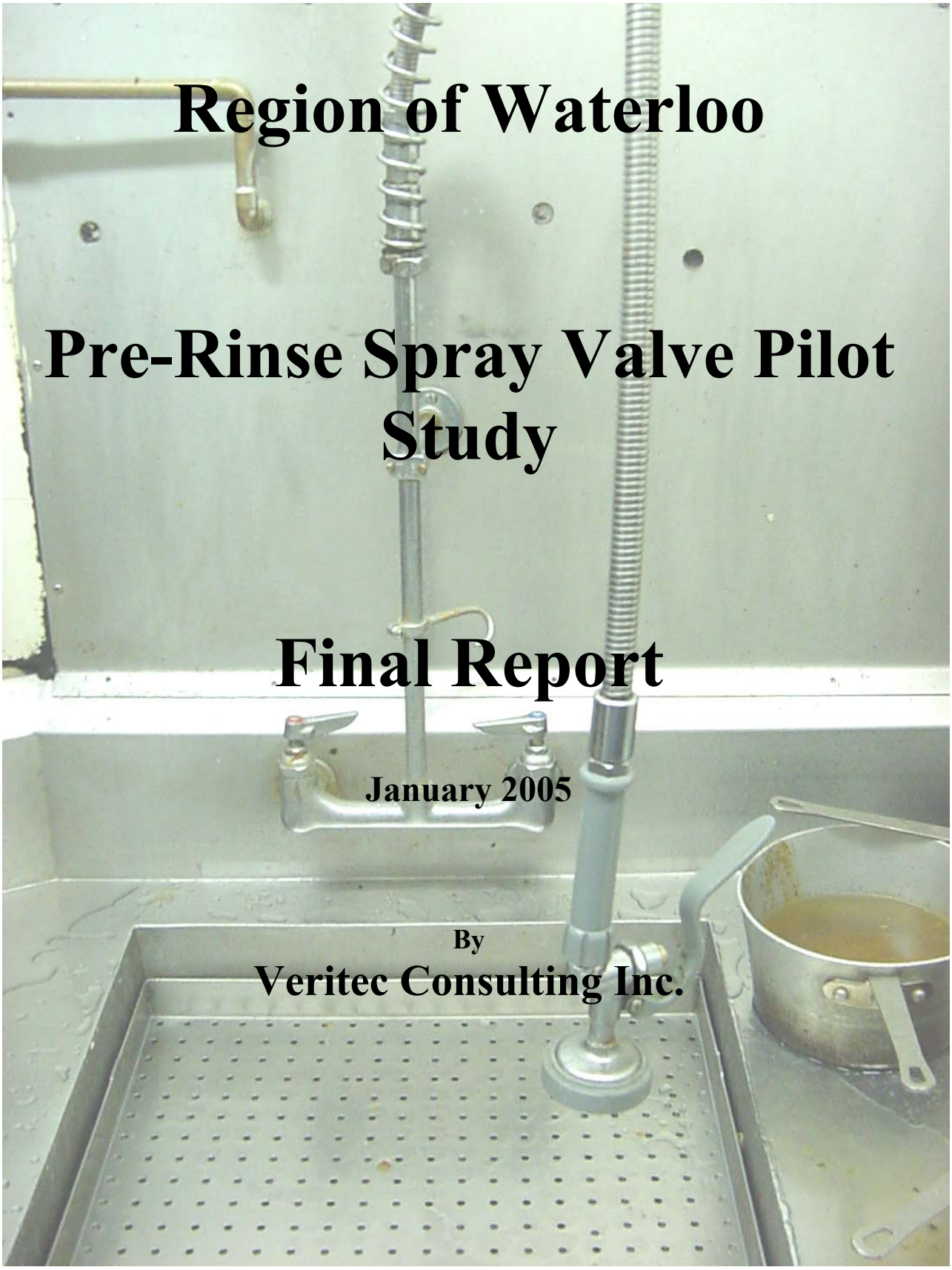
Region of Waterloo

Pre-Rinse Spray Valve Pilot Study

Final Report

January 2005



By

Veritec Consulting Inc.

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Acknowledgement

Some photographs used in this report were obtained from the California Urban Water Conservation Council's Rinse & Save Final Report Summary.

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Executive Summary

The Region of Waterloo is considered a leader in Canada regarding water efficiency. It is also the largest municipality in the country relying on groundwater as its major supply. The Region is committed to reducing per capita water demands across the Region and, as such, they actively investigate potential water-efficiency measures.

One relatively new water-efficiency measure to receive attention is the pre-rinse spray valve (also called a spray nozzle or spray head). These valves are used by restaurant and cafeteria kitchen staff to remove loose or 'sticky' food from plates and other dishes prior to loading them in the dishwasher. The efficient valves utilize a 'knife-edge' spray rather than a 'shower-type' spray to better focus the available energy and remove food particles more efficiently.

An ongoing program (*Rinse & Save*) by the California Urban Water Conservation Council (CUWCC) has identified that replacing existing valves with new efficient units save not only significant volumes of water but energy as well. In fact, the savings identified in the Californian study are so significant that the cost of these valves (approximately CAN$60 each) are 100 percent subsidized, i.e., they are supplied and installed at no cost to restaurants or cafeterias.

Because of the significant potential for savings identified in the CUWCC program, the Region of Waterloo has initiated their own pilot project to replace pre-rinse spray valves in ten area facilities. Data collected at each of these ten sites included:

- flow rate of existing fixture,
- flow rate of replacement fixture,
- supply pressures,
- duration of use.

The Region's pilot project was extremely successful and identified significant savings – an average of about 245 litres per valve per day (about three times the savings expected from installing an ultra-low-flush toilet) and about 30 percent greater than the savings identified in the *Rinse & Save* project. Total savings are estimated at $300 per year per valve or about $1,500 over the five-year life of the valve when energy savings are included.

Given that the efficient valves cost only about $60 each (when purchased in bulk) the payback period is estimated to be slightly less than three months. What's more, the savings are such that the Region could justify providing the valves at no cost to qualifying restaurants, institutional kitchens, and commercial food preparation operations.

It is expected (though not confirmed) that the Region will use the data collected as part of this pilot project in conjunction with the results of the CUWCC *Rinse & Save* program to develop a Region-wide pre-rinse spray valve replacement program. Replacing inefficient spray valves is extremely cost-effective to both the customer and to the Region and, as such, there are several options regarding a full program roll-out: the Region may limit its involvement to advertising/promotion alone, it may subsidize the full cost of the efficient valves (similar to the *Rinse & Save* program), or it may choose some combination of promotion and subsidy.

Summary of the Region of Waterloo Pilot Project Results

- **Approximate Cost of Valve: $60**
- **Average Water Savings: 245 litres per day per valve**
- **Expected Customer Savings: $300 per year per valve (water and energy)**
- **Projected water savings, Region-wide program: 317 m^3/day**

1.0 OVERVIEW

There have been significant advancements in many areas of water efficiency in recent years; many of these are related to residential fixtures and appliances (e.g., 6-litre toilets, horizontal-axis clothes washers). One measure beginning to receive significant attention in the food service sector (restaurants, cafeterias, etc.) is the installation of efficient pre-rinse spray valves (also called spray nozzles or spray heads).

Figure 1: Efficient nozzle

Figure 2: Nozzle and hose

Typically, large restaurants and food service operations utilize commercial dishwashers. Prior to loading the dishwasher, plates and dishes are manually sprayed (pre-rinsed) to remove loose or 'sticky' food. The time it takes to successfully pre-rinse the dishes is a function of how well the spray valve works – better valves clean dishes in less time, using less water and less energy.

The *Rinse & Save* program in California[1] states that the dishwashing operation in a typical restaurant can consume over two-thirds of the facility water use. What's more, it concluded that in some cases, nearly half of the water demand in the entire dishwashing process is used by the pre-rinse spray valve. Traditional spray nozzles use 10 to 20 litres of water per minute (Lpm) while the new models use 6 Lpm or less[2]. Efficient nozzles are inexpensive, easy to install, and don't require any additional effort on the part of the user to obtain water and energy savings.

Figure 3: Using a spray valve

The valves in the *Rinse & Save* program are delivered and installed at no charge to the customer. The program expects to replace a total of 42,000 inefficient valves by December 2005. Each valve is expected to save 190 m^3 of water and 335 therms of natural gas per year[3]. The acceptance of the program has surpassed officials' expectations.

Based on the success of the *Rinse & Save* program, the Region of Waterloo initiated a pilot project to identify savings related to a Region-wide program. The pilot project included ten area establishments (identified below). These sites were chosen somewhat randomly and are not intended to represent all of the possible types or sizes of facilities using pre-rinse spray valves in the Region.

1. Waterloo Motor Inn Limited (Rushes Restaurant)	2. King Street Trio
3. Frederick Street Cafeteria	4. Price Chopper (supermarket)
5. Angie's Kitchen Limited	6. Cambridge Wendy's Restaurant
7. Concordia Club	8. Sobeys Inc. (supermarket)
9. Stone Crock Inc.	10. Tim Horton's

[1] California Urban Water Conservation Council, *Rinse & Save*, 2003
[2] Under typical system pressures.
[3] The *Rinse & Save* program targets only hot water valves (cold water valves do not qualify).

The results of the Region's pilot project, in conjunction with the *Rinse & Save* program, is expected to be used by the Region and other Canadian municipalities intent on reducing water and energy demands and considering the replacement of inefficient pre-rinse spray valves as an option.

The *Rinse & Save* project estimates that restaurants will save an *average* of about 190 litres of water per day for each hour per day the valves are used. The life-cycle of pre-rinse spray valves is estimated to be approximately five years. The following table illustrates the projected savings in the *Rinse & Save* project based on detailed measurements at 19 food service facilities (average valve use of 2.7 hours per day), as well as the projected savings based on one hour valve use per day and on forty minutes valve use per day (the average use in the Region of Waterloo pilot project).

Spray Valve Utility Savings – California

Average Restaurant[4]	Water / Wastewater Savings (Litres / day)	Gas Savings[5] (therms / day)	5-Yr Water Savings (m^3)
Valve Used 2.7 hours / day	520	0.9	946
Valve Used 1.0 hour / day	190	0.33	350
Valve Used 40 minutes / day	128	0.22	233

Similar water savings in the Regional and Californian projects were expected as the operating conditions of restaurants are similar in both areas (e.g., water pressures and temperatures, materials used to make plates/cups/saucers, types of foods served, etc.), however, the average use in the Region's pilot project was only about 40 minutes per day. As such, an *average* water savings of approximately 128 litres per day would be expected in participating facilities within the Region[6].

The *Rinse & Save* program is being completed by staff going door-to-door offering to supply and install efficient nozzles. In this pilot program the Region simply contacted a number of potential participants (selected somewhat randomly) and pre-selected 10 sites based on these sites representing a range of facility types and their willingness to participate. Because there is some concern that restaurant owners and operators do not generally respond well to rebate programs because of the attention they must dedicate to dealing with their business[7] the Region of Waterloo is expected to evaluate several alternatives for advertising and publicizing the potential water and energy savings should they decide to proceed with a Region-wide program.

[4] Based on number of employees. In California 53% of the sites were Very Small (one to nine full-time employees), 43% were Small (10 to 50 full-time employees), and 5% were Medium (greater than 50 full-time employees).
[5] Assumes 100% hot water
[6] 40 minutes (Waterloo) ÷ 163 minutes (California) x 520 L/d = 127 L/d projected savings.
[7] CUWCC Pre-Rinse Spray Head Distribution Program, May 2004

2.0 FISHER MODEL 2949 PRE-RINSE SPRAY VALVE

Similar to the *Rinse & Save* program, the Regional project involved replacing existing pre-rinse spray valves with Fisher Model 2949 valves claiming flow rates of six litres per minute at 80 PSI. The Food Service Technology Center (FSTC) in San Ramon, California originally completed testing of various spray valves against the pre-determined specifications developed by John Koeller[8] and the FSTC. The Fisher spray valve was (at the time) the only valve to meet the testing criteria. It was also considered as superior in design to other products because it is manufactured with all brass fittings (some other models use plastic components).

Unlike the Californian study, kitchen staff in the Region's project did not receive any special training in the use of the valve even though its flat knife-like spray pattern is different than that of high-flow rate models (illustrated in photos at right). It was anticipated that the use of the new valve would be somewhat intuitive.

Figure 4:
Typical Spray Valve

Figure 5:
Efficient Spray Valve

3.0 METHODOLOGY

Veritec Consulting Inc. was retained to evaluate the effectiveness of the Waterloo Region's pilot program through monitoring the water demands associated with both the existing and new efficient valves. Originally, it was expected that sub-meters would be installed on each facility's pre-rinse spray valve supply piping and that these meters would be data logged to identify usage patterns[9].

It was discovered during lab-testing, however, that the inline water meters selected for use in this project would over-register by as much as 35% when subjected to short-duration pulsed flows. The lab-testing was completed by installing the water meters on the supply piping of the pre-rinse valves and operating the valve in short 'bursts' while collecting the spray water in a pail. After several minutes of pulsed valve operation the volume of water recorded by the meter was compared to the volume of water collected in the pail. Several sets of tests were completed using several types of meters but in all cases the volume recorded by the meter was between 15-40% greater than the actual volume collected in the pail. According to information published on the web, positive displacement meters can not over-register, yet it was found to occur in all lab tests[10]. It should be noted that the over-registering of the water meters is not necessarily indicative of the size of error that would result

[8] John Koeller, P.E., Koeller & Company, a consulting engineer retained by CUWCC to develop testing protocol.
[9] Nineteen sites were monitored this way as part of the *Rinse & Save* program.
[10] Example reference: http://www.roseville.ca.us/index.asp?page=866, bottom of page

from using the meters in field applications because there would be over-registration during both the 'pre' and the 'post' monitoring periods and the errors may 'cancel' each other out somewhat.

Because of the potential for error, however, Veritec concluded it was better to utilize a different method of field data collection. Instead of using sub-meters Veritec decided to complete the project using data-logged KOBOLD PSR paddle-type flow switches and pressure loggers.

Figure 6: Paddle-type Reed Switch

The flow switch operates as follows: Flowing water presses against the paddle of the flow switch. The paddle is fitted to one end of a balance arm that is in direct contact with a pre-stressed leaf spring. At the other end of the balance arm is a permanent magnet. This magnet actuates a reed contact located within a moveable housing outside the flowing water. The reed contact switches on or off depending on the position of the permanent magnet, i.e., if there is flow in the pipe or not. The paddle-type flow switch is mounted in an integral TEE piece fitted into the water supply line.

This type of monitoring was suitable for the project since there is typically no throttling in the operation of pre-rinse spray valves (they are either 'on' or 'off'). The data collected by the reed-switches and pressure loggers was used to establish accurate flow rate and duration patterns for each of the site installations.

Veritec completed a series of laboratory tests to establish flow vs. pressure curves for replacement and existing valves. Figure 7 on the following page illustrates the pressure (in pounds per square inch, or PSI) vs. flow rate data for both the laboratory-testing (controlled environment) and for the spot field measurements (uncontrolled environment). Notice that except for the site with very high supply pressures, the field measurements closely matched laboratory results.

Similar curves were derived for the spray valves removed from the field (Figure 8), though, unlike the Fisher valve, each of the field-nozzles is somewhat unique (different makes, models, ages, etc.) and has an individual curve. These flow vs. pressure curves were used in the data analysis to determine flow rates over the entire range of pressures each site was exposed to.

Note that each field valve had their own flow rate vs. pressure curve and, with the exception of the Concordia Club (which was already low-flow), their curves show much greater flow rates for any given pressure than the Fisher valve.

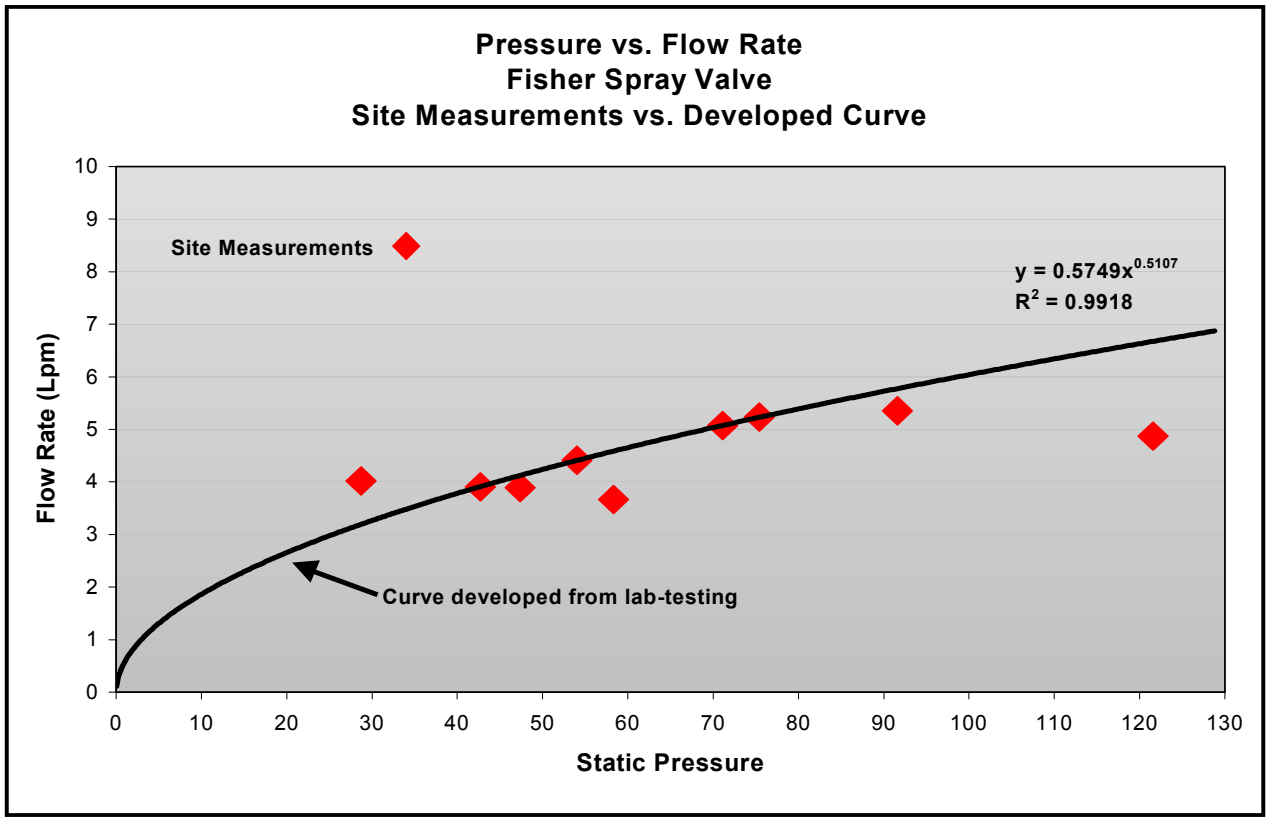

Figure 7

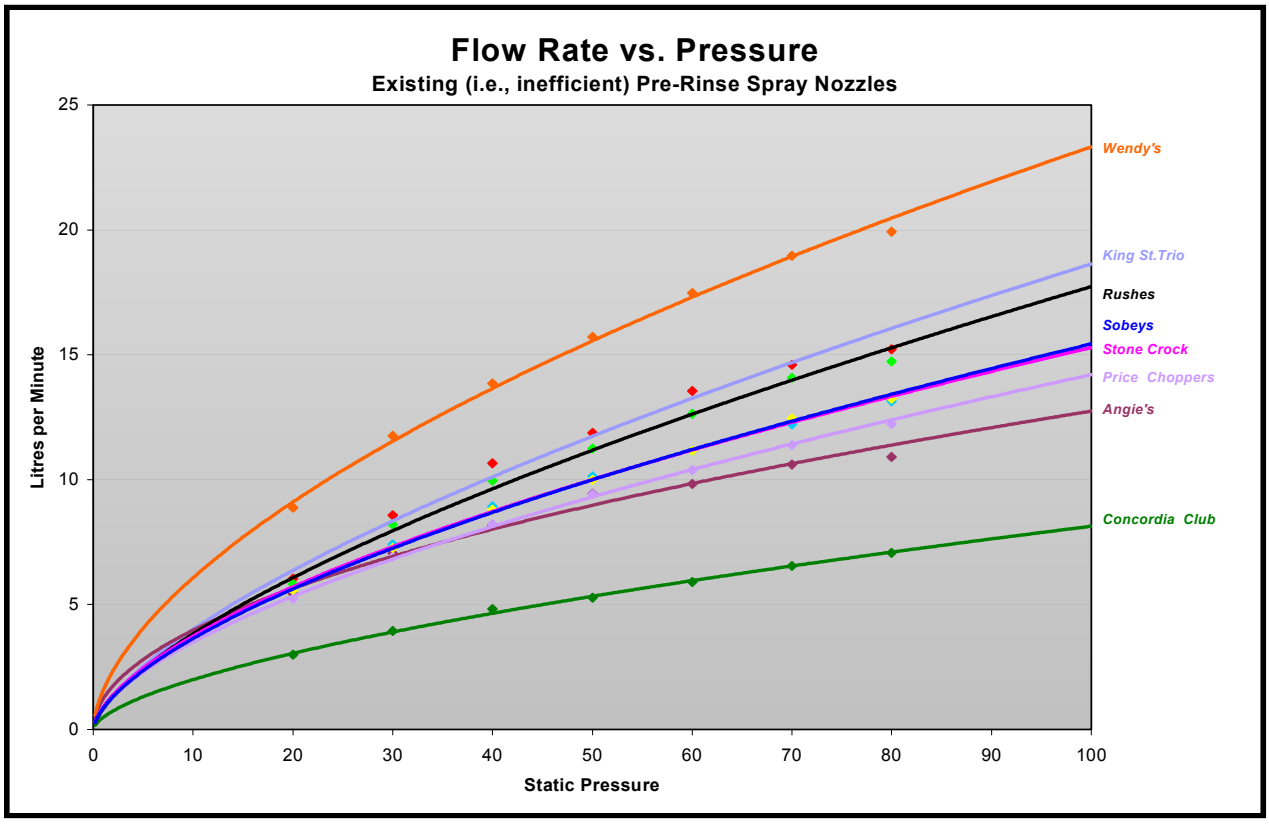

Figure 8

4.0 MONITORING RESULTS

4.1 Data for All Participating Sites

Table 1 below identifies the average, minimum, and maximum flow rates of both the original and the new replacement spray valves, as well as the average, minimum, and maximum system pressures the valves were subjected to during the monitoring period. The average duration that the valves were used during the monitoring period is also identified. Average daily use (litres/day) is calculated by multiplying the average flow rate by the average daily use[11]. The average pressure during the pre and post monitoring was constant at 66 PSI. The average flow rate of the original valves was 10.4 litres per minute, whereas the average flow rate of the efficient valves was only 4.6 Lpm[12].

Table 1 – Pre vs. Post Demands (10 sites)

Site		Avg. (Lpm)	Min. (Lpm)	Max. (Lpm)	Avg. (Psi)	Min. (Psi)	Max. (Psi)	Duration minutes/day	Daily Use (litres/day)
1	Angie's Kitchen PRE	8.9	7.0	9.9	50	30	61	15.0	134
	Angie's Kitchen POST	4.1	2.9	4.6	48	24	58	13.0	53
2	Cambridge Wendy's PRE	11.8	8.9	13.1	31	19	37	12.5	147
	Cambridge Wendy's POST	3.3	3.1	3.5	31	27	35	13.4	44
3	Concordia Club PRE	6.8	6.5	7.0	75	69	79	83.5	568
	Concordia Club POST	5.2	5.1	5.4	75	71	80	78.2	406
4	Frederick Street Cafeteria PRE	6.1	-	-	93	65	97	12.1	74
	Frederick Street Cafeteria POST	5.8	5.5	6.0	92	85	98	11.1	64
5	King Street Trio PRE	15.9	14.3	16.7	78	67	84	40.1	637
	King Street Trio POST	5.4	5.2	5.5	80	73	84	48.5	262
6	Price Choppers PRE	9.9	4.4	13.3	56	15	89	3.8	37
	Price Choppers POST	4.6	4.1	5.3	60	35	95	5.3	24
7	Waterloo Motor Inn Rushes PRE	12.0	11.0	13.0	56	49	63	66.2	794
	Waterloo Motor Inn Rushes POST	4.6	4.3	4.7	58	52	62	95.6	440
8	Sobey's PRE	13.3	10.2	18.5	79	52	133	21.2	281
	Sobey's POST	5.6	5.0	7.4	88	60	151	25.8	145
9	Stone Crock PRE	10.4	8.6	11.0	53	39	59	109.8	1,142
	Stone Crock POST	4.4	3.8	4.6	55	40	59	166.1	731
10	Tim Hortens PRE	9.1	-	-	93	-	-	25.3	230
	Tim Hortens POST	3.2	-	-	75	-	-	6.3	20
Averages PRE		**10.4**	**8.9**	**12.8**	**66.3**	**45.0**	**77.9**	**38.9**	**404**
Averages POST		**4.6**	**4.3**	**5.2**	**66.1**	**51.9**	**80.1**	**46.3**	**219**
							Percent Change	**19%**	**-46%**
							Average Savings Per Site per Day	**-**	**185**

Table 1 illustrates that the average savings in the 10 participating sites is 185 litres per day per site – a 46% savings. The table also shows that the duration of use of the pre-rinse spray valve increased by an average of 19%.

[11] Note: although two weeks of pre-monitoring was completed for the Stone Crock only data from the first week is used in calculations as data collected during the second week indicates that restaurant use was not typical during this time (pre-rinse spray valve use was 110 minutes per day during the first week of pre-monitoring and only 12 minutes per day during the second week).

[12] The Fisher valves are rated for a flow rate of 6 Lpm at 80 PSI.

4.2 Effects of Extreme Pressures on Performance

There were some unexpected difficulties encountered during the implementation of this project. Most of these problems appear to be pressure related and are described as follows:

- pressure at Sobey's was very high (average of 88 PSI, maximum of 151 PSI) resulting in complaints from the staff about there being "too much pressure from the spray valve".
- Wendy's staff stated new valve could not clean lettuce-shredding equipment (original valve was 12.5 Lpm, Fisher valve was only 4.0 Lpm). Wendy's requested that original spray valve be re-installed after pilot. Average pressure on site was only 31 PSI.
- Frederick St. cafeteria staff said new valve caused excessive spraying and splashing. Staff requested that original spray valve be re-installed after pilot. Average pressure on site was 92 PSI. Also, original spray valve had efficient flow rate (6.1 Lpm) thereby limiting the potential for additional savings.
- Tim Horton's staff said new valve caused excessive spraying and splashing, thus rarely used new valve (verified by monitoring, i.e., 25 minutes/day PRE and 6 minutes POST). Staff requested that their original spray valve be re-installed after pilot. Average pressure at site was also reasonably high at 75 PSI.

Similar performance problems were noted in the *Rinse & Save* program when very low or high water pressures were identified. Based on these results the Region may wish to consider only targeting sites for pre-rinse spray valve replacement that have moderate water supply pressures.

4.3 Data for Sites with Moderate Supply Pressures

Water savings are somewhat better if only sites with moderate supply pressures are included (Table 2). Table 2 shows an average savings per sites of 245 litres per day – a 43 percent savings even though duration of use increased by 28 percent. This savings is significant, especially considering that a portion of the savings is hot water and, therefore, energy is being saved as well.

In addition to the water savings, a survey of site staff identified the following comments:

Angie's Kitchen: "I love it. It's great." Would recommend it.
Concordia Club: Valve works well, experience very positive. Would recommend it.
King Street Trio: Like new valve. Would recommend to others.
Cambridge Price Chopper: Liked new valve. Would recommend new valve.

Table 2 – Pre vs. Post Demands (6 sites)

Site		Avg. (Lpm)	Min. (Lpm)	Max. (Lpm)	Avg. (Psi)	Min. (Psi)	Max. (Psi)	Duration minutes/day	Daily Use (litres/day)
1	Angie's Kitchen PRE	8.9	7.0	9.9	50	30	61	15.0	134
	Angie's Kitchen POST	4.1	2.9	4.6	48	24	58	13.0	53
2	Concordia Club PRE	6.8	6.5	7.0	75	69	79	83.5	568
	Concordia Club POST	5.2	5.1	5.4	75	71	80	78.2	406
3	King Street Trio PRE	15.9	14.3	16.7	78	67	84	40.1	637
	King Street Trio POST	5.4	5.2	5.5	80	73	84	48.5	262
4	Price Choppers PRE	9.9	4.4	13.3	56	15	89	3.8	37
	Price Choppers POST	4.6	4.1	5.3	60	35	95	5.3	24
5	Waterloo Motor Inn Rushes PRE	12.0	11.0	13.0	56	49	63	66.2	794
	Waterloo Motor Inn Rushes POST	4.6	4.3	4.7	58	52	62	95.6	440
6	Stone Crock PRE	10.4	8.6	11.0	53	39	59	109.8	1,142
	Stone Crock POST	4.4	3.8	4.6	55	40	59	166.1	731
Averages PRE		**10.7**	**8.6**	**11.8**	**61.3**	**44.9**	**72.4**	**53.1**	**565.1**
Averages POST		**4.7**	**4.2**	**5.0**	**62.4**	**49.3**	**72.9**	**67.8**	**319.7**
		Percent Change						**28%**	**-43%**
		Average Savings Per Site per Day						**-**	**245**

5.0 WATER & ENERGY SAVINGS

The Region's pilot program saved an average of 245 litres per day per valve[13] when only sites without pressure-related problems are included (Table 2) and 185 litres per day per site when all sites are included (Table 1). A value of 245 litres savings per day is used in calculations because it is expected a Region-wide program would not include facilities with very high or low pressures. Gas and electricity savings related to the replacement of inefficient valves are calculated based on values provided in the *Rinse & Save* report summary. No specific site data regarding energy savings was gathered as part of this project.

Water Savings:	**245 litres per valve per day**
	89.4 m^3 per valve per year
	447 m^3 per valve over the 5-year life of product
	$805 in savings (based on avg. cost of $1.80/$m^3$ over 5 yrs.)
Energy Savings[14]	
Gas Savings:	**0.35 therms per valve per day**
	126 therms per valve per year
	632 therms per valve over the 5-year life of product
	1,788 m^3 of gas saved[15]
	$769 in savings at $0.43 per m^3
Electric Savings	**4.8 kWh per valve per day**
	1,762 kWh per valve per year
	8,654 kWh per valve over the 5-year life of product
	$606 in savings at $0.07 per kWh

The total average projected customer savings are, therefore, about $300 per year ($161 per year water plus an average of about $139 per year energy) or about $1,500 over the life of the valve.

Total Expected Savings = $300 per year; $1,500 over five years

6.0 POTENTIAL REBATE LEVEL

It is anticipated that customers will save about $1,500 per valve over the life of the valve when water, wastewater, and energy savings are included. Given that the cost of the Fisher valve is approximately $60, this measure appears to be very cost-effective for the customer (a payback period of less than three months).

[13] Only one valve was replaced at each site
[14] Assuming 50% hot, 50% cold water, 70% efficiency for gas hot water heater, 90% efficiency for electric hot water heater.
[15] It takes approximately 8 m^3 of natural gas to heat 1.0 m^3 of water by 50C.

As a comparison, the Region's current rebate level for installing efficient toilets of $40 per fixture with an expected savings of almost 80 litres per day based on the latest (and most reasonable) expectation of savings (see following calculations):

- Average occupancy: 2.65 persons/single-family home in Region
- Flushes: 5 flushes/capita/day
- Savings per flush: 12 litres
- Avg. # of toilets: 2 toilets/home

2.65 persons x 5 flushes/capita/day x 12 L/flush ÷ 2 toilets = 79.5 L savings/toilet/day

Based on an average pre-rinse spray valve savings of 245 litres per day (or about three times greater than the savings expected from installing a single toilet) the Region could offer a rebate of about $120 per pre-rinse spray valve (three times current $40 toilet rebate), which is more than the valve costs. In other words, it appears that if the Region of Waterloo desired to, it could conduct a program similar to that of the CUWCC, i.e., it could offer the efficient valves for free to potential sites[16]. If the Region decides to complete any type of Region-wide program, however, it should fully review the CUWCC's reports as part of their preparation.

Maximum Potential Rebate Level = $120 per valve

7.0 PROJECTED SAVINGS – REGION-WIDE PROGRAM

To estimate the potential savings that could be achieved by implementing a pre-rinse spray valve replacement program on a Region-wide basis it is necessary to know the number of sites that use these valves (primarily restaurants), daily usage, and average flow rates of existing valves.

There are approximately 2,500 restaurants in the Region of Waterloo[17]. Based on the data collected as part of this project it appears that the average duration of valve use is approximately 53 minutes 'Pre' and 68 minutes 'Post'[18]. Although some of the larger restaurants will use their valves for a longer duration each day (e.g., the Stone Crock restaurant uses their valve more than 100 minutes per day), using a lower value in calculations will provide a more conservative, and, therefore, more acceptable, savings target. Data collected as part of this project also identified the average flow rate of existing valves to be approximately 10.7 litres per minute and of the new valves to be 4.7 litres per minute.

If we assume 80 percent of restaurants in the Region have pre-rinse valves and 80 percent of these have moderate supply pressures and that 80 percent of these sites participate[19] then the projected water savings from a Region-wide project can be estimated as follows:

2,500 sites x 80% x 80% x 80% x (53 min. x 10.7 Lpm – 68 min. x 4.7 Lpm) = 316,800 L/day savings

A program savings of almost 317 m^3/d is significant. It is enough water to meet the needs of approximately 1,268 persons at a per capita demand rate of 250 litres per person per day.

[16] Assuming no pressure-related problems at sites.
[17] Data provided by Regional Health Department.
[18] Assuming only sites with suitable water supply pressures are included.
[19] Measure is very cost-effective even without incentive from the Region, and it is expected the Region will provide at least some level of incentive.

8.0 PROGRAM BARRIERS

Although the pilot program was very successful, some problems were identified, i.e., pressures either too high or too low. Low pressure at Wendy's combined with the significantly lower flow rate of the new valve to negatively effect the restaurant's staff's ability to clean their lettuce-shredding equipment. High water pressure at several sites caused excessive and unacceptable splashing and over-spraying.

Similar conditions were observed in the Californian study where sites with extremely low water pressure experienced a weak spray pattern, lacking the water velocity to effectively clean food particles off the dishes, and sites with extremely high water pressures experienced over-spraying that was unsatisfactory to the users. Once these problems were recognized staff ceased installing efficient valves in high- and low-pressure sites. Only 105 spray valves of the first 17,000 installed in California were ultimately removed due to customer dissatisfaction. The California study survey data also showed that over the first year the estimated spray head retention rate was about 95 percent, indicating that participants will keep the efficient valve if they are satisfied.

Based on the result of both the Region of Waterloo's and the *Rinse & Save* program it appears that at least a minor effort must be made to pre-select program participants with moderate supply pressures.

9.0 CONCLUSION

The Region of Waterloo's pre-rinse spray valve replacement pilot program saved approximately 245 litres per valve per day (185 litres if sites with pressure-related problems are included). This unit savings level is approximately three times greater than the units savings related to toilet replacement programs. Total savings for the participant over the 5-year life of the valve is approximately $1,500 when water, wastewater, and energy costs are included. The cost of each valve is approximately $60.

Based on expected savings the Region could potentially offer the efficient spray valves at no charge to eligible customers, though how or if the Region decides to implement a full program has not yet been determined. If a program is initiated the Region may wish to conduct some sort of pre-selection process to avoid including sites with extremely high or low water pressures[20].

The pilot project identified significant water, wastewater, and energy savings. These savings help to verify the savings achieved in California's *Rinse & Save* program. It is expected, therefore, that other Canadian municipalities will see the opportunity to achieve cost-effective savings (to both the customer and the utility) and begin implementing some type of pre-rinse spray valve replacement programs.

Should you have any questions regarding the findings in this report please contact the author at:

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[20] For example, students could check pressures at each site prior to installing the efficient valve.