The SR-FX option causes a significant increase in the cost of water for the average residential customer while the IB-FX1 and SR-FX options have the most significant impact on water bills of large ICI customers.
- The SR-FX option causes the greatest increase in revenue instability.

The main factor influencing the evaluation of conservation rate structures was the lack of a significant impact on water sales when only the rate structure was changed. Forecast impacts on water demand were much smaller than the normal variations in demand caused by the seasonal variability of demand. This factor, combined with evidence of adverse impacts associated with revenue stability convinced WAC members to select the UR-FX rate structure as the preferred structure. But this choice does not represent the status quo. Relatively large reductions in water demand are expected to occur as a result of a shift of water and sewer costs from the property tax to the water bill. For this reason, WAC members propose a UR-FX rate structure featuring full recovery of all water and sewer costs from the water bill.

4.5 EVALUATION OF OTHER RATE STRUCTURE OPTIONS

4.5.1 THE DROUGHT RATE

A drought rate is an emergency rate that is used to reinforce bans on water use and to mitigate the revenue loss cause by a watering ban. The drought rate structure was proposed as a means of reinforcing other measures to limit water use during periods of severe drought by providing a strong economic incentive to curtail all water use. It also helps the water authority to recover fixed operating costs at a time of depressed sales.

Dealing with the issue of incentives first: it is probably not correct to assume that the economic incentive created by water rates is the same during drought as it is in normal years. Faced with a watering ban during drought, residential customers do not have options such as improved irrigation efficiency or mulching to protect their gardens, and most customers will not have alternative sources of supply (e.g. rain barrels will be empty). An increase in the water rate may not therefore actually alter a customer's decision about outdoor water use if the customer assigns a high value to his or her lawns and gardens. Important factors that are likely to affect this decision include community spirit and the fear of enforcement efforts for the ban. A drought rate may only serve to erode community spirit if it is seen as a double penalty given that a watering ban is already in place. The DR may not therefore have the intended incentive effect.

The benefit of improved cost recovery during drought may be significant. An analysis of total monthly retail sales for the period 1990 to 1999 revealed that summer flows (i.e. May to September) account for 54% of total flows. By comparing this amount to winter water use, it was determined that excess summer water use accounts for 21% of total retail water use. The existing retail water rates all use UR-FX structures. About 44% to 84% of residential revenues are derived from the variable charge in these structures (see section 3.1.2). The variable proportion for total revenues will be somewhat higher than this. An effective watering ban could reduce volumetric sales by up to about 20%. This in turn would reduce rate revenues by 8% to 16% depending on the size of the variable portion of revenues. A water authority has a number of options to overcome unexpected losses of revenue such as this. Operating reserves are usually maintained to cover contingencies of this sort, but these may not be sufficient especially if 2 or 3 years of drought follow in succession. It is also usually possible to reduce budgeted costs for instance by delaying discretionary capital expenditures. Finally, some water authorities may receive transfers or loans from general municipal government revenues to offset revenue shortfalls. Given these means of dealing with revenue loss caused by drought, an emergency drought rate may not be necessary.

4.5.2 THE LIFELINE RATE

A lifeline rate is a subsidised rate on a minimum volume of water for basic residential needs. It is a form of assistance to low income households. Lifeline rates are incorporated into increasing or decreasing block rate structures.

The lifeline rate structure provides the basic quantity of water needed by a household at a nominal and affordable fee. This helps low income households but it also gives financial help to all customers since it usually applies to all customers. For this reason, it does not target the intended recipients effectively.

A direct assistance program serves as an alternative to the lifeline rate structure. Direct assistance can be provided in various ways. For those families receiving social support, welfare payments may already include an allowance for utility costs. But this does not help the working poor. It might be possible to mount a program that allows households to apply for relief from a portion of their water bill. In this case, the onus is on the customer to take action to receive the benefit. The application would require that the customer provide some evidence of their financial condition. Upon approval of their application, they would be charged a lower tariff or would receive a rebate on their water bill. Direct assistance may also be granted automatically to certain households such as those receiving social support.

The direct assistance approach is clearly targeted to those customers who are most in need of help. It does however require greater administrative effort on the part of the water authority. It also gives the water authority a social services role, which it is not properly equipped to administer. Since other agencies have been established to provide social services, it is unreasonable to expect the water authority to take on a direct role in supporting low-income families. Moreover, the need to provide households with support to offset utility bills is a matter that should be evaluated by the social service agencies.

4.6 WHOLESALE RATE STRUCTURES

Alternative wholesale rate structures were presented in Section 3.2.2.7. Wholesale rates include the following: UR, UR-FX, SR, EU, and DC-FX. The UR-FX and DC-FX structures have fixed charges as part of the rate structure, but the other three rate structures are assumed to use only a volumetric charge (the norm for wholesale rates). An assessment of the performance of these rate structures is provided in Table 42. This assessment uses the same criteria used above to evaluate the retail rate structures, with the exception of the criteria on public acceptance, economic impact and affordability which are relevant at the retail level but not necessarily at the wholesale level.

Wholesale rate structures were evaluated after recommendations were formulated concerning reform of the retail rate structure. At the retail level, the decision was to continue with the existing retail rate structures and to advocate full cost recovery of water and sewer costs through the water bill. Existing wholesale rate structures are compatible with the current retail rate structures. Any change towards a conservation structure at the wholesale level loses much of its value since the price message that would be conveyed by the conservation wholesale rate would not be carried forward to the retail customer through the retail rate structure.

The remaining value of a conservation structure at the wholesale level lies in its economic impact on the retail service providers. Case studies of wholesale rates included structures that were designed to motivate the water retailer to provide storage to meet peak demands or to provide over season storage (see page 39). These approaches are not applicable in the CRD where both peak and seasonal demand storage are provided at the wholesale level.

In light of the preceding discussion, a reform of the wholesale rate structure is not recommended at this time.

TABLE 43: PERFORMANCE OF WHOLESALE RATE STRUCTURES

Criteria	**UR**	**UR-FX**	**SR**	**EU**	**DC-FX**
Water efficiency	all water use is subject to a volumetric charge, does not target peak or seasonal use	reduced incentive to conserve water due to the lower volumetric charge	targets all peak season use with a higher rate	targets excess peak season use with a much higher rate	targets peak day or max. hour use using a fixed charge, does not necessarily help control high seasonal volume
Equity	capacity costs are poorly allocated based on total volume	capacity costs are poorly allocated based on size of service	improved allocation of capacity costs based on seasonal volumes	capacity costs are allocated based on excess seasonal volume	capacity costs allocated based on capacity requirement
Full cost recovery	full cost recovery achieved with proper rate design	full cost recovery achieved with proper rate design	full cost recovery achieved with proper rate design	full cost recovery achieved with proper rate design	full cost recovery achieved with proper rate design
Technical feasibility	feasible	feasible	feasible	feasible	feasible but may require new metering equipment
Admin. Ease	represents status quo	minor change from status quo	minor change from status quo, may require cost of service analysis	minor change from status quo, may require cost of service analysis	more complex rate, may require cost of service analysis
Minimum financial risk	variability of rate revenues is high without a fixed charge	fixed charge helps to stabilise revenues	financial dependence on variable summer sales increases	financial dependence on excess summer sales increases	fixed demand charge stabilises revenues
Security of supply	no change status quo	negligible impact	Increased incentive to reduce total summer demand	Increased incentive to reduce excess summer use	provides strong incentive to reduce peak demands

5 CAPITAL PLANNING AND CONSERVATION RATES

5.1 WHOLESALE WATER SUPPLY SYSTEM

5.1.1 GENERAL

One of the objectives of water conservation is to defer capacity expansion projects and thus avoid financing costs for the project over the period of deferral. To properly establish the initiation and impact of deferral, the following elements on Supply Side Management should be examined:

- Existing and future sources of water supply and their respective reliability
- Current and target level of reliability,
- Projected demand increase with and without Demand Management
- Estimated costs of capacity expansion options.

All of these elements have been extensively addressed in the report "Strategic Plan for Water Management - Supply Management and Demand Management" (SPWM) prepared by Reid Crowther and Partners Ltd. in association with Aqualta and Context Research in March 1999. The intent of this chapter is to apply the findings and conclusions from that study to establish the impacts of conservation water rates on the capital plan.

The SPWM Report deliberated on options for both Supply Side and Demand Side management and recommended two options. The assessment of conservation water rates presented in this report is based on the adoption of Option 3A - Moderate Demand Side Management together with raising of Sooke Dam.

For completeness of this report and to provide ready references, the issues in the SPWM report relevant to the present study are summarised below.

5.1.2 SOURCE RELIABILITY

One of the most important aspects of a public water utility is the reliability of its sources of supply. Reliability is defined as the probability that the supply system can provide a predetermined amount of water, for example, 100% reliability means that the source of supply can meet all expected water needs at all times. Barring mechanical or electrical breakdown, a desalination plant might be considered 100% reliable. At the other end of the spectrum, the reliability of a reservoir filled by rain-fed run-off, such as Sooke Reservoir, is more likely to be less than 100% when the amount of draw-off from it represents a significant portion of its capacity. The higher the draw-off, the less reliable the system will be. The level of reliability that is deemed to be acceptable limits the maximum amount of draw-off. On the other hand, the amount of draw-off from a finite source can be increased if a lower level of reliability is adopted.

The reliability of a supply system is generally established through simulation of a monthly draw-off pattern over a long period using actual or synthetic rainfall records. The number of times the supply system fails to meet the required draw-off represents the number of system failures over the simulation period. The probability of failure can be expressed in several formats. For the purpose of illustration, the following statements all express the same probability of failure for a system, which, in a 100-year simulation analysis, fails to meet draw-off requirements on 4 occasions:

- One in 25 chance of failure,
- Service level with 25 year return period against failure to meet the draw-off,

- 4% probability of not meeting the draw-off in any year,
- 96% reliability.

5.1.3 CURRENT AND FUTURE SUPPLY SOURCES

CRD presently receives water from the following sources:

- Sooke Reservoir with Council Creek flow diverted to it.
- Partial storage from Goldstream Reservoir as an emergency supply.

Options for future expansions of the source of supply include:

- Raising Sooke Dam to increase yield from the Sooke Reservoir.
- Pumping out north Sooke Reservoir basin to capture the storage below the existing intake.
- Diversion of the Goldstream Reservoir spill into Sooke Reservoir.
- Diversion of Leech River into Sooke River via Deception Reservoir or directly into Sooke Reservoir.

The reliability of these options was evaluated in SPWM using 82 years of historical rainfall records. A decision has now been made to raise the Sooke Dam immediately. With this measure, the available yield increases to 68.2 million m^3 (15 billion gallons) per annum given the current target reliability of 96%. Figure 15[14] presents the draw-off/reliability relationship for this option.

5.1.4 CURRENT AND PROJECTED DEMAND

Historical water demand in the CRD shows a steady increase over the years (Figure 16).[15] In the SPWM Report, future demands were forecasted to 2006 (a weather-adjusted mid-point projection). The mid-point forecast was then extrapolated to 2020 with a low and high range calculated using deviation factors of 0.91 and 1.07 to give the minimum (wet year) and maximum (dry year) projections (see Table 44)[16]. In the course of preparing these projections, the effect of technological change (e.g. water efficient appliances) and the trend towards multi-family dwellings with lower outdoor demands were taken into account.

[14] Figure 4.10 from CRD Report – Strategic Plan for Water Management, Volume 1, by Reid Crowther et al.
[15] Figure 4.13 from CRD Report – Strategic Plan for Water Management, Volume 1, by Reid Crowther et al.
[16] Table 5.6 from CRD Report – Strategic Plan for Water Management, Volume 1, by Reid Crowther et al.

TABLE 44: DEMAND PROJECTIONS (ML)

	MINIMUM		MID-POINT		MAXIMUM	
YEAR	**Annual**	**Daily**	**Annual**	**Daily**	**Annual**	**Daily**
1996	54,700	149	60,800	166	65,000	177
1997	55,200	150	61,300	167	65,600	178
1998	55,500	152	61,700	169	66,000	181
1999	56,000	154	62,200	171	66,500	183
2000	56,400	155	62,700	172	67,100	184
2001	56,900	156	63,200	174	67,600	186
2002	57,300	157	63,700	175	68,200	187
2003	57,800	158	64,200	176	68,700	188
2004	58,300	160	64,800	178	69,300	190
2005	58,800	161	65,300	179	69,900	191
2006	59,300	163	65,900	181	70,500	193
2007	59,700	164	66,400	182	71,000	195
2008	60,200	165	66,900	183	71,600	196
2009	60,700	166	67,500	185	72,200	198
2010	61,200	167	68,000	186	72,700	199
2011	61,700	169	68,600	188	73,400	201
2012	62,300	170	69,200	189	74,000	202
2013	62,700	172	69,700	191	74,600	204
2014	63,300	173	70,300	192	75,200	205
2015	63,700	174	70,800	194	75,800	207
2016	64,300	175	71,400	195	76,400	209
2017	64,700	177	71,900	197	76,900	211
2018	65,200	179	72,500	199	77,600	213
2019	65,800	180	73,100	200	78,200	215
2020	66,200	182	73,600	202	78,700	216

FIGURE 15: RELIABILITY OF SUPPLY SYSTEM YIELD – RAISED SOOKE DAM

FIGURE 16: TOTAL ANNUAL WATER CONSUMPTION

5.1.5 IMPACT ON SOURCE SUFFICIENCY—WATER USE RESTRICTIONS

Applying the available yield of 68.2 m^3 per annum from the raised Sooke Reservoir and Council Creek Diversion to the mid-point demand projection given in Table 43**,** the currently available yield will be fully committed by the year of 2011. Stage 2 water restrictions would allow the available yield to meet demands up to 2020. Such restrictions result in a 15% demand reduction in the summer months or an overall annual demand reduction of 7% based on the average ratio of summer to winter consumption (SPWM Report, Table 4.6, Section 4.9.1).

Table 43 also shows that under the maximum demand projection for an extreme dry year, the yield of the raised Sooke Dam will be fully committed by 2003. Under such a situation, a Stage 3 water restriction would probably reduce the demand by about 20% over the summer months. Assuming a 20% reduction is achieved for a period of 4 months, the overall reduction to the annual demand would be in the order of 9%. This would allow the available yield to meet maximum demands up to 2014.

5.1.6 IMPACT ON SOURCE SUFFICIENCY—CONSERVATION RATES

The likely impact from conservation water rates on demand was assessed for three case study municipalities in section 4.4.5 (page 55). The proposed reform, entailing a shift of all water and sewer costs onto the water bill, was forecast to reduce annual water demands by 8% to 15% in the case study municipalities. This analysis was extended to the Greater Victoria Service area in order to evaluate impacts on capital plans and system reliability. The estimated overall reduction was 10%. Assuming a reduction of demand by 10%, the raised Sooke Reservoir should be sufficient to meet mid-point demand up to 2025 and maximum dry weather demand up to 2016.

5.1.7 CAPITAL WORK DEFERRAL

The most logical incremental supply source appears to be the diversion of Goldstream Reservoir overflow into Sooke Reservoir at an estimated cost of $10 million (1999 price levels). With a reduction of demand of 10% the yield of the raised Sooke Dam will meet average annual demand beyond 2020 and demand during maximum dry weather conditions up to 2016. This means that this source of supply will not be required before 2016 at the earliest.

The impact of demand reductions through conservation water rates is not clear. Rate reforms would have their greatest impact on discretionary water uses such as lawn watering. Such discretionary uses can also be controlled during periods of drought through legislation. Rate reforms may not result in savings beyond those that could be achieved with water restrictions. However, the response to rate reforms is ongoing while responses to restrictions during drought are temporary.

Assuming that Stage 2 restrictions reduce annual demand by 7% and that rate reforms reduce demand by 10%, the net effect of conservation water rates when combined with Stage 2 restrictions might only be 3 or 4%. The equivalent impact of water rate reforms under a Stage 3 restriction would probably be negligible.

A 3% reduction in demand when the source of supply is fully committed would be equivalent to an increase of 2.0 million m^3 (0.4 billion gallons) and would defer the next capacity investment by 4 years from 2011 to 2015. The present value of deferring the $10 million Goldstream diversion project from 2011 to 2015 is about $1.4 million (7% discount rate).

5.2 LOCAL WATER SUPPLY SYSTEM

5.2.1 GENERAL

While the Capital Regional District is responsible for the bulk water supply and transmission to the local municipalities who, in turn, are responsible for distributing the water to individual customers. To fulfil this function, the local municipalities provide the distribution systems and meter customers. They are required to maintain, expand and extend distribution systems to meet growing demands of existing and new customers. Previously, municipalities provided infrastructure for new developments but it is now common for developers to extend services and turn these over to the municipalities upon completion. The local municipalities must also replace old systems at the end of their life cycles.

It is fortuitous that most of the CRD service areas can receive water by gravity without pumping. This helps keep wholesale water costs low. Other costs incurred at the retail level are for meter reading and billing, operations and repairs, and life-cycle replacement and upsizing. The last two activities are often carried out concurrently.

5.2.2 IMPACT OF DEMAND SIDE MANAGEMENT

Demand management activities directed at the retail customers include water use restrictions, conservation water rates and a variety of other options based on information dissemination and customer incentives. Water use restrictions can have an immediate and significant impact on total or peak summer demands. They can also reduce peak flows in distribution systems, which helps protect undersized and older distribution systems with marginal residual pressure. In this respect water use restrictions may theoretically defer the capital program for replacement of undersized or old systems. But this benefit is only realised if restrictions are permanent, as is the case with a permanent odd/even lawn-watering program. Emergency restrictions during drought do not affect local capital programs.

Water rate reforms may provide customers with an ongoing incentive to conserve water like permanent restrictions. They may therefore have a similar impact on local capital programs. But because of the design of water distribution systems and the complex nature of factors that cause the degradation and failure of mains, capital deferrals in watermain replacement programs are unlikely to occur because of water rate reforms.

5.2.3 IMPACT OF LIFE CYCLE REPLACEMENT ON RETAIL WATER RATES

Reforms of the retail water rates that are recommended in Chapter 4 focus on increasing the existing relatively low rates by shifting all of the existing water and sewer costs onto the water bill and off of the property tax bill. Increases in the water rates such as these must be justified by local revenue requirements in light of the constraint that water and sewer departments must operate on a full cost recovery basis. During the review of the municipal water utility accounts, it was noted that most of the municipalities have not established watermain life-cycle replacement programs. Where they do exist, the life cycle is long (100 years or so) and practical applications often stretch even further into the future. Over the last couple of decades, the local municipalities have however replaced most of their outdated and undersized grid main systems.

The importance of setting up properly funded lifecycle replacement programs should not be overlooked. One side benefit of setting up such programs is that they establish a legitimate revenue requirement that in turn can justify increases in the local water rates. These increases would reinforce the conservation effects of the rate reforms that are recommended in Chapter 4.

6 IMPLEMENTATION STRATEGY

6.1 LEGISLATIVE REQUIREMENTS

Due to legislative limitations, sewer costs cannot be added to a user rate. From a legislative perspective, the most pressing requirement for rate reform therefore concerns Provincial legislation. The CRD allocates operating, maintenance and administration (OM&A) costs for sewer services to the local municipalities based on flow. Capital costs are allocated in proportion to the share of downstream capacity provided. The Region can charge these costs to the local municipalities by means of requisitions, fees and charges or parcel taxes. How these CRD charges are recovered by the local municipalities is restricted by legislation and varies by municipality. For example, the CRD uses the requisition method for recovering OM&A costs. It is generally accepted that this type of charge can only be recovered by means of the property tax bill and Victoria, for example follows this approach and bills the requisition in the tax bill and remits the amount to the CRD.

It would be preferable if there were no legislative restrictions impeding the ability of local municipalities to bill CRD sewer requisition on a user pay basis. Currently the local municipalities are restricted to property value taxes as the sole source of recovering the CRD trunk sewer charges. This has already been recognised as an issue by the CRD Board, which approved the following recommendation on May 10, 2000:

> "That the Board request, under Section 251(1) of the Municipal Act, that the Lieutenant Governor in Council, by regulation give authority to the Capital Regional District for the CRD municipalities to recover their trunk sewer and sewage disposal annual requisition by way of fees and charges set independently within each municipality, on such basis as is independently determined by each municipality of by a property tax or combination thereof."

At a local level, legislative requirements include a revision of bylaws pertaining to the recovery of water and sewer bylaws from customers.

6.2 COST RECOVERY ISSUES

Apart from legislative constraints, number of issues arise in consideration of proposals to shift sewer and water system costs from property and parcel taxes to the water bill:

1. Senior government agencies do not pay municipal taxes on the property that it owns and some do not make payments in lieu of taxes. In this situation, service charges represent the best means of recovering the cost of utility services from these agencies, and the proposal to shift sewer and water costs onto the water bill is therefore very practical.
2. In some jurisdictions, capital costs for sewer and water are recovered through property and parcel taxes from both serviced and unserviced properties. This is a common practice reflecting the fact that unserviced properties benefit from having ready access to infrastructure. Since unserviced properties do not receive a water bill, it may therefore be preferable to continue using the property tax bill to recover capital costs in specified areas and to transfer only operation, maintenance and replacement costs to the water bill.
3. When costs are recovered through the property tax based on assessed value, large non-residential properties often pay a disproportionately large share of those costs. Shifting those

costs to the volumetric charges on the water bill means that small customers end up with a larger cost burden. While this may represent a more equitable allocation of the costs of service, it may also raise issues of affordability and be difficult to implement from a political perspective.

These issues must be addressed in more detail at a local level in order to develop a feasible implementation plan for the reform of retail rate structures.

6.3 ADMINISTRATIVE REQUIREMENTS

The recommended rate reform, recovery of all water and sewer costs through the user charges is less onerous from an administrative perspective than reform of the rate structure. Once bylaws have been revised in order to authorise rate reforms, the principle requirements include: (1) calculation of new rates for water and sewer services on the water bill and offsetting adjustments in parcel taxes, mill rates or other affected taxes; (2) modifications to billing software and the water bill forms in order to incorporate the new rates (this may simply entail changing the charge levels in the software); (3) development and implementation of a communication plan for the rate reform; (4) implementation of charging with the new rates.

It is essential that an implementation plan be carefully developed before any policy that affects the public cost for water and sewer services. This plan should include staff training to deal with customer inquiries, particularly front line staff such as customer service representatives. It should also include public relations material or activities such as bill stuffers, advertisements, letters and meetings with individual large users and the public. It is most important that the public is not unpleasantly surprised. The communication plan should be implemented about 3 months prior to changes in the rates and should continue for at least two billing periods following the changes.

Information that can be delivered through the communication plan include the following:

- the purpose of the reforms
- the impact of rate reforms on typical customer water bills and tax bills
- options that customers can use to mitigate increases in their water bills
- information on cost increases, if any, that accompany the rate reforms
- timing of the reforms
- contact information for questions and complaints.

A phase-in is often recommended when rate reforms are planned. The phase-in of changes would typically take place over 2 to 5 years and allows customers to adjust to the change with a minimum of disruption. In the current case, the rate reform is motivated by a desire to promote water conservation. The conservation effect will be greatest if rates are changed more quickly since customers are more likely to notice and respond to the change. For this reason, a shorter phase-in period of 2 years is recommended.

The existing retail meter reading and billing frequencies are adequate to implement the proposed rate reforms since these only involve a shift in costs from property tax instruments onto the water bill. An increase in meter reading and billing frequency from 3 times per year (every 4 months) to 4 times per year (every three months) would however be beneficial for a number of reasons:

- More frequent billing would reduce the delay between the time that the retail customer uses the water and the time when the water is billed. This helps to reinforce the incentive effect of the water bill.

- Individual water bills are smaller with more frequent billings and this may help low-income households budget for the expense.
- More frequent meter readings generate more information on seasonal water use and increase the ability the local water departments to manage demand and forecast sales revenues.
- More frequent meter readings will help the billing department and/or the water department to spot anomalies in customer water use caused, for instance, by meter failure or undetected customer leaks, and to warn the customer or take other appropriate actions.
- More frequent billings may improve cash flow.

For the above reasons it is recommended that meter reading and billing frequencies be increased to a quarterly schedule for residential and smaller ICI customers and that bimonthly billing be considered for larger ICI customers.

7 CONCLUSIONS AND RECOMMENDATIONS

This report documents a study of conservation-oriented water rate structures that was undertaken to help the CRD pursue the water demand management objectives defined in 1999 in the "Strategic Plan for Water Management." Although the CRD is a wholesaler of water, this study focused on retail rates since only these have a direct impact on the water demand of end users. Recommendations arising from the study therefore focus primarily on the retail rates.

Objectives of the study included:

1. Review current and historical water utility data at the wholesale and retail levels.
2. Establish rate setting principles and rate structure evaluation criteria.
3. Identify, describe and evaluate alternative rate structures using the evaluation criteria.
4. Recommend a preferred rate structure and an implementation strategy for rate reform.

The study was completed under the guidance of CRD staff and members of WAC and the MTLC. In pursuing the objectives, study team members reviewed local data and information, documented relevant case studies, completed financial and economic analyses of alternative rate structure options, and completed an evaluation exercise in consultation with WAC and MTLC.

The study team considered rate reforms based on the existing rate structures as well as alternative rate structures. The following rate structures were evaluated:

Uniform	Constant volumetric charge plus a fixed meter charge (existing rate structures)
Declining block	The volumetric charge falls as water use increases
Increasing block	The volumetric charge increases as water use increases
Humpback	The volumetric charge increases first then decreases as water use increases
Seasonal	The volumetric charge is higher for all water used in the summer
Excess use	The volumetric charge is higher only for excessive water use in the summer
Demand charge	Constant volumetric charge plus a fixed charge that is based on the customer's maximum water demand (replaces the fixed meter charge)

Wholesale water supply costs are recovered by the CRD using a uniform volumetric charge for water sold to local municipalities. The local municipalities recover water supply costs through retail water sale revenues as well as parcel and property taxes. The retail water rates are a combination of fixed charges plus uniform consumption charges. Where fixed charges are used on the water bill, they represent from 16% to 56% of the typical domestic water bill. In two municipalities, fixed charges for water appear on the property tax bill rather than the water bill. Some municipalities use the water bill to recover a portion of their sanitary sewer service costs, but most of these costs are recovered through fixed charges on the property tax bill.

The wholesale water rate is currently $0.198/m^3$ and volumetric retail water rates for the 8 local water supply retailers range from $0.292/m^3$ to $0.727/m^3$. When fixed charges and charges for sewer services are factored in, the cost of water for the average household in the CRD ranges from $0.53/m^3$ to $1.54/m^3$. At these levels, the cost of water in the CRD is low relative to costs elsewhere in North America. Conversely, levels of water consumption are relatively high at 550 litres per capita per day. Domestic water use is a large share of this demand, with the average household water use at about 30 m^3 per month. Demands are also highly seasonal. Average daily summer water sales are more than double the average daily winter sales in some local municipalities due primarily to lawn and garden watering.

The principal conclusions arrived at during the course of this study are as follows:

- The CRD benefits from a very high quality and low cost source of supply. For this reason, existing water rates are relatively low and do not provide customers with a strong economic incentive to conserve water. When water bills are low because of low cost recovery requirements, the opportunity to create a strong economic incentive through reform of the rate structure alone is limited. None of the alternative rate structures is therefore expected to have a significant impact on water demand.
- Water bills are also low because several municipalities use the property tax bill rather than the water bill to recover certain sewer and water costs. Increases in the water rates resulting from the transfer of water supply and sewer service costs from the property tax bill to the water bill will have the greatest impact on water use. Reductions in demand caused by such a transfer are expected to be significant.
- Financial analysis of the alternative rate structures was completed to determine how they would impact customers and the water utilities. The analysis indicated that seasonal and excess use rate structures will cause a significant increase in the cost of water for the average residential customer while the increasing block and seasonal options will have a significant impact on water bills of large non-residential customers.
- From a utility perspective, cost recovery and revenue stability are very important. With proper rate design, adequate cost recovery is assured. However, conservation-oriented rate structures that increase the volumetric rates for water used in the summer will increase the reliance on summer water sales for cost recovery. This increases revenue instability because summer sales are highly variable. The seasonal rate structure causes the greatest increase in revenue instability.
- By itself, rate reform does not usually give the water utility enough leverage to achieve their water conservation objectives. Other actions are required to reinforce the economic incentives created by rate reform. For instance, most retail meter reading and billing practices in the CRD employ a 4-month billing cycle. Consequently, customer billings for water services are infrequent and customers are billed in the late fall or winter for water used in the summer. Long delays like this in customer billing weaken the economic incentive to use less water created by charges on the water bill.
- A demand management program is one of the most effective actions that a municipality can adopt in conjunction with rate reform to promote water conservation. The most successful case study municipalities that were considered in this study all used aggressive water conservation programs. The existing water conservation program is therefore an essential component of any strategy used to pursue water conservation objectives in the CRD.

Recommendations that follow on from the above findings and conclusions are as follows:

Recommendation	Discussion
Retain the uniform rate structure at the retail level.	Alternative rate structures will result in relatively modest reductions in water demand
Use the retail water bill, where possible, to recover all water and sewer costs including costs now recovered using property and parcel taxes.	Transferring costs now recovered using parcel or property taxes to volumetric charges on the water bill will increase these charges and provide a strong economic incentive to conserve water.
Fixed charges in the retail rate structure should generate no more than about 15% of total water bill revenues.	When fixed charges are too high the volumetric charges are correspondingly lower and the incentive to conserve water is diminished.
Municipalities should consider increasing the frequency of retail meter reading and billing to a quarterly schedule for residential customers (i.e. every 3 months) and a bimonthly schedule for large ICI customers.	A quarterly schedule has several advantages: (1) more frequent billing reinforces the economic incentive to conserve water, (2) quarterly data on water use allows more equitable billing for sewer services based on indoor usage alone which is estimated using winter water use data, (3) it is easier for low income households to budget for smaller quarterly bills.
Retain the existing wholesale rate structure.	This structure is compatible with the proposed rate structure at the retail level.
Continue to lobby the Lieutenant Governor in Council to allow CRD municipalities to recover trunk sewer and sewage disposal costs by way of fees and charges set independently within each municipality.	Current Provincial legislation requires CRD trunk sewer charges to be recovered from property taxes. This impedes the ability of local municipalities to recover sewer costs on a user pay basis in the water bill and prevents the adoption of full-cost water and sewer rates.
Continue the existing demand program to promote efficient water use.	Programs that combine promotions such as rebates for installing low flush toilets with economic incentives created by rate structures are more effective in controlling water demand.
Complete more detailed studies at the retail level to design implementation plans for rate reform and to address a number of outstanding issues.	Examples of outstanding issues include the recovery of sewer and water costs from unserviced properties, the allocation of costs among residential and ICI customers, and administrative requirements for rate reform.
Phase in rate reforms over a two-year period.	A two-year phase in period allows customers some time to adjust to the new rates but is not so gradual that the reforms will pass unnoticed.
Develop and implement an effective communication plan to promote rate reforms.	The public will often oppose any type of rate reform. An effective communication plan will do much to overcome public opposition.

A number of benefits will be realised with the implementation of recommendations made above:

Rate reform is an important tool for water demand management that will help the CRD and its member municipalities achieve their strategic water conservation objectives. The recommended reforms to retail water rates are expected to reduce overall water demand by up to 10%. This reduction will increase the effective water supply capacity and thus improve system reliability in times of drought. It will also allow additional growth to be serviced without expanding capacity and thus will allow the CRD to defer future capacity investments.

The recommended reforms adhere to the user pay principal by shifting cost recover from property taxes to charges on the water bill. This shift will assure that water bills will more fairly reflect the cost of both large and small servicing customers. Rate reform will thus lead to a more equitable distribution of costs among customers.

With more frequent readings of customer meters, water utility staff develop a better understanding of water use patterns and are in a better position to manage water demand.

The effort and cost required to implement the recommended reforms are lower than would be required to adopt an entirely new conservation-oriented rate structure. Increases in metering and billing costs are minimised and existing billing systems should readily accommodate the proposed changes.

GLOSSARY OF TERMS

Average cost – A measure of the unit cost of production estimated as total costs per period of time, usually one year, divided by total output per period of time; for example, the unit cost of a cubic meter of treated water or the unit cost of treating a cubic meter of wastewater.

Average cost pricing – Setting prices equal to average costs. See distributed cost pricing, marginal cost pricing.

Average day demand or production – Total water produced or demanded (that is, sold) in a period divided by the number of days in the period. The period is usually a year, a month or a season. Average day production exceeds average day demand due to the production of non-revenue generating water. Average day demand can be calculated for all customers, for classes of customers or for individual customers.

Average daily flow – Total water flow for a period divided by the number of days in the period. The period is usually a year, a month or a season. Average daily flow can refer to water or wastewater production, water sales, instream water flows, etc.

Block rates – Volumetric charges that vary in discrete steps as the customer's level of water use increases. see declining block rates, increasing block rates, and inverted u or hump back rates.

Commodity charge – volumetric charge.

Cost of service – The imbedded costs incurred to service a utility customer.

Cost of service study – An in-depth analysis that determines how costs are associated with different aspects of water supply operations (e.g. treatment, conveyance, billing, engineering, etc.) and examines how these costs are caused by the demands for service. Important factors causing costs include the quality and location of the source of supply, average and peak demand characteristics, and the number and geographic dispersal of customers. The end product is an allocation of costs to segments of the serviced market representing entities such as customer classes, pressure zones, distinct geographic service areas or areas lying inside and outside of the municipal boundary. These allocated costs are then used to set water tariffs that differentiate among customers or types of use.

Decreasing block rates – A volumetric charge for water that falls as the customer's consumption of water increases; for example, \$1.50/m^3 for the first 20 m^3/month, \$1.00/m^3 for the next 100 m^3/month, \$0.50/m^3 for the remaining consumption.

Demand charge – In water supply, a fixed charge in the rate structure that is based on the customer's peak water demand; e.g. if the demand charge is \$0.50/m^3 for the customer's maximum month water demand in the previous year, a customer using a maximum of 100 m^3/month last year pays \$50 per month every month this year. This charge is used at the wholesale level.

Demand curve for water – A mathematical expression that describes the relationship between the demand for water and underlying socio-economic factors that affect the level of demand such as the price of water, the income of domestic customers, weather conditions related to water use, the production technologies of non-domestic customers, etc. Economists use statistical techniques to develop demand curves for entire communities, for classes of customers or for individual customers. They estimate either short or long term responses of demand to changes in causal factors.

Demand Management – Implementation of measures to reduce water use, thereby freeing up water supply capacity to serve new growth. Measures may target average or seasonal customer water use or non-revenue water.

Distributed cost pricing – A form of average cost pricing in which prices are based on the costs of service for various classes of customers.

Efficiency – In production of goods and services, technical efficiency is achieved when a given level of output is produced with minimum inputs of labour, materials and capital. But different combinations of inputs can be technically efficient. Allocative efficiency is achieved in production when the technically efficient combination of inputs is also the least cost combination. Allocative efficiency is achieved in consumption when consumers use a combination of goods and services that yields the greatest possible benefit or value to them for a given level of expenditure. Overall, allocative efficiency requires efficiency in both production and consumption. In a competitive market economy, prices provide producers and consumers with an economic incentive to make decisions that promote efficiency. See marginal cost pricing.

Elasticity of demand for water – Price elasticity of water demand is a negative number that measures the response of customer demand to changes in the total volumetric rate including any extra fees and charges that are added to the water bill. It usually lies in the range of -0.0 to -1.0. An elasticity of -1.0 means that a 10% increase in the tariff causes a 10% fall in demand, while, with an elasticity of -0.2, demand falls by 2%. An elasticity of zero means that demand does not respond to the tariff. Zero elasticity is appropriate for the demand of unmetered customers or residential and commercial tenants who are not individually metered. Elasticities are estimated by the statistical analysis of water demand data. Values for price elasticity are often reported as positive numbers but they are in fact negative values.

Equity – In accounting: Ownership of the investors in the net assets of a firm including invested capital and accumulated reserves (generally includes common shares but not preferred shares where these are used as a method of finance). In economics: Condition of increased social welfare brought about by a more uniform distribution of income. In the delivery of utility services this meaning of equity takes the form of a concern with the affordability of the service to low income households. see lifeline rates. In rate setting: A rate structure is considered equitable if the amounts that customers are charged reflect the costs of servicing those customers. See cost of service.

Excess use charge – In water supply, a high volumetric charge in the rate structure applied to water sold to a customer during the peak water demand season that exceeds a threshold volume estimated as a multiple of the customer's base or off-peak season demand. A multiplier between 1.0 and 1.5 is typical.

Fixed charge – A user charge in the rate structure that does not vary with the level of demand for service in the billing period.

Fixed costs – A cost that does not vary as the level of production changes. In the short run, the cost of capital is the principle fixed cost in water and wastewater systems. Most labour costs will also be fixed.

Humpback rate (Inverted U block rate) – A volumetric charge for water that increases then falls as the customer's consumption of water increases. e.g. $1.00/m^3 for the first 10 m^3/month, $1.50/m^3 for the next 10 m^3/month, $3.50/m^3 for the next 20 m^3/month, $1.00/m^3 for the next 100 m^3/month, $0.50/m^3 for the remaining consumption.

Increasing block rates – A volumetric charge for water that increases as the customer's consumption of water increases. e.g. $1.00/m^3 for the first 10 m^3/month, $1.50/m^3 for the next 10 m^3/month, $3.50/m^3 for the remaining consumption.

Incremental cost – The marginal cost of production. Average incremental cost is one measure of marginal cost. It is the average cost of production from the next major addition to the production capacity of a plant.

Infiltration – Groundwater entering sanitary sewers through cracks, defective joints and other openings.

Inflation – Inflation is a general increase in the level of all prices in an economy. Inflation is commonly measured using a price index, such as the consumer price index, that measures relative change in the average price of a bundle of goods and services.

Inflow – Surface runoff entering sanitary sewers through cross connections with storm sewers, roof and footing drains connected to the sanitary sewers, etc.

Lifeline rate – A rate structure featuring a nominal charge for an initial volume of water used by the customer. The low charge is designed to be affordable to low-income households and to assure that those households have access to utility services required for basic domestic needs. See equity.

Marginal cost – The increase or decrease in total cost that occurs when output is varied by a small amount. Fixed costs are not included in marginal cost. Variable costs are included, as are the costs of expanding production capacity if this is needed to increase output because existing output equals plant capacity. Marginal cost = opportunity cost.

Marginal cost pricing – Setting price equal to marginal cost. Economists advocate marginal cost pricing as a means of promoting efficiency in water supply and other utility services because the value that customers realise from consuming the service will be at least as great as its opportunity cost. For example, the marginal cost of water is higher than average cost when output is at capacity and growing demands require a capacity expansion. When water is priced at its average cost, customers will use it in ways that yield less value to them than its opportunity cost, for example that might not fix leaks. The resulting high demands lead to a capacity expansion. Higher prices based on marginal cost prior to the expansion would motivate customers to use less water, and the lower levels of demand would allow deferral of the expansion. Efficiency in this case comes from the deferral of capital costs.

Maximum day – The maximum daily amount of water produced over an annual period. Maximum day is a design parameter for sizing capacity expansions. In Ontario, maximum day is usually 1.4 to 2.0 times average day production.

Non-revenue water – Water that is produced by a water production facility but that is not sold to customers. Non-revenue water includes water that is metered but not billed to customers, unmetered public water uses (e.g. fire fighting, public area landscaping), unauthorised water use (e.g. illegal connections, meter reading errors, known leaks), and UNACCOUNTED FOR WATER (losses, undetected leaks in the distribution system)

Peak load pricing – In water supply, pricing using a rate structure that features a high volumetric charge for customer demand during the peak water demand season. See seasonal charge, excess use charge, demand charge.

Rate schedule – The combination of user charges that are used estimate the regular service bill of a utility customer. A one-part rate structure uses only one charge. A two-part rate structure has a fixed charge and a volumetric charge.

Reliability – For a water supply system, the probability that the supply system can provide a predetermined amount of water, for example, 100% reliability means that the source of supply can meet all expected water needs at all times.

Seasonal charge – In water supply, a high volumetric charge in the rate structure applied to all water sold during the peak water demand season.

Unaccounted for water – A portion of NON-REVENUE WATER that can not be attributed to authorised uses such as fire fighting water; metered water that is not charged back to the customer; and water used by the municipality for mains flushing, parks irrigation etc. UFW includes water lost through system leakage, apparent water losses due to metering errors and water theft.

Uniform Rate - A volumetric charge for water that remains constant as the customer's consumption of water increases. e.g. \$1.00/m^3 for the all water used.

Unit cost – The total cost of an activity, operation or capital facility divided by the number of units of output or production. To estimate the unit cost of activities and operations, the measure of output used in the calculation is the actual level. To estimate the unit cost of a capital facility, the measure of output normally used is the capacity of the facility.

Variable cost – A cost that varies as the level of production changes. In the short run, the costs of energy and chemicals are the principle variable costs in water and wastewater systems.

Volumetric charge – For water and wastewater services, a user charge in the rate structure that applies to the volume of water consumed or the volume of wastewater discharged to the sanitary sewer. Metered water use is normally used as a proxy measure of wastewater production. Metered water may be adjusted to account for water used but not discharged to the sewer (for example, irrigation water).