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RESEARCH REPORT

DUAL-FLUSH TOILET PROJECT

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Dual-flush Toilet Project

Canada Mortgage and Housing Corporation

September 2002

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Veritec Consulting Inc.

In association with

Canada Mortgage and Housing Corporation
Capital Regional District Water Department, Victoria, B.C.
Greater Vancouver Regional District, B.C.
City of Calgary Waterworks, Alberta
Engineering and Works Department, City of Regina, Saskatchewan
Manitoba Conservation, Winnipeg, Manitoba
Planning and Public Works Department, Halton Region, Ontario
Water Services Division, Regional Municipality of Waterloo, Ontario
Region of Durham, Water Efficient Durham, Whitby, Ontario
Water and Wastewater Services Division, Water Efficiency Section, City of Toronto, Ontario
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Department of Engineering and Planning, City of St. John's, Newfoundland and Labrador

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Cette publication est aussi disponible en français sous le titre : Étude sur les toilettes à double chasse, 63043

This research project was (partially) funded by Canada Mortgage and Housing Corporation (CMHC). The contents, views and editorial quality of this report are the responsibility of the author(s) and CMHC accepts no responsibility for them or any consequences arising from the reader's use of the information, materials and techniques described herein.

National Library of Canada cataloguing in publication data

Main entry under title :

Dual-flush toilet project

Issued also in French under title: Étude sur les toilettes à double chasse.

ISBN 0-662-33050-1

Cat. no. NH15-397/2002E

1. Toilets - Environmental aspects - Canada—Public opinion.

2. Water conservation.

I. Veritec Consulting Inc.

II. Canada Mortgage and Housing Corporation.

TH6498.D82 2002

696'.182

C2002-980277-6

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Printed in Canada

Produced by CMHC

Executive Summary

Canada Mortgage and Housing Corporation (CMHC) led a project involving 13 agencies/ participants in 7 Canadian provinces to evaluate dual-flush toilet technology regarding:

1. public perception, acceptance, and satisfaction;
2. water savings compared to 6-L or 13-L toilets; and
3. cost-effectiveness compared to 6-L or 13-L toilets.

Dual-flush toilets utilize 2 flush options: a 6-L full flush for solids and a 3-L flush for liquid waste.

A small number of 6-L toilet models were installed as part of this project to serve as a comparison to the dual-flush toilet: 6 TOTO *Drakes*, 4 Niagara *flapperless*, 2 Vitra *Wellingtons*, and 1 Western Pottery *Aris*.

Public Perception, Acceptance, and Satisfaction with Toilets

A total of 158 customer satisfaction surveys were completed as part of this project. The following list summarizes the survey results.

- All of the toilets included in the program received average ratings ranging between 7.2 and 7.9 out of 10 (the Caroma dual-flush toilet scored 7.8) [see Appendix 1 Participant Survey, Customer Satisfaction Survey, #7].
- Participants stated that they were willing to pay an additional cost for the toilets included in the program—approximately \$25 more for the Niagara *Flapperless* and the Western Potteries *Aris*, and \$45 more for the Caroma dual-flush and TOTO *Drake*.

- 85 per cent of all the toilets in the program had average ratings of **Good** or **Satisfactory** on appearance, clearing solids and clearing liquids.
- 66 per cent of participants said they would definitely recommend dual-flush toilets to others.
- 60 per cent said they definitely liked the dual-flush toilet better than their existing toilet.
- 100 per cent of the responses stated that they liked the dual-flush technology.
- Bowl streaking was the largest single complaint about the Caroma dual-flush toilet.

Water Savings

The dual-flush toilets in the program reduced existing flush volumes by about 68 per cent when installed in single-family homes [average flush volumes of existing toilets is 14.7 L], 56 per cent when installed in office washrooms [average flush volumes of existing toilets is 14.5 L], and 52 per cent when installed in the participating coffee shop [the existing toilet flushing with 10.9 L]. The actual volume of water saved is dependant upon how often the toilet is flushed. Less water savings are achieved if the dual-flush toilet is used in a facility equipped with urinals.

The data collected as part of this program indicated that dual-flush toilets save approximately 26 per cent more water than conventional 6-L toilets when used to replace existing non-efficient toilets (in this study non-efficient toilets averaged 14.1 L).

Cost-Effectiveness of Dual-flush Toilets

The cost-effectiveness of a toilet reflects the relationship between the cost of the toilet and the associated water savings. However, toilets may be selected for a number of reasons including design, water savings, performance, cost, colour, etc. Cost-effectiveness calculations consider only the cost and flush volume of a toilet, and the two factors are not related, for example, more expensive toilets do not flush with less water.

Although the Caroma *Caravelle* and *Tasman* toilets appear to be as cost-effective as other “high-end” toilets, virtually no “high-end” toilet is as cost-effective as an entry level or “commodity” toilet. This result was not unexpected, for example, maximizing water savings is not generally the primary consideration for customers purchasing “high-end” toilets.

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Section I - Introduction

As the strain on municipal water systems continues to increase, demand-side management (DSM) has quickly been recognized as being a cost-effective alternative “source” of water to expanding supply infrastructure (supply-side management or SM). Effectively implementing water efficiency measures can extend the life of both water and wastewater systems by allowing larger populations to be serviced with existing infrastructure and, thereby, ultimately reducing the costs to customers.

Currently, 6-L toilets are mandated for new residential construction in only a handful of locations within Canada. The 1996 Ontario Building Code mandates 6-L toilets province wide. A similar regulation exists for the city of Vancouver as part of their 1994 Building By-law. The same 6-L (1.6-gallons) flush requirement is mandated across the entire USA.

An even more innovative approach is the dual-flush technology which provides a choice of 2 different flush volumes (for example, 3-L and 6-L) depending on use. Dual-flush technology is mandated in Australia and Singapore and though 1 dual-flush toilet is CSA approved the technology is still relatively unknown in Canada.

Canada Mortgage and Housing Corporation (CMHC) led a national project involving 13 agencies/participants in 7 provinces

to evaluate dual-flush toilet technology in Canada with regards to:

1. public perception, acceptance, and satisfaction with dual-flush toilets;
2. system performance and water consumption compared to 6-L or 13-L toilets; and
3. cost-effectiveness compared to 6-L or 13-L toilets.

Dual-flush Toilets

At the time of this project only dual-flush toilets from Caroma Industries Ltd. were CSA approved in Canada. These were the only dual-flush toilets used for the project as the goal here was to evaluate certified dual-flush technology rather than to identify problems with unproven makes and models.

Theoretically, a toilet using 3 L for liquid waste and 6 L for solid waste would flush with an average of about 3.8 L¹—a savings of almost 37 per cent more than the design flush volume of a standard 6-L toilet. Data collected as part of this project was analyzed to determine *actual* savings.



Comparison with other Ultra Low-Flow (ULF) Toilets

Caroma dual-flush toilets use a “washdown” flush action vs. the more common (in North America) siphonic flush action. In washdown toilets the waste is “pushed” out of the bowl by the flush, while in siphonic toilets the waste is “pulled” or siphoned out of the bowl by the flush.

A small number of other 6-L toilet models were also installed as part of this project to serve as a comparison in customer satisfaction. These additional models included 6 TOTO *Drakes*, 4 Niagara *Flapperless*, 2 Vitra *Wellingtons*², and 1 Western Pottery *Aris*.

The *Aris* toilet flushes in a conventional manner, while the *Flapperless* and *Drake* models both incorporate innovative flushing mechanisms.

- The Niagara *Flapperless* uses a tipping bucket rather than a flapper to provide water for flushing. The bucket is situated near the top of the toilet tank and is designed to hold a volume of water only slightly greater than 6 L. When the handle is depressed, the bucket “tips” and the water is discharged into to bowl.
- The TOTO *Drake* uses a proprietary 3-inch flapper. The toilet, therefore, flushes approximately twice as quickly as toilets using a standard 2-inch flapper. TOTO calls this system of flushing the GRAVITY MAX system.

Footnotes

- ¹ Based on a ratio of approximately 3 “short” flushes for every “long” flush.
- ² The Vitra toilets were added to the project to replace two toilets that were broken during shipping. No data was collected regarding the Vitra toilets.

Section 2 - Methodology

Site Selection

A total of 70 toilets were installed as part of this project—56 Caroma dual-flush toilets³, 9 TOTO *Drakes*, 4 Niagara *Flapperless*, and 1 Western Pottery *Aris*⁴. Ten Caroma toilets were installed in single-family homes, 15 in a single multi-unit apartment building, and 31 in ICI sites (offices, golf courses, schools, coffee shop). The 9 *Drakes* and the 4 *Flapperless* were all installed in ICI sites, while the single *Aris* was installed in Durham’s municipal office. As such, parts of the data analysis have been delineated to reflect the various sectors involved.

The following list identifies the 13 participants in the program:

- Calgary, Alberta
- Durham Region, Ontario
- GVRD, British Columbia
- Halton Region, Ontario
- Minto Property Management, Ontario
- Québec City, Quebec
- Regina, Saskatchewan
- St. Johns, Newfoundland
- Toronto, Ontario
- Vernon, British Columbia
- Victoria, British Columbia
- Waterloo, Ontario
- Manitoba Conservation, Manitoba

Participant details and site locations are attached as Appendix 4.

Survey: public perception

Customer Satisfaction Surveys were provided at each location in order to gauge public perception of the dual-flush toilet technology (see Appendix 1). Survey Respondents included end users as well as lead contacts for each site. Some sites put up signs explaining the dual-flush technology.

Flush volume and frequency: comparison with existing toilets

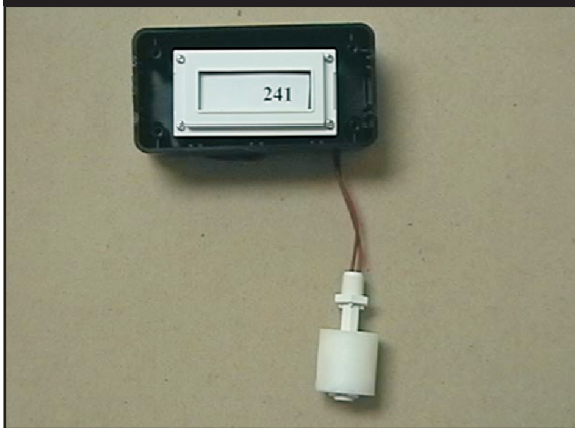
The relative effectiveness of the dual-flush toilet was determined by physically measuring the two parameters that contribute to the total water demands related to toilet flushing:

1. Flush Volume—flush volumes of the existing toilets and “long” and “short” flush volumes of the dual-flush toilets were measured using an inline water meter (Figure 2). Note that the meter was only installed temporarily to determine the flush volumes of existing and replacement toilets and was removed prior to the toilets being used by participants.
2. Number of Flushes—electronic flush counters were installed in the existing toilets and 2 counters were installed in the dual-flush toilets to count both “long” and “short” flushes (Figure 3). A significant increase in the total number of flushes at any site would indicate an increased incidence of “double-flushing”. The monitoring program was to include 1 month of “pre-monitoring” existing toilet and between 1 and 2 months of “post-monitoring” replacement toilet (depending upon the type of site).

Figure 2: Measuring Flush Volumes



Figure 3: Electronic Flush Counter



Cost-effectiveness of Dual-flush Toilets vs. 6-L or 13-L Toilets

The relative cost-effectiveness was determined by comparing the associated water savings with the relative costs of both dual-flush and conventional toilets (6-L and 13-L models).

Footnotes

- ³ Fifteen of the dual-flush toilets were installed in a single low-rise apartment building in Toronto.
- ⁴ It is expected that data from the 56 dual-flush installation sites is accurate to within approximately ± 13 per cent with a 95 per cent confidence level. These sites were responsible for greater than 400 flushes per day.

Section 3 - Project Results

Survey: public perception

A total of 158 surveys were submitted as part of this project, as follows:

- Caroma 121 surveys
- TOTO 11 surveys
- Niagara 13 surveys
- Western Pottery 13 surveys

The results of the customer satisfaction surveys are summarized in the following tables. Charts illustrating comprehensive survey results are presented in Appendix 2.

Toilet	Overall Average Rating out of 10	Additional cost participants would be willing to pay for toilet
Caroma	7.8	\$46
TOTO	7.6	\$45
Niagara	7.9	\$25
Western Pottery	7.2	\$23

Toilet	Appearance			Clear Solids			Clear Liquids			Recommend			Like vs. Existing toilet		
	Good, %	Average, %	Poor, %	Good, %	Satisfactory, %	Poor, %	Good, %	Satisfactory, %	Poor, %	Yes, %	Perhaps, %	No, %	More, %	Same, %	Less, %
Caroma	64	34	2	61	27	12	77	16	7	66	26	8	60	28	12
TOTO	64	36	0	56	33	11	91	9	0	56	36	9	25	50	25
Niagara	38	62	0	67	33	0	75	25	0	62	38	0	27	73	0
Western Pottery	23	69	8	54	31	15	77	15	8	38	38	24	28	36	36

Additional Observations

- During the project period, a total of approximately 15,200 “long” flushes and 24,000 “short” flushes were recorded for the dual-flush toilets, or a ratio of almost 1.6 “short” flushes for every “long” flush.
- While 88 per cent of respondents stated they liked the Caroma the same or more than their existing toilet (Table 2) 100 per cent of the respondents stated that they liked the dual-flush option.
- 82 per cent of respondents gave the Caroma a rating of 7 or more out of 10 based on overall satisfaction.
- The Second Cup restaurant stated that their existing toilet (in the patron’s restroom) required plunging almost every day and that it frequently overflowed. They had no occurrences with plugging, plunging, or overflowing with the dual-flush toilet and they were extremely happy with its performance.

- The 15-unit apartment building installed efficient showerheads and aerators as well as dual-flush toilets and reduced its water demands by 360 L per suite per day (slightly more than 50 per cent). Savings directly related to toilet installation equate to 124 L per suite per day (approximately 35 per cent of the total savings). Savings related to reduced toilet leakage equate to 176 L per suite per day. (See Appendix 3 for complete details savings achieved at this site.)

Program participants expressed a range of satisfaction with the Caroma dual-flush toilets. While most comments were very positive, others expressed a strong dislike of the toilet. Significant bowl “streaking” was the most common complaint, even among participants that expressed support for the dual flush technology.

Water Savings Compared to Existing Toilets

The dual-flush toilets in the program reduced existing flush volumes by about 68 per cent when installed in single-family homes, 56 per cent when installed in office washrooms, and 52 per cent when installed in the participating coffee shop (Table 5). The actual volume of water saved is dependant upon how often the toilet is flushed. In this program total water savings associated with toilet flushing averaged 92 L/day for single family homes, 155 L/day for the office washrooms and 732 L/per day for the coffee shop. Total water savings will vary depending on frequency of use, for example, the coffee shop registered an average of 143 flushes per day.

The data collected as part of this program indicated that dual-flush toilets save approximately 26 per cent more water than conventional 6-L toilets when used to replace existing non-efficient toilets.

The study found that a range of flush volumes existed for all toilets used in the program. The existing toilets tended to be the older 13- and 20-L styles with a flush volume range of 6.2 to 29.4 L. The Caroma dual-flush toilets “long” flush volumes ranged from 5.0 to 7.2 L and the “short” flush volumes ranged from 2.5 to 4.3 L. The average flush volumes of each type of toilet (Table 3) are used later in calculations to determine water savings (Table 6).

The Toto 6-L flush volumes ranged from 5.4 to 6.6 L. The Niagara 6-L flush volumes ranged from 5.6 to 6.7 L. The single Western Pottery *Aris* flushed with 7.5 L and it was later learned that a large number of *Aris* toilets were shipped with the wrong flapper—causing the toilet to flush with too great a volume. A flush volume of 7.5 L therefore, may not be indicative of what could be expected in further tests of *Aris* toilets.

Toilet	Flush Volume, L
Existing Toilets	14.1
Caroma	3.4 “short”, 6.0 “long”
TOTO	6.1
Niagara	6.2
Western Pottery	7.5

Table 4: Changes in Average Flushes per Day

Site	Flushes/Day Pre	Flushes/Day Post	Changes in Flushes/Day ⁶
Caroma	16.6	10.6 “short”, 6.8 “long”	5% increase
TOTO	14.0	12.0	14% decrease
Niagara	13.0	7.9	39% decrease
Western Pottery	10.9	15.0	37% increase

Note: Western Pottery toilet was not functioning properly during some of the pre monitoring period which may explain the increase in flush frequency.

Table 5: Comparison of Caroma Savings in Different Sectors⁷

Sector	“Short” Flushes per Day	“Long” Flushes per Day	Ratio “Short” to “Long”	Increase in Flushes per day	Savings, %
Single-Family	9.0	4.1	1.6 to 1	5%	68%
Office (overall)	7.9	4.6	1.7 to 1	6%	56%
Office (female)	12.8	4.8	2.7 to 1	-1%	64%
Office (male)	4.5	4.2	1.1 to 1	12%	50%
Coffee Shop	82	61	1.3 to 1	12%	52%

While data from the *Office (female)* sector shows that there are approximately 2.7 “short” flushes to every 1 “long” flush, data from the *Office (male)* sector indicates that the number of “short” and “long” flushes are similar. This result suggests that less water savings should be expected if dual-flush toilets are installed in washrooms where urinals are available (Table 5).

The ratio of “short” to “long” flushes was also relatively low at the Coffee Shop. This may be more related to customer curiosity about the toilet than to flush performance (for example, a changing customer base may continue to be curious about the novelty of a dual-flush toilet and experiment with the different flushes).

The effective flush volume of a dual-flush toilet (for example, the total volume of water used divided by the total number of flushes, both “long” and “short”) depends upon the location where it is installed. The effective flush volume decreases as the ratio of “short” flushes to “long” flushes increases and vice versa. The effective flush volume identified in this project was 4.4 L per flush⁸. It should be reiterated, however, that the effective flush volume is dependent on the installation location, for example, the effective flush volume appears to be lower in ladies restrooms than in men’s restrooms equipped with urinals⁹. This said, the effective flush volume of dual-flush toilets appears to be about 32 per cent less than that of conventional 6-L toilets in ladies restrooms, 27 per cent less in single-family applications, and 23 per cent less in men’s restrooms where urinals are installed. Overall dual-flush toilets in this project appeared to save 26 per cent more water than single flush 6-L toilets.

The data also showed a small increase in the average number of flushes per day at sites where dual-flush toilets were installed (5 per cent more flushes), and a decrease at sites where TOTO *Drakes* and Niagara *Flapperless* toilets were installed (14 per cent and 39 per cent fewer flushes respectively¹⁰) (Table 4).

There is insufficient data, however, to ascertain whether the increase in flush rates at dual-flush sites is related to flush performance (need for double flushing) or simply to participant curiosity about the toilet.

Overall however, there did not appear to be any correlation between flush volumes and changes in flush frequency nor between type of facility and flush frequency.

Table 6: Avg. Savings per Flush (based on replacing existing toilet flushing with 14.1 L¹¹)

Toilet	Savings per Flush	Savings per Flush
Caroma (based on “effective flush volume”)	9.7 L	69%
TOTO	8.0 L	57%
Niagara	7.9 L	56%
Western Pottery	6.6 L	47%

Cost-effectiveness of Dual-flush Toilets

The cost-effectiveness of a toilet reflects the relationship between the cost and the water savings associated with the toilet. To avoid misinterpretation it should be pointed out that:

- toilets are often selected for a variety of reasons—design, water savings, flush performance, cost, colour, etc.,
- cost-effectiveness calculations consider only the cost and flush volume,
- the cost of a toilet is not necessarily related to the flush volume.

The following tables identify approximate costs of toilets included in this study as well as other makes and models. The tables also

includes the simple payback period for each toilet assuming the following conditions:

- the full retail cost of the toilet is used,
- an existing toilet flushing at 14.1 L is replaced (average flush volume of existing toilets in program),
- a non-dual-flush toilet will save 8.0 litres/flush (14.1 L - 6.1 L average of single flush toilets in program),
- a dual-flush toilet will save 9.7 L/flush, (14.1 L - 4.4 L effective flush volume)
- each toilet is flushed 10 times per day,
- the combined water/sewer cost is \$1.00 per m³.

Table 7: Approximate Retail Cost of Toilets in Program

6-L Toilet Make/Model	Cost	Payback Period in Years
Caroma Tasman	\$300	8.5
Caroma Caravelle	\$400	11.3
TOTO Drake	\$300	10.3
Niagara Flapperless	\$169	5.8

- example: *Tasman*
 - 9.7 L/flush x 10 flushes/day x 365 days/year x \$1/1,000 L = \$35.41/year in savings

Table 8: Sample Retail Costs of 13-L Toilets*

13-L Toilet Make/Model	Cost	Payback Period in Years
Briggs <i>Altima</i>	\$97	3.3
Briggs <i>Abingdon Elongated</i>	\$119	4.1
American Standard <i>Plebe</i>	\$175	6.0
American Standard <i>Cadet III</i>	\$189	6.5

Table 9: Sample Retail Costs of 6-L Toilets*

6-L Toilet Make/Model	Cost	Payback Period in Years
Komet International <i>Deco 611</i>	\$78	2.7
American Standard <i>Marina</i>	\$116	4.0
Komet International <i>Deco 614</i>	\$118	4.0
Komet International <i>Albany</i>	\$198	6.8
Briggs <i>Millennium</i> one piece	\$248	8.5
Komet International <i>Bohemian</i>	\$290	9.9
Briggs <i>Kingsley</i> one piece	\$298	10.2

*prices from 'The Building Box' flier, Book 3/02, 16/03/02, pages 28 and 29

- retail cost of \$300/\$35.51/year = 8.5 years

As can be seen in Tables 7, 8, and 9, there is a range of toilet costs and, therefore, a range in respective payback periods. Based on the criteria outlined above, however, it appears that the additional savings achieved in this program by employing dual-flush technology were not significant enough to completely offset the additional costs of the *Tasman* or *Caravelle* toilets. Again, it is important to note that maximizing water savings is often not the primary consideration for persons purchasing new toilets.

Footnotes

- ⁵ Note that it is likely that this reduction in leakage would have been achieved by installing any non-leaking toilet, or perhaps even by replacing the existing toilet flappers (flush valves).
- ⁶ Outliers, erroneous and incomplete data have been removed. The analysis includes data from 30 Caroma, 7 TOTO, 3 *Flapperless*, and 1 *Aris* toilet; Caroma value is expected to be accurate to ± 18 per cent at 95 per cent confidence, other values are significantly less accurate and are presented for illustration purposes only.
- ⁷ Similar analysis for schools, golf courses, etc., was not included because of insufficient data.
- ⁸ $(3.4 \text{ L/flush} * 10.6 \text{ flushes/day} + 6.0 \text{ L/flush} * 6.8 \text{ flushes/day}) \div (10.6 \text{ flushes/day} + 6.8 \text{ flushes/day}) = 4.4 \text{ L/flush.}$
- ⁹ The “effective flush volume” is based on the ratio of “long” to “short” flushes per day and flush volumes of 6.0 and 3.4 L—a higher percentage of “short” flushes means a lower average flush volume.
- ¹⁰ Outliers, erroneous and incomplete data have been removed from calculation.
- ¹¹ The average flush volume of all existing toilets in this program was 14.1 L.

Section 4 - Conclusions

1. The dual-flush toilets in the program reduced existing flush volumes by about 68 per cent when installed in single-family homes, 56 per cent when installed in office washrooms, and 52 per cent when installed in the participating coffee shop. The actual volume of water saved is dependant upon how often the toilet is flushed. Less water savings are achieved if the dual-flush toilet is used in a facility equipped with urinals.
2. There are additional water savings associated with the dual-flush option vs. 6-L only flush toilets. The amount of additional savings, however, is dependant upon the type of application. In this study the existing toilets flushed with an average of 14.1 L and the additional savings attributable to the dual-flush option vs. a single flush 6-L toilet ranged from 23 per cent to 32 per cent depending on the availability of urinals within the restroom. The average additional savings for all sectors was 26 per cent.
3. The cost of any additional water savings achieved by utilizing a dual-flush option would be offset if the cost of the dual-flush toilet is greater than about 130 per cent the cost of a 6-L only flush toilet. It should be noted, however, that water savings is only one of many criteria considered by home owners and facility managers choosing to install new toilets.
4. One hundred per cent of the participants were pleased with having the option of being able to choose between a “short” or “long” flush.
5. The Caroma “long” flush, the TOTO *Drake*, and the Niagara *Flapperless* all flushed with average flush volumes of between 5.9 and 6.2 L.
6. Water savings are related to the type of application, for example, a greater volume of savings would be expected in “high use” applications.
7. All toilet models received similar scores on customer satisfaction surveys. All toilets (regardless of make and model) had average rating of between 7.2 and 7.9 points out of 10.
8. Nearly all participants rated the appearance of *Tasman/Caravelle*, *Drake*, *Flapperless*, and *Aris* as either Good or Average.
9. Major concerns with the Caroma *Tasman/Caravelle* are related to bowl streaking (cleaning) and, secondly, to the physical size of the toilet (may be too large to fit in some stalls and smaller bathrooms). A number of respondents also expressed that the *Tasman's* plastic tank looked “cheap” and that the seat was not comfortable.
10. Participants generally liked the Caroma better than their existing toilet.
11. The ratio of “short” to “long” flushes varies depending upon whether the toilet is installed in a residential or non-residential site, and whether it is installed in a restroom equipped with a urinal or not.

The flush ratio in single-family homes 1.6:1 (for example, 1.6 short flushes for every long flush) in office washrooms (female) the ratio was 2.7:1, and in office washrooms (male) the ratio was 1.1:1. The *overall* flush ratio was approximately 1.56 “short” flushes to every “long” flush.

12. There is insufficient data, however, to ascertain whether the increase in flush rates at dual-flush sites is related to flush performance (need for double flushing) or simply to participant curiosity about the toilet.

Appendix I

Participant Surveys

Customer Satisfaction Survey: Caroma Toilet

This new toilet is called a Caroma Toilet. It incorporates a “dual-flush” technology designed to save water by allowing the user to select a “short” flush for liquid waste (3 L) and a “long” flush for solid waste (6 L).

Please help us by taking a minute to answer the following questions. Thank you.

Date _____

1. How would you rate the appearance of this toilet?

Pleasing	Average	Poor
----------	---------	------

2. How do you like the option of selecting either the “short” flush or “long” flush?

Like It	Don't Like It	Don't Use It
---------	---------------	--------------

3. How well did this toilet clear bowl of solids? Liquids?

Good	Satisfactory	Poor
------	--------------	------

Solids

Liquids

4. Would you recommend this toilet to others wishing to purchase a water-efficient toilet?

Yes	Perhaps	No
-----	---------	----

5. How do you like the Caroma toilet compared to other toilets?

More	Same	Less
------	------	------

6. If there was one thing you could have the manufacturer change, what would it be?

7. On a scale of 1 to 10, with “1” totally unsatisfactory and “10” excellent, how would you rate the Caroma?

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

8. What additional cost would you be willing to pay to purchase a dual-flush toilet vs. a conventional toilet?

\$0	\$50	\$100	\$150
-----	------	-------	-------

Comments

Customer Satisfaction Survey

This new toilet is designed to flush better than standard toilets and to use only 6 L of water per flush—older toilets flush with between 13 and 20 L. It is installed as part of a program to determine how much water these toilets save and also the public's opinion of these toilets.

Please help us by taking a minute to answer the following questions. Thank you.

Date _____

Type of toilet installed: TOTO Drake Western Pottery Aris Flapperless

1. How would you rate the appearance of this toilet?

 Pleasing Average Poor

2. How well did this toilet clear bowl of solids? Liquids?

 Good Satisfactory Poor
Solids
Liquids

3. Would you recommend this toilet to others wanting to purchase a water-efficient toilet?

 Yes Perhaps No

4. How do you like this toilet compared to other toilets?

 More Same Less

5. If there was one thing you could have the manufacturer change, what would it be?

6. On a scale of 1 to 10, with “1” totally unsatisfactory and “10” excellent, how would you rate this toilet?

 1 2 3 4 5 6 7 8 9 10

7. What additional cost would you be willing to pay to purchase an efficient toilet vs. a conventional toilet?

 \$0 \$50 \$100 \$150

Comments

Please complete the next section only if you also installed a TOTO or Flapperless toilet.

12. What other type of toilet did you install?

TOTO Flapperless

13. How many did you install? _____

14. How would you rate the appearance of this toilet?

Pleasing Average Poor

15. How well does toilet clear bowl of solids? Liquids?

Good Satisfactory Poor

Solids
Liquids

16. Compared to your old toilet, this toilet: More Same Less

Clogs . . .
Requires double flushing . . .
Requires bowl cleaning . . .

17. Would you recommend this toilet? Yes Perhaps No

18. If there was one thing you could have the manufacturer change, what would it be?

19. On a scale of 1 to 10, with "1" totally unsatisfactory and "10" excellent, how would you rate this toilet?

1 2 3 4 5 6 7 8 9 10

20. What additional cost would you be willing to pay to purchase an efficient toilet vs. a conventional toilet?

\$0 \$50 \$100 \$150

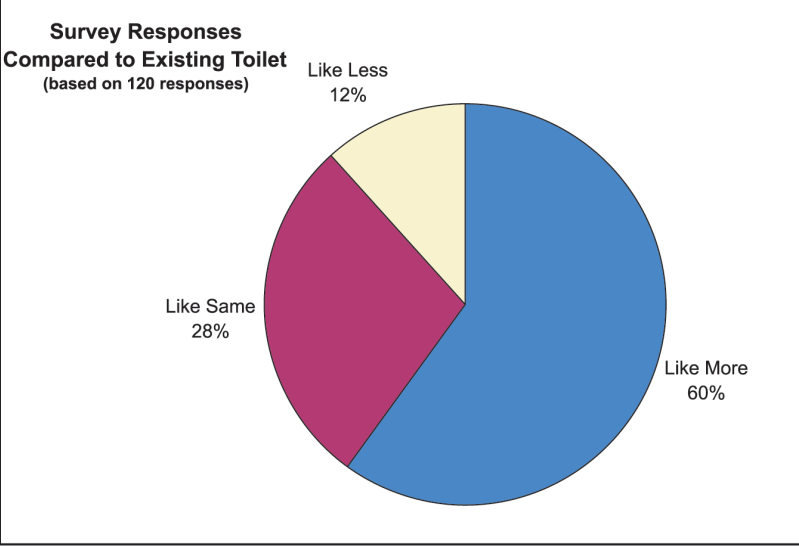
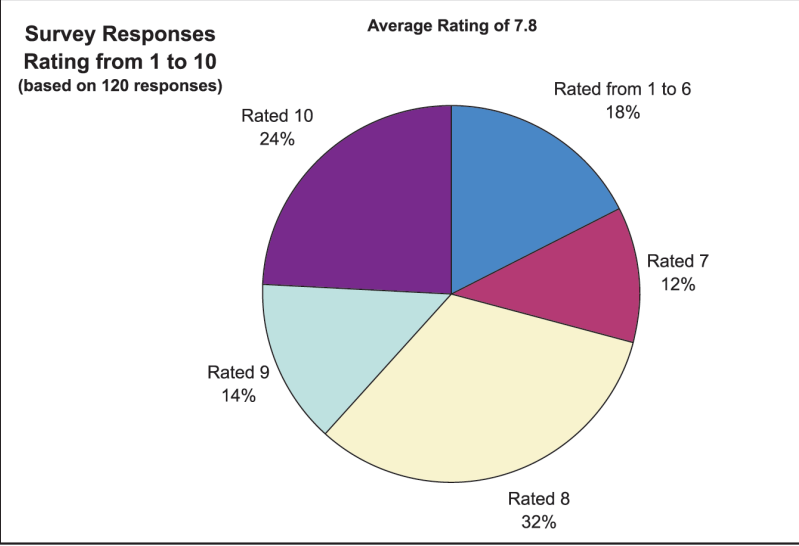
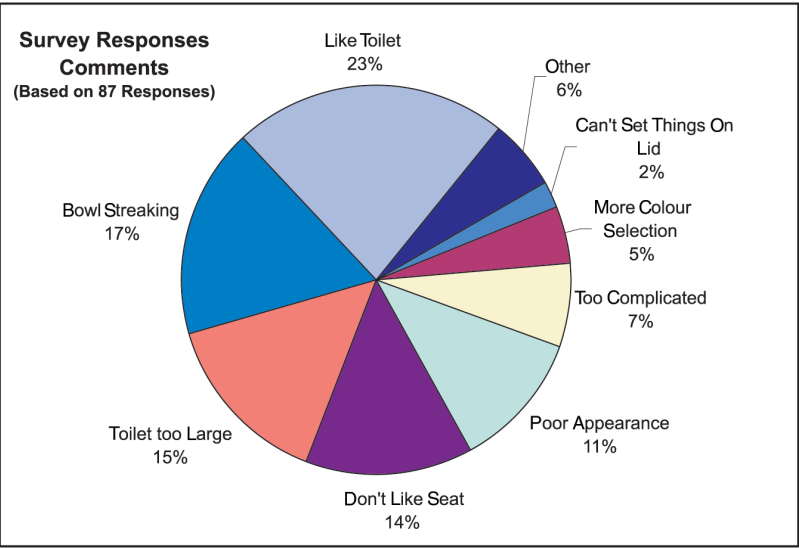
Comments

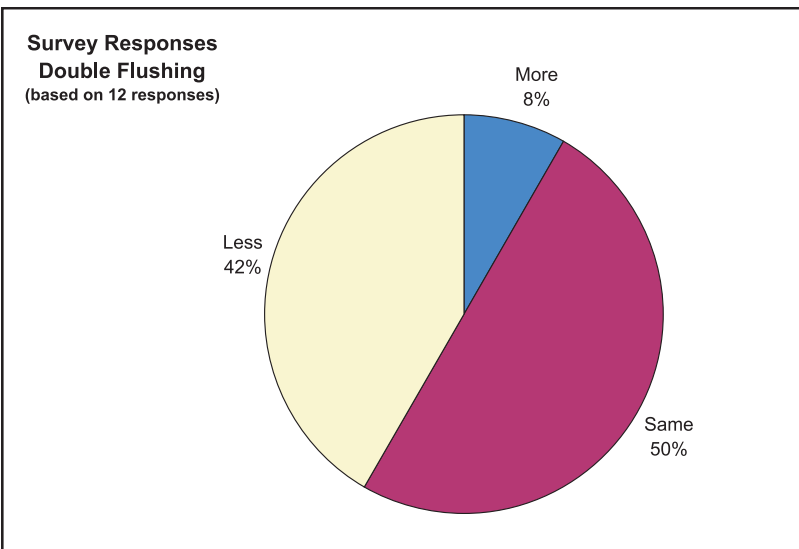
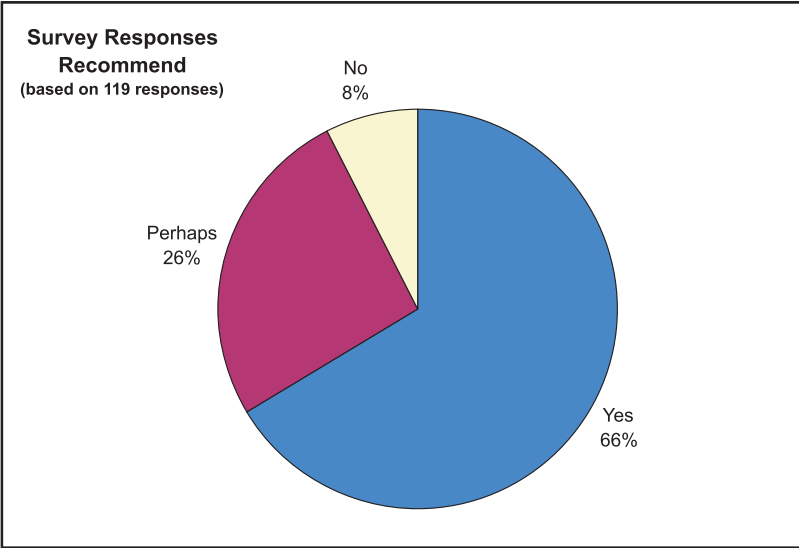
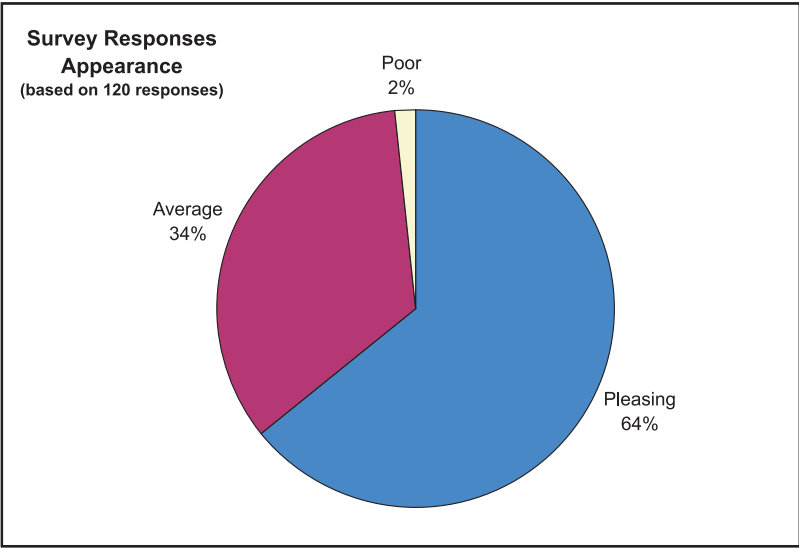
Appendix 2

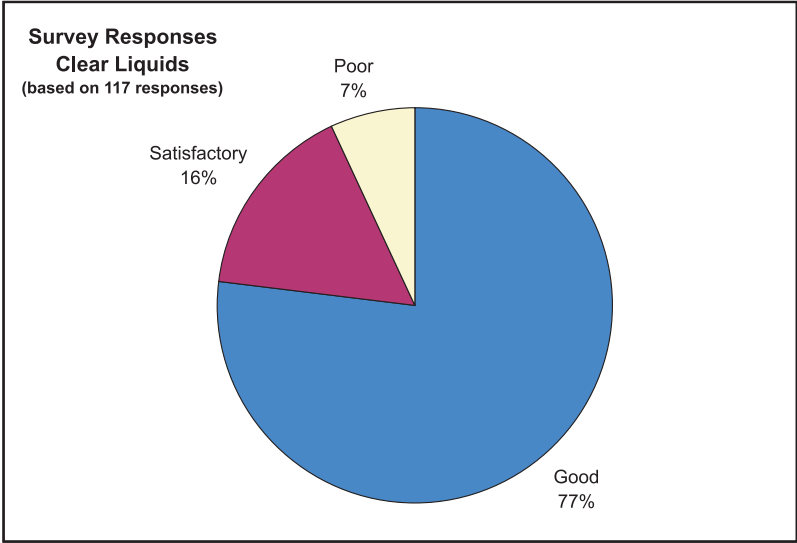
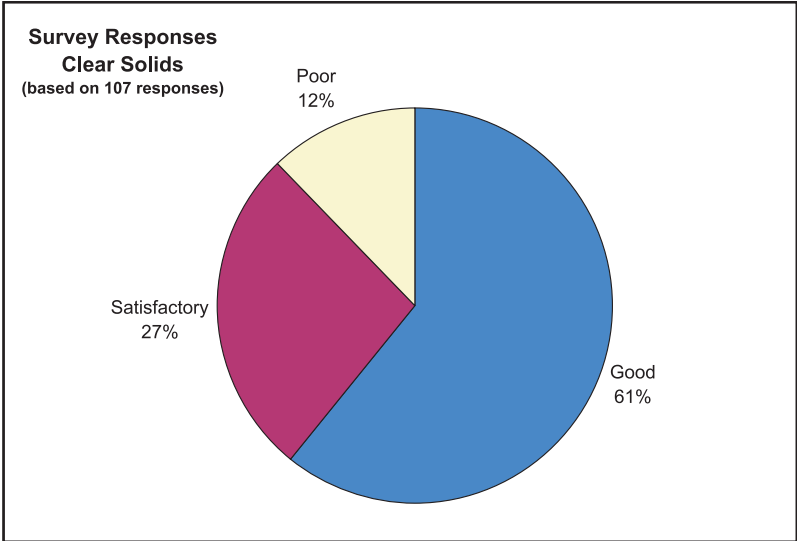
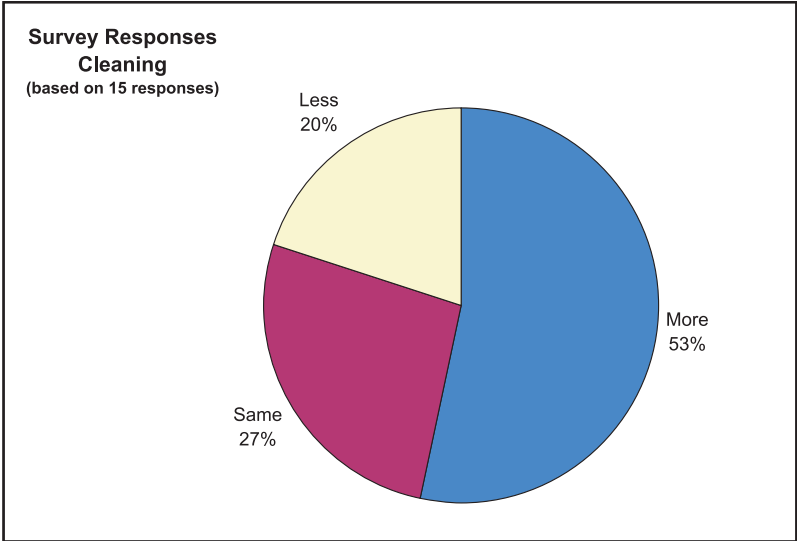
Charts Illustrating Survey Responses for Caroma Toilets

Other comments include:

- Can't flush while sitting
- Seat too far from tank, can't lean back
- Don't like connection to floor
- Too noisy
- Where would you find replacement parts?
- Bowl sides are too steep







Appendix 3

**Water Demand Reductions
15-Unit Apartment Bldg.,
39 Harcourt Ave., Toronto**

Introduction

As part of Toronto's involvement in the CMHC Dual-Flush Toilet Evaluation Project, all of the toilets in the public housing apartment building located at 39 Harcourt Avenue were replaced with Caroma dual-flush models. The new toilets are designed to flush with both a "long" flush of 6 L (for solid waste) and a "short" flush of 3 L (for liquid waste).

In addition to replacing the toilets in this 15-unit apartment building the program also involved evaluating the effectiveness (such as water savings) resulting from installing efficient showerheads and aerators. Because most multi-residential toilet replacement programs typically include replacing showerheads and faucet aerators at the same time as the toilets are changed-out only the aggregate water savings is known, for example, the individual water savings directly related to replacing toilets, showerheads, or aerators cannot be quantified. Because the toilets, showerheads, and aerators were each replaced at different times during this project it was possible to identify the water savings associated with the replacement of each of these fixtures.

Monitoring

The program included installing a data logger on the building's ¾" Rockwell SR11 water meter to record water demands over the entire monitoring period. The data logger was installed on May 23rd—before any changes to the building's plumbing was initiated—to

collect "pre" data. The following illustrates the milestone dates of the program:

- May 23 - Start of "pre" data collection
- June 14 - Dual-flush toilets installation completed
- July 10 - Water efficient showerheads installed
- July 24 - Water efficient aerators installed
- July 26 - Data logger removed

Results

The fixture replacement program achieved an overall water savings of slightly more than 50 per cent based on data collected during the monitoring period—a significant water demand reduction. During the "pre" monitoring period (before any change to the building's plumbing fixtures) the average water demand was 716 L per apartment suite per day. Data collected by the monitoring equipment identified a constant leakage of approximately 1.83 L per minute—this leakage was later identified as being related to leaking toilets.

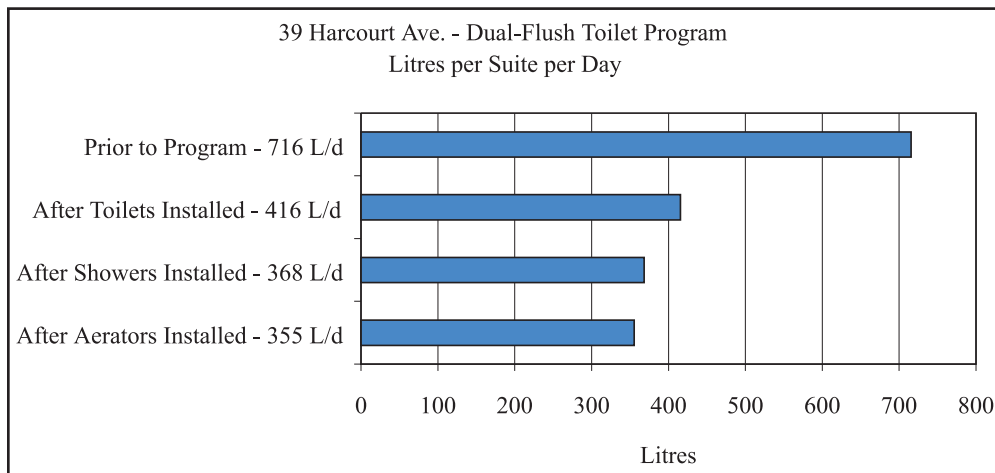
After the existing toilets were replaced with the new Caroma dual-flush toilets the per suite water demand was reduced to 416 L. The 300 L per suite water savings during this phase of the program could be broken down into 124 L savings related to lower flush volumes and to 176 L related to eliminating the toilet leak(s)¹.

Replacing the existing showerheads with new water-efficient units resulted in an additional savings of 47 L per suite per day, while installing new aerators saved about 13 L per suite per day. The following table summarizes the savings.

Fixture	Savings, L/suite/d	Reduction in Demand
Dual-flush toilet	124	17.4%
Leakage	176	24.5%
Showerhead	47	6.6%
Aerator	13	1.8%
Total	360	50.3%

The aggregate water savings achieved in multi-residential buildings by installing water efficient toilets, showerheads and aerators has typically ranged between 25-35 per cent (including reduced leakage). A savings of greater than 50 per cent is, therefore, substantial. This high level of savings may be due in part to the installation of dual-flush water efficient toilets vs. the more conventional 6-L per flush units². It should also be noted, however, that a significant portion of this savings was obtained from toilet leakage reduction.

The following chart helps to illustrate the savings achieved at each phase of the program.



Estimation of Flush Volume Savings

An analysis of the collected “pre” data identified the average flush volume of the existing toilets was approximately 14.8 L. A similar analysis of the “post” data identified that the average volume of the “long” flush was approximately 6.2 L and the average of the “short” flush was 3.7 L.

“Pre” Toilet Change-Out

Estimated per suite toilet demand before toilet change-out can be calculated as follows:

Per suite water demand (excluding leakage)

$$716 \text{ L/suite} - 176 \text{ L leakage} = 540 \text{ L/suite}$$

Toilet use of approximately 30%

$$30\% \times 540 \text{ L/suite} = 162 \text{ L/suite toilet demand}$$

Flushes per suite per day

$$162 \text{ L/suite/day} \div 14.8 \text{ L/flush} = 10.95 \text{ flushes/suite/day}$$

“Post” Toilet Change-Out

Estimated per suite toilet demand after toilet change-out can be calculated as follows:

Assume ratio of 4 “short” flushes to every 1 “long” flush, which means that 80% of flushes are “short.”

Total number of flushes per suite per day = 10.95

Number of “short” flushes

$$80\% \times 10.95 = 8.76 \text{ “short” flushes/day/suite}$$

Flush volume associated with “short” flushes

$$8.76 \text{ “short” flushes} \times 3.7 \text{ L/flush} \\ = 32.4 \text{ L/suite/day}$$

Number of “long” flushes

$$20\% \times 10.95 = 2.19 \text{ “long” flushes/day/suite}$$

Flush volume associated with “long” flushes

$$2.19 \text{ “long” flushes} \times 6.2 \text{ L/flush} \\ = 13.6 \text{ L/suite/day}$$

Per suite water demand associated with toilet flushing

$$32.4 \text{ L (“short” flush)} + 13.6 \text{ L (“long” flush)} \\ = 46 \text{ L/suite/day}$$

Savings associated with toilet change-out equals the difference between “pre” and “post” toilet demands per suite -

$$162 \text{ L/suite “pre”} - 46 \text{ L/suite “post”} \\ = 116 \text{ L/suite savings}$$

The calculated water savings using the above methodology identifies a water savings associated with installing the new dual-flush toilets of approximately 116 L per suite per day. The savings based on data logging is equal to 124 L per suite per day. The small difference between these two values (approximately 6.7 per cent) verifies that the assumptions used to calculate flush volume savings are fundamentally sound, for example,

that the “short” flush is used for approximately 80 per cent of the flushes. The following table summarizes these results.

Average “Pre” flush volume	14.8 litres
Average “Long” flush volume	6.2 litres
Average “Short” flush volume	3.7 litres
Number of flushes per suite per day	10.95
“Short” flush duty factor	80%
“Long” flush duty factor	20%

Additional Water Savings vs. Installing Conventional 6-L Toilets

The water savings directly related to installing the dual-flush toilets was 124 L per suite per day. The expected savings using conventional 6-litre toilets can be estimated as follows³:

$$10.95 \text{ flushes/day} \times (14.8 \text{ L/flush “pre”} \\ - 6 \text{ L/flush “post”}) = 96.4 \text{ L/suite/day}$$

The additional water savings achieved by installing the dual-flush toilets is, therefore:

$$124 \text{ L/suite/day} - 96.4 \text{ L/suite/day} \\ = 27.6 \text{ L/suite/day}$$

This additional water savings equates to an additional 28.6 per cent, for example,

$$27.6 \text{ L}/96.4 \text{ L} = 28.6 \text{ per cent}$$

Conclusion

The high level of detail pertaining to the water savings specifically related to the replacement of the different types of plumbing fixtures at 39 Harcourt is rare and was only achievable because:

1. detailed monitoring and data logging was performed, and
2. the toilets, showerheads, and aerators were replaced at different times.

This study has shown that installing water-efficient plumbing fixtures in multi-residential apartment buildings can result in significant water savings—greater than 50 per cent of the water demand was saved in the building at 39 Harcourt Ave.

This study has also shown that greater than 80 per cent of the water savings achieved was either directly or indirectly related to the installation of water-efficient toilets. Even if the reduced leakage is not considered, toilets still account for more than 67 per cent of the total savings⁴.

The additional water savings that has been achieved by installing dual-flush toilets vs. conventional 6-L toilets in this building has been estimated to be approximately 28.6 per cent.

Footnotes

- ¹ Data logging revealed an immediate cessation in leakage after the new toilets were installed.
- ² A study completed in Seattle identified an additional savings of 26 per cent when using dual-flush vs. conventional 6-L toilets.
- ³ Assuming that the new toilet flushes with exactly 6.0 L.
- ⁴ 124 L per unit per day saving from toilets and a total savings of 184 L (without leakage).

Appendix 4

Contact and Site Information for Program Participants

Participant in CMHC Dual-Flush Toilet Program	Number of Caroma Toilets	Number of Other Toilets
<p>City of Calgary, Alberta Contact: Pamela Reid Phone: (403) 268-5729 Fax: (403) 268-5709 Email: preid@gov.calgary.ab.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 2 Caromas in residential applications • 2 Caromas in Waterworks office 	4	0
<p>Québec City, Quebec Contact: Michel Lagacé Phone: (418) 691-6481 Fax: (418) 691-7642 Email: mlagace@ville.quebec.qc.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 4 Caromas in municipal office 	4	0
<p>City of St. Johns, Newfoundland Contact: Gerri King Phone: (709) 576-8613 Fax: (709) 576-8625 Email: Gking@city.st-johns.nf.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 1 Caroma in Eastern Water Treatment Plant, 1 in Western Plant 	2	0
<p>Region of Durham, Ontario Contact: Glen Pleasance Phone: (905) 668-7721, ext. 5391 Fax: (905) 668-2051 Email: Glen.Pleasance@region.durham.on.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 3 Caromas in municipal office building • 1 Drake, 1 Flapperless, and 1 Aris in municipal office building 	3	3

Participant in CMHC Dual-Flush Toilet Program	Number of Caroma Toilets	Number of Other Toilets
<p>Region of Halton, Ontario Contact: Cassandra Bach Phone: (905) 825-6123, ext. 7787 Fax: (905) 825-8822 Email: Bachc@region.halton.on.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 1 Caroma in Landfill Site office • 1 Caroma in North Service Centre • 1 Drake in Landfill Site office • 1 Flapperless in North Service Centre 	2	2
<p>City of Regina, Saskatchewan Contact: Randy Burant Phone: (306) 777-7819 Fax: (306) 777-6806 Email: rburant@cityregina.com</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 5 Caromas in school • 1 Caroma in municipal office bldg • 1 Drake in municipal office bldg. • 1 Caroma in golf course • 2 Drakes in golf course • 1 Caroma in residence 	8	3
<p>Greater Vancouver Regional District, British Columbia Contact: Andrew Doi Phone: (604) 436-6825 Fax: (604) 436-6970 Email: andrew.doi@gvrd.bc.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 2 Caroma in residential • 1 Caroma in commercial • 1 Drake in commercial • 1 Caroma in institutional 	4	1

Participant in CMHC Dual-Flush Toilet Program	Number of Caroma Toilets	Number of Other Toilets
<p>Region of Waterloo, Ontario Contact: Roger D'Cunha Phone: (519) 575-4423 Fax: (519) 575-4452 Email: droger@region.waterloo.on.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 2 Caromas at Waste Management Centre at Waterloo Landfill • 1 Drake at Waste Management Centre at Waterloo Landfill 	2	1
<p>Manitoba Conservation Contact: Lisbeth Liebgott Phone: (204) 945-8980 Fax: (204) 945-1211 Email: lliebgott@gov.mb.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 2 Caromas in public washrooms of seniors apartment bldg. • 2 Caromas Gimli's heritage Town Hall office • 1 Caroma - Gimli High School - female bathroom • 1 Caroma - Skills training centre • 1 Flapperless - Single mothers' assistance office • 1 Drake - Single mothers' assistance office • 1 Flapperless - Gimli High School - female bathroom • 1 Drake - Gimli High School - female bathroom 	6	4
<p>City of Toronto, Ontario Contact: Roman Kaszczij Phone: (416) 392-4967 Fax: (416) 392- 2974 Email: roman_kaszczij@city.toronto.on.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 1 Caroma in Second Cup restaurant • 1 Caroma in 15-unit apartment building <p>Note: Toronto is purchasing additional 14 Caroma toilets required to replace all of the existing toilets in the 15-unit apartment building.</p>	2	0

Participant in CMHC Dual-Flush Toilet Program	Number of Caroma Toilets	Number of Other Toilets
<p>City of Victoria, British Columbia Contact: Deborah Walker Phone: (250) 474-9683 Fax: (250) 474-4012 Email: dwalker@crd.bc.ca</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 2 Caromas in single-family houses • 2 Caromas in municipal office 	4	0
<p>City of Vernon, British Columbia Contact: Phone: Fax: Email:</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 2 Caroma in firehall • 2 Caroma residential • 1 Caroma commercial <p>Note: The project contact, Eric Jackson is no longer employed by the City of Vernon and there has been no replacement assigned to the project.</p>	5	0
<p>Mintourban Communities Inc., Ontario Contact: Andrew Pride Phone: (416) 977-0777 Fax: (416) 596-3444 Email: apride@minto.com</p> <p>Installation Sites:</p> <ul style="list-style-type: none"> • 1 Caroma in apartment suite 	1	0

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