ASSESSMENT OF WATER SAVINGS FOR COMMERCIAL WASHERS

REPORT ON THE MONITORING AND ASSESSMENT OF WATER SAVINGS FROM THE COIN-OPERATED MULTI-LOAD CLOTHES WASHERS VOUCHER INITIATIVE PROGRAM

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Abstract

After extensive research, it has been determined that Multi-Load Clothes Washers (washers that wash 35 pounds of laundry or more) use more water per pound of laundry than smaller front load washers.

This study establishes that the best way for water utilities to save water in commercial laundries is to encourage the replacement of older single top load washers with front load washers that have a capacity of 1½ to 2 times the size of the single top load washers.

<u>Abbreviations used in this report:</u>

SDCWA:	**San Diego County Water Authority**
DWR:	**Department of Water Resources**
STL, SFL:	**Single Top-Load Washer, Single Front Load**
ML:	**Multi-Load Washer**
DOE:	**Department of Energy**
CEE:	**Consortium of Energy Efficiency**
WF:	**Water Factor Rating**
WMI:	**Water Management, Inc.**
MEF:	**Modified Energy Factor**
AWWA:	**American Water Works Association**
GPM:	**Gallons per minute**
CII:	**Commercial Industrial and Institutional Program**

BACKGROUND:

The funding for this project was provided by the Department of Water Resources (DWR) as part of the Proposition 13 Urban Water Conservation Capital Outlay Grant. The grant was managed by the San Diego County Water Authority (SDCWA). As part of this grant, SDCWA determined that an effective way to save water and meet the needs of the community would be to support a project that would provide vouchers in the amount of $775 for the installation of multi-load (ML) washers. Water Management, Inc.'s (WMI) task was to determine the effectiveness of that initiative.

In developing the rebate program, SDCWA recognized that utility expenses are a major business cost for Laundromat owners."[1] SDCWA reasoned that a well-designed rebate program would provide a minimum of three benefits:

1. Significant rebates for ML washers would enable the Laundromat owners to upgrade to 30 pounds and greater ML washers when they might not otherwise be able to do so. It is important to note that prior to approving the $775 voucher amount, Laundromat owners in the San Diego area stated in focus groups that they were aware of the significant utility savings available, but that they did not have the money needed to make the investment.[2] Therefore, a significant rebate would certainly accelerate the market transition to ML washers and would achieve savings earlier than anticipated.
2. The SDCWA reasoned that by providing significant rebates for Laundromat owners, Laundromat customers would also benefit. Customers who routinely use Laundromats would realize the benefit of using [ML washers] to do large amounts of laundry quickly at a lower cost. ML washers would benefit customers by reducing expense to them by washing more laundry per dollar spent, reducing dryer time, and reducing the amount of detergent required[3].
3. The final advantage of the high-efficiency washers is the significant energy and water resource savings that could be realized by the community at large.

The Coin-Op Laundry Association estimates that there are 35,000 Laundromats in the United States with approximately 400,000 commercial family-sized washers.[4] These washers typically get a great deal of use (6-8 turns or wash loads every day) and consequently, have a lifespan of 7-10 years." There are estimated 200 - 225 Laundromats in the San Diego service area, each with an average of 30 - 35 [washers]."[5] With a 7-10 year replacement cycle, 600 to 1200 commercial washers are in need of replacement each year in the San Diego area. Discussions conducted with the San Diego Coin-Op Laundry

[1] March, 2002
[2] March, 2002
[3] March, 2002
[4] Consortium for Energy Efficiency (1998) Commercial, family-sized washers: an initiative description of the consortium for energy efficiency. http://www.cee1.org/com/cwsh/comwsh_prog_des.pdf
[5] San Diego County Water Authority (March, 2002) Prop 13 urban water conservation capital outlay grant: coin-operated multi-load clothes washer voucher incentive program. http://www.owue.water.ca.gov/docs/finpdf/PSP_165.PDF

Association prior to the beginning of this study indicated that local Laundromat owners were interested in replacing one-half of their small top-load (TL) washers with ML washers over the next 2 – 4 years - roughly 3,000 post-retrofit washers.

To encourage Laundromat owners to transition to ML washers, SDCWA developed the Multi-Load Clothes Washer Voucher Incentive Program. Manufacturers' data was provided and used in the development of this Incentive Program. The table below was presented in the March 2002 Grant request for the Voucher Incentive Program and is presented here again as a reference. SDCWA used this information to help develop their current rebate program and this information was also used as a baseline in conducting this study. The following assumptions were provided from the manufacturers' data:

- Pounds of laundry per load were chosen as a basis of comparison rather than tub size.
- Number of pounds of laundry per load is about 66% of the rated capacity.
- Single, front-load (SFL) washers is the product rejected by Laundromat owners in preference to ML washers.
- ML washers have a useful life of at least 10 years and are used about 5 times per day.

TABLE 1A: SINGLE TOP-LOAD WASHER AND MULTI-LOAD WASHER COMPARISON[6]

	Top-Single	Front-Single	Front Multi-Load	Front Multi- Load
Pounds Rated	12 lb	14 lb	35 lb	55 lb
Pounds Typical	7.92	9.24	23.1	33
Tub Size (cubic feet)	2.50	2.90	5.76	8.18
Gallons/Load	31.5	21.5	62.2	80.9
Average Hot Water/Load	6.5	2.5	7.5	10.2
Therms/Load Hot Water	0.433	0.167	0.500	0.680
kWhr/Load	0.15	0.10	0.30	0.42
RMC%	75	60	73	73
RMC Pounds	5.9	5.5	16.9	24.1
Therms/Dryer	0.128	0.119	0.363	0.518

Comparing efficiencies based on pounds of laundry washed is a good method when comparing washers of equal size as was recently done in the Seattle Public Utilities Study, but for the purposes of this study where washers of different sizes were being compared; it was necessary to use the Water Factor the (WF) rating. "The Water Factor is the number of gallons per cycle per cubic foot of tub size that the washer uses. The lower the Water Factor,

[6] March, 2002

the more efficient the washer is."[7] For example, if a washer uses 24 gallons per cycle and has a tub volume of 3.0 cubic feet, then the WF is 8.0. A washer with a lower WF number is more water-efficient than one with a higher number.[8] The Department of Energy's (DOE) Energy Star specifications effective January 2007 require WF ratings of 8.0 or lower to qualify.

Looking again at Table No. 1, the WF can be calculated as follows:

TABLE 1B: SINGLE TOP-LOAD WASHER AND MULTI-LOAD WASHER COMPARISON

	Top Single - Load	Front Single - Load	35 lb Front Multi - Load	55 lb Front Multi - Load
Tub Size	2.5	2.9	5.76	8.18
Gallons/Load	31.5	21.5	62.2	80.9
Water Factor	12.6	7.4	10.8	9.9

Summarizing Table #1 with the WF:

- Note that the ranges for WF are from a high of 12.6 for the STL washer to a low of 7.4 for the SFL washer.
- The larger ML washers listed in the table have a WF that is above 9.9.
- In order of efficiency, the front-load (FL) 14-pound washer is the most efficient based on the WF.
- The single top-load (STL) 12-pound washer is the least efficient.

For further information regarding the WF for various washers see Appendix 5. This appendix is a copy of DOE's 2006 list of over 200 residential type washers currently being manufactured and their corresponding modified energy factor (MEF) and WF's. The washers listed in the DOE report are mostly residential washers sized 12 to 18 pounds. The largest washers listed in DOE's report based on the cubic foot volume of the tub are 3.89 cubic feet. Washers with cubic foot capacity of 3.89 typically correspond to washers that are rated at a capacity of 25 pounds.

This information is consistent with the requirements set forth for smaller ML clothes washers in the Energy Policy Act of 2005 Public Law 109-58, August 8, 2005. In this Act, smaller ML washers were identified as washers with a tub-bin size of not more than 3.5 cubic feet for horizontal axis washers and 4.0 cubic feet for vertical-axis washers.

The Act goes on to state that smaller ML washers manufactured on or after January 1, 2007 shall have a WF of not more than 9.5 and a MEF of at least 1.26.

For the purposes of this study, it is important to note that larger ML washers (30 pounds and above) <u>are not required</u> to comply with the water and energy standards set forth in this Act.

[7] (n.a., n.d.) Definitions for clothes washer product listing column headers. Retrieved from the Energy Star Website, http://www.energystar.gov/index.cfm?fuseaction=clotheswash.display_column_definitions

[8] (n.a.) (2006) ENERGY Star includes water factor in new clothes washer specifications. *CEE Newsletter*. Retrieved from the CEE website, http://www.cee1.org/resrc/post-retrofitpost-retrofits/06-01nl/06-01nl.pdf

BASELINE INVESTIGATION:

Manufacturers often rate the size of washers in pounds of laundry a washer can wash. However, there is no standard for the type of laundry that is used to rate a washer. Since fabrics have varying degrees of density, a rating for a pound of laundry is not exactly the same from one manufacturer to another. For example, 30 pounds of terry cloth towels may not have the same volume as 30 pounds of cotton bed sheets; thus the size of the load may not serve as an indication of the weight of the load of laundry.

Essentially, the pound rating of the washers may vary slightly based on what each manufacturer uses as a pound of linen. The good news is that the variance does not appear to be significant from one manufacturer to another. In fact, there is remarkable consistency in the relationship of the size of the washer tubs and the rated capacities of various models –at least among the ML models. The analysis found that relationship to be 0.14 cubic feet of tub volume for every pound of rated capacity. Conventional STL washers can nominally wash 12 pounds of laundry. The larger ML washer typically washes between 30 and 55 pounds of laundry and is the most common larger ML washer found in Laundromats.

There are also a large number of washers that fall in between the 12 to 30-pound class. Because many of the washers at the test sites were rated between 18 and 30-pounds, it was necessary to determine how these smaller ML washers compared to the larger ML washers. To do this, it was necessary to conduct a tub volume and water volume analysis of different sizes of ML washers built by different manufacturers.

Baseline Tub Volume Analysis:

Tub volume analysis was completed on ML washers made by seven (7) different manufacturers. We found remarkable consistency in the relationship of tub volume and rated capacity among models and manufacturers. Table 2 below lists the actual tub volume sizes as supplied by the manufacturer. **This table is a valuable tool because increasingly, manufacturers are not giving washers a poundage-rating; instead, they provide the tub volume size.**

TABLE 2: TUB VOLUME SIZE

Manufacturer	**Tub Volume Size (Cu Ft)**											
	18 lb	**20 lb**	**25 lb**	**30 lb**	**35 lb**	**40 lb**	**50 lb**	**55 lb**	**60 lb**	**75 lb**	**80 lb**	**125 lb**
Continental	2.54			4.2		6.3	7.4			11.2		19.4
Maytag	2.61		3.27		5.72		7.68				11.79	
Speed Queen/ Huebsch		2.76	3.76	4.19		6.34			9		12.96	
IPSO	2.59		3.36		5.93	6.39	8.26			10.74		
Milnor					6.14			9				
Dexter	2.7		4			6		9				
Wascomat		3		4.6		6.4		8.8		11.7		

To normalize this relationship, we divided tub volume (cubic feet) by the nominal capacity (pounds). The resultant values are shown below in Table 4**.** The analysis indicates the relationship, 0.14 ft^3 per rated capacity of clothes in the vast majority of washer designs.

TABLE 3: TUB VOLUME ANALYSIS: CU FT/LB

Manufacturer	**Tub Volume Ratio -Tub Volume (Cu Ft) / Rated Capacity (lbs)**											
	18 lb	20 lb	25 lb	30 lb	35 lb	40 lb	50 lb	55 lb	60 lb	75 lb	80 lb	125 lb
Continental	0.14			0.14		0.16	0.15			0.15		0.16
Maytag	0.15		0.13		0.16		0.15				0.15	
Speed Queen/ Huebsch		0.15	0.15	0.14		0.16			0.15		0.16	
IPSO	0.14		0.13		0.17	0.16	0.17			0.14		
Milnor					0.18			0.16				
Dexter	0.15		0.16			0.15		0.16				
Wascomat (Emerald)		0.15		0.15		0.16		0.16		0.16		
Average	0.15	0.14	0.14	0.14	0.17	0.16	0.16	0.16	0.15	0.15	0.15	0.16

Baseline Water Volume Analysis

Water consumption figures on various sizes of ML washers were provided by six (6) different manufacturers prior to beginning the study. Usage per load information was provided from manufacturers on the ML washers for comparison with that of TL washers.

Water consumption for TL washers was taken from data provided from the manufacturers and from three studies (Bern Study, Laguna Woods, and Fort Hood).

The consumption values (gallons) for both types of washers were divided by the nominal size (pounds) per washer. For the ML washers, the range in values of water consumption was between 0.8 gallons per pound to 2.0 gallons per pound. For STL washers, the range in values of water consumption is between 2.3 and 3.5 gallons per pound. These values are presented in Table 5.

The models presented below are a general representation of TL and ML washers.

TABLE 4: FRONT-LOAD ML WASHER'S WATER CONSUMPTION RATIO

	Manufacturer Reported Average Water Usage (Gallons/ Pound)												
	Top-Load (TL)	**Multi-Load (ML)**											
Manufacturer	12 lb	18 lb	20 lb	25 lb	30 lb	35 lb	40 lb	50 lb	55 lb	60 lb	75 lb	80 lb	125 lb
Continental		1.1			1.1		1.2	1.1			1.2		1.2
GE[9]	3.2												
Maytag	3.5[10]	ND		1.5		1.3		1.2				1.5	
Speed Queen/ Huebsch			1.5	1.5	1.4		2.0			ND		1.3	
Whirlpool[11]	2.3												
IPSO		ND		ND		ND	ND	ND			ND		
Roper[12]	3.0												
Milnor						1.1			0.8				
Dexter		1.4		1.5			1.3		1.3		1.2		
Wascomat			1.7		1.7		1.7		1.7		1.7		
Average	3.0	1.3	1.6	1.5	1.4	1.2	1.5	1.2	1.3		1.3	1.4	1.2

ND = NO DATA RECEIVED BY THE MANUFACTURER BUT REQUESTED

BLANK=NO DATA FOUND THROUGH LITERATURE SEARCH

[9] Sullivan, G.P., Currie, J.W., Hillman, T.C., Parker, G.B. (2000). *Southern California Edison High-Performance Clothes Washer Demonstration at Leisure World Laguna Woods*. Prepared for Battelle for Southern California Edison Company, Rosemead, California.

[10] Oak Ridge National Laboratory. *Bern Clothes Washer Study Final Report.* Prepared for US Department of Energy.

[11] Sullivan, G.P., Currie, J.W., Hillman, T.C., Parker, G.B. (2000). *Southern California Edison High-Performance Clothes Washer Demonstration at Leisure World Laguna Woods*. Prepared for Battelle for Southern California Edison Company, Rosemead, California.

[12] Sullivan, G.P., Parker, S.A. 2000. *Assessment of High-Performance, Family Sized Commercial Clothes Washers.* Prepared for U.S. Army Forces Command.

The data in Table 4 compares the water used in gallons to wash a load of laundry in pounds of ML washers to STL washers, respectively. The data shows that the most inefficient ML washers will use 2.0 gallons/pound and are more water-efficient than the most efficient TL washers that use 2.3 gallons/pound.

NOTE: In practical application, coin-op consumers generally load washers to about 67% capacity. Manufacturers of front ML washers, however, generally rate the per cycle water consumption with the basket empty. When dry clothes are placed in the wash basket and the washer is started, the water is absorbed into the clothes. This takes the weight off the water level control pressure switch and additional water is allowed to enter the wash basket. Therefore, water consumption for FL washers is not as consistent as the water usage for TL washers.

Baseline Energy Analysis:

The major objective of the ML washer monitoring and assessment study was to determine the potential water and energy savings that could be achieved by the replacement of inefficient STL washers with ML washers. The major focus of this study is on evaluating water usage, but we also collected significant machine and water consumption information from manufacturers in the initial phase of this study.

TABLE 5: ANALYSIS OF HOT WATER USAGE FOR STL AND ML WASHERS

Type of Machine	Poundage	Gallons/Cold Water	Gallons/ Hot Water	Total Gallons	Gallons Hot Water per pound
Single Top-Load	12	26	9.5	35.5	0.79
Double Front-Load	25	38.6	14	52.6	0.56
Triple Front-Load	35	65.9	22.3	88.2	0.64
Quad Front-Load	50	90.2	28.6	118.8	0.57

Note: ML washer consumption is based on Maytag washers. STL consumption is based on a study done by PNNL at Fort Hood (May 2000). Table 2 shows that by using a ML washer instead of a STL washer, the gallons of hot water per pound of laundry can be reduced by 19%-29%.

SURVEY OF SAN DIEGO COUNTY COIN-OP LAUNDROMATS*:*

While setting up the sites to be monitored during the end of 2004 and beginning of 2005, twenty-nine (29) laundries in the San Diego area were surveyed to determine the number, type, and the cost of using commercial washers in San Diego County. This spreadsheet analysis is presented in Appendix 1 and Appendix 2 at the end of this report. The following should be noted regarding the survey:

- These laundries were randomly selected.
- The laundries had a total 1,411 washers (over 10% of the commercial coin-op laundries in the San Diego service area).
- This distribution is a reflection of the sizes and types of washers that are currently in use in the San Diego service area.

The results of this survey indicated that 772 (55%) of the washers in the coin-op survey group in San Diego County have single-load (SL) washers and 476 (39%) of the washers are ML washers sized 18 to 30 pounds and 6% are ML washers sized 35 pounds and above. Of the 772 SL washers, 28% have been converted to front SL high-efficiency washers. For more details see Appendix 1.

Charges for STL washers ranged from a low of $0.75 to a high of $1.75 per cycle. SFL washers are priced the same or just $0.25 higher. Charges for ML washers sized 18 to 25 pounds seem low compared to the SFL high-efficiency washer typically found to charge only $0.50 to $1.00 more. Larger ML washers sized 40 pounds to 55 pounds had pricing of $4.00 to $6.00 that better reflected their value.

STUDY PROTOCAL AND PROCEDURES

Equipment:

This study involved the metering of three test sites and one control site. The control site did not receive any post-retrofit ML washers. Each of the other three test sites had at least two ML washers replaced. Since the major purpose of this study was to determine the water savings generated from replacing TL washers with ML washers, it was essential to have data collected accurately in order to determine:

- Water consumption per washer
- Number of wash cycles per washer

The equipment that was used to collect water consumption per washer was Aqura water meters from Wellspring. The Aqura meters are small, point of use meters that can be connected to the hot and cold supply lines of each of the washers. The meters collect cumulative water consumption (gallons).

The following are the components for the metering equipment.

1. Flow meter
2. Transmitter
3. Receiver

The flow meter is basically a turbine that rotates when water flows through. The turbine has a magnet that provides a "pulse". The flow meter is connected between the hose assemblies.

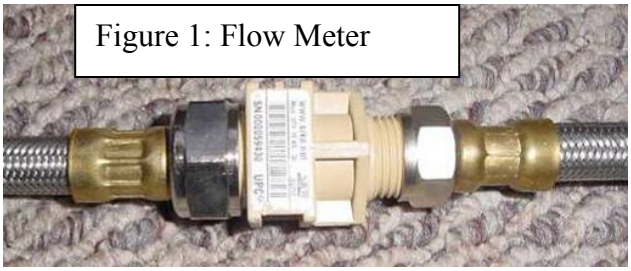


Figure 1: Flow Meter

Figure 2: Meter and hose assembly

A transmitter is connected onto the flow meter to pick up and record the flow meter "pulse". The flow meter has a system accuracy that meets applicable IAPMO and ANSI national standards and AWWA accuracy requirements that are ± 1.5%. Flow sensing range is 0.5 gallons per minute (gpm) to 8.0 gpm with leak sensing down to 0.2 gpm. Flow rates to fill either hot or cold water are anticipated to be below 5 gpm in most cases.

The data is recorded directly onto the transmitter. Data is collected cumulatively. This means that the meter quantifies the water consumed in the same manner as a mechanical water meter would. The transmitter sends out a signal that transmits the data via radio signal one time per day to a receiver located at the Laundromat.

Figure 3
Receiver

The receiver records the data that is sent out via a radio signal by the transmitters. The data must be manually downloaded by a cable connection to a computer. Because counter information needed to be collected for each washer, meter reading data from each site was collected physically at the same time the counter information was obtained.

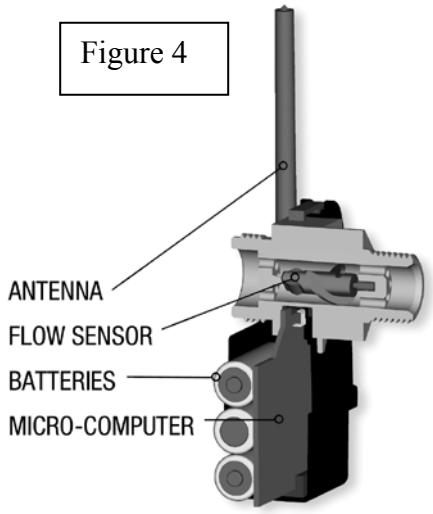
Procedures:

Baseline consumption for each monitored laundry was intended to be taken over a 30-day period prior to the installation of post-retrofit ML washers. This measurement was done on a daily basis and provided data on current consumption. After the 30-day baseline period, the post-retrofit ML washers were to be installed. Once this was completed, post-retrofit consumption data was to be recorded over a 60-day period to determine the effect on the overall consumption.

Since water consumption per washer needed to be determined, the number of wash cycles needed to be determined as well. Electromechanical counters were attached to the "washer in use" light. The counter was installed so that it would only trip if the light went on. These counters provided an accurate record of the number of wash loads for some washers. But for most of the washers in the study, mechanical cycle counters were installed. The mechanical counters for these washers were placed in the coin box. Each time the water meters were read, it was necessary to open the coin box lid to read the counter.

Typically, the post-retrofit and larger washers have electronic controls with a built-in feature that logs the number of wash cycles. The cycle counter is accessed using the washer's microprocessor and is obtained by pressing a series of buttons.
The number of times each washer was used during the test period was calculated for each washer for each measured parameter.

Figure 4



The metering technology used in this study was originally developed for the "point of use" sub-metering of apartments, and is well suited for the metering of washers. The technology has a low installation cost when compared to other technologies where multiple meters are required since the information can be transmitted electronically on a daily basis and the data generated is received in an Excel spreadsheet format.

Usage by washer was recorded in the following categories:

- Hot water consumption for the period (cumulative by washer)
- Cold water consumption for the period (cumulative by washer)
- Number of washer uses or cycles
- Average hot water per use (by washer)
- Average cold water per use (by washer)
- Gas therms consumed by unit for the period (cumulative by washer – calculated)

Water-related specifications generally monitor water metering system accuracy. Battery life, flow sensor life, temperature range, and pressure range exceeded the time frame of one year that was the intended duration of the study. Flow sensing range was 0.5 gpm to 8 gpm with leak sensing down to 0.2 gpm. Flow rates to fill either hot or cold water were below 5 gpm in most cases.

The individual meter radio transmitters operate on 24-volt batteries. The communication is one-way using an encrypted, time stamped communication methodology. The metering technology broadcasts at 916.5 MHz up to 1000 feet. Output is a very low +0.75 milivolts.

To increase the understanding of washers in use, efforts were also made to weigh customers' laundry at each of the four test sites. Data was collected manually, weighing customers' laundry as they used the washers at the control and test sites. During the laundry weighing, customers were paid for their wash in exchange for permission to weigh their laundry.

Customer's habits were captured by weighing a typical wash load. Clothes were loaded, then taken out and weighed, then placed back in the washer. When the wash cycle ended, the clothes were re-weighed. This last measure was for weighing the residual moisture left in the clothing, affecting the energy required to dry the clothing.

A summary of the weighing data and residual moisture data is presented in Appendix 3-A.

MONITORED SITES

Requirements:

Laundromat owners who qualified for the study did so by replacing at least one TL, inefficient, SL washer with a new ML washer with a capacity of 30 pounds or greater. In return, the Laundromat owner that participated in this study was eligible for the following:

- **$775** voucher for each new ML washer with a capacity of 30 pounds or greater purchased (at least one TL washer was to be replaced by one ML washer).
- **$1000** additional incentive from WMI if two ML washers or more were purchased.

Technique:

Small, non-intrusive water meters were installed at each washer in the Sites Nos.1-4. The meters were considered small and fit behind the washers out of sight. The meters did not interfere with the operation of the washers.

In addition, several patrons were asked to allow weighing of their laundry before and after a wash load. Drying of their laundry was paid for in exchange for the weight measurement. The purpose was to learn how people actually load different sized washers.

Duration at each site:

The total length of time for the metering was not to exceed 4 months. First, the meters were installed to determine how much water was consumed by the Laundromat without the new ML washers (slated not to exceed 4 weeks). The second phase of the study involved removing the TL washers and installing the new ML washers (slated not to exceed 8 weeks). The total water consumption was again monitored after the efficient ML washers were installed.

Monitoring results:

Four facilities were tested successfully: one control site and three treatment sites. The following are the results of four sites that have been monitored, their corresponding washer change out history, collection timeline, and a preliminary determination of the water and energy saved as calculated to date.

1. Site No. 1, Control Site, San Diego, CA
2. Site No. 2, Treatment, San Diego, CA
3. Site No. 3, Treatment, Oceanside, CA
4. Site No. 4, Treatment, San Diego, CA

Site No. 1, Control Site:

This site was chosen as the control site for its diverse washer brand inventory (See Appendix 4). There were 36 of the 12-pound STL washers, five of the 30 pound ML washers, and five of the 40-pound ML washers. Per-cycle estimates of water consumption are shown in the table below.

TABLE 6: CONTROL SITE SUMMARY DATA

Washer Size	Per-cycle Total Consumption (April - July)	Per-cycle Total Consumption (August - November)	Water Factor
12 pounds 25 washers	33.5 gal (7,594 wash cycles)	34.5 gal (7,170 wash cycles)	13.5
30 pounds 2 washers	56.3 gal (325 wash cycles)	54.0 gal (421 wash cycles)	13.7
40 pounds 1 washer	46.8 gal (123 wash cycles)	48.0 gal (99 wash cycles)	7.9

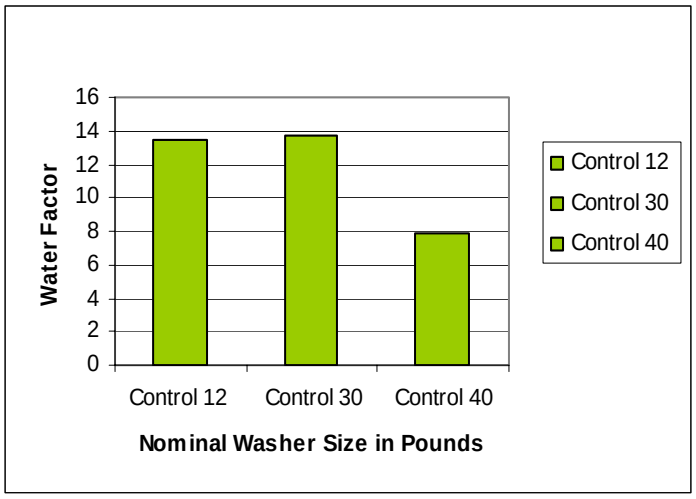
ACTUAL WASHER COUNT IS NOTED IN APPENDIX 4

***NOTE: NOT ALL DATA STATISTICALLY QUALIFIED TO BE INCLUDED AS USABLE**

Summary of Table 7:

- There is no significant difference in water use per-cycle between the 30 and 40-pound washers.
- The WF for the 40-pound washer indicates a greater efficiency in this washer, comparatively, and fits with the EP Act 2005 for a WF of 9.5 or better.
- The data was separated into 4-month increments to assess whether any extraneous factors may have affected water use in San Diego laundries and allowed for any changes in washer habits based on seasonal changes.
    - There appeared to be no significant difference in seasonal usage.
    - The data was repeatable and considered a strong control site.

Graph 1: Nominal Washer Size vs. Water Factor (WF) for Site No. 1



Graph 1 shows a trend of an indirect relationship between the WF and nominal washer size; a decreasing WF as the nominal washer size increases. A total of 28 washers were metered at this site, with 15,831 wash cycles metered to generate the WF for these three washer sizes. The 30-pound was the least efficient of the three systems analyzed, using 40% more water than the 12-pound washer and 14% more water per cycle than the 40-pound washer. The timeline for this site exceeded the original study design due

to a change of direction by the Laundromat owners. No washers were changed out, thus, this served as a control site. Data collection timeline: monitoring commenced on April 27, 2005 and was completed December 1, 2005. Total timeline duration was 31 weeks.

Site No. 2, Treatment Site

Treatment Site No. 2 initially had twenty-three 12-pound washers, three 20-pound washers, and three 30-pound washers. At Treatment Site No. 2, a high percentage of washers were replaced with similar models. Twenty 12-pound STL washers were replaced with 20 new STL 12-pound models; three 12-pound STL washers remained. Three 20-pound washers were replaced with three 30-pound washers, which qualified this site for the SDCWA, CII voucher program.

Per-cycle estimates of water consumption are as follows:

TABLE 7 A: TREATMENT SITE NO. 2 - BEFORE RETROFIT (CONTROL FOR SITE NO. 2)

Washer Size	Per-cycle Total Consumption	Water Factor
12 pounds TL 14 washers	30.9 gal (1,290 wash cycles)	12.3
20 pounds 2 washers	30.4 gal (1,241 wash cycles)	11.4
30 pounds 2 washers	48.0 gal (766 wash cycles)	8.6

ACTUAL WASHER COUNT IS NOTED IN APPENDIX 4

***NOTE: NOT ALL DATA STATISTICALLY QUALIFIED TO BE INCLUDED AS USABLE**

TABLE 7 B: TREATMENT SITE NO. 2 – AFTER RETROFIT

Washer Size	Per-cycle Total Consumption	Water Factor
12 pounds TL 17 washers	21.8 gal (6,390 wash cycles)	7.9
30 pounds (post-retrofit) 2 washers	30.6 gal (179 wash cycles)	5.2

ACTUAL WASHER COUNT IS NOTED IN APPENDIX 4

***NOTE: NOT ALL DATA STATISTICALLY QUALIFIED TO BE INCLUDED AS USABLE. ALSO, THE PRE-RETROFIT 30-POUND WASHERS WERE NOT RETROFITTED, SO THE ESTIMATE OF 48 GALLONS PER-CYCLE APPLIES.**

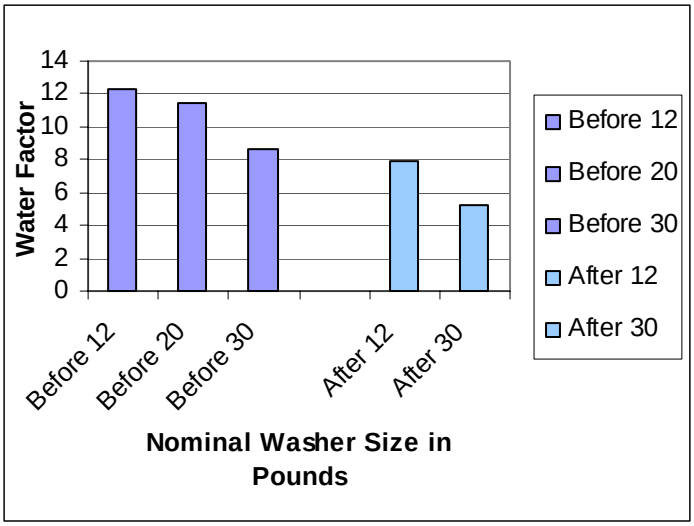
Summary of Tables 7A and 7B:

- The pre-retrofit 12-pound STL washers' WF is not in range with Energy Star standards and may not qualify in today's market. The post-retrofit ML washer has a

WF that would qualify as a water-conservation commercial washer (WF of 9.5 or less[13]).

- The pre-retrofit 12-pound washers used 31.3% more water compared to the post-retrofit 12-pound washers.
- There is no significant difference in water use per cycle between the pre-retrofit 20-pound washers and the post-retrofit 30-pound washers.
- The post-retrofit 30-pound washer compared to the pre-retrofit 20-pound washers showed the same water consumption of ~30 gallons/load. If both washers operated at or near their respective capacity then on a per-pound basis the 30-pound washers would use 33.3% less water
- The post-retrofit 30-pound washers use 36% less water per load than the pre-retrofit (not replaced) 30-pound washers.

Graph 2: Nominal Washer Size vs. WF for Site No. 2



Graph 2 shows a WF trend that is descending. The WF is indirectly proportional to the nominal washer size; as the washer size gets larger, the WF gets smaller. A total of 37 machines were metered at this site with a total of 9,866 wash cycles metered to generate the WF for these 5 washer types. The STL 12 pound washer was the least efficient of all washers monitored at this site; the post-retrofit 30-pound washer is the most water-efficient washer.

TABLE 7 C: TREATMENT SITE NO. 2 – VARIATION IN INTENSITY OF USE

Washer Capacity	Number of Washers	Cycles / Washer / Day	Percentage of Washers	Percentage of Loads
Site No. 2 (pre-retrofit)				
12 lbs. TL	23	2.3	76.90%	51.90%
20 lbs.	3	5.7	11.50%	19.30%
30 lbs.	3	8.5	11.50%	28.80%
Site No. 2 (post-retrofit)				
12 lbs. TL	23	2.3	76.90%	65.20%
30 lbs.	6	4.1	23.10%	34.80%

[13] Energy Policy Act, 2005; Public Law 109-58, Section 136 (e) (B)

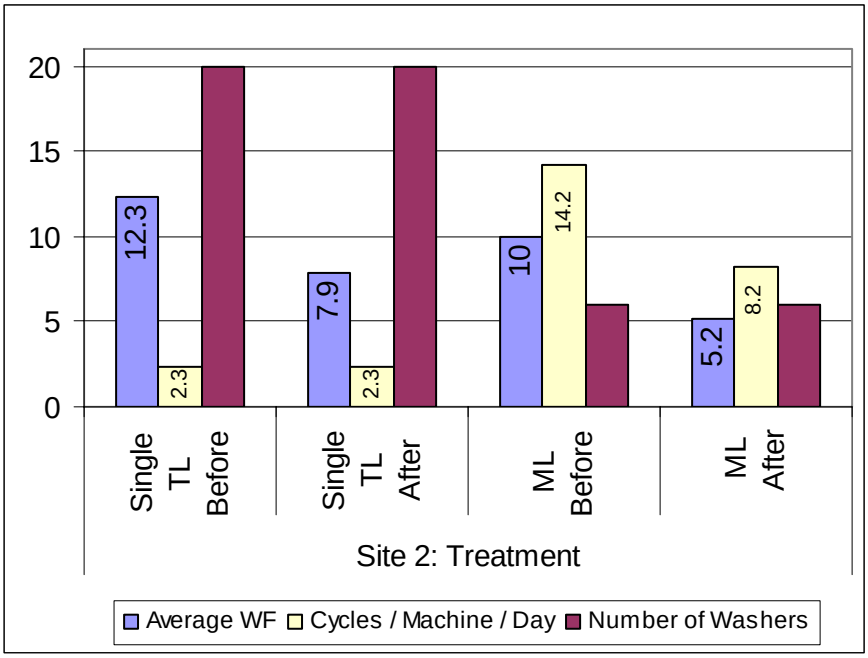
Summary of Tables 7 A-C:

- Comparing the pre-retrofit STL with post-retrofit STL washers:
  - Same quantity of washers, same quantity of users, a change in the WF from 12.3 to 7.9, respectively
  - A water savings of 23 gallons per machine per day
- Comparing the pre-retrofit ML with post-retrofit ML washers:
  - The quantity of ML washers remained constant (20-pound washers were replaced with 30 pound washers) and WF improved. However, the number of washer users decreased.
  - If washer usage was normalized to the same amount as before the retrofit, then the resultant water savings would be 36% when comparing the pound capacity by removing the pre-retrofit 20-pound washers and replacing them with the post-retrofit 30-pound washers.
- Based on Table 8 C, the cycles / washer / day of the older ML washers were getting a collective 7.1 cycles per turn, resulting in 3.0 more turns per day than the post-retrofit ML washers. Since the 12-pound uses for the washer / day stayed the same, <u>this site had a decrease in total turns / washer / day after the retrofit</u>.

It is important to note that interviews conducted at Site No. 2 with customers revealed that the customers preferred the older 30-pound washers to the newer 30-pound washers for three reasons:

1. The older 30-pound washers look larger on the outside.
2. The older 30-pound washers cost $.25 less.
3. The older 30-pound washers do a better job of rinsing the laundry.

Graph 3: Nominal Washer Size vs. WF for Site No. 2



Site Timeline:

Data collection timeline for pre-installation:

- Monitoring commenced for SL 12-pound washers on April 13, 2005 and was completed on May 26, 2005. Total timeline duration was 6 weeks.
- The data collection timeline was extended for the pre-installation of 30-pound washers:
- The monitoring commenced for double load 20-pound washers on April 13, 2005 and was completed on October 7, 2005. The total timeline duration was 25 weeks.

Data collection timeline for post-installation:

- Monitoring commenced for 12-pound washers on July 22, 2005 and was completed on January 5, 2006. Total timeline duration was 24 weeks.
- Monitoring commenced for 30-pound washers on November 14, 2005 and was completed on January 5, 2006. Total timeline duration was the anticipated 8 weeks.

The timeline for our analysis required an extension for this site because the owner of the Laundromat purchased post-retrofit washers but encountered some issues with the larger footprint base size, requiring customized bases to be made before installation.

Site No. 3, Treatment Site:

Ownership of this Laundromat changed hands after the baseline data had been completed. This site was initially intended to serve as the control site. The post-retrofit ownership undertook a detailed remodel of the facility, replacing most of the STL washers with ML washers, qualifying the site for the voucher program.

The facility before the retrofit had thirty STL, 12-pound washers, ten 20-pound washers, and four 30-pound washers. With the exception of the original ten 20-pound washers, all of the washers were replaced with new 18 and 30-pound washers. Four 12-pound and three 55-pound ML washers were also added.

Per-cycle estimates of water consumption are as follows:

TABLE 8 A: TREATMENT SITE NO. 3 - BEFORE RETROFIT (CONTROL FOR SITE NO. 3)

Washer Size	Per-cycle Total Consumption	Water Factor
12 pounds TL 23 washers	32.7 gal (5,509 wash cycles)	13
20 pounds 8 washers	31.7 gal (1,719 wash cycles)	11.3
30 pounds 1 washer	62.8 gal (177 wash cycles)	13.9

ACTUAL WASHER COUNT IS NOTED IN APPENDIX 4

***NOTE: NOT ALL DATA STATISTICALLY QUALIFIED TO BE INCLUDED AS USABLE**

TABLE 8 B: TREATMENT SITE NO. 3 AFTER RETROFIT

Washer Size	Per-cycle Total Consumption	Water Factor
12 pounds TL 3 washers	26.9 gal (273 wash cycles)	10.7
20 pounds (pre-retrofit washers) 9 washers	34.1 gal (603 wash cycles)	12.1
18 pounds (post-retrofit washers) 10 washers	15.2 gal (662 wash cycles)	5.8
30 pounds (post-retrofit washers) 8 washers	34.2 gal (194 wash cycles)	5.7
55 pounds (post-retrofit washers) 3 washers	86.0 gal* (152 wash cycles)	9.7

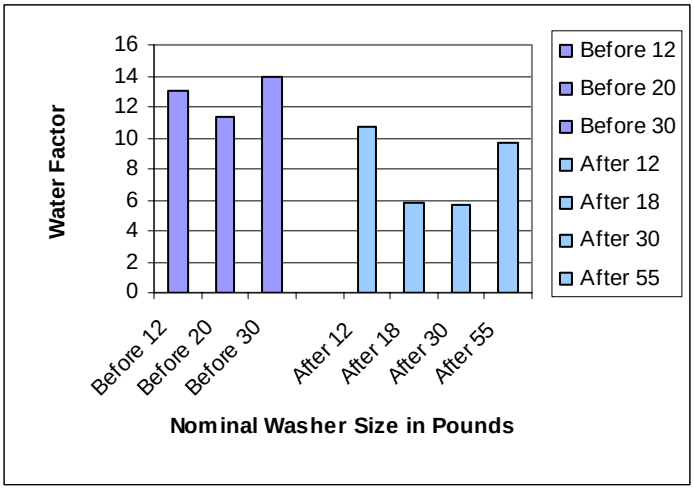
ACTUAL WASHER COUNT IS NOTED IN APPENDIX 4

***NOTE: NOT ALL DATA STATISTICALLY QUALIFIED TO BE INCLUDED AS USABLE**

Summary of Tables 8 A and B:

- None of the pre-retrofit washers would qualify under the Energy Star standards
- There is a 27% savings from pre-retrofit 12-pound washers to the post-retrofit 12-pound washers
- 52% savings from pre-retrofit 20-pound washers to the post-retrofit 18-pound washers
    - When comparing nominal capacity to average gallons per-cycle, it is evident that the pre-retrofit 20-pound washers were half as efficient as the post-retrofit 18-pound washers.
    - The post-retrofit 30-pound washers were 40% more efficient than the pre-retrofit 20-pound washers based on a capacity per total gallons used.

Graph 4: Nominal Washer Size vs. Water Factor for Site No. 3



The post-retrofit data indicates that a descending trend occurs if the 55-pound data is omitted. (See note below). A total of 64 machines were metered at this site with a total of 9,289 wash cycles metered to generate a WF for these 7 machine types. The 30-pound pre-retrofit and the STL 12 pound pre-retrofit washers were the least efficient of all washers monitored; the 18 and 30-pound post-retrofit washers were the most efficient.

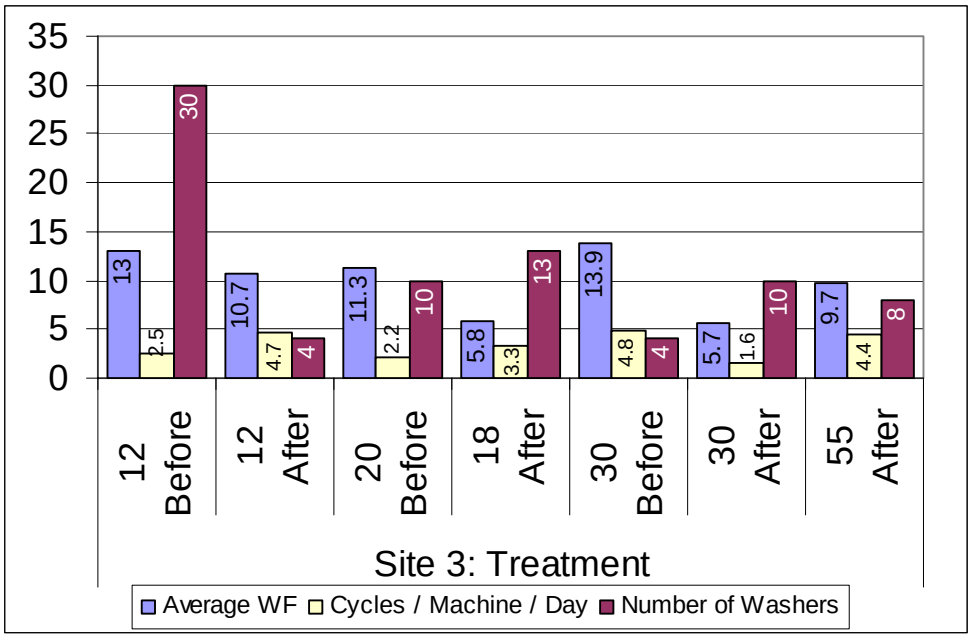
TABLE 8 C: TREATMENT SITE NO. 3 VARIATIONS IN INTENSITY OF USE

Washer Capacity	Number of Washers	Cycles / Washer / Day	Percentage of Washers	Percentage of Loads
#3 (pre-retrofit)				
12 lbs.	30	2.5	68.20%	64.10%
20 lbs.	10	2.2	22.70%	19.30%
30 lbs.	4	4.8	9.10%	16.60%
#3 (post-retrofit)				
12 lbs.	4	4.7	11.40%	16.70%
18 lbs.	13	3.3	37.10%	38.00%
20 lbs. (old washers)	10	1.6	28.60%	14.20%
30 lbs.	8	4.4	22.90%	31.10%

Summary of Tables 8A-C

- Overall, post-retrofit water usage at this site increased by 141,370 gallons per year (9%)
- 26 STL 12-pound washers were replaced by 20 ML washers (3 55-pounds, 4 30-pounds, and 13 18-pounds)
- A increase of 36% in total potential capacity (680 pounds pre-retrofit, 927 pounds post-retrofit)
- Frequency of use increased from 2.5 uses/day to 4.7 uses/day
- The quantity of 30-pound washers increased by 50%
- Water usage essentially remained the same, with an increase of 50% capacity for this washer type.
  - Pre-retrofit 30-pound washer used 62.8 gallons/turn*4.8 turns per day*4 washers=1205.76 gallons/washer/day
  - Post-retrofit 30-pound washer used 34.2 gallons/day*4.4turns/day*8 washers= 1203.84 gallons/washer/day

Graph 5: Nominal Washer Size vs. W F, Number of Machines, & Cycles /Machine/Day for Site No. 3



* Note: The data for the 55-pound washers indicated that the usage for the three washers averaged 56 gallons per cycle. This data seemed low, so information was reviewed with the manufacturer who stated that the usage for this washer is typically between 86 - 94 gallons. Data collection methodology for this study was reviewed and an investigation was made of the meters that were installed on the washers. It was determined that the reason WMI data indicated low usage was because these larger washers have three (3) water supply lines (hot, cold and warm) and even though meters were installed on all three water lines, the software only collected information from two of the three source points. Therefore, for the purposes of

the above analysis, WMI has used the lowest reported usage number of 86 gallons per wash cycle.

Site Timeline:

Data collection timeline for pre-installation: monitoring commenced on June 20, 2005 and was completed on December 1, 2005. Total timeline duration was 23 weeks. This was due primarily to the change in ownership, post-retrofit washer purchases, and renovation planning of the facility.

Data collection timeline for post-installation: monitoring commenced on December 22, 2005 and was completed on February 2, 2006. Total timeline duration for testing was 6 weeks.

Site No. 4, Treatment Site:

At treatment site No. 4, we measured only the washers being replaced and the post-retrofit washers being installed. Three STL 12-pound washers were replaced with two 40-pound ML washers.

Per-cycle estimates of water consumption are as follows:

TABLE 9 A: TREATMENT SITE #4 – BEFORE RETROFIT

Washer Size	Per-cycle Total Consumption	Water Factor
12 pounds TL 3 washers	41.3 gal (203 wash cycles)	16.3

TABLE 9 B: AFTER RETROFIT

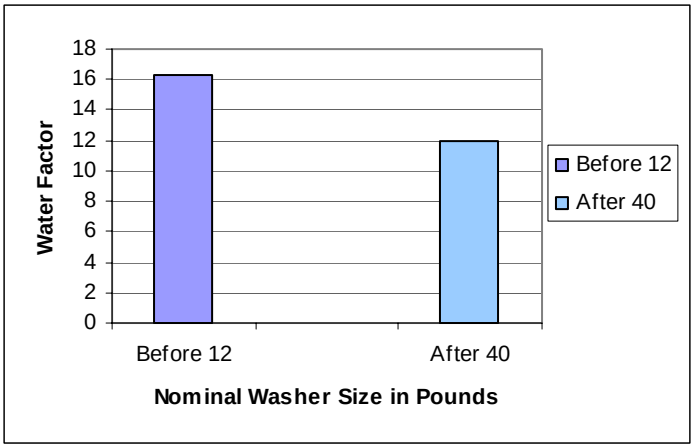
Washer Size	Per-cycle Total Consumption	Water Factor
40 pounds (post-retrofit) 2 washers	76.1 gal (184 wash cycles)	12

Site Results:

- The usage data demonstrates that as a result of this modification, the two post-retrofit ML washers were able to wash twice the amount of clothing than the three smaller TL washers. Total savings in water usage per year is 166,000 gallons, of which 31% is hot water savings (see Appendix 3-C).
- By replacing three 12-pound STL washers with two 40-pound washers, the capacity of the Laundromat increased while the water use decreased.
- Prior to retrofit, the three STL washers were each using on average 41.3 gallons per wash.
- After retrofit, the hot and cold consumption patterns were observed. The total average usage for each of the two 40-pound washers was approximately 76 gallons per wash.

- Treatment Site No. 4 replaced washers as the study was designed. This site realized significant water and energy savings and an increase in Laundromat capacity.

Graph 6: Nominal Washer Size vs. Water Factor for Site No. 4



Site Timeline:

Data collection timeline for pre-installation: monitoring commenced on April 19, 2006 and was completed on May 25, 2006. Total timeline duration was 5 weeks.

Data collection timeline for the post-installation: monitoring commenced on May 29, 2006 and was completed on July 16, 2006. Total timeline duration was 6 weeks.

This significant time shift of this test site from the three original participants was due primarily to a lack of interest the coin-operating communities in San Diego County held for participating in this study. Additional incentives of $1,000 were offered early in 2005 to entice initial participation as an added incentive to the rebate offered by the County's CII program. No additional funding was allocated from the budget to increase interest in participation.

The owners of this last test site decided to replace STL washers with ML washers and responded to the study through the Coin-Op Association.

DATA ANALYSIS

Results from water analysis:

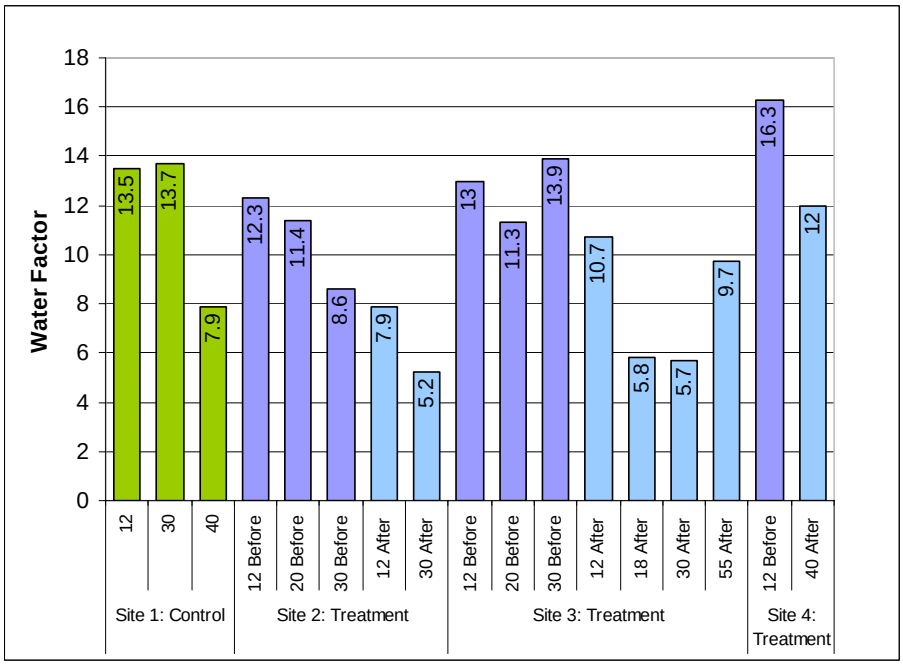
To provide accurate information about the water savings for ML washers compared to STL washers, water consumption per load for 185 washers of varying makes, models, brands, and sizes, was monitored. Laundry load size was also measured. The initial study design did not include metering all of the washers in the selected Laundromats, but because the owners of the Laundromats for Sites 2 and 3 did know which washers were going to be replaced, WMI felt it was necessary to meter all of the washers in Sites 1, 2 and 3.

Metering all of the washers in the first three sites significantly fortified the overall scope of this report. Initially, WMI intended to monitor only the replacement of STL washers with larger ML washers, but because WMI metered all of the washers and because the owners of Sites 2 and 3 replaced the majority of their washers, WMI was able to monitor the water savings from different SL and ML washers. In order to provide a more targeted scope WMI defined three different types of washers in the Coin-Operated Universe:

1. Small washers: STL and SFL washers with a nominal load size of 10-14 pounds.
2. Small ML washers: 18-30 pounds
3. Large ML washers: 35-pounds and above

The washer testing was conducted from April 2005, through July, 2006 in four unique sites in San Diego County. It involved 185 machines with 134 machines generating usable data. A total of 35,274 usable cycles were analyzed to determine a WF for 12, 18, 20, 30, 35, 40, and 55-pound washers. WF was determined by dividing average gallons used per machine (through field testing) by the manufacturer's tub dimensions (in cubic feet). Below is a summary of these findings:

Graph 7: Nominal Washer Size vs. Water Factor for Sites No. 1-4



Summary of water consumption analysis, Graph No. 5:

- Site 1 Control data supports the assumptions of this study. Large ML washers are more water-efficient than STL washers and smaller ML washers. Note that the 40-pound washer at Site 1 has a WF of 7.9.
- Site 2 Treatment data supports that replacing older STL washers with newer STL washers can generate significant savings. Note that the WF for the STL washers was reduced from 12.3 to 7.9 as a result of the retrofit.
- Site 2 Treatment data demonstrates that not all 30 pound washers are the same (WF reduction from 8.6 to 5.2 was realized). Also it was noted that older 20-pound washers have a WF that is just about as high as the WF for older STL washers.
- Site 3 Treatment data again supports that replacing older STL washers with newer STL washers can generate significant savings. Note that the WF for the STL washers was reduced from 13 to 10.7 as a result of the retrofit.
- Site 3 Treatment data demonstrates that replacing the 12 pound TL washers (WF 13.0) and the 20-pound ML washers (WF 11.3) with new 18 pound ML washers (WF 5.8) and new 30-pound ML washers (WF 5.7) resulted in water savings potential of approximately 50%.
- Site 4 Treatment data again supports the assumption of this study. Replacing three STL washers with two 40-pound ML washers resulted in increased capacity for the Laundromat and washers with a lower WF. WF was reduced from 16.3 to 12.0.

Results from laundry weighing:

The weighing of customers' laundry was included in the scope of this project for two primary purposes. First, to determine how load size related to washer size and second, to determine how load size impacts the moisture retained in the clothes.

The laundry weighing coincided with the washer monitoring in all sites where appropriate.

A common assumption is that smaller machines would be filled to capacity while larger machines would not be. The weighing data (see Appendix 3-A) indicates that customers in the four (4) monitored sites from 185 washers typically filled washers to approximately 67% of capacity regardless of drum size.

Another assumption regarding the impact of retained moisture on a load of laundry is that the closer the actual load is to the maximum capacity of the washer, the less water the laundry would retain. To determine the accuracy of this assumption, we metered and weighed laundry on two identical washers, side-by-side. One washer was loaded to capacity while another washer of the same size, model, and water pressure was loaded to half capacity. The washer loaded to capacity would assumedly retain more water – this did not occur. Our analysis, therefore, indicates that the amount of water retained in the laundry is related to the type of fabrics laundered and not the load size.

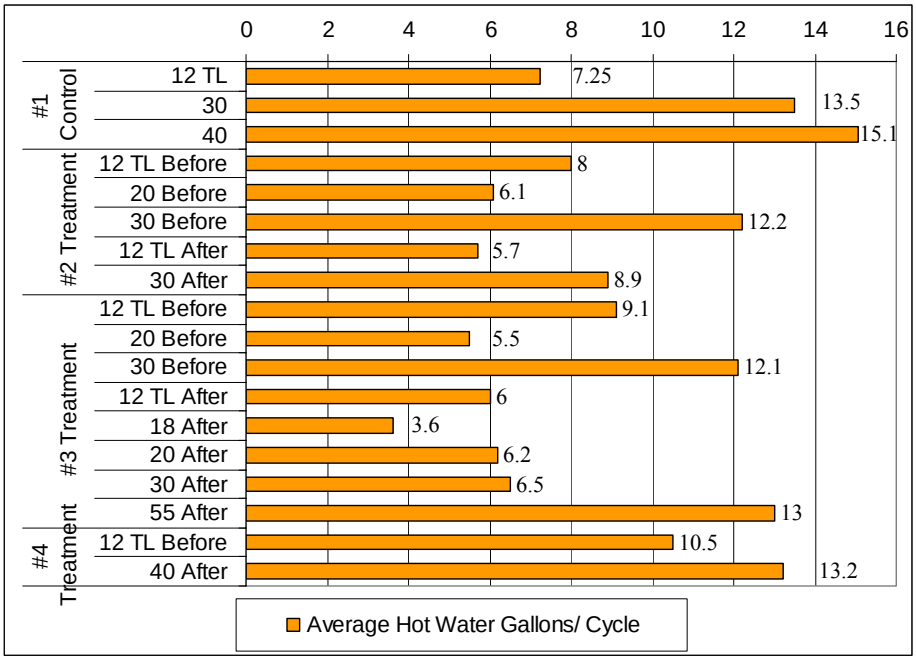
Results from energy monitoring:

According to the Fort Hood Study "Assessment of High-Performance, Family sized Commercial Clothes Washers," the following was found:

Baseline for the STL clothes washer consumption was 35.4 gallons. Of this, 9.0 gallons was hot water and 26.5 gallons was cold water (see Table 5 page 12). The average water use of the high performance clothes washers was 18.8 gallons, of which 3.4 gallons was hot water and 15.4 gallons was cold water. These savings represent a reduction in hot water use of 5.6 gallons per load or a 62% reduction in hot water use.

This information is somewhat consistent with what we found in our analysis.

Graph 8: Average Hot Water Usage in gallons



Summary of hot water usage:

- Hot water usage for clothes washers has gone down in the past ten years. Very few washers allow for rinses to be in hot water, and more and more consumers are choosing cold water in which to wash their laundry. Veterans of clothes washing realize that choosing warm water for initial fill increases the speed of the fill cycle.
- On average, the hot water usage for the older STL washers at the four sites before the retro-fit was only 8.67 gallons per load. This is very consistent with the data determined from the Fort Hood study. This usage accounts for 25% of the total water usage. Average hot water usage for the SL washers after the retrofit was 5.85 gallons per load. The savings realized of 32% is significant but the actual savings in dollars and cents works out to only approximately one penny per gallon or $.03 cents.

- The percentage of hot water usage for most of the larger ML washers in our analysis was less than 20% of the total water usage. The main reason that the percentage of use was less for ML washers was because the total water usage was greater (see Appendix 3-B: Ratio of Total Water Usage to Hot Water Usage (gallons/Cycle)).
- Total hot water savings was greatest at Site 4 where older inefficient STL washers were replaced with hot water-efficient 40-pound washers. Hot water savings was the least at Site 2 where the majority of STL washers were replaced with similar water-efficient STL washers (for more information See Appendix 3-C).
- Energy savings from reduction in hot water usage is based on the fact that if hot water is being saved, then the cost of heating that water is eliminated. Our calculation of savings is based on gas water heater efficiency of 85%, a temperature increase for the city water of 60˚ (from 60˚ to 120˚), and a therm rate of $1.00 per therm.

ESTIMATING ANNUAL WATER SAVINGS FROM MULTI-LOAD WASHERS

Although ML washers appear to use less water than TL washers, how much water per year is a retrofit likely to save? This requires assessing how often washers are used, and who likely will shift to ML washers. While we cannot provide conclusive answers to these questions, data collected under the parameters of this study can provide insight.

Table 10 shows how the intensity of use (cycles per day) varies from the Control Site to the two Treatment Sites #2 and #3 where a high percentage of washers were retrofitted. At the Control Site where no retrofits took place, on average, each 12-pound TL washer was used 3.3 times per day, 30-pound ML washers 3.0 times per day, and 40-pound ML washers 2.3 times per day during the measured period.[14] Table 11 also shows the total number of washers in each category and also the percentage distribution of both washers and loads. So, for example, 12-pound washers account for roughly 78% of all washers at the Control Site, and 82% of all loads.

Treatment Site #2 provided a different sort of setting. Here, almost all the 12-pound TL washers were retrofitted with post-retrofit TL washers, and three of the pre-retrofit 20-pound ML washers were replaced with 30-pound ML washers. The distribution of washers versus loads clearly suggests that after the retrofit, customer preferences for the post-retrofit STL washers had increased, and that preferences from the users of the now removed 20-pound ML washers had become bifurcated in favor of the post-retrofit STL washers over the post-retrofit 30-pound ML washers.

Treatment Site #3 is an example of a coin-op laundry where the poundage of washers was significantly shifted toward the ML washers. Prior to the retrofit, 68% of all the washers were 12-pound, STL washers, accounting for 64% of all loads. After the retrofit, only four of the

[14] A couple of caveats are in order here. Estimates of cycles per day are based upon a reading week of measurement. We are assuming that seasonality is not strong in San Diego coin-op usage patterns, so that these estimates are reasonable approximations of what might be observed on an annual basis. Second, the estimates of cycles per day are based upon data that were deemed clean after the editing was completed.

washers were STL 12-pound washers and the rest were ML washers. The data from this site is very revealing. This location reduced the number of STL washers from 30 to 4 and increased the number of double-load ML washers from 10 to 23, and triple-load or larger washers from 4 to 11. This radical change in the distribution size of the washers has allowed the laundry to reduce water usage significantly and have an increase in the nominal weight allowance by 34% with 6 less washers. It is clear that customers had successfully shifted their washes to the higher capacity washers, somewhat favoring the 18 and 30-pound ML washers over the 20-pound ML washers. Although the 12-pound TL washers were being used more intensely per day after the retrofit, the data does not suggest that customers resisted switching to the ML washers.

We surmise from this data that where only marginal changes occur in the inventory of washers, customers are less likely to switch to larger, more efficient washers. However, when a high percentage of the inventory is changed to smaller ML washers, customers are more likely to adjust their laundry habits and use the larger washers than resort to going to another Laundromat.

TABLE 10: VARIATION IN INTENSITY OF USE

Washer Capacity	Number of Washers	Cycles / Washer / Day	Percentage of Washers	Percentage of Loads
#1 (Control)				
12 lbs.	36	3.3	78.30%	81.80%
30 lbs.	5	3	10.90%	10.30%
40 lbs.	5	2.3	10.90%	7.90%
#2 (pre-retrofit)				
12 lbs. TL	20	2.3	76.90%	51.90%
20 lbs.	3	5.7	11.50%	19.30%
30 lbs.	3	8.5	11.50%	28.80%
#2 (post-retrofit)				
12 lbs. TL	20	2.3	76.90%	65.20%
30 lbs.	6	4.1	23.10%	34.80%
#3 (pre-retrofit)				
12 lbs.	30	2.5	68.20%	64.10%
20 lbs.	10	2.2	22.70%	19.30%
30 lbs.	4	4.8	9.10%	16.60%
#3 (post retrofit)				
12 lbs.	4	4.7	11.40%	16.70%
18 lbs.	13	3.3	37.10%	38.00%
20 lbs.	10	1.6	28.60%	14.20%
30 lbs.	8	4.4	22.90%	31.10%

WHAT IS A MULTI-LOAD RETROFIT LIKELY TO SAVE?

To address this question requires asking what type of customer is likely to switch to a larger washer if such an option were available, and involves knowing how often such washers are likely to be used, the life of the washer, and the cost of water and any other fees charged by jurisdictions where the Laundromat is located.

By taking the best estimate of consumption for the 20 and 30-pound washers as somewhere between 30 and 34 gallons per-cycle (median 32 gallons per-cycle), and assuming that each type of washer is loaded to capacity, then three loads in a 20-pound ML washer amounts to two loads of a 30-pound ML washer. Thus, on average, each load washed in a 30-pound ML washer ought to save approximately 16 gallons. Table 11 shows the value of saved water (without discounting) for washer life, use intensity (cycles per day) and the price of water. So, for example, if a washer saves 16 gallons per load and is used 4 times per day, and the price of water is $195 per acre-foot, then the value of saved water over the lifetime of the washer would calculate to be $143.

TABLE 11: COST OF WATER TO OPERATE WASHER FOR A LIFETIME

Life of Washer	Cycles per day	$200/ acre foot
10 years	3	$107
	4	$143
	5	$179

DATA COLLECTION CHALLENGES

The meters chosen for this study could not be read manually. Data automatically downloaded into a receiver daily. Readings could only be obtained by downloading the data from the receiver into an Excel spreadsheet that initially showed as 10 columns of numbers representing a specific parameter. For data analysis, information was extracted from only two of the columns and compared to the usage from the previous week's reading. Each week, approximately 600 lines of data were downloaded. The process of updating the data spreadsheet was not automatic, and, therefore, errors in the data were not easily detected.

The most common metering errors were either due to transmission error or battery failure. This would typically happen only on either the cold or hot side – not both sides, but because it was important to calculate total consumption, we would often have to throw out all of the data from that washer.

Another problem encountered on one of the sites (#2 Treatment Site) was 6 of the washers indicated that they were using in excess of 75% hot water. In general, washers use more cold water than hot water, but for these six washers the data showed the opposite pattern. Initially, it was suspected that this was the result of mislabeling the hot for cold and cold for hot meters in the data or maybe the water lines themselves were switched (these washers shared a common wall and were back-to-back with other washers). New washers come from the factory using no hot water during rinse cycles* which means that even if all of those washers were set on “hot” for all of the washes, the greatest amount of hot water they could use would be 35%.

* Note: New washers with microprocessors can be programmed to use hot water in the rinse cycles.

CALCULATION OF UNCERTAINITY BANDS (CONFIDENCE INTERVALS)

Consumption per cycle can vary from washer to washer due to variation in washer and customer characteristics. Although per-cycle consumption estimates are based upon data averaged over (usually) hundreds of wash cycles, a band of uncertainty surrounds the estimates presented above. How large are these uncertainty bands likely to be?

This question cannot be rigorously addressed in the present context. But reasons outlined below indicate these bands are likely to be narrow in most instances. In this study, consumption on a per-cycle basis was not observed. Total consumption and total cycles occurring in a given period were observed (that is, the time between successive reads). Half a dozen reads could account for hundreds of cycles for a given class of washers. Treating each read as a single observation, and calculating confidence intervals, based upon the variation in average consumption across reads, would be conceptually incorrect.

It is suggested that this issue be addressed by making suitable assumptions about variation in per-cycle consumption, and by deriving uncertainty bands from this assumption. For example, we could posit that per-cycle consumption varies around the average with a standard deviation of 5 gallons. What does this assumption imply in practical terms? It implies that consumption in 95 out of every 100 cycles will tend to lie within a band of ±10 gallons surrounding the average metered value. So, if on average, a washer uses 30 gallons per cycle, then a range of 20-40 gallons per cycle (a fairly wide interval) will capture 95% of the observed cycles.

Were average consumption calculated using data collected over 100 reading cycles from the above distribution, the uncertainty band (95% confidence interval) surrounding the average would work out to ±0.5 gallons.[15] Data for this study was derived from thousands of cycles, so in practice these bands are likely to be considerably narrower. Or, expressed differently, one could assume much larger bands of variation in consumption per-cycle, and still not arrive at a very large uncertainty band surrounding the overall average.

STUDY CHALLENGES

Study challenges included problems with monitoring devices, monitoring timeline delays, and difficulty locating and keeping participants.

Monitoring device issues arose from the beginning of the study. The abilities of the meters may have been misunderstood; they could not detect total cycle counts, they would instead meter "events." Multiple events can make up one cycle, meaning that the pre-rinse, wash, and rinse would count as three events. This data would vary per washer and would thus be considered unusable due to its ambiguity. This required the additional purchase and installation of individual electro-mechanical counters to determine the correct number of cycles (uses) per washer.

[15] This is derived by using the statistical formula $1.96*(\sigma^2/N)$, where σ is the standard deviation and N is the total number of cycles from which the average is derived.

Once monitoring commenced at a specific site, the timelines were often delayed for a variety of reasons. Some of the reasons for delays were:

- Change in ownership
- Participants did not implement washer change-outs in the timeline as planned
- The need to create necessary accommodations for washers with larger footprints as shown below in Table 13. Moving from a 20-pound ML washer to a 30-pound ML washer requires a substantial modification in the width

TABLE 12: FOOTPRINT SIZES OF WASHERS

Washer Sizes	Nominal LBS	Footprint	
		Width (inches)	Depth (inches)
Top Load			
Single Load Washer	12	25"- 27"	26.75" - 28.25"
One and a Half Load Washer	18	26.88"	28"
Double Load Washer	20	26"	25.625"
Front Load			
Single Load Washer	12	26.75"	27"
One and a Half Load Washer	18	27"	28.25"
Double Load Washer	20	26" - 26.88"	27"- 30.13"
Triple Load Washer	30	28.375"- 29"	30.63"- 32.5"
Four Load Washer	40	30.63"	36"
Four and a Half Load Washer	55	32.69"	39"

The biggest and most surprising challenge was the difficulty in locating and keeping participants. Although the County had external cooperators such as WSA marketing supplying outreach, public relations, and direct marketing activities, additional incentives (over and above the voucher incentive) were necessary to obtain participation from the four sites. To entice more participants, a number of options were explored. WMI first contacted Laundromat owners through WSA. Next, contacts through manufacturers were used and, finally, participants were given the option to be first in line for $775 vouchers offered by the County. None of these options were successful. As a final effort to save the study, WMI offered an additional monetary incentive of $1,000 per participant.

Study challenges were overcome with the support understanding of the SDCWA and their respective stakeholders, the tenacity of the contractor, and especially the encouragement from CII Voucher Incentive Program Manager for SDCWA.

SUMMARY

This monitoring and assessment pilot project created for the San Diego County Water Authority (SDCWA) and funded by the Department of Water Resources (DWR) Proposition 13 Grant was intended to determine the best way to maximize water efficiency in the coin-operated Laundromat community in San Diego County. This pilot project is designed to provide data on the incentives (vouchers) used by SDCWA to encourage Laundromat owners to replace inefficient coin-operated single top-load (STL) washers with more efficient and larger multi-load (ML) washers.

This report analyzes the benefit and the effect of replacing of single top-load washers with multi-load washers. During the course of this study (April 2005 through July 2006), extensive data from seven manufacturers was obtained and analyzed, site surveys were performed at 29 laundry sites in San Diego County, and consumption information from 35,274 usable cycles were collected from 186 washers. The results are presented here.

Why this type of study now:

This pilot project comes at a time when market pressures and governmental forces have impressed upon manufacturers to improve the efficiencies of both residential and commercial clothes washers. Efficiency requirements have been set for residential-sized washers for a number of years. New requirements are being set forth for commercial clothes washers in the upcoming Energy Policy Act of 2005 (Public Law 109-58-Aug. 8, 2005). These new requirements apply to some commercial clothes washers, but are not inclusive to all commercial clothes washers. Particularly, clothes washers' with a tub volume (capacity) of less than 3.5 cubic feet for horizontal-axis washers and less than 4.0 cubic feet for vertical-axis washers are targeted for Energy Act's parameters. Other parameters include a Water Factor of less than or equal to 9.5 for washers manufactured after January 1, 2007.

In this report, a great deal of data is presented. Understanding this data is made easier when one recognizes that the manufacturers of commercial clothes washers are caught in between two distinct and different market pressures. These market pressures are to increase energy and water efficiency and to please the high-end user market.

Water and Energy Efficiency Pressure: Attached to this report is a copy of the Department of Energy's (DOE) Energy Star Listing of Active Washers. Only units with a tub volume of 3.89 cubic feet (25-pound washer) or less are listed. The manufacturers of these residential sized washers are under a great deal of pressure from DOE, the Consortium of Energy Efficiency (CEE) and the County of San Diego to continue to improve both water and energy efficiencies. All Energy Star washers receive a Water Factor (WF) rating. Water Factor ratings of 8.0 or lower are the goal for residential and smaller multi-load washers.

Performance Pressure: The commercial laundry industry is in transition. Commercial laundry managers for hotels, hospitals, and prisons are demanding washers with greater performance - washers that can provide extra rinses, longer soak times, and different wash formulas based on different detergents are in high demand for this type of user market. Coin-Op Laundromat owners are also requesting washers with automated electronic controls and extra performance options. Microprocessor technology found in multi-load washers allows

manufacturers to design washers with more than 30 different wash and rinse features in order to accommodate the needs of this particular customer.

What this monitoring and assessment program confirms:

- This project confirms that large multi-load washers (washers with tub volumes of 5.0 cubic feet or larger) are more water-efficient than the existing inventory of single top-load (STL) washers.

What this monitoring and assessment program found:

- This project found that smaller multi-load washers (washers with tub volumes of 4.0 cubic feet or less) are generally more water efficient than larger multi-load washers (washers with tub volumes greater than 5.0 cubic feet).

Further information from this pilot project is presented below:

- There are estimated 200 - 225 Laundromats in the San Diego service area, each with an average of 30 - 35 washers."[16] Approximately 600 to 1200 commercial washers are in need of replacement each year in the San Diego area (page 5).
    - Twenty Eight percent (28%) of the single load washers in the Coin-Op Laundromats in San Diego are already front-load (FL) washers (Appendix 1).
    - Eleven percent (11%) of the washers in the Coin-Op Laundromats in San Diego are multi-load washers with a capacity of 35 pounds or greater (Appendix 1).
    - Washers in the Coin-Op Laundromats in San Diego have less than 4.5 uses per day. Industry average is 6-8 uses per washer per day (Table 10, page 31 Variations in Intensity of Use).
    - In San Diego County, if a Laundromat owner adds extra washers they will be required to obtain a permit from the City. For every washer added to the inventory, the owner is required to pay a permit fee of $3,130. Installing multi-load washers in place of single-load washers gives Laundromat owners the ability to increase capacity and avoid permit costs.
- Multi-load washers are more water efficient than single top-load washers. This is because the majority of single-load washers are top-load (vertical axis) washers that use a different washing process than front-load (horizontal axis) washers.
    - Literature obtained from manufacturers indicates that single front-load washers are more water-efficient than single top-load washers and they are also more water efficient than larger multi-load washers (Table 1-B, page 7).

[16] San Diego County Water Authority (March, 2002) Prop 13 urban water conservation capital outlay grant: coin-operated multi-load clothes washer voucher incentive program. http://www.owue.water.ca.gov/docs/finpdf/PSP_165.PDF

  - Data generated from the Control Site concluded that multi-load washers were more water efficient than single top-load washers (based on data from over 14,700 wash cycles, page 18).
  - Site No.4, Treatment Site, multi-load washers were more efficient than single-load washers (based on data from over 350 wash cycles, page 25).

- Replacing older Single Top-Load washers with newer Single Top-Load washers can generate significant savings.
  - Data collected from Site No.2, demonstrates that the water factor for the Single Top-Load washers was reduced from 12.3 to 7.9 as a result of a retrofit with a 31.3% water savings (data based on 7,500 wash cycles) (page 19).
  - Site No.3, Treatment Site data demonstrated that the Water Factor for the Single Top-Load washers was reduced from 13 to 10.7 with a 27% savings as a result of the retrofit (based on over 5,500 wash cycles page 22).

- Replacing older machines with new machines, regardless of the size results in an increase in water efficiency:
  - Not all 30-pound washers are the same. Site No.2, Treatment Site data demonstrates that a Water Factor reduction from old 30-pound machines of 8.6 to the new 30-pound machines of 5.2 was realized (based on 950 wash cycles).
  - Site No.3, Treatment Site data demonstrates that the 12-pound Single Top-Load washers and 20-pound multi-load washers with a Water Factor of 13.0 and 11.3, respectively were replaced with new 18-pound and 30-pound multi - load washers with Water Factors of 5.8, and 5.7, respectively. There is a water savings potential of approximately 50% realized for this site (based on over 9,000 wash cycles page 22).

- An increasing in the capacity of a Laundromat can be realized by replacing Single Top-Load washers with multi-load washers,
  - Site No. 2 increased capacity by 8%, reduced total water usage by 44% and reduced hot water by 39% (see Appendix 3-C).
  - Site No. 3, Treatment Site increased capacity by 36%, increased water usage by 9%, and reduced hot water usage by 14% (see Appendix 3-C).
  - Site No. 4, Treatment Site increased capacity and decreased in Water Factor

- Marketing new multi-load machines is an important factor for Laundromat owners:
  - Customers migrate to the larger washers only when they perceive they are getting a better bargain (Site No.2, page 20 and Appendix 2). Therefore, pricing and obvious appearance of more capacity for the dollar have a lot to do with creating customer demand for larger washers.
  - Customers do not always fill larger washers to capacity.
    - Post retrofit weighing data for 18-pound Top-Load washers reported that customers were only filling the washers to 53% of capacity (see Appendix 3-A).

- Weighing data for 18 and 30-pound multi-load washers indicate that customers are filling washers to 68% of capacity (see Appendix 3-A).
- They are filling the largest capacity multi-load washers (55-pounds) to 88% of capacity (see Appendix 3-A).

- Hot water usage decreases with new multi-load washers:
  - On average the hot water usage for the older single top-load washers at the four sites before the retro-fit was only 8.67 gallons per load based on over 21,700 wash cycles). This usage accounts for 25% of the total water usage.
  - Average hot water usage for the single load washers after the retrofit was 5.85 gallons per load (based on over 6,600 wash cycles).
  - The savings realized is 32% (see page 29, Graph 8).
  - The percentage of hot water usage for most of the larger multi-load washers in our analysis was less than 20% of the total water usage. The main reason was the total water usage for multi-load washers was greater (see Appendix 3-B: Ratio of Total Water Usage to Hot Water Usage (gallons/Cycle).
  - Total hot water savings was greatest at Site 4 where older, inefficient single top-load washers were replaced with hot-water-efficient 40-pound washers.
  - Hot water savings was the least at Site 2, where the majority of single top-load washers were replaced with similar water-efficient single top-load washers (for more information See Appendix 3-C).

APPENDIX

Appendix 1: Washer count based on type in San Diego County, 2004-2005

	Top	Front	Double	Double	Double	Triple	Triple	Four	Five	Five	Ten
	Load	Load	Load	Load	Load	Load	Load	Load	Load	Load	Load
Laundromats	12 lb	12 lb	18 lb	20 lb	25 lb	30 lb	35 lb	40lb	50 lb	55 lb	80 lb
1	30	16	0	2	3	4	8	4	4	0	0
2	16	0	0	0	0	0	0	0	0	0	0
3	28	6	6	0	0	0	5	0	2	0	0
4	24	6	0	0	0	17	0	0	2	1	0
5	32	0	11	0	0	3	0	0	0	0	0
6	0	10	0	10	0	5	3	0	1	0	0
7	22	0	22	0	0	8	0	0	2	0	0
8	4	30	17	0	0	13	0	0	2	0	0
9	36	32	0	17	0	7	6	0	4	2	0
10	21	0	0	0	0	0	0	0	0	0	0
11	33	0	52	0	0	24	0	0	0	0	5
12	20	0	2	0	0	0	0	0	0	0	0
13	18	0	16	0	0	8	2	0	0	0	0
14	0	32	0	0	0	0	4	0	6	0	0
15	16	0	13	0	0	0	10	0	8	0	0
16	8	10	0	0	0	9	0	3	0	0	0
17	20	0	5	2	0	5	2	0	0	0	0
18	0	25	0	0	0	0	6	0	2	0	0
19	28	9	8	0	0	5	6	1	0	0	0
20	16	0	0	0	0	6	0	0	0	0	0
21	12	13	0	12	6	0	0	7	4	0	0
22	13	9	5	0	0	2	2	0	0	0	0
23	16	14	10	0	0	0	0	0	0	0	0
24	20	0	0	0	0	4	0	0	0	0	0
25	30	6	0	0	0	5	0	0	2	0	0
26	9	0	5	0	0	9	0	0	3	0	0
27	37	0	26	0	0	0	24	0	5	0	0
28	12	0	16	0	0	0	0	0	8	0	0
29	33	0	52	0	0	24	0	0	6	0	1
Total	554	218	266	43	9	158	78	15	61	3	6
	39.3%	15.5%	18.9%	3.0%	0.6%	11.2%	5.5%	1.1%	4.3%	0.2%	0.4%
Total		54.8%		22.5%		16.7%					6.0%
AVERAGE	19	8	9	1	0	5	3	1	2	0	0
MAX	37	32	52	17	6	24	24	7	8	2	5

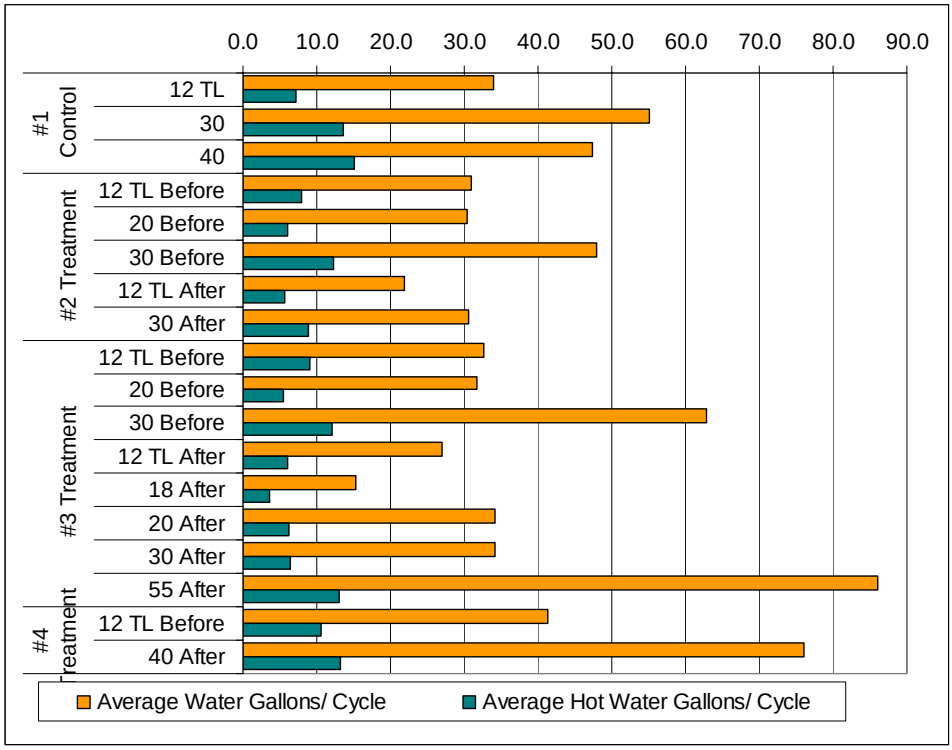
Appendix 2: Cost Analysis per load of laundry based on washer type

	Top Load	Front Load	Double Load	Double Load	Double Load	Triple Load	Triple Load	Four Load	Five Load	Five Load	Ten Load
Laundromats	12 lb	12 lb	18 lb	20 lb	25 lb	30 lb	35 lb	40lb	50 lb	55 lb	80 lb
1	$1.75	$1.75		$2.50	$2.50	$3.25	$3.00	$3.50	$4.50		
2											
3	$1.25	$1.25	$1.75				$3.00		$4.50		
4	$1.25	$1.50				$2.75			$4.50	$6.00	
5	$1.25		$1.25			$3.00					
6				$2.50		$3.50	$3.50		$4.00		
7	$0.75		$1.00			$2.50			$4.50		
8	$1.25	$1.25	$1.50			$2.50			$4.00		
9	$1.25	$1.25		$2.25		$3.00	$3.00		$5.00	$5.00	
10	$1.50										
11	$1.30		$1.60			$3.00					$6.95
12	$1.25		$1.75								
13	$1.00		$1.25			$2.50	$3.00				
14		$1.50					$3.00		$4.00		
15	$1.00		$1.25				$2.00				
16	$1.50	$1.75				$2.75		$3.75			
17	$1.75		$2.00	$2.00		$3.50	$3.50				
18		$1.50					$3.75		$5.50		
19	$1.50	$1.50	$1.50			$3.50	$3.00	$3.00			
20						$2.50					
21				$2.00	$2.25			$3.75	$4.50		
22	$1.50	$1.50	$1.50			$3.00	$3.00				
23	$1.50	$1.50	$1.75								
24	$1.75					$2.50					
25	$1.25	$1.50				$1.75			$3.00		
26			$1.50			$3.25			$4.00		
MAX	$1.75	$1.75	$2.00	$2.50	$2.50	$3.50	$3.75	$3.75	$5.50	$6.00	$6.95
MIN	$0.75	$1.25	$1.00	$2.00	$2.25	$1.75	$2.00	$3.00	$3.00	$5.00	$6.95
COUNT	19	12	13	5	2	17	11	4	12	2	1

Appendix 3-A: Weighing Data and Water Weight Remaining

	Date	Type	Pounds Rated	Pounds Actual	% of Capacity	Weight After Cycle	Weight Change
Control Site	2/2/2006	Top-Load	18	12	67%	19	7
	2/2/2006	Top-Load	18	10.15	56%	17.75	7.6
	2/2/2006	Top-Load	18	9.4	52%	14.35	4.95
	2/2/2006	Top-Load	18	6.4	36%	8.3	1.9
				Average	**53%**		
	2/2/2006	Front-Load	30	14.3	48%	18.4	4.15
	2/2/2006	Front-Load	30	22.2	74%	34.5	12.35
				Average	**61%**		
Treatment Site # 3	1/5/2006	Front-Load	18	14.95	83%	21.8	6.85
	1/5/2006	Front-Load	18	7.25	40%	10.75	3.5
	1/5/2006	Front-Load	18	10.15	56%	13.9	3.75
	1/26/2006	Front-Load	18	11.95	66%	17.75	5.8
	1/26/2006	Front-Load	18	16.45	91%	25.75	9.3
				Average	**68%**		
	1/26/2006	Front-Load	30	18.9	63%	30.8	11.9
	1/26/2006	Front-Load	30	26.1	87%	41.95	15.85
	1/26/2006	Front-Load	30	16.45	55%	26.9	10.45
				Average	**68%**		
	1/5/2006	Front-Load	55	51	93%	79	28
	1/26/2006	Front-Load	55	46.25	84%	78.2	31.95
				Average	**88%**		

Appendix 3-B: Ratio of Total Water Usage to Hot Water Usage (gallons/Cycle)



Appendix 3-C: Annual Savings

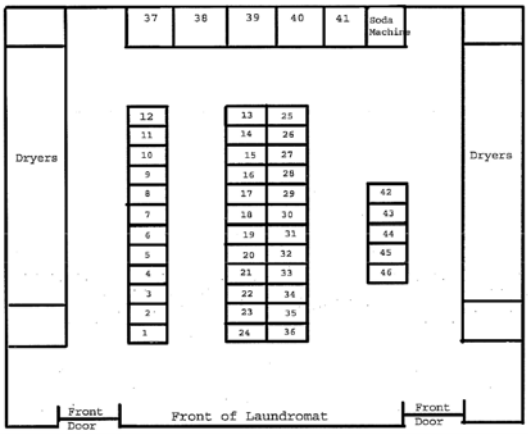
Washer Capacity (Pounds)	Pounds Cap. Before Retrofit	Pounds Cap. After Retrofit	% Capacity Increase	Annual Water Use Before Retrofit	Annual Water Use After Retrofit	Annual Hot Water Use Before Retrofit	Annual Hot Water Use After Retrofit
#1 Control							
12 TL	432	432		1,474,308	1,474,308	314,375	314,375
30	150	150		301,946	301,946	73,913	73,913
40	200	200		198,962	198,962	63,172	63,172
TOTAL	782	782		1,975,216	1,975,216	451,459	451,459
#2 Treatment							
12 TL Before	240			518,811		134,320	
20 Before	60			189,742		38,073	
30 Before	90			446,760		113,552	
12 TL After		240			366,022		95,703
30 After		180			274,757		79,913
TOTAL	390	420	8%	1,155,313	640,779	285,945	175,616
Savings (gallons)					514,533		110,329
#3 Treatment							
12 TL Before	360			895,163		249,113	
20 Before	200			254,551		44,165	
30 Before	120			440,102		84,797	
12 TL After		48			184,588		41,172
18 After		234			238,009		56,371
20 After		180			694,515		126,275
30 After		300			199,728		37,960
55 After		165			414,348		62,634
TOTAL	680	927	36%	1,589,816	1,731,188	378,074	324,412
Savings (gallons)					-141,372		53,662
#4 Treatment							
12 TL Before	36			279,094		70,956	
40 After		80			113,055		19,610
TOTAL	36	80	122%	279,094	113,055	70,956	19,610
Savings (gallons)					166,038		51,346
Overall Total							
TOTAL	1,106	1,427	29%	4,999,438	4,460,238	1,186,434	971,098
Savings (gallons)					539,200		215,337

Appendix 4: Laundry Sites Washer and Map Data

Control Site #1

36 TL 12-pound Speed Queen washers
5 ML 30-pound Speed Queen, 5 ML 40-pound Speed Queen washers

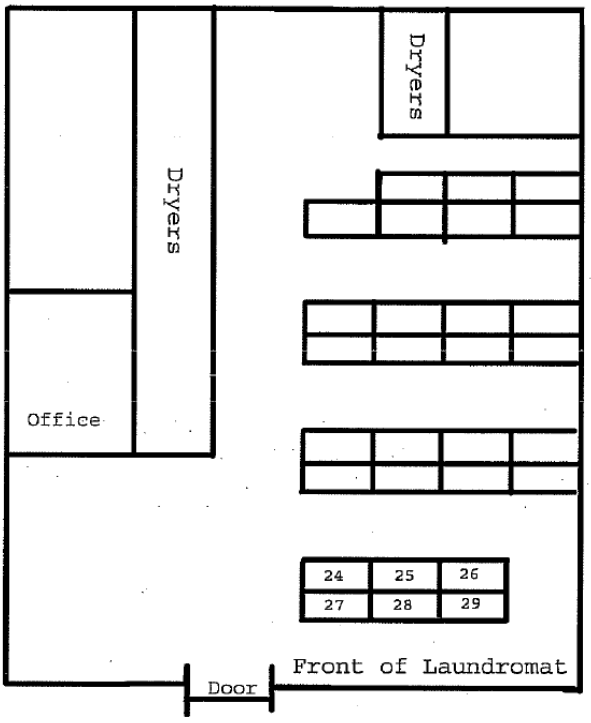
Machine #	Hot Meter	Cold Meter	Model #	Cu ft	Pound	Type	Manufacturer
1	5038775	5036423	EA2821LT	2.52	12	TL, SL	Speed Queen
2	5038355	6006765	EA2821LT	2.52	12	TL, SL	Speed Queen
3	5038357	5037747	EA2821LT	2.52	12	TL, SL	Speed Queen
4	6005868	5036985	EA2821LT	2.52	12	TL, SL	Speed Queen
5	6007182	5037329	EA2821LT	2.52	12	TL, SL	Speed Queen
6	5038343	5038371	EA2821LT	2.52	12	TL, SL	Speed Queen
7	5037736	5037357	EA2821LT	2.52	12	TL, SL	Speed Queen
8	5038153	5037737	EA2821LT	2.52	12	TL, SL	Speed Queen
9	5037344	6007195	EA2821LT	2.52	12	TL, SL	Speed Queen
10	5037522	6006755	EA2821LT	2.52	12	TL, SL	Speed Queen
11	5037327	6006764	EA2821LT	2.52	12	TL, SL	Speed Queen
12	5038421	5037867	EA2821LT	2.52	12	TL, SL	Speed Queen
13	5021713	5020462	EA2821LT	2.52	12	TL, SL	Speed Queen
14	5029304	5021743	EA2821LT	2.52	12	TL, SL	Speed Queen
15	5021714	5021617	EA2821LT	2.52	12	TL, SL	Speed Queen
16	5021179	5020499	EA2821LT	2.52	12	TL, SL	Speed Queen
17	5020498	5022121	EA2821LT	2.52	12	TL, SL	Speed Queen
18	5021747	5021919	EA2821LT	2.52	12	TL, SL	Speed Queen
19	5021860	5020487	EA2821LT	2.52	12	TL, SL	Speed Queen
20	5021906	5021863	EA2821LT	2.52	12	TL, SL	Speed Queen
21	5021872	5021916	EA2821LT	2.52	12	TL, SL	Speed Queen
22	5021867	5021621	EA2821LT	2.52	12	TL, SL	Speed Queen
23	5020489	5021754	EA2821LT	2.52	12	TL, SL	Speed Queen
24	5021909	5021831	EA2821LT	2.52	12	TL, SL	Speed Queen
25	5021937	5021626	EA2821LT	2.52	12	TL, SL	Speed Queen
26	5021832	5021914	EA2821LT	2.52	12	TL, SL	Speed Queen
27	5029252	5021869	EA2821LT	2.52	12	TL, SL	Speed Queen
28	5031008	5020473	EA2821LT	2.52	12	TL, SL	Speed Queen
29	5020483	5021975	EA2821LT	2.52	12	TL, SL	Speed Queen
30	5020468	5022110	EA2821LT	2.52	12	TL, SL	Speed Queen
31	5022113	5021902	EA2821LT	2.52	12	TL, SL	Speed Queen
32	5030861	5022014	EA2821LT	2.52	12	TL, SL	Speed Queen
33	5021756	5022116	EA2821LT	2.52	12	TL, SL	Speed Queen
34	5029300	5021915	EA2821LT	2.52	12	TL, SL	Speed Queen
35	5021870	5021812	EA2821LT	2.52	12	TL, SL	Speed Queen
36	5022414	5021908	EA2821LT	2.52	12	TL, SL	Speed Queen
37	6007208	5038019	EX3251610121	4.00	30	ML	Speed Queen
38	5027171	5029336	EX3251610121	4.00	30	ML	Speed Queen
39	5029250	5030829	EX3251610121	4.00	30	ML	Speed Queen
40	5038372	5028504	EX3251610121	4.00	30	ML	Speed Queen
41	5033295	5029249	EX3251610121	4.00	30	ML	Speed Queen
42	5029479	5029260	EX4400	6.00	40	ML	Speed Queen
43	5029262	5032971	EX4400	6.00	40	ML	Speed Queen
44	5028919	5033298	EX4400	6.00	40	ML	Speed Queen
45	5029287	5029526	EX4400	6.00	40	ML	Speed Queen
46	5030903	5033971	EX4400	6.00	40	ML	Speed Queen



Treatment Site #2

Before Retrofit:	23 Single Top-Load (STL) 12-pound - SpeedQueen washers 3 Wascomat Junior 20-pound & 3 Wascomat Senior 30-pound washers
After Retrofit:	3 Single Top-Load - SpeedQueen, 20 Single Top-Load Huebsch washers 3 SpeedQueen 30-pound & 3 Wascomat Senior 30-pound washers

Machine #	Hot Meter	Cold Meter	Old Capacity	Model	Cu Ft	Replaced	Date	New Capacity	Model	Cu Ft
1	5038886	5038902	12	SpeedQueen	2.52	No	N/A	N/A		
2	5038933	5038900	12	SpeedQueen	2.52	No	N/A	N/A		
3	5038876	5038928	12	SpeedQueen	2.52	No	N/A	N/A		
4	5038891	5037927	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
5	5038913	5038905	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
6	5038873	5038903	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
7	5037925	5038915	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
8	5038159	5038814	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
9	5038813	5038901	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
10	5038875	5038817	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
11	5038821	5037928	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
12	5038812	5038822	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
13	5038916	5038819	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
14	5038942	5038877	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
15	5038906	5038889	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
16	5038924	5038899	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
17	5038166	5038810	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
18	5038811	5038823	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
19	5038887	5037926	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
20	5026529	5026236	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
21	5026587	5026254	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
22	5026575	5026234	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
23	5026584	5026222	12	SpeedQueen	2.52	Yes	7/8/2005	12	Huebsch	2.75
24	5038892	5038809	20	Wascomat Jr	2.67	Yes	10/24/2005	30	SpeedQueen	4.19
25	5038885	5038820	20	Wascomat Jr	2.67	Yes	10/24/2005	30	SpeedQueen	4.19
26	5038917	5038890	20	Wascomat Jr	2.67	Yes	10/24/2005	30	SpeedQueen	4.19
27	5038876	5038818	30	Wascomat Sr	5.59	No	N/A	N/A		
28	5038808	5038929	30	Wascomat Sr	5.59	No	N/A	N/A		
29	5038934	5038925	30	Wascomat Sr	5.59	No	N/A	N/A		



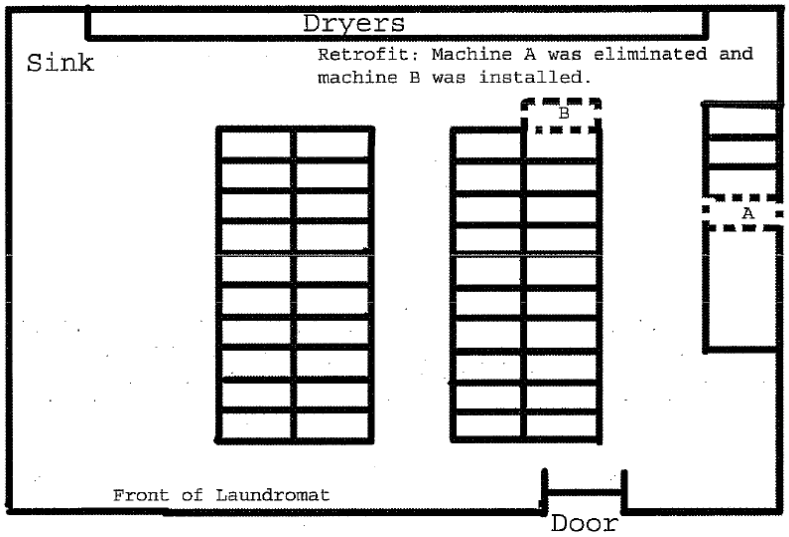
Treatment Site #3 Change-over 12/1/2005

Before Retrofit:
30 Maytag STL 12-pound washers
10 Wascomat 20-pound & 4 Wascomat 30-pound washers

Machine #	Hot Meter	Cold Meter	Old Capacity	Replaced	Date	Washer Type	Cu Ft
1	5026602	5026528	12	Yes	12/1/2005	Maytag TL	2.52
2	5026047	5026621	12	Yes	12/1/2005	Maytag TL	2.52
3	5031166	5025541	12	Yes	12/1/2005	Maytag TL	2.52
4	5026269	5026572	12	Yes	12/1/2005	Maytag TL	2.52
5	5026204	5025543	12	Yes	12/1/2005	Maytag TL	2.52
6	5031547	5026279	12	Yes	12/1/2005	Maytag TL	2.52
7	5031652	5031071	12	Yes	12/1/2005	Maytag TL	2.52
8	5026545	5026220	12	Yes	12/1/2005	Maytag TL	2.52
9	5026207	5025531	12	Yes	12/1/2005	Maytag TL	2.52
10	5026598	5031638	12	Yes	12/1/2005	Maytag TL	2.52
11	5026299	5026537	12	Yes	12/1/2005	Maytag TL	2.52
12	5030146	5026278	12	Yes	12/1/2005	Maytag TL	2.52
13	5025544	5031550	12	Yes	12/1/2005	Maytag TL	2.52
14	5026253	5026215	12	Yes	12/1/2005	Maytag TL	2.52
15	5032706	5026221	12	Yes	12/1/2005	Maytag TL	2.52
16	5026226	5026539	12	Yes	12/1/2005	Maytag TL	2.52
17	5026549	5026620	12	Yes	12/1/2005	Maytag TL	2.52
18	5026617	5026546	12	Yes	12/1/2005	Maytag TL	2.52
19	5026303	5026260	12	Yes	12/1/2005	Maytag TL	2.52
20	5026550	5038782	12	Yes	12/1/2005	Maytag TL	2.52
21	5039052	5038783	12	Yes	12/1/2005	Maytag TL	2.52
22	5038345	5038151	12	Yes	12/1/2005	Maytag TL	2.52
23	5038336	5038793	12	Yes	12/1/2005	Maytag TL	2.52
24	5038943	5038152	12	Yes	12/1/2005	Maytag TL	2.52
25	5039048	5038801	12	Yes	12/1/2005	Maytag TL	2.52
26	5039038	5038158	12	Yes	12/1/2005	Maytag TL	2.52
27	5038344	5039050	12	Yes	12/1/2005	Maytag TL	2.52
28	5038798	5038337	12	Yes	12/1/2005	Maytag TL	2.52
29	5039032	5039256	12	Yes	12/1/2005	Maytag TL	2.52
30	5039047	5039036	12	Yes	12/1/2005	Maytag TL	2.52
31	5039037	5038795	20	No	N/A	Wascomat w75	2.67
32	5038157	5038156	20	No	N/A	Wascomat w75	2.67
33	5038346	5038339	20	No	N/A	Wascomat w75	2.67
34	5038941	5038805	20	No	N/A	Wascomat w75	2.67
35	5038796	5038779	20	No	N/A	Wascomat w75	2.67
36	5038008	5038347	20	No	N/A	Wascomat w75	2.67
37	5038091	5038090	20	No	N/A	Wascomat w75	2.67
38	5038099	5038799	20	No	N/A	Wascomat w75	2.67
39	5039039	5038935	20	No	N/A	Wascomat w75	2.67
40	5038338	5038944	20	No	N/A	Wascomat w75	2.67
41	5038934	5039051	30	Yes	12/1/2005	Wascomat W125	5.6
42	5037745	5037523	30	Yes	12/1/2005	Wascomat W125	5.6
43	5038363	5038340	30	Yes	12/1/2005	Wascomat W125	5.6
44	5038351	5038368	30	Removed	N/A	Wascomat W125	5.6

After Retrofit
4 Maytag STL 12-pound, 13 Maytag ML 18-pound washers
10 Wascomat ML 20-pound, 8 Wascomat ML 30-pound washers
3 Wascomat ML 55-pound washers

Machine #	Hot Meter	Cold Meter	New Capacit	Washer Type	Cu Ft
26	5039051	5037745	55	Wascomat G	8.8
27	5038363	5038340	55	Wascomat G	8.8
28	5038351	5038934	55	Wascomat G	8.8
29	5039037	5038795	20	Wascomat	2.67
30	5038157	5038156	20	Wascomat	2.67
31	5038346	5038339	20	Wascomat	2.67
32	5038941	5038805	20	Wascomat	2.67
33	5038796	5038779	20	Wascomat	2.67
34	5038088	5038347	20	Wascomat	2.67
35	5038091	5038090	20	Wascomat	2.67
36	5038099	5038799	20	Wascomat	2.67
37	5039039	5038935	20	Wascomat	2.67
38	5038338	5038944	20	Wascomat	2.67
39	5039032	5039256	18	Maytag	2.61
40	5038798	5038337	18	Maytag	2.61
41	5038344	5039050	18	Maytag	2.61
42	5039038	5038158	18	Maytag	2.61
43	5039048	5038801	18	Maytag	2.61
44	5038943	5038158	18	Maytag	2.61
45	5038336	5038793	18	Maytag	2.61
46	5038345	5038783	18	Maytag	2.61
47	5039052	5038151	18	Maytag	2.61
48	5026545	5031071	30	Wascomat s	4.6
49	5031652	5026279	30	Wascomat s	4.6
50	5031547	5025543	30	Wascomat s	4.6
51	5026204	5026572	30	Wascomat s	4.6
52	5026269	5026215	30	Wascomat s	4.6
53	5031166	5025541	30	Wascomat s	4.6
54	5030146	5026278	30	Wascomat s	4.6
55	5026299	5026528	30	Wascomat s	4.6
56	5026602	5026357	18	Maytag	2.61
57	5026047	5026621	18	Maytag	2.61
58	5025544	5031550	18	Maytag	2.61
59	5026253	5026221	18	Maytag	2.61
60	5032706	5026539	12	Maytag TL	2.52
61	5026226	5026620	12	Maytag TL	2.52
62	5026549	5026546	12	Maytag TL	2.52
63	5026617	5026220	12	Maytag TL	2.52



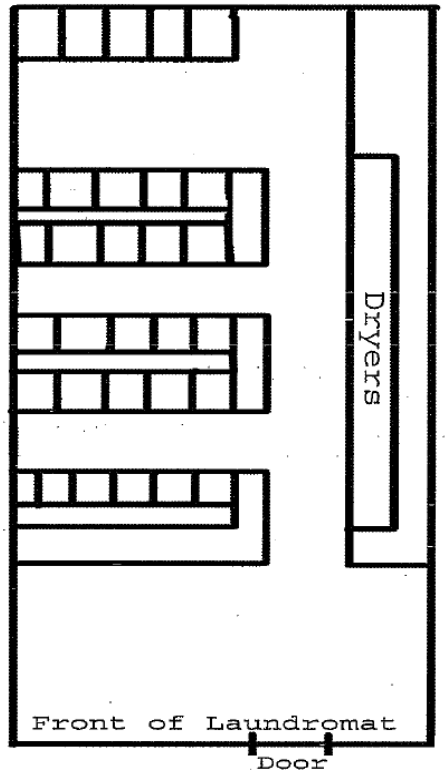
Treatment Site #4 Change-over 5/27/2006

Before Retrofit:
5 SpeedQueen STL 12-pound, 3 Maytag TL 18-pound washers
1 Wascomat 16-pound ML, 3 SpeedQueen 20-pound, 4 Wascomat 30-pound, 2 Wascomat 40-pound washers

After Retrofit:
5 SpeedQueen STL 12-pound washers
1 Wascomat 16-pound ML washer, 3 SpeedQueen 20-pound ML washers, 4 Wascomat 30-pound ML washers, 2 Wascomat 40-pound ML washers, 2 SpeedQueen 40-pound ML washers

Machine #	Hot Meter	Cold Meter	Washer Type	Old Capacity	Replaced	Cu. Ft.	Date	Hot Meter	Cold Meter	Washer Type	New Capacity	Cu Ft
1	5038782	5036944	Maytag	18	Removed	2.52	5/27/2006					
2	5038798	6006666	Maytag	18	Yes	2.52	5/27/2006	5038798	5036782	SpeedQueen	40	6
3	5038363	5021747	Maytag	18	Yes	2.52	5/27/2006	5021747	5036944	SpeedQueen	40	6

Test Site #4



Appendix 5: DOE Energy Star List

ENERGY STAR Qualified Clothes Washers

Last Modified: 08/02/2006

Brand	Model	Volume (cubic feet)	kWh/ year	Modified Energy Factor (MEF)	Federal Standard (MEF)	Water Factor (WF)	Annual Water Use (gal/ year)
Admiral	AAV8005	3.36	285	1.5	1.04	9.6	12,618
Amana	NAV8805	3.44	347	1.48	1.04	10.0	13,485
Ariston	AW120	1.92	143	1.92	1.04	5.0	3,763
Ariston	AW121	1.64	176	1.71	1.04	7.7	4,976
Ariston	AW122	1.64	176	1.71	1.04	7.7	4,976
Ariston	AW125	1.64	176	1.71	1.04	7.7	4,976
Ariston	AW129	1.9	189	2.25	1.04	6.0	4,439
Ariston	AW149	1.9	189	2.25	1.04	6.0	4,439
Ariston	AWD120	1.92	143	1.92	1.04	5.0	3,763
Ariston	AWD121	1.64	176	1.71	1.04	8.5	5,432
Ariston	AWD129	1.64	176	1.71	1.04	8.5	5,432
Asko	W6021	1.96	209	1.66	1.04	7.5	5,749
Asko	W6022	1.96	146	1.7	1.04	7.5	5,762
Asko	W6222	1.96	129	1.8	1.04	3.6	2,766
Asko	W6441	1.96	189	1.74	1.04	7.5	5,749
Asko	W6461	2.04	127	2.5	1.04	6.9	5,486
Asko	W6761	1.96	189	1.84	1.04	7.5	5,749
Asko	WCAM1812	2.46	217	2.5	1.04	7.5	7,213
Bosch	WFL2060UC	1.85	194	1.8	1.04	6.5	4,692
Bosch	WFMB3200UC	3.31	186	2.1	1.04	5.3	6,877
Bosch	WFMC1001UC	3.31	146	2.24	1.04	4.3	5,592
Bosch	WFMC2100UC	3.31	170	2.13	1.04	4.7	6,150
Bosch	WFMC2201UC	3.31	165	2.43	1.04	4.3	5,631
Bosch	WFMC3200UC	3.31	186	2.1	1.04	5.3	6,877
Bosch	WFMC3301UC	3.31	182	2.4	1.04	4.2	5,501
Bosch	WFMC330SUC	3.31	182	2.4	1.04	4.2	5,501
Bosch	WFMC4300UC	3.31	182	2.31	1.04	4.6	5,956
Bosch	WFMC4301UC	3.31	182	2.4	1.04	4.2	5,501
Bosch	WFMC6400UC	3.31	178	2.2	1.04	4.5	5,839
Bosch	WFMC6401UC	3.31	176	2.43	1.04	4.1	5,268
Bosch	WFMC640SUC	3.31	176	2.43	1.04	4.1	5,268
Bosch	WFR2460UC	1.85	184	2.08	1.04	5.7	4,155
Crosley	CAH4205	2.9	243	1.9	1.04	7.2	8,185
Danby Designer	DWM5500W-1	1.7	154	1.8	1.04	6.6	4,418

Equator	EW 510	1.7	176	1.72	1.04	7.1	4,745
Equator	EZ 1612 V	1.92	135	2.04	1.04	4.9	3,650
Equator	EZ 1710 V	1.7	176	1.72	1.04	7.1	4,745
Equator	EZ 2512 CEE	1.6	125	1.83	1.04	6.0	3,763
Equator	EZ 3612 CEE	1.92	143	1.92	1.04	5.0	3,763
Equator	EZ 3710 CEE	1.7	176	1.72	1.04	7.1	4,745
Equator	EZ2512CEE	1.6	125	1.83	1.04	0.0	0
Equator	EZ3612CEE	1.92	143	1.92	1.04	0.0	0
Eurotech	EWC177	2.46	217	2.5	1.04	7.5	7,213
Eurotech	EWF150	1.6	241	1.45	1.04	11.6	7,301
Eurotech	EWF172	2.5	306	1.52	1.04	8.0	7,879
Eurotech	EWF272EL	2.4	212	2.66	1.04	7.3	6,868
Fisher & Paykel	GWL15	3	212	2	1.04	8.1	9,573
Fisher & Paykel	IWL15	3	208	1.86	1.04	12.9	15,123
Fisher & Paykel	IWL16	3	223	1.91	1.04	8.3	9,714
Frigidaire	ATF6000E	3	240	2.04	1.04	5.3	6,174
Frigidaire	ATF7000E	3	257	2.01	1.04	5.1	5,998
Frigidaire	ATFB6000E	3	240	2.04	1.04	5.3	6,174
Frigidaire	ATFB7000E	3	257	2.01	1.04	5.1	5,998
Frigidaire	FTF2140E	3	247	1.82	1.04	5.6	6,633
Frigidaire	FTF530E	2.65	142	1.82	1.04	8.4	8,726
Frigidaire	FTF530F	2.65	126	1.97	1.04	7.0	7,272
Frigidaire	FTFB4000F	3	247	1.82	1.04	5.6	6,633
Frigidaire	GLEH1642D	2.65	225	1.74	1.04	8.6	8,882
Frigidaire	GLGH1642D	2.65	225	1.74	1.04	8.6	8,882
Frigidaire	GLTF2940E	3	215	1.98	1.04	5.1	6,033
Frigidaire	GLTF530D	2.65	142	1.91	1.04	8.4	8,726
Frigidaire	GLTR1670A	2.65	341	1.51	1.04	9.4	9,806
Frigidaire	LFT530F	2.65	126	1.97	1.04	7.0	7,272
Frigidaire	LTF2140E	3	247	1.82	1.04	5.6	6,633
Frigidaire	LTF2940E	3	215	1.98	1.04	5.1	6,033
Frigidaire	LTF6000E	3	240	2.04	1.04	5.3	6,174
Frigidaire	LTF7000E	3	257	2.01	1.04	5.1	5,998
General Electric	S5200EWW	3.45	330	1.51	1.04	11.5	15,499
General Electric	S8000EWW	3.45	346	1.46	1.04	11.5	15,580
General Electric	WBVH6240F	3.21	239	1.82	1.04	4.6	5,785
General Electric	WCVH6260F	3.21	239	1.82	1.04	4.6	5,785
General	WHDRE526E	3.45	330	1.51	1.04	11.5	15,499

Electric							
General Electric	WHDVH626F	3.21	239	1.82	1.04	4.6	5,785
General Electric	WHRE5260E	3.45	336	1.47	1.04	11.4	15,431
General Electric	WHSE5240D	3.15	302	1.52	1.04	12.1	14,929
General Electric	WNRD2050D	3.45	320	1.49	1.04	11.9	16,026
General Electric	WPGT9350C***	3.53	620	1.45	1.04	7.0	9,653
General Electric	WPGT9360E**	3.53	269	1.98	1.04	7.1	9,797
General Electric	WPRB8050D	3.45	346	1.46	1.04	11.5	15,580
General Electric	WPRB9110D	3.45	257	1.54	1.04	11.6	15,661
General Electric	WPRB9220D**	3.45	368	1.5	1.04	10.8	14,660
General Electric	WSERE526F	3.45	330	1.51	1.04	11.5	15,499
General Electric	WSXH208F	2.65	250	1.64	1.04	9.5	9,817
General Electric	WZRE5260F	3.45	336	1.47	1.04	11.4	15,431
Gibson	GTF1040C	2.65	341	1.51	1.04	9.4	9,806
Haier	HLT364XXQ	3.15	238	1.77	1.04	10.7	13,249
Haier	XQS100-0677	3.15	238	1.77	1.04	10.7	13,249
Kenmore	1584#40**	3.16	319	1.44	1.04	11.9	14,728
Kenmore	1585*	3.16	319	1.44	1.04	11.9	14,728
Kenmore	1586#40**	3.16	319	1.44	1.04	11.9	14,728
Kenmore	1594#40**	3.14	303	1.49	1.04	12.0	14,820
Kenmore	1595#40**	3.14	303	1.49	1.04	12.0	14,820
Kenmore	1596#40**	3.14	303	1.49	1.04	12.0	14,820
Kenmore	1673*50+	3.16	308	1.51	1.04	11.2	13,837
Kenmore	1674*50+	3.16	308	1.51	1.04	11.2	13,837
Kenmore	1675*50+	3.16	308	1.51	1.04	11.2	13,837
Kenmore	1685*50+	3.16	285	1.54	1.04	11.7	14,481
Kenmore	1686*50+	3.16	285	1.54	1.04	11.7	14,481
Kenmore	1688*50+	3.16	285	1.54	1.04	11.7	14,481
Kenmore	1692*50+	3.14	305	1.46	1.04	11.8	14,524
Kenmore	1694*50+	3.14	305	1.46	1.04	11.8	14,524
Kenmore	1696*50+	3.14	305	1.46	1.04	11.8	14,524
Kenmore	1697*50+	3.14	311	1.5	1.04	12.3	15,078
Kenmore	1698*50+	3.14	311	1.5	1.04	12.3	15,078
Kenmore	2206*10+	3.01	297	1.67	1.04	7.0	8,236
Kenmore	2208*10+	3.01	297	1.67	1.04	7.0	8,236

Kenmore	2408*20+	3.01	297	1.67	1.04	7.0	8,236
Kenmore	2506*50+	3.01	288	1.69	1.04	6.8	8,047
Kenmore	2508*50+	3.01	288	1.69	1.04	6.8	8,047
Kenmore	2703*60+	3.77	500	1.56	1.04	11.2	16,581
Kenmore	2704*60+	3.77	500	1.56	1.04	11.2	16,581
Kenmore	2706*60+	3.89	326	1.96	1.04	7.5	11,376
Kenmore	2707*60+	3.89	326	1.96	1.04	7.5	11,376
Kenmore	2708*60+	3.89	326	1.96	1.04	7.5	11,376
Kenmore	2709*60+	3.89	326	1.96	1.04	7.5	11,376
Kenmore	4282*20+	3.18	268	1.81	1.04	4.4	5,435
Kenmore	4292*20+	3.18	278	1.96	1.04	4.4	5,522
Kenmore	4390*20+	3.18	278	1.96	1.04	4.4	5,522
Kenmore	4409	3	230	2	1.04	4.7	5,574
Kenmore	4410	2.65	246	1.68	1.04	9.4	9,796
Kenmore	4482*30+	3.18	268	1.81	1.04	4.4	5,435
Kenmore	4483*20+	3.18	268	1.81	1.04	4.3	5,323
Kenmore	4483*30+	3.18	268	1.81	1.04	4.4	5,435
Kenmore	4492*20+	3.18	278	1.96	1.04	4.4	5,522
Kenmore	4492*30+	3.18	278	1.96	1.04	4.1	5,111
Kenmore	4493*20+	3.18	278	1.96	1.04	4.4	5,522
Kenmore	4493*30+	3.18	278	1.96	1.04	4.1	5,111
Kenmore	4508*40+	3.3	215	2.19	1.04	4.0	5,200
Kenmore	4509*40+	3.3	215	2.19	1.04	4.0	5,200
Kenmore	4580*50+	3.3	195	2.07	1.04	4.5	5,808
Kenmore	4586#40**	3.3	176	2.03	1.04	4.3	5,575
Kenmore	4586*50+	3.3	195	2.07	1.04	4.5	5,808
Kenmore	4587#40**	3.3	176	2.03	1.04	4.3	5,575
Kenmore	4587*50+	3.3	195	2.07	1.04	4.5	5,808
Kenmore	4596*50+	3.3	188	2.08	1.04	4.5	5,808
Kenmore	4597*50+	3.3	188	2.08	1.04	4.5	5,808
Kenmore	4598#40**	3.3	215	2.19	1.04	4.0	5,200
Kenmore	4599#40**	3.3	215	2.19	1.04	4.0	5,200
Kenmore	4646*50+	2.88	170	2.1	1.04	4.8	5,408
Kenmore	4647*50+	2.88	170	2.1	1.04	4.8	5,408
Kenmore	4751*60+	3.03	161	2.11	1.04	4.8	5,654
Kenmore	4753*60+	3.03	161	2.11	1.04	4.8	5,654
Kenmore	4754*60+	3.03	161	2.11	1.04	4.8	5,654
KitchenAid	KHWS01P#**	3.3	312	1.76	1.04	4.3	5,537
KitchenAid	KHWS02R*+	3.3	311	1.85	1.04	4.3	5,524
LG Electronics	WD-324*RHD	1.96	298	2.1	1.04	5.0	3,872
LG	WD-327*RHD	1.95	140	1.86	1.04	6.4	4,854

Electronics							
LG Electronics	WM0532H*	3.22	191	2.01	1.04	4.2	5,238
LG Electronics	WM064#H*	3.32	167	2.38	1.04	3.8	4,948
LG Electronics	WM1811C*	3.22	184	1.76	1.04	4.3	5,380
LG Electronics	WM1812C*	2.96	184	1.89	1.04	4.5	5,163
LG Electronics	WM1814C*	2.96	184	1.89	1.04	4.5	5,163
LG Electronics	WM1815C*	2.96	184	1.89	1.04	4.5	5,163
LG Electronics	WM1832C*	3.22	184	2.09	1.04	4.0	5,074
LG Electronics	WM2011H*	3.22	191	1.83	1.04	4.0	5,048
LG Electronics	WM2032H*	3.22	191	2.04	1.04	4.2	5,238
LG Electronics	WM204#C*	3.32	152	2.37	1.04	3.7	4,828
LG Electronics	WM207#C*	3.22	195	2.03	1.04	3.9	4,910
LG Electronics	WM2177H*	3.21	253	1.96	1.04	4.2	5,285
LG Electronics	WM2277H*	3.21	253	1.96	1.04	4.2	5,285
LG Electronics	WM2411H*	3.22	199	1.87	1.04	4.0	5,039
LG Electronics	WM2432H*	3.22	199	2.08	1.04	4.1	5,213
LG Electronics	WM244#H*	3.32	167	2.38	1.04	3.8	4,948
LG Electronics	WM248#H**	3.47	167	2.44	1.04	3.4	4,557
LG Electronics	WM2677H**	3.32	176	2.34	1.04	3.6	4,731
LG Electronics	WM268#H**	3.47	171	2.48	1.04	3.5	4,690
LG Electronics	WM3431H*	2.11	197	1.96	1.04	5.2	4,260
LG Electronics	WM3611H*	3.22	199	1.87	1.04	4.0	5,039
LG Electronics	WM3632H*	3.22	199	2.08	1.04	4.1	5,213
LG Electronics	WM3677H*	3.22	253	1.96	1.04	4.2	5,301
Malber	P21	1.65	176	1.51	1.04	10.6	6,856
Malber	P25	2.47	164	1.94	1.04	9.9	9,586
Malber	WD 1000	1.65	178	1.48	1.04	10.4	6,727
Maytag	FAV6800	3	250	1.74	1.04	7.8	9,196
Maytag	FAV9800	3	298	1.66	1.04	8.2	9,596
Maytag	MAH2400	2.05	170	1.78	1.04	5.9	4,701

Maytag	MAH5500B	2.9	243	1.9	1.04	7.2	8,185
Maytag	MAH55FLB	2.9	243	1.9	1.04	7.2	8,185
Maytag	MAH6500	2.9	243	1.9	1.04	7.2	8,185
Maytag	MAH6700	2.82	214	1.81	1.04	4.7	5,173
Maytag	MAH7500*	2.9	258	1.76	1.04	8.1	9,254
Maytag	MAH8700	3.31	250	1.83	1.04	4.1	5,281
Maytag	MAH9700	3.31	270	1.84	1.04	4.0	5,151
Maytag	MAV3955	3.36	347	1.48	1.04	10.0	13,171
Maytag	MAV551E	3.44	347	1.48	1.04	10.0	13,485
Maytag	MAV5758	3.44	347	1.48	1.04	10.0	13,485
Maytag	MAV5920	3.44	347	1.48	1.04	10.0	13,485
Maytag	MAVT546	3.44	347	1.48	1.04	10.0	13,485
Maytag	MLE2000 (stack unit)	2.9	291	1.69	1.04	8.0	9,094
Maytag	MLG2000 (stack unit)	2.9	291	1.69	1.04	8.0	9,094
Miele	W1113	1.73	113	2.11	1.04	4.5	3,045
Miele	W1119	1.73	113	2.11	1.04	4.5	3,045
Miele	W1203	2.08	127	2.04	1.04	4.4	3,547
Miele	W1213	2.08	127	2.04	1.04	4.4	3,547
Miele	W1215	2.08	127	2.04	1.04	4.4	3,547
Miele	W1966	2.01	258	1.66	1.04	5.1	3,995
Miele	W1986	2.01	258	1.66	1.04	5.1	3,995
Quietline	WD9900	2	277	1.59	1.04	7.4	5,833
Samsung	B1013J	1.77	175	1.65	1.04	9.3	6,446
Samsung	B1113J	1.77	175	1.65	1.04	9.3	6,446
Samsung	P1001	1.77	175	1.65	1.04	9.3	6,446
Samsung	P1003J	1.77	175	1.65	1.04	9.3	6,446
Samsung	P1005J	1.77	175	1.65	1.04	9.3	6,446
Samsung	P1091	1.77	175	1.65	1.04	9.3	6,446
Samsung	P801	1.77	175	1.65	1.04	9.3	6,446
Samsung	WF306BHW	3.29	230	1.97	1.04	4.0	5,107
Samsung	WF306LAW	3.29	210	2.01	1.04	3.9	5,017
Samsung	WF316***	3.29	220	2.01	1.04	3.9	5,017
Samsung	WF326LAS	3.29	220	2.06	1.04	3.9	4,978
Samsung	WF326LAW	3.29	220	2.06	1.04	3.9	4,978
Siemens	WFXD5200UC	3.31	186	2.1	1.04	5.3	6,877
Siemens	WFXD5201UC	3.31	182	2.57	1.04	4.3	5,514
Siemens	WFXD8400UC	3.31	178	2.2	1.04	4.5	5,839
Siemens	WFXD840AUC	3.31	176	2.43	1.04	4.1	5,268
Speed Queen	ATS90***	2.84	224	1.89	1.04	6.2	6,902
Speed	ATS95***	2.84	257	1.77	1.04	7.3	8,127

Queen							
Speed Queen	AWS48**	3.26	288	1.55	1.04	12.0	15,335
Speed Queen	AWS53**	3.26	337	1.47	1.04	9.4	12,012
Speed Queen	CTS90***	2.84	224	1.89	1.04	6.2	6,902
Speed Queen	CTS97***	2.84	224	1.89	1.04	6.2	6,902
Speed Queen	CTS99***	2.84	224	1.89	1.04	6.2	6,902
Splendide	WD 2050S NA	1.64	191	1.63	1.04	7.7	4,976
Splendide	WD 2150 NA	1.64	191	1.63	1.04	7.7	4,976
Splendide	WD2000S	1.64	176	1.71	1.04	7.7	4,976
Splendide	WD2100	1.92	143	1.92	1.04	4.9	3,650
Splendide	WD2100	1.92	143	1.92	1.04	0.0	0
Splendide	WDC5200	1.6	125	1.6	1.04	6.0	3,763
Splendide	WDC5200	1.6	125	1.6	1.04	0.0	0
Splendide	WDC6200CEE	1.92	143	1.92	1.04	5.0	3,763
Splendide	WDC6200CEE	1.92	143	1.92	1.04	0.0	0
Staber	HXW2304	2	180	1.75	1.04	6.8	5,292
Summit	SPW1102	1.7	154	1.8	1.04	6.6	4,418
Thor	WD9900	2	277	1.59	1.04	7.4	5,833
Thor	XQG65-11	2.01	203	1.85	1.04	5.7	4,491
Whirlpool	GHW9100L*+	3.18	282	1.69	1.04	4.3	5,335
Whirlpool	GHW9150P*+	3.3	180	2.04	1.04	4.6	5,912
Whirlpool	GHW9160P*+	3.3	190	1.98	1.04	4.6	5,899
Whirlpool	GHW9250M*+	3.18	285	1.92	1.04	4.3	5,410
Whirlpool	GHW9300P*+	3.3	186	1.99	1.04	4.6	5,938
Whirlpool	GHW9400P#**	3.3	227	2.04	1.04	4.2	5,368
Whirlpool	GHW9460P#**	3.3	227	2.04	1.04	4.2	5,368
Whirlpool	GSW9800P#**	3.14	338	1.45	1.04	11.3	13,958
Whirlpool	GSW9900P#**	3.14	332	1.47	1.04	8.1	9,970
Whirlpool	GVW9959K*+	2.99	296	1.69	1.04	6.8	8,017
Whirlpool	IP4400**	3.16	333	1.46	1.04	11.4	14,134
Whirlpool	LHW0050**	2.46	212	2.79	1.04	6.0	5,796
Whirlpool	LSW9700P*+	3.14	353	1.46	1.04	11.2	13,749
Whirlpool	LSW9750P#**	3.14	353	1.46	1.04	11.3	13,909
Whirlpool	WFW8300S*	2.88	168	2.08	1.04	4.9	5,521
Whirlpool	WFW8500S*+	3.1	152	2.26	1.04	4.4	5,286
Whirlpool	WTW6200*+	3.77	464	1.6	1.04	11.2	16,567
Whirlpool	WTW6300*+	3.77	464	1.6	1.04	11.2	16,567
Whirlpool	WTW6400S*+	3.89	307	1.98	1.04	6.9	10,476
Whirlpool	WTW6600S*+	3.89	307	1.98	1.04	6.9	10,476

Relevant Web Site Links

http://www.owue.water.ca.gov/docs/finpdf/PSP_165.PDF - San Diego County Water Authority (March, 2002) Prop 13 Urban Water Conservation Capital Outlay Grant: Coin-Operated Multi-Load Clothes Washer Voucher Incentive Program

http://www.cee1.org/com/cwsh/comwsh_prog_des.pdf - Consortium for Energy Efficieincy (1998) Commercial, Family-Sized Washers:An Initiative Description of the Consortium for Energy Efficiency

http://www.energystar.gov/index.cfm?fuseaction=clotheswash.display_column_definintions - Provides definintions for clothes washer types

http://www.cee1.org/resrc/news/06-01nl/14_cw.html - Water Factor in new clothes washer specifications