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User pay financing of stormwater management: A case-study in Ottawa-Carleton, Ontario

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Stormwater management upgrade and maintenance costs in the province of Ontario are significant. As capital grant programs decline, municipalities are exploring alternative means for financing the abatement of stormwater quantity and quality problems. User pay financing represents one such option. The economic, institutional and legal issues related to implementing user pay financing of stormwater management in Ontario are addressed using the Regional Municipality of Ottawa-Carleton (RMOC) as a case-study. The paper reviews the experience with user pay stormwater management programs in Canada and the USA, and recent stormwater issues and financing needs in the RMOC. The presented spreadsheet rate model is based on stormwater quantity and quality considerations and best management practices (BMPs) for various land-use categories. The modelling results vary depending on the inclusion or exemption of certain land-use categories and whether BMPs are implemented. Preliminary results indicate the monthly stormwater user charges are comparable with those charged in USA programs. In Ontario, existing statutes provide the enabling legislation for stormwater user charges, and there are no legal or regulatory barriers to implementing them. However, program we start-up costs and public perception could be significant obstacles to instituting user charges.

Keywords: stormwater management, BMPs, financing, user pay.

Introduction and objectives

Urban development dramatically changes the hydrologic cycle of urban areas, primarily by increasing surface runoff and the export of sediment and pollutants from urban areas to the receiving waters. To mitigate such adverse impacts, urban stormwater management was adopted in drainage practice in Ontario in the early 1970s, mainly for controlling peak flows from new developments. Since then, stormwater management has evolved further and has become more comprehensive, reflecting the concepts of ecosystem protection and sustainable development.

Thus, stormwater management can be described as a set of measures that control of stormwater flows, enhance stormwater quality, and mitigate stormwater discharge impacts on receiving waters. In terms of flow control, reductions in flow volumes and peak flows, and high-flow duration are important. Stormwater quality enhancement has been developed with reference to solids, nutrients, heavy metals, hydrocarbons, trace organic contaminants, faecal bacteria and temperature control. With respect to mitigating impacts, important considerations include prevention of flooding, excessive erosion, damage of habitat, and water quality deterioration, while providing general amenities as well as recreational and economic opportunities.

Stormwater management measures, also referred to as best management practices (BMPs), can be classified as either non-structural or structural measures. The first category includes source controls by policies/ordinances controlling urban development and resource planning, preservation of natural drainage, chemical use control,

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surface sanitation, and erosion and sedimentation control (Lawrence *et al*., 1996). Structural measures include porous pavement, water quality inlets and oil/grit separators, perforated sewer pipes and catchbasins, grassed drainage filters/swales, sand filters and biofilters, infiltration facilities, stormwater management ponds, and constructed wetlands (Marsalek and Kok, 1997; OMOEE, 1994).

Experience with stormwater BMPs has been summarized in many publications (e.g. OMOEE, 1994; Lawrence *et al*., 1996; Marsalek and Kok, 1997) and they show that BMP effectiveness in stormwater quantity and quality control cannot be sustained without proper maintenance. As the structural BMPs in Ontario and other jurisdictions age, there are concerns that without proper upkeep, or even upgrading in the case of obsolete facilities, stormwater BMPs can become environmental liabilities (Jones and Jones, 1984). Thus, the issue of funding stormwater management is critically important not just for construction of new facilities, but also for keeping the older ones fully functional.

Urban runoff is a major contributor to the degradation of water quality in many Ontario waterbodies. For example, stormwater contributes over 15% of the total phosphorus load to the Bay of Quinte (Bay of Quinte RAP, 1993) and almost 21% of the total lead load to Hamilton Harbour (Hamilton Harbour RAP, 1992). The cost of upgrading and maintaining Ontario's stormwater infrastructure is high. Capital upgrade costs in Ontario's 16 Remedial Action Plan (RAP) sites have been estimated at $2·5 billion (Hickling *et al*., 1992). Another study developed a range of $20 million to $8 billion, depending on the level of abatement and targetted pollutants at these same sites (CH2M Hill Engineering Ltd., 1993). In the Regional Municipality of Ottawa-Carleton (RMOC) for example, required capital expenditures for stormwater control have been estimated at $90 million (Gore and Storrie, 1992). Although province-wide estimates are not available, the cost to municipalities for stormwater management is large. Further, the elimination of Ontario's main capital grant program for water-related infrastructure—the Municipal Assistance Program—and the transfer of responsibilities to local governments (and the resulting increase in competition for funds), makes it difficult for municipalities to generate sufficient revenues for stormwater management. Yet there are significant potential economic benefits (such as increased water-related recreational activities, tourism activity and property values), in addition to the many bio-physical improvements from reductions in stormwater pollutant releases, that justify remediation in many cases.

The importance of improved urban stormwater-management programs is being recognized internationally. The European Commission's Environment—Water Task Force—cites management of stormwater in urban areas as a priority research area (European Commission, 1998). Australia has already focused on public education and outreach as a means to convey the critical need for urban stormwater management. A $2 million Urban Stormwater Education program is aimed at bringing substantial change to the behaviour of communities to reduce stormwater pollution. In the USA, the Environmental Protection Agency's Nonpoint Source Pollution Control Program continues to provide technical assistance, funding support, and education/training (under the regulatory provisions of the Clean Water Act) for local stormwater management.

The present paper develops an economic model to implement user pay financing of stormwater management in Ontario, using the RMOC as a case study. The paper also identifies institutional and legal issues for operationalizing this approach in Ontario. The remainder of this paper is organized into four main sections: a review of the experience with user pay stormwater financing in the United States and Canada; an introduction to stormwater management issues in the RMOC; program design and rate base considerations related to the provision of municipal stormwater services; and institutional and legal issues as they apply to the RMOC case study.

Experience of user pay

Public services, including stormwater management, are often provided with little consideration to the disparities between those who pay and those who use and benefit from the services. However, recent realities

in municipalities across Canada and elsewhere have forced a shift in thinking, including: the substantial costs in some areas for stormwater-related capital works; the perception of high tax burdens facing Canadians; reduced capital grant programs; uncertainty over future municipal institutions and fiscal health; and an increased awareness of concern for environmental issues. For example, Toronto, the largest city in Canada, recently embarked on a wholesale examination of how stormwater services are provided and funded. The investigation includes a detailed review of alternative funding mechanisms, with special attention focused on the user pay approach. Increasing numbers of municipalities across Canada face similar circumstances to Toronto, and are examining user pay financing programs, including programs for stormwater management.

Stormwater user pay financing represents a significant change from current financing mechanisms. In most Canadian municipalities, including Ottawa-Carleton, stormwater revenues are typically generated through a combination of property taxes, development or 'in lieu of' development charges, and through surcharges on water bills (Apogee Research, 1997). Under the user pay scheme, changes are levied on property owners for the use and benefit they derive from stormwater management infrastructure and programs. Most frequently, these charges are based on property-specific measures. Their attraction is that they can generate a predictable and sustainable revenue stream, can act as an incentive to adopt on-site best management practices, and if designed properly, can be a fair and equitable alternative to other financing mechanisms (Lindsey, 1990).

US experience

Over 100 US municipalities have implemented user pay approaches to stormwater management (Table 1). The main observations from a 1996 survey of stormwater utilities (Black and Veatch, 1996) are as follows:

- over 80% of US stormwater programs serve only metropolitan areas;
- approximately 66% of these are based on utilities, while 34% operate through public works departments;

Table 1. US Stormwater user pay programs

Characteristics of US stormwater programs	
Introduced	1972 and later
Jurisdiction Served	City or county
Population Served	5000–5000 000
Area Served	5–2000 km^2
Time to Develop	6 months to 6 years
Typical characteristics of US billing systems	
Revenues	User charges
Billing Method	Utility bills
Billing Frequency	Monthly
Rate Base	All properties
Rate Structures	Area based
Average monthly residential charges	
Eastern USA	US$1·00–$6·00
Western USA	US$1·50–$8·00
Average monthly revenues from charges	
Eastern USA	US$6000–700 000
Western USA	US$40 000–500 000

Information on US experience with user charges is from Apogee Research (1992, 1997), Black and Veatch (1996), and Benson (1992).

- per capita expenditures are less than US$10 annually for 36% of programs, from US$10 to US$19 annually for 45% of programs, and over US$19 for 19% of programs;
- monthly residential bills are in the US$1–4 range under 75% of programs (across all programs, the lowest monthly rates are US$0·24 per property per month and the highest rates US$10·98 per month); and
- nearly 60% of user charge programs are based on estimates of impervious property area with the remaining bills based on location, size of residences, water rates, etc.

Canadian experience

To date, only one major Canadian city has introduced a stormwater user charge program: the City of Regina, Saskatchewan. Prior to 1992, Regina financed stormwater services through flat fees per property, supplemented by monies from the general revenue fund. Recognizing the inherent shortcomings of this approach in terms of sustainability and fairness, user charges based on estimated total property area were introduced. Typical residential properties now pay approximately $3·50 per month, with larger properties paying more. Currently, revenues raised from user charges do not

cover the full costs of municipal stormwater-management programs. As such, the amount of the charges is being expanded, annually, to recover a greater portion of costs in subsequent years. This move reduces pressures on the general fund and other municipal accounts.

A number of other Canadian municipalities have examined the potential of user charges, but none has yet implemented them. A number of reasons likely explain this relative lack of experience:

- enabling legislation for user pay approaches is new, and is untested within Canada's legal system;
- the relatively limited introduction of other user charge programs to serve as 'models';
- stormwater services have traditionally been supplied 'free of charge', and many Canadians reject the idea of being 'charged for rain';
- the public is not yet fully aware of the financial and environmental benefits of shifting towards user pay programs.

Stormwater management in the RMOC

Ottawa-Carleton lies on the south banks of the Ottawa river, a tributary to the St Lawrence River (Figure 1). The Rideau River flows north to the Ottawa River through the Region, bisecting the land area. Within the RMOC boundaries, both rivers are impacted by agricultural, residential, commercial and light industrial land uses.

The RMOC population is about 700 000. Flows in the Ottawa and Rideau Rivers are approximately 2000 and 13 m^3/s, respectively. Eleven local municipalities within the RMOC have responsibility for stormwater management within their respective boundaries. The RMOC has responsibility for monitoring and reporting on the condition of surface waters within its boundaries. It also plays a co-ordination role in water quality initiatives which cross jurisdictions within the area.

The environmental impact of stormwater runoff within the RMOC that has the

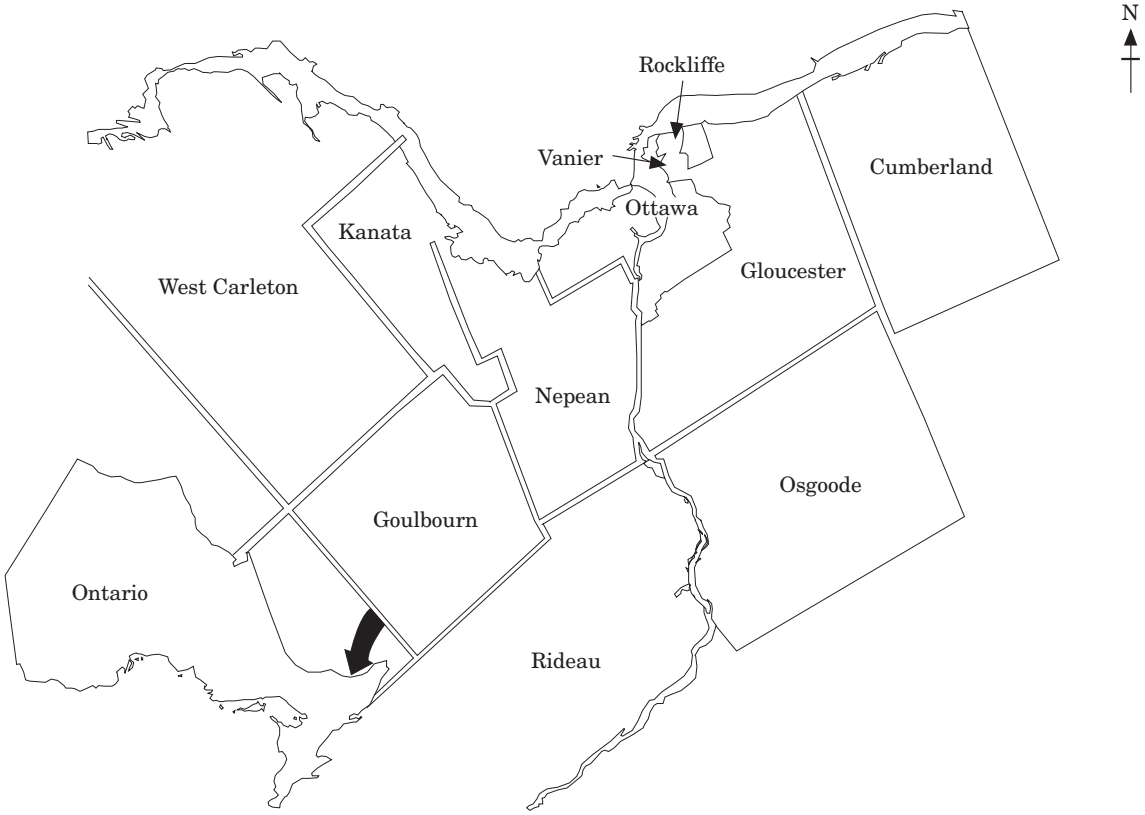

Figure 1. Regional municipality of Ottawa-Carleton.

highest public profile is the closure of urban beaches following significant rainfall events. Beach closures are required when the Ontario recreational water quality guideline is exceeded (when the geometric mean of a series of samples exceeds 100 *Escherichia coli* bacteria counts per 100 ml of water). Longer-term environmental impacts of stormwater runoff contribute to degradation of fish habitat, weed growth and algae blooms, bioaccumulation of toxicants, and loss of biodiversity in the aquatic and associated terrestrial species.

In 1992, the Rideau River Stormwater Management Study identified that $90 million in stormwater management infrastructure capital would be required to reduce bacterial loadings to the Rideau River to levels acceptable for water contact recreational activities (Gore and Storrie, 1992). The estimate assumes that the entire reach of the Rideau River within the RMOC should be 'swimable'. At that time, the focus was on the issue of faecal bacterial loadings to the Rideau. As part of sub-watershed studies conducted subsequent to the Rideau River study, the public expressed a concern for aquatic habitat preservation and restoration in addition to water contact health-related issues. A reassessment of the estimate of stormwater infrastructure to address environmental concerns and validation of the assumption that the entire river should be suitable for water contact recreation has yet to be conducted. Nevertheless, it is a safe assumption that stormwater infrastructure capital and operating costs will place a significant and increasing demand on local municipal revenues.

In conjunction with the infrastructure needs assessment, additional work is required to evaluate 'softer' measures to control quality issues. Public education, local area best management practices, source control for agricultural activities and improved municipal practices (such as street sweeping) may prove to be cost-effective investment options.

Currently, revenue sources for stormwater management vary slightly from one municipality to another. The newer or suburban municipalities have more development charge revenues than the older more central municipalities. Most municipalities within RMOC use a portion of the sewer surcharge revenues to fund stormwater operational costs. The sewer surcharge is calculated as a percentage of the central drinking water system volume consumed and is paid by residents as part of their water bill. Thus, the financial contribution of each resident to stormwater management is a function of their household purified water consumption as opposed to property size, imperviousness or runoff quality. Residents on private wells do not fund any portion of the sewer system or stormwater management costs in this respect.

The main advantage of the current rate-based system is that it is administratively established and politically acceptable. Issues of perceived equity discrepancies resulting from the rate-based system have not yet been raised by the public. Based on public reception to suggestions of tax increases by any level of government, any plan to move stormwater revenues from the existing rate base to another revenue generating system would need to be accompanied by an aggressive public information campaign, as used when considering charges for use of highways and other transportation services, access to health care services, entrance to government-operated parks, provision of commercial fishing licenses, and processing of passports, to name a few examples. However, if stormwater is to be addressed properly, increased revenues will need to be raised, irrespective of what tool is used (e.g. stormwater charges, property taxes).

The advantage of using the RMOC in this analysis is that their existing stormwater financing sources (development charges, general revenues, water bill surcharges and cash-in lieu of construction charges) are indicative of most municipalities in Ontario. Therefore, the results of the user pay model developed here are broadly applicable. Also, like many municipalities in Ontario, the required stormwater investment is significant and existing financing arrangements are inadequate.

Program design and rate model considerations

This section describes the program and economic foundations for implementing a user

pay stormwater program and presents a rate model to identify typical monthly stormwater user charges for property owners in the RMOC.

Program considerations

Revenue needs

The inadequacy of existing financing mechanisms is frequently cited as a main impetus for establishing a user pay system (Apogee Research, 1992). Clearly, the generation of sufficient revenues is conditional on an exhaustive estimation of all short and long-term (upgrade and maintenance) expected costs.

As mentioned previously, the Rideau River Stormwater Management Study (Gore and Storrie, 1992) estimated the need for $90 million in stormwater-management infrastructure capital costs to reduce faecal bacterial loadings to the Rideau River to levels acceptable for water contact recreational activities. If all of the recommended stormwater control options are implemented, RMOC's future annual stormwater expenditures (capital, operation and maintenance and program costs inclusive) are estimated to be about $14 million (Apogee Research, 1997). Current and future annual revenues, from existing sources, have been estimated at $5 million. We make the assumption in this paper that all incremental revenue requirements—the difference of $9 million per year—will be met by the new user pay program, although this variable can be adjusted in the rate model to accommodate any amount of revenue requirements. For example, to streamline the system and enhance public accountability, the entire $14 million could be generated through user charges by shifting the current $5 million from other revenue sources such as property taxes.

Rate base

The decision regarding which properties and land use types to include or exempt from stormwater user charges can be controversial. Local legal and political considerations in conjunction with enabling legislation usually dictate exemptions. For illustration purposes, a baseline and two additional scenarios are provided in the RMOC study; the baseline scenario offers no exemption for any land use type, and the remaining two scenarios exempt nine land-use categories.

Water quantity

At a minimum, a user pay program must be based on some measure of a property's contribution to the volume of stormwater runoff. In the RMOC case-study, different runoff coefficients are assigned to specific land-use categories.

Water quality

In the USA stormwater charges have largely been based on land use categories or absolute or relative amounts of impervious or semi-pervious area. Past approaches, which may correlate well with volumes of runoff, may not reflect loadings of different pollutants such as phosphorus, nitrogen, sediments, hydrocarbons, pathogens and toxics including metals. Local governments in the USA have limited experience in incorporating variables related to the quality of runoff in stormwater charges, though it is an area of ongoing research.

Where the quality of stormwater runoff has been considered in the USA, three approaches have typically been used: generalized loading equations for classes of industry; monitoring the quality of runoff from different land uses; and differentiation of charges by watershed according to the cost of capital improvements. In the spreadsheet rate model developed for the RMOC, any combination of water quality parameters can be included in rate calculations.

Best management practices

Economic incentives can be introduced by incorporating credits for BMPs in the design of user charges. If individuals introduce these BMPs, they are rewarded by paying reduced charges, and the implementing agency benefits since the BMPs can reduce the need for future investment in public stormwater infrastructure and programs. This can also give the public a greater sense of control

over their tax dollars, which is largely absent when funds are raised via property taxes.

In the USA, some local governments have incorporated credits against charges for onsite controls of volumes of runoff (i.e. quantity of runoff) through the use of BMPs. A 1988 survey of 25 US utilities found that 16 (64%) provided some type of credit for onsite management (Lindsey, 1990). In 1996, 26% of user pay programs included credits or incentives for onsite management (Black and Veatch, 1996).

Some US public works officials have been hesitant to approve credits because of the potential reduction in revenues and because of uncertainties associated with the effective operation and maintenance of BMPs. For instance, additional costs can be incurred by municipalities through periodic inspections to establish that BMPs do exist on individual properties, and remain operating effectively over time. The issue of whether to adopt credits is one that typically is debated whenever charges are considered.

In the RMOC case-study, BMPs were incorporated into the rate model at the land-use category level. The scope of the exercise (in addition to the limited documentation of the effectiveness of various BMPs) prohibited the matching of specific BMP options with the level of credit, but provision has been made in the model to vary this parameter. More work is required in this area to develop and verify rate coefficients for specific BMPs.

Rate model structure for the RMOC

A rate model was developed for the RMOC to gain insight into how required stormwater revenues would be allocated among various land uses, depending on their characteristics. Annual and monthly charges are generated using a spreadsheet algorithm. The following section describes the rate model developed for the RMOC and highlights variable inputs and model results for the baseline and two selected scenarios.

The key inputs to the model include:

- total required revenue;
- area for each land-use category;
- weight for each land-use category;
- quantity rate coefficients for each land-use category;
- quality rate coefficients for each land-use category;
- BMP credit rate coefficients for each land-use category;
- number of parcels for each land use category.

These seven pieces of information are sufficient to derive the equivalent runoff units (ERUs, described below) for each land-use category, and calculate annual and monthly charges. All parameters and data used in the spreadsheet model (Table 2) are described below.

Land-use categories

Existing documentation identified twenty-seven land use categories in the RMOC.

Area

Estimates of the total area of each land-use category were collected. Area is an important variable in the spreadsheet model, since charges to individual property owners are a function of property area. Areas can be changed to reflect changes in the zoning of land in the RMOC.

Weighting of land-use category

The weighting of land-use category is a continuous variable bounded by one and zero. A value of zero exempts a land-use category from charges; a value of one assigns the full user charge to a particular land-use category. A value between zero and one provides a category with special treatment by scaling charges appropriately.

Quantity rate coefficient

The quantity rate coefficient provides a measure of the quantity of stormwater runoff from different land-use categories. More impervious land (i.e. a parking lot) has a higher quantity rate coefficient than less impervious land (i.e. agricultural land). This variable allows higher charges to be levied against land-use categories which generate greater volumes of stormwater runoff.

Quality rate coefficients

Analogous to the quantity rate coefficients, the quality rate coefficients provide a measure of the quality of runoff from different land-use categories. Land-use categories generating lower-quality runoff in terms of each parameter are assigned higher-quality rate coefficients than land-use categories which generate less polluted runoff in terms of each parameter. These coefficients could also be varied by subwatershed if desired. The quality rate coefficient used in the RMOC watershed model is based on hypothetical phosphorus concentrations, although any number of other quality rate coefficients can be specified.

BMP rate coefficient

The BMP rate coefficient is a continuous variable bounded by one and zero. A value of one for a land use category is used when no BMPs have been introduced, and no BMP stormwater credits are given. Lower BMP rate coefficients reflect the introduction of BMPs, and are rewarded by lower charges. For instance, a BMP rate coefficient of 0·9 indicates that a land-use category is charged only 90% of what it would in the absence of BMPs. In the RMOC case-study, actual BMP coefficients are not as yet available, consequently, hypothetical values are used to illustrate how this variable can impact user charges.

ERUs

Equivalent runoff units (ERUs) provide estimates of the total environmental impact of stormwater runoff from different land-use categories. The ERUs are calculated as the product of the area, quantity rate coefficient, quality rate coefficients for each land use category. In this manner, they provide a comparable measure of the total impact of stormwater runoff from each land-use category. These environmental effects take into account both the quantity and quality of runoff.

Required revenues

Required revenues are the total amount of revenues required to be collected through charges—in this case $9 million annually. Required revenues from each land-use category are calculated as the product of a land-use category's share of total ERUs and the total amount of revenue which must be collected. For instance, if one land-use category contributes 10% of total ERUs, it is responsible for paying 10% of total required revenues.

Number of parcels

The number of parcels represents the number of distinct properties against which a charge is applied. With respect to a residence, a parcel represents a single property with a family dwelling on it, such as one house or one apartment unit. In other cases, a parcel is a distinct business unit, such as a store, restaurant or factory. One bill is to be applied (monthly, quarterly or annually) to each of the 338 568 parcels in the RMOC jurisdiction, (less those properties exempted from charges).

Annual charge

The annual charge represents the total payment per year, per parcel for financing stormwater management programs. The annual charge is calculated by dividing the required revenues for each land-use category by the number of parcels in each category.

Monthly charge

The monthly charge represents the monthly charge per parcel for financing stormwater-management programs. The monthly charge is the annual charge divided by 12.

Model results

Table 2 shows the spreadsheet model variables, land-use categories and rate calculation results for the baseline scenario. Under the baseline scenario, all land-use categories are included, one quantity and quality rate coefficient (phosphorus) is included, and no credits are granted for BMPs.

Table 2. RMOC stormwater financing model—baseline scenario

Land-use category	Area (ha)	Weighting of land-use Category	Quantity coefficient	First Quality coeffective	BMP credit rate coefficient	Equivalent runoff units	Required revenues ($)	Number of parcels	Annual charge per parcel ($)	Monthly charge per parcel ($)	Revenues collected ($)
Agricultural	340·84	1·00	0·04	0·44	1·00	0·24	856·96	302·00	2·84	0·24	856·96
Commercial, neighbourhood	200·77	1·00	0·70	0·68	1·00	3·82	13 652·29	321·00	42·53	3·54	13 652·29
Commercial other	462·82	1·00	0·60	0·68	1·00	7·54	26 975·66	1 901·00	14·19	1·18	26 975·66
Commercial regional	541·00	1·00	0·80	0·68	1·00	11·76	42 043·22	55·00	764·42	63·70	42 043·22
Communication	9·22	1·00	0·40	0·60	1·00	0·09	316·11	8·00	39·51	3·29	316·11
Hospital	136·34	1·00	0·70	0·60	1·00	2·29	8180·36	31·00	263·88	21·99	8180·36
Industrial	1011·95	1·00	0·70	0·73	1·00	20·66	73 871·98	519·00	142·34	11·86	73 871·98
Industrial mall	153·01	1·00	0·80	0·73	1·00	3·57	12 765·34	18·00	709·19	59·10	12 765·34
Institution	570·75	1·00	0·15	0·60	1·00	2·05	7338·18	303·00	24·22	2·02	7338·18
Maintained open space	615·21	1·00	0·04	0·36	1·00	0·35	1265·57	323·00	3·92	0·33	1265·57
Mobile home	7·74	1·00	0·45	0·61	1·00	0·08	303·52	183·00	1·66	0·14	303·52
Office	1439·93	1·00	0·85	0·63	1·00	30·81	110 154·10	1370·00	80·40	6·70	110 154·10
Recreation	2017·65	1·00	0·40	0·21	1·00	6·77	24 211·68	1846·00	13·12	1·09	24 211·68
Residential, high density	738·34	1·00	0·60	0·62	1·00	10·97	39 237·30	82 062·00	0·48	0·04	39 237·30
Residential, low density	10 135·53	1·00	0·40	0·40	1·00	64·79	231 668·11	163 011·00	1·42	0·12	231 668·11
Residential medium density	2335·86	1·00	0·50	0·52	1·00	24·27	86 760·08	84 794·00	1·02	0·09	86 760·08
School, elementary	424·37	1·00	0·60	0·58	1·00	5·90	21 097·15	200·00	105·49	8·79	21 097·15
School, high	321·40	1·00	0·60	0·58	1·00	4·47	15 978·09	389·00	41·07	3·42	15 978·09
Street	1314·84	1·00	0·80	0·07	1·00	2·94	10 518·67	55·00	191·25	15·94	10 518·67
Transportation	335·00	1·00	0·95	0·07	1·00	0·89	3182·48	82·00	38·81	3·23	3182·48
Unassigned	245 395·73	1·00	0·50	0·47	1·00	2304·07	8 238 244·29	168·00	49 037·17	4086·43	8 238 244·29
Under construction	42·14	1·00	0·40	0·79	1·00	0·53	1902·31	42·00	45·29	3·77	1902·31
University	159·14	1·00	0·70	0·50	1·00	2·23	7956·96	15·00	530·46	44·21	7956·96
Utilities	246·83	1·00	0·50	0·60	1·00	2·96	10 578·38	83·00	127·45	10·62	10 578·38
Vacant	1326·08	1·00	0·10	0·37	1·00	1·96	7009·25	357·00	19·63	1·64	7009·25
Vacant building	16·33	1·00	0·40	0·52	1·00	0·14	485·23	95·00	5·11	0·43	485·23
Water	89·36	1·00	0·50	0·54	1·00	0·96	3446·73	35·00	98·48	8·21	3446·73
Totals	270 388·18	27·00	14·18	14·18	27·00	2517·12	9 000 000·00	338 568·00	52 345·35	4362·11	9 000 000·00
Minimum	7·74	1·00	0·04	0·07	1·00	0·08	303·52	8·00	0·48	0·04	303·52
Mean	10 014·38	1·00	0·53	0·53	1·00	93·23	333 333·33	12 539·56	1938·72	2·22	333 333·33
Maximum	245 395·73	1·00	0·95	0·79	1·00	2304·07	8 238 244·29	163 011·00	49 037·17	4086·43	8 238 244·29

Any number of additional stormwater quality coefficients can be added to the model.

The baseline scenario results in mean monthly charges of $2·22. Parcels on 16 land-use categories pay monthly charges of less than $5·00 and all residential properties pay less than 15 per month. The lowest monthly charges are allocated to 'high-density residential' parcels ($0·04 per month) and the highest monthly charges are allocated to 'unassigned' land parcels ($4086·43 per month) due, in part, to their exceptionally large size.

The 'unassigned' category is land within the RMOC boundary which is not within the urban envelope, as identified in the Region's Official Plan. These lands are principally rural in nature, characterized by natural features such as woodlands and wetlands. This category, among others, is excluded from the remaining two scenarios. The results of the baseline and two rate scenarios are compared in Table 3.

Table 3 outlines the monthly charges per parcel under the three hypothetical scenarios developed for the RMOC case study. Exempting 'unassigned' lands, in addition to other land-use categories from charges in scenarios 1 and 2, lead to increases, sometimes large, in monthly payments for the remaining land-use categories.

The inclusion of credits for BMPs further affects rates, depending on the nature of the practice and the associated credit. For illustrative purposes, scenario 2 assigns hypothetical BMP rate coefficients for different land uses (all other model variables remain unchanged). 'Agricultural' land use, for example, was allocated a BMP rate coefficient of 0·6, indicating that this land-use category is

Table 3. Scenario results overview of monthly charges ($) per parcel

Land-use category	Baseline scenario[a]	RMOC	
		Scenario 1[b]	Scenario 2[c]
Agriculture	$0·24	$3·18 (0·6)	$2·21
Commercial—Neighbourhood	$3·54	$47·68 (0·7)	$38·65
Commercial—other	$1·18	$15·91 (0·6)	$11·05
Commercial—regional	$64·70	$856·92 (0·5)	$496·24
Communication	$3·29	$44·30 (0·9)	$46·17
Hospital	$21·99	$0·00 (0·8)	$0·00
Industrial	$11·86	$159·56 (0·7)	$129·36
Industrial mall	$59·10	$795·00 (0·6)	$552·46
Institution	$2·02	$27·15 (0·9)	$28·30
Maintained open space	$0·33	$0·00 (0·9)	$0·00
Mobile home	$0·14	$1·86 (0·9)	$1·94
Office	$6·70	$90·13 (0·8)	$83·51
Recreation	$1·09	$0·00 (0·8)	$0·00
Residential—high density	$0·04	$0·54 (1·0)	$0·62
Residential—low density	$0·12	$1·59 (1·0)	$1·85
Residential—medium density	$0·09	$1·15 (1·0)	$1·33
School—elementary	$8·79	$0·00 (0·9)	$0·00
School—high	$3·42	$0·00 (0·9)	$0·00
Street	$15·94	$214·39 (0·6)	$148·98
Transportation	$3·23	$43·51 (0·8)	$40·31
Unassigned	$4086·43	$0·00 (1·0)	$0·00
Under construction	$3·77	$50·77 (0·9)	$52·93
University	$44·21	$0·00 (0·9)	$0·00
Utilities	$10·62	$0·00 (0·9)	$0·00
Vacant	$1·64	$22·01 (1·0)	$25·49
Vacant building	$0·43	$5·73 (1·0)	$6·63
Water	$8·21	$0·00 (1·0)	$0·00

[a]Key assumptions: (1) all land-use categories included in rate base; (2) one quantity and quality rate coefficient included; (3) no credits are granted for BMPs.
[b]Key assumptions: (1) hospital, open space, recreation, education, unassigned utility land uses excluded from rate base; (2) one quantity and quality rate coefficient included; (3) no credits are granted for BMPs.
[c]Key assumptions: (1) hospital, open space, recreation, education, unassigned and utility land uses excluded from rate base; (2) one quantity quality rate coefficient included; (3) credits are granted for BMPs (in parentheses).

charged only 60% of what it would be in the absence of BMPs, explaining the reduction in monthly fees in scenario 2.

On the whole, monthly charges to residential properties are comparable to (if not lower than) charges of approximately US$3·00 per month which have typically been levied in the USA. Monthly charges to non-residential properties are similar to, and in some cases lower than those in the USA. Regional commercial centres might be charged US$50–500 per month depending on the rate structure. Similar commercial centres would pay approximately US$225 in Cincinnati, US$350 in Louisville, and US$525 in Daytona Beach (Apogee Research, 1992).

Institutional and legal issues in Ontario

Institutional issues

It is common practice in many US states to establish a separate stormwater utility to raise revenues, implement fees, and undertake capital investments, operations and maintenance (Black and Veatch, 1996; Apogee Research, 1992). This stormwater utility concept offers several advantages. Stormwater utilities provide a secure revenue source for local stormwater management activities, since revenues are dedicated and are unavailable to competing uses. Furthermore, because funds are generated under user pay schemes, revenues can be more stable and predictable than other sources, supporting better long-term stormwater-management planning and implementation.

However, a user pay stormwater program can be administered by existing water and wastewater utilities or within existing public works or environment departments. The choice will primarily be a function of existing institutions, the magnitude of required capital upgrades and the costs of change. Billing, for example, is typically combined with other utility bills such as water, waste water or hydroelectricity. There is, of course, the potential for higher costs to local governments of adopting user pay approaches. These potential costs can be the result of program development, financial budgeting, other one-off set-up costs, data collection and validation activities, as well as on-going billing and administrative expenses.

Little evidence of the typical magnitudes of these costs exists, since they are often incurred at different times and sometimes by different groups. Anecdotal evidence from the USA suggests that these costs are typically small, perhaps in the range of 5% of capital costs annually (Apogee Research, 1992). However, since the existing resources available to local governments and the type and size of capital expenditures vary among stormwater programs, there is a great deal of variability.

In particular, a major determinant of these costs could be for the collection, preparation and validation of data describing the characteristics of individual properties. In municipalities with relatively little data, these costs may be large. Other municipalities may incur no costs, if these data are available. Similar comparisons can be drawn based on existing administrative arrangements, billing capabilities, financial data and analysis services, etc. Furthermore, the distribution of, and ability to absorb, these costs will vary between departments and agencies, emphasizing the need for a cooperative approach to stormwater management within local governments.

To understand better the potential financial effects of user charges on budgeting and planning, a survey of the 11 municipalities comprising the RMOC was undertaken. The survey, conducted by telephone with senior municipal financial officers, aimed to uncover the institutional changes, if any, necessary to facilitate a user charge program. Most officers surveyed felt that financial budgeting and planning impacts on the regional municipalities would be small to negligible, given the existing resources devoted to these activities. However, concern was raised that a user charge program might alter the distribution of stormwater-management costs and revenues among the 11 RMOC constituent municipalities if a region-wide program were implemented.

Legal authority

A review of Ontario statutes suggests that the main piece of legislation that provides

the authority for municipalities to implement user charges for stormwater management comes from the Municipal Act. Section 221(2) authorizes the establishment of sewer rates (including drainage and stormwater) upon owners who 'derive or may derive' a benefit from a regional work or works. Section 221(6) further specifies that a rate shall be calculated by any number of methods (such as frontage, hectarage, mill rates, a fixed rate per property) including 'any other method Council considers fair'. Section 221(22) further allows Council to establish a rate structure that reflects different classes of users, nature, volume and frequency of use and all other relevant matters to ensure that rates are imposed on a fair basis.

The Regional Municipalities Act is similar. Section 86(1) and 86(3) indicate that the region has the power to impose rates for the establishment, construction, maintenance, operation, extension, improvement and financing of any regional works.

Therefore, a preliminary assessment suggests that existing statutes provide the enabling legislation for stormwater user charges, and that there appears to be no major legal or regulatory barrier to implementing these charges. However, local by-laws would be required to institute user charges, and it is here where public and political barriers could be encountered.

Local governments in the USA that have established user charge systems have occasionally experienced legal challenges. Many of the challenges have come from non-profit-making organizations such as hospitals and churches that have been exempt from property taxes and other taxes collected as part of general revenues. Individuals and corporations have also brought suits because of new charges. Of the 15 reported legal challenges, nine have upheld charges, four struct down charges and two decisions are pending (Black and Veatch, 1996).

The experience here suggests that charges based solely on some indicator of runoff volumes, such as land-use classification, are more susceptible to challenges than charges based on measurements of property characteristics, because of the variability in runoff from parcels, even among parcels with similar commercial or industrial uses.

Conclusion and discussion

As capital grant programs decline in Ontario, municipalities will continue to pursue other mechanisms for generating sustainable revenues for financing stormwater management. A review of US experiences indicates that the user pay concept represents one viable option. A preliminary assessment of RMOC indicates that stormwater user charges are technically feasible and rates would be comparable with those levied in the USA. Also, there appears to be no legal or regulatory barriers to implementing user charges, and such programs can be administered by existing water and wastewater utilities, public works or environment departments.

Based on a review of US experience and site-specific analysis in the RMOC, a number of general observations can be made. First, the attraction to stormwater user charges is their equitable and sustainable revenue stream. If designed properly, they can be a fair and equitable alternative to other financing mechanisms. The rate of payment is better linked with the burden the landowner puts on the stormwater system and/or the benefits derived from upgrades. Also, stormwater charges that include BMPs can give the public and private sectors a certain degree of control over how much they are charged and this opportunity rarely exists under existing financing mechanisms, especially property taxes.

First, user charges can generate a predictable and sustainable revenue stream to finance stormwater management. Consequently, if fees are indeed dedicated to stormwater management, the associated water quality benefits and economic benefits of reduced flood damages are more likely to be realized.

Second, stormwater user charges can be consistent with the concept of sustainable development since they can act as an incentive for landowners to reduce the quantity and/or improve the quality of their stormwater runoff. However, the reality is that relatively few existing programs have rate structures that include water quality considerations and incentives for BMPs. More work is required in this area to build in incentives for improved behavioural practices, since the ability to control what one pays is a key

underlying difference between user charges and taxes.

Third, in most cases, stormwater user charge programs can be initiated using existing data. This may be as simple as charging on the basis of property area and billing through existing hydroelectric or water bills. The basis for charges could be refined over time to include impervious property area, stormwater quality, and/or the implementation of BMPs. Ultimately, stormwater user charge programs should be designed to balance technical rigour with administrative practicality.

Fourth, user charge programs are flexible and can be used in conjunction with other revenue mechanisms such as development or in lieu of construction fees. Municipalities also have flexibility in selecting among numerous design options including program phase-in, which land uses to include, whether to introduce special assessments, and how to bill ratepayers. All of these considerations can be changed as the program evolves. This flexibility can help improve the acceptability of the program to the public and meet the financial needs of individual municipalities.

Last, public acceptability is often the overriding factor that determines whether a user pay approach is implemented. Also, the introduction of region-wide user charge programs can be contentious since costs and revenues will need to be shared among a number of constituent municipalities. As such, municipalities should consider carefully the opportunities for and implications of different public awareness and support initiatives. In particular, these initiatives should identify the need for stormwater management, the options for financing, and the benefits of the user pay approach.

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References

Apogee Research (1997). *Financing Options for Stormwater Quantity and Quality Management in the RMOC*. Two Reports. Prepared for the Regional Municipality of Ottawa-Carleton, Environment Canada and Ontario Ministry of Environment and Energy. April.

Apogee Research (1992). *Storm Water Utilities: Innovative Financing for Storm Water Management*. Prepared for Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, Washington.

Bay of Quinte RAP (1993). 'Bay of Quinte Remedial Action Plan, Stage 2 Report—Time to Act.' Prepared by Bay of Quinte RAP Coordinating Committee. September.

Benson, R. B. (1992). 'Financing Stormwater Utility User Fees—Where Are We Now?' *Water Environment and Technology* September, 59–62.

Black and Veatch (1996). 'Survey '96: A Current Review of Stormwater Management Utilities' Presented at the WEFTEC '96, Dallas, Texas, October 5–9, 1996.

CH2M Hill Engineering Ltd. (1993). *Urban Runoff Control Costs at Seventeen Ontario RAP Sites*. Prepared for Environment Canada. Waterloo, Ontario, October.

European Commission. (1998). *Freshwater: A Challenge for Research and Innovation*. Environment-Water Task Force.

Gore and Storrie. (1992). *Rideau River Stormwater Management Study*. Vol. 1. Prepared for the Regional Municipality of Ottawa-Carleton.

Hamilton Harbour RAP. (1992). 'Remedial Action Plan for Hamilton Harbour—Goals, Options and Recommendations' Volume 2, Main Report. RAP Stage 2. November.

Hickling, Anderson and Resource Futures International. (1992). *Potential Funding Mechanisms for implementation of Remedial Action Plans and their Impact on Users, Beneficiaries, Polluters and Society*. Prepared for Ontario Ministry of the Environment by Hickling Corporation, R.V. Anderson Ltd. and Resource Futures International, November.

Jones, J. E. and Jones, D. E. (1984). Essential urban detention ponding considerations. *Journal of Water Planning and Management* **110**, 418–433.

Lawrence, A. I., Marsalek, J., Ellis, J. B. and Urbonas, B. (1996). Stormwater detention and best management practices. *Journal of Hydraulic Research* **34**, 799–814.

Lindsey, G. (1990). Charges for urban runoff: issues in implementation. *Water Resources Bulletin* **26**, 117–125.

Marsalek, J. and Kok, S (Eds.) (1997). Great Lakes 2000 Cleanup Fund Program: stormwater management and control of combined sewer overflows. *Water Quality Research Journal of Canada, Special Issue*, **32**.

OMOEE (1994). *Stormwater Management Practices Planning and Design Manual*. Ontario: Ministry of Environment and Energy.