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## Effectiveness Determination of Two Different Water-Saving Devices for Toilet Tanks

C. Earl Israelsen

Gilberto Urroz

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# **UTAH DIVISION OF WATER RESOURCES**

## **Effectiveness Determination of Two Different Water-Saving Devices for Toilet Tanks**

June 1993

C. Earl Israelsen  
Gilberto Urroz



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# DESCRIPTION OF EQUIPMENT AND TEST PROCEDURES

## Introduction

The project was successful in obtaining eight different brands of new toilet tanks of the 3.5 gals-per-flush-variety, and two used ones requiring 5.0 gals per flush. The tanks were installed one

at a time on a padded steel frame and connected to a water supply. The float was adjusted to maintain the water in the tank at the level recommended by the manufacturer. When the flush and shut-off mechanisms were adjusted properly, the testing began.

## Equipment Used in Test

### Toilet tanks (3.5 gals - new)

Briggs - Model #4930 - Conserver Tank

American Standard - Cadet 3.5

Crane - Water Economy Tank 3-222

Kohler - 4519-A-0-47 Water Gard Tank

Artesian - Model C-4850

Ambassador - Model R01 Water Saver

Lamosa Ambassador - Model #GAM USA

Chinaware Promo - UL-477 EAP

From Lawson-Yeates, Inc.  
Plumbing Wholesale Supply

From Ernst Home and Nursery

From Fred Meyer  
One Stop Shopping

### Toilet tanks (5.0 gals - used)

American Standard

Kohler

From a Local Plumber

## Water-saving devices

1. Fill-Cycle Regulator (blue restrictor)  
by  
Econtec  
11431 Sunrise Gold Circle  
Suite B  
Rancho Cordova, CA 95670  
(916)635-8838

2. Water Saver Refill Cycle Adapter T (white restrictor)  
by  
Karlson Products  
22 South Angela Way  
North Salt Lake, UT 84054  
(801)295-4749

### **Measurement of Flush and Overflow Water Amounts**

Each toilet was flushed ten times into a plastic bucket that stood on a digital scale platform. The weight of water for the flush was recorded for each, as well as the total weight of the flush water plus the overflow (the water that is directed down the overflow tube to fill the toilet trap).

When the ten standard flushes were completed for each of the ten different tanks, each of the two water-saving units was installed in turn and data collected for ten flushes on each of the ten tanks as described above.

### **Endurance Test**

The contract calls for an endurance test to be performed on each of the two water-saving devices. Inasmuch as this test was intended to test the endurance of the water-saving units themselves and not of the toilet tank flushing mechanisms, the units were installed together on a water supply line and were subjected to more than 200,000 on-off cycles of water flowing through them. Three of each water-saving device were tested, simultaneously.

## **TEST RESULTS**

All of the data collected during the test are presented in Tables 1 through 11. Figures 1 through 5 are graphical representations of data shown in the tables.

**Table 1. Tests on Kohler 5 gallon flush toilet.**

Water weight in pounds (lbs).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	33.6	5.6	39.2	1	34.6	2.2	36.8	1	33.4	2.8	36.2
2	33.6	5.8	39.4	2	34.6	2.2	36.8	2	34.4	2.6	37.0
3	34.6	5.4	40.0	3	35.0	2.2	37.2	3	34.4	2.6	37.0
4	34.0	5.6	39.6	4	35.4	2.2	37.6	4	34.8	3.0	37.8
5	35.0	5.6	40.6	5	35.2	2.2	37.4	5	34.0	2.4	36.4
6	35.0	5.8	40.8	6	34.8	2.2	37.0	6	36.6	2.8	39.4
7	33.6	5.6	39.2	7	35.4	2.2	37.6	7	34.4	3.0	37.4
8	35.0	6.0	41.0	8	35.8	2.4	38.2	8	34.6	2.6	37.2
9	34.4	5.6	40.0	9	36.0	2.2	38.2	9	35.0	2.6	37.6
10	34.4	5.8	40.2	10	35.4	2.0	37.4	10	34.6	2.6	37.2
Average	34.3	5.7	40.0	Average	35.2	2.2	37.4	Average	34.6	2.7	37.3

Water volume in gallons (gals).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	4.03	0.67	4.70	1	4.15	0.26	4.41	1	4.00	0.34	4.34
2	4.03	0.70	4.72	2	4.15	0.26	4.41	2	4.12	0.31	4.44
3	4.15	0.65	4.80	3	4.20	0.26	4.46	3	4.12	0.31	4.44
4	4.08	0.67	4.75	4	4.24	0.26	4.51	4	4.17	0.36	4.53
5	4.20	0.67	4.87	5	4.22	0.26	4.48	5	4.08	0.29	4.36
6	4.20	0.70	4.89	6	4.17	0.26	4.44	6	4.39	0.34	4.72
7	4.03	0.67	4.70	7	4.24	0.26	4.51	7	4.12	0.36	4.48
8	4.20	0.72	4.92	8	4.29	0.29	4.58	8	4.15	0.31	4.46
9	4.12	0.67	4.80	9	4.32	0.26	4.58	9	4.20	0.31	4.51
10	4.12	0.70	4.82	10	4.24	0.24	4.48	10	4.15	0.31	4.46
Average	4.11	0.69	4.80	Average	4.22	0.27	4.49	Average	4.15	0.32	4.47

**Table 2. Tests on American Standard 5 gallon flush toilet.**

Water weight in pounds (lbs).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	31.4	5.2	36.6	1	31.2	2.2	33.4	1	31.8	2.0	33.8
2	31.4	5.0	36.4	2	31.2	1.8	33.0	2	32.0	2.4	34.4
3	31.6	4.6	36.2	3	29.8	2.2	32.0	3	32.0	2.2	34.2
4	31.6	4.2	35.8	4	31.2	2.2	33.4	4	32.6	2.2	34.8
5	31.6	4.4	36.0	5	31.0	2.4	33.4	5	32.6	2.2	34.8
6	32.0	5.8	37.8	6	32.0	2.6	34.6	6	32.6	2.2	34.8
7	31.2	4.8	36.0	7	32.0	2.0	34.0	7	32.4	2.6	35.0
8	32.0	4.8	36.8	8	31.8	2.0	33.8	8	32.0	2.0	34.0
9	32.0	4.4	36.4	9	31.6	2.2	33.8	9	33.0	2.0	35.0
10	31.8	4.4	36.2	10	31.6	1.8	33.4	10	33.0	2.0	35.0
Average	31.7	4.7	36.4	Average	31.3	2.2	33.5	Average	32.4	2.2	34.6

Water volume in gallons (gals).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	3.76	0.62	4.39	1	3.74	0.26	4.00	1	3.81	0.24	4.05
2	3.76	0.60	4.36	2	3.74	0.22	3.96	2	3.84	0.29	4.12
3	3.79	0.55	4.34	3	3.57	0.26	3.84	3	3.84	0.26	4.10
4	3.79	0.50	4.29	4	3.74	0.26	4.00	4	3.91	0.26	4.17
5	3.79	0.53	4.32	5	3.72	0.29	4.00	5	3.91	0.26	4.17
6	3.84	0.70	4.53	6	3.84	0.31	4.15	6	3.91	0.26	4.17
7	3.74	0.58	4.32	7	3.84	0.24	4.08	7	3.88	0.31	4.20
8	3.84	0.58	4.41	8	3.81	0.24	4.05	8	3.84	0.24	4.08
9	3.84	0.53	4.36	9	3.79	0.26	4.05	9	3.96	0.24	4.20
10	3.81	0.53	4.34	10	3.79	0.22	4.00	10	3.96	0.24	4.20
Average	3.80	0.57	4.37	Average	3.76	0.25	4.01	Average	3.88	0.27	4.15

**Table 3. Tests on Artesian model C-4850 flush toilet.**

Water weight in pounds (lbs).

No.	Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor		
	Flush	Residual	Total		Flush	Residual	Total		Flush	Residual	Total
1	23.2	7.0	30.2	1	22.8	2.2	25.0	1	23.4	2.8	26.2
2	23.6	6.8	30.4	2	23.0	2.2	25.2	2	23.0	3.0	26.0
3	23.6	6.6	30.2	3	23.2	2.2	25.4	3	23.4	2.8	26.2
4	23.6	6.8	30.4	4	23.2	2.2	25.4	4	23.6	2.6	26.2
5	23.6	6.8	30.4	5	23.2	2.2	25.4	5	23.2	3.0	26.2
6	23.6	6.8	30.4	6	23.2	2.2	25.4	6	23.2	2.8	26.0
7	23.6	6.8	30.4	7	23.2	2.2	25.4	7	23.2	2.8	26.0
8	23.6	6.6	30.2	8	23.0	2.2	25.2	8	23.6	3.0	26.6
9	23.6	6.6	30.2	9	23.2	2.2	25.4	9	23.6	2.8	26.4
10	23.6	6.8	30.4	10	23.0	2.4	25.4	10	23.4	3.0	26.4
Average	23.6	6.7	30.3	Average	23.1	2.2	25.3	Average	23.4	2.8	26.2

Water volume in gallons (gals).

No.	Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor		
	Flush	Residual	Total		Flush	Residual	Total		Flush	Residual	Total
1	2.78	0.84	3.62	1	2.73	0.26	3.00	1	2.81	0.34	3.14
2	2.83	0.82	3.64	2	2.76	0.26	3.02	2	2.76	0.36	3.12
3	2.83	0.79	3.62	3	2.78	0.26	3.04	3	2.81	0.34	3.14
4	2.83	0.82	3.64	4	2.78	0.26	3.04	4	2.83	0.31	3.14
5	2.83	0.82	3.64	5	2.78	0.26	3.04	5	2.78	0.36	3.14
6	2.83	0.82	3.64	6	2.78	0.26	3.04	6	2.78	0.34	3.12
7	2.83	0.82	3.64	7	2.78	0.26	3.04	7	2.78	0.34	3.12
8	2.83	0.79	3.62	8	2.76	0.26	3.02	8	2.83	0.36	3.19
9	2.83	0.79	3.62	9	2.78	0.26	3.04	9	2.83	0.34	3.16
10	2.83	0.82	3.64	10	2.76	0.29	3.04	10	2.81	0.36	3.16
Average	2.82	0.81	3.63	Average	2.77	0.27	3.04	Average	2.80	0.34	3.14



**Table 4. Tests on Ambassador model R01 Water Saver flush toilet.**

Water weight in pounds (lbs).

Without Restrictor				With Blue Restrictor				With White Restrictor			
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	21.6	7.6	29.2	1	22.4	3.0	25.4	1	21.2	3.2	24.4
2	21.0	8.0	29.0	2	21.4	3.0	24.4	2	20.8	3.2	24.0
3	21.4	8.0	29.4	3	22.0	3.0	25.0	3	21.4	2.8	24.2
4	21.4	8.0	29.4	4	22.2	3.2	25.4	4	21.0	3.2	24.2
5	21.4	8.0	29.4	5	21.4	3.0	24.4	5	21.0	3.0	24.0
6	21.4	8.2	29.6	6	22.2	3.0	25.2	6	21.2	3.2	24.4
7	21.2	8.0	29.2	7	22.0	2.6	24.6	7	21.4	2.8	24.2
8	21.6	8.0	29.6	8	21.2	3.0	24.2	8	20.8	2.8	23.6
9	21.2	7.8	29.0	9	21.6	3.0	24.6	9	21.4	2.8	24.2
10	21.4	8.2	29.6	10	21.2	3.0	24.2	10	21.0	3.0	24.0
Average	21.4	7.9	29.3	Average	21.8	2.9	24.7	Average	21.1	3.0	24.1

Water volume in gallons (gals).

Without Restrictor				With Blue Restrictor				With White Restrictor			
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	2.59	0.91	3.50	1	2.69	0.36	3.04	1	2.54	0.38	2.93
2	2.52	0.96	3.48	2	2.57	0.36	2.93	2	2.49	0.38	2.88
3	2.57	0.96	3.52	3	2.64	0.36	3.00	3	2.57	0.34	2.90
4	2.57	0.96	3.52	4	2.66	0.38	3.04	4	2.52	0.38	2.90
5	2.57	0.96	3.52	5	2.57	0.36	2.93	5	2.52	0.36	2.88
6	2.57	0.98	3.55	6	2.66	0.36	3.02	6	2.54	0.38	2.93
7	2.54	0.96	3.50	7	2.64	0.31	2.95	7	2.57	0.34	2.90
8	2.59	0.96	3.55	8	2.54	0.36	2.90	8	2.49	0.34	2.83
9	2.54	0.94	3.48	9	2.59	0.36	2.95	9	2.57	0.34	2.90
10	2.57	0.98	3.55	10	2.54	0.36	2.90	10	2.52	0.36	2.88
Average	2.56	0.96	3.52	Average	2.61	0.36	2.97	Average	2.53	0.36	2.89

**Table 5. Tests on American Standard Cadet 3.5 flush toilet.**

Water weight in pounds (lbs).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	20.2	7.8	28.0	1	21.4	2.2	23.6	1	21.8	2.8	24.6
2	20.6	7.4	28.0	2	21.4	2.0	23.4	2	21.6	2.6	24.2
3	21.8	7.4	29.2	3	21.4	2.2	23.6	3	21.4	2.6	24.0
4	20.6	7.6	28.2	4	21.0	2.2	23.2	4	21.6	3.0	24.6
5	20.6	7.8	28.4	5	20.6	1.8	22.4	5	21.6	2.8	24.4
6	20.4	9.0	29.4	6	21.0	2.0	23.0	6	21.4	2.6	24.0
7	21.0	7.4	28.4	7	21.4	2.0	23.4	7	22.0	2.8	24.8
8	20.2	8.8	29.0	8	21.6	2.0	23.6	8	21.6	2.8	24.4
9	21.0	8.0	29.0	9	21.0	2.2	23.2	9	21.8	2.6	24.4
10	20.4	7.6	28.0	10	21.6	2.2	23.8	10	21.4	3.0	24.4
Average	20.7	7.9	28.6	Average	21.2	2.1	23.3	Average	21.6	2.8	24.4

Water volume in gallons (gals).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	2.42	0.94	3.36	1	2.57	0.26	2.83	1	2.61	0.34	2.95
2	2.47	0.89	3.36	2	2.57	0.24	2.81	2	2.59	0.31	2.90
3	2.61	0.89	3.50	3	2.57	0.26	2.83	3	2.57	0.31	2.88
4	2.47	0.91	3.38	4	2.52	0.26	2.78	4	2.59	0.36	2.95
5	2.47	0.94	3.40	5	2.47	0.22	2.69	5	2.59	0.34	2.93
6	2.45	1.08	3.52	6	2.52	0.24	2.76	6	2.57	0.31	2.88
7	2.52	0.89	3.40	7	2.57	0.24	2.81	7	2.64	0.34	2.97
8	2.42	1.05	3.48	8	2.59	0.24	2.83	8	2.59	0.34	2.93
9	2.52	0.96	3.48	9	2.52	0.26	2.78	9	2.61	0.31	2.93
10	2.45	0.91	3.36	10	2.59	0.26	2.85	10	2.57	0.36	2.93
Average	2.48	0.94	3.42	Average	2.55	0.25	2.80	Average	2.59	0.33	2.92

**Table 6. Tests on Briggs model 4930 Conservor Tank flush toilet.**

Water weight in pounds (lbs).

Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor			
No.	Flush	Residual		Total	Flush	Residual		Total	No.	Flush	Residual
1	20.6	7.0	27.6	1	20.6	2.6	23.2	1	21.2	2.8	24.0
2	20.8	6.6	27.4	2	20.8	2.2	23.0	2	22.0	3.0	25.0
3	20.6	6.8	27.4	3	20.6	2.6	23.2	3	21.8	3.0	24.8
4	20.8	6.8	27.6	4	20.6	2.6	23.2	4	21.6	3.0	24.6
5	20.6	6.8	27.4	5	20.6	2.6	23.2	5	21.6	3.2	24.8
6	20.4	7.0	27.4	6	20.4	2.4	22.8	6	21.8	3.0	24.8
7	20.2	7.0	27.2	7	21.0	2.6	23.6	7	21.8	3.2	25.0
8	20.6	6.8	27.4	8	21.2	2.6	23.8	8	21.8	3.0	24.8
9	20.4	7.0	27.4	9	21.0	2.2	23.2	9	21.4	3.2	24.6
10	20.6	7.0	27.6	10	20.6	2.4	23.0	10	21.6	3.2	24.8
Average	20.6	6.8	27.4	Average	20.7	2.5	23.2	Average	21.7	3.0	24.7

Water volume in gallons (gals).

Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor			
No.	Flush	Residual		Total	Flush	Residual		Total	No.	Flush	Residual
1	2.47	0.84	3.31	1	2.47	0.31	2.78	1	2.54	0.34	2.88
2	2.49	0.79	3.28	2	2.49	0.26	2.76	2	2.64	0.36	3.00
3	2.47	0.82	3.28	3	2.47	0.31	2.78	3	2.61	0.36	2.97
4	2.49	0.82	3.31	4	2.47	0.31	2.78	4	2.59	0.36	2.95
5	2.47	0.82	3.28	5	2.47	0.31	2.78	5	2.59	0.38	2.97
6	2.45	0.84	3.28	6	2.45	0.29	2.73	6	2.61	0.36	2.97
7	2.42	0.84	3.26	7	2.52	0.31	2.83	7	2.61	0.38	3.00
8	2.47	0.82	3.28	8	2.54	0.31	2.85	8	2.61	0.36	2.97
9	2.45	0.84	3.28	9	2.52	0.26	2.78	9	2.57	0.38	2.95
10	2.47	0.84	3.31	10	2.47	0.29	2.76	10	2.59	0.38	2.97
Average	2.46	0.83	3.29	Average	2.49	0.29	2.78	Average	2.60	0.36	2.96

**Table 7. Tests on Crane Water Economy Tank 3-222 flush toilet.**

Water weight in pounds (lbs).

No.	Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor		
	Flush	Residual	Total		Flush	Residual	Total		Flush	Residual	Total
1	20.8	6.4	27.2	1	20.4	1.8	22.2	1	20.0	2.2	22.2
2	20.2	6.4	26.6	2	20.0	2.0	22.0	2	21.4	2.6	24.0
3	20.2	5.6	25.8	3	20.2	2.0	22.2	3	20.4	2.6	23.0
4	20.8	6.4	27.2	4	20.0	2.2	22.2	4	20.4	2.6	23.0
5	20.4	6.8	27.2	5	19.8	2.0	21.8	5	21.2	2.4	23.6
6	20.6	6.0	26.6	6	20.0	1.8	21.8	6	21.2	2.6	23.8
7	20.6	6.4	27.0	7	20.4	1.8	22.2	7	21.2	2.6	23.8
8	20.8	6.0	26.8	8	20.4	1.8	22.2	8	20.6	2.8	23.4
9	20.2	6.6	26.8	9	20.0	2.0	22.0	9	21.0	2.8	23.8
10	20.4	6.4	26.8	10	19.8	2.0	21.8	10	20.8	2.6	23.4
Average	20.5	6.3	26.8	Average	20.1	1.9	22.0	Average	20.8	2.6	23.4

Water volume in gallons (gals).

No.	Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor		
	Flush	Residual	Total		Flush	Residual	Total		Flush	Residual	Total
1	2.49	0.77	3.26	1	2.45	0.22	2.66	1	2.40	0.26	2.66
2	2.42	0.77	3.19	2	2.40	0.24	2.64	2	2.57	0.31	2.88
3	2.42	0.67	3.09	3	2.42	0.24	2.66	3	2.45	0.31	2.76
4	2.49	0.77	3.26	4	2.40	0.26	2.66	4	2.45	0.31	2.76
5	2.45	0.82	3.26	5	2.37	0.24	2.61	5	2.54	0.29	2.83
6	2.47	0.72	3.19	6	2.40	0.22	2.61	6	2.54	0.31	2.85
7	2.47	0.77	3.24	7	2.45	0.22	2.66	7	2.54	0.31	2.85
8	2.49	0.72	3.21	8	2.45	0.22	2.66	8	2.47	0.34	2.81
9	2.42	0.79	3.21	9	2.40	0.24	2.64	9	2.52	0.34	2.85
10	2.45	0.77	3.21	10	2.37	0.24	2.61	10	2.49	0.31	2.81
Average	2.46	0.75	3.21	Average	2.41	0.23	2.64	Average	2.50	0.31	2.81

**Table 8. Tests on Kohler 4519-A-0-47 Water Gard Tank flush toilet.**

Water weight in pounds (lbs).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	17.2	6.0	23.2	1	17.0	2.6	19.6	1	19.2	2.4	21.6
2	18.0	6.0	24.0	2	16.2	2.2	18.4	2	18.2	2.4	20.6
3	16.8	5.6	22.4	3	17.2	2.6	19.8	3	16.6	2.2	18.8
4	17.4	6.0	23.4	4	16.8	2.4	19.2	4	18.6	2.4	21.0
5	17.6	6.2	23.8	5	16.8	2.4	19.2	5	18.8	2.4	21.2
6	16.8	5.4	22.2	6	17.0	2.4	19.4	6	18.2	2.6	20.8
7	16.8	6.0	22.8	7	16.2	2.4	18.6	7	18.2	2.2	20.4
8	18.0	6.2	24.2	8	17.8	2.4	20.2	8	18.0	2.6	20.6
9	17.0	6.0	23.0	9	16.8	2.2	19.0	9	18.4	2.4	20.8
10	17.8	6.4	24.2	10	16.4	2.2	18.6	10	17.0	2.4	19.4
Average	17.3	6.0	23.3	Average	16.8	2.4	19.2	Average	18.1	2.4	20.5

Water volume in gallons (gals).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	2.06	0.72	2.78	1	2.04	0.31	2.35	1	2.30	0.29	2.59
2	2.16	0.72	2.88	2	1.94	0.26	2.21	2	2.18	0.29	2.47
3	2.01	0.67	2.69	3	2.06	0.31	2.37	3	1.99	0.26	2.25
4	2.09	0.72	2.81	4	2.01	0.29	2.30	4	2.23	0.29	2.52
5	2.11	0.74	2.85	5	2.01	0.29	2.30	5	2.25	0.29	2.54
6	2.01	0.65	2.66	6	2.04	0.29	2.33	6	2.18	0.31	2.49
7	2.01	0.72	2.73	7	1.94	0.29	2.23	7	2.18	0.26	2.45
8	2.16	0.74	2.90	8	2.13	0.29	2.42	8	2.16	0.31	2.47
9	2.04	0.72	2.76	9	2.01	0.26	2.28	9	2.21	0.29	2.49
10	2.13	0.77	2.90	10	1.97	0.26	2.23	10	2.04	0.29	2.33
Average	2.08	0.72	2.80	Average	2.02	0.28	2.30	Average	2.17	0.29	2.46

**Table 9. Tests on Chinaware-Promo UL-477 EAP flush toilet.**

Water weight in pounds (lbs).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	17.6	5.4	23.0	1	16.6	2.2	18.8	1	17.2	2.2	19.4
2	17.0	5.2	22.2	2	16.6	2.2	18.8	2	17.2	2.2	19.4
3	17.4	5.4	22.8	3	17.0	2.2	19.2	3	17.2	2.4	19.6
4	17.4	5.2	22.6	4	16.0	2.4	18.4	4	17.2	2.4	19.6
5	17.2	5.4	22.6	5	17.0	2.4	19.4	5	17.0	2.6	19.6
6	18.0	5.8	23.8	6	17.0	2.2	19.2	6	17.4	2.4	19.8
7	17.2	5.4	22.6	7	17.0	2.4	19.4	7	18.6	2.6	21.2
8	17.2	5.6	22.8	8	17.0	2.2	19.2	8	18.0	2.4	20.4
9	17.6	5.2	22.8	9	17.2	2.2	19.4	9	17.8	2.4	20.2
10	17.4	5.4	22.8	10	17.0	2.6	19.6	10	18.2	2.4	20.6
Average	17.4	5.4	22.8	Average	16.8	2.3	19.1	Average	17.6	2.4	20.0

Water volume in gallons (gals).

Without Restrictor			With Blue Restrictor			With White Restrictor					
No.	Flush	Residual	Total	No.	Flush	Residual	Total	No.	Flush	Residual	Total
1	2.11	0.65	2.76	1	1.99	0.26	2.25	1	2.06	0.26	2.33
2	2.04	0.62	2.66	2	1.99	0.26	2.25	2	2.06	0.26	2.33
3	2.09	0.65	2.73	3	2.04	0.26	2.30	3	2.06	0.29	2.35
4	2.09	0.62	2.71	4	1.92	0.29	2.21	4	2.06	0.29	2.35
5	2.06	0.65	2.71	5	2.04	0.29	2.33	5	2.04	0.31	2.35
6	2.16	0.70	2.85	6	2.04	0.26	2.30	6	2.09	0.29	2.37
7	2.06	0.65	2.71	7	2.04	0.29	2.33	7	2.23	0.31	2.54
8	2.06	0.67	2.73	8	2.04	0.26	2.30	8	2.16	0.29	2.45
9	2.11	0.62	2.73	9	2.06	0.26	2.33	9	2.13	0.29	2.42
10	2.09	0.65	2.73	10	2.04	0.31	2.35	10	2.18	0.29	2.47
Average	2.09	0.64	2.73	Average	2.02	0.27	2.29	Average	2.11	0.29	2.40

**Table 10. Tests on Lamosa Ambassador model #GAM USA flush toilet.**

Water weight in pounds (lbs).

No.	Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor		
	Flush	Residual	Total		Flush	Residual	Total		Flush	Residual	Total
1	16.2	5.8	22.0	1	15.6	1.8	17.4	1	15.4	2.2	17.6
2	16.2	5.8	22.0	2	16.2	1.8	18.0	2	16.2	2.0	18.2
3	16.2	5.4	21.6	3	15.8	2.2	18.0	3	16.0	2.0	18.0
4	16.0	5.4	21.4	4	15.8	2.0	17.8	4	15.6	2.0	17.6
5	15.8	5.6	21.4	5	16.2	2.0	18.2	5	15.8	2.2	18.0
6	16.2	5.2	21.4	6	16.0	2.0	18.0	6	15.8	2.4	18.2
7	16.2	5.4	21.6	7	15.8	1.8	17.6	7	15.4	2.0	17.4
8	16.0	5.6	21.6	8	15.8	1.8	17.6	8	15.2	2.2	17.4
9	16.0	5.4	21.4	9	15.8	1.8	17.6	9	16.0	2.2	18.2
10	16.4	5.6	22.0	10	15.8	2.2	18.0	10	16.0	2.2	18.2
Average	16.1	5.5	21.6	Average	15.9	1.9	17.8	Average	15.7	2.2	17.9

Water volume in gallons (gals).

No.	Without Restrictor			No.	With Blue Restrictor			No.	With White Restrictor		
	Flush	Residual	Total		Flush	Residual	Total		Flush	Residual	Total
1	1.94	0.70	2.64	1	1.87	0.22	2.09	1	1.85	0.26	2.11
2	1.94	0.70	2.64	2	1.94	0.22	2.16	2	1.94	0.24	2.18
3	1.94	0.65	2.59	3	1.89	0.26	2.16	3	1.92	0.24	2.16
4	1.92	0.65	2.57	4	1.89	0.24	2.13	4	1.87	0.24	2.11
5	1.89	0.67	2.57	5	1.94	0.24	2.18	5	1.89	0.26	2.16
6	1.94	0.62	2.57	6	1.92	0.24	2.16	6	1.89	0.29	2.18
7	1.94	0.65	2.59	7	1.89	0.22	2.11	7	1.85	0.24	2.09
8	1.92	0.67	2.59	8	1.89	0.22	2.11	8	1.82	0.26	2.09
9	1.92	0.65	2.57	9	1.89	0.22	2.11	9	1.92	0.26	2.18
10	1.97	0.67	2.64	10	1.89	0.26	2.16	10	1.92	0.26	2.18
Average	1.93	0.66	2.59	Average	1.90	0.24	2.14	Average	1.89	0.25	2.14

**Table 11. Summary of average water use in ten different toilet tanks, with and without flow restrictors.**

Water weight in pounds (lbs).

Product	Without Restrictor			With Blue Restrictor			With White Restrictor			Water saved		% water saved	
	Flush	Residual	Total	Flush	Residual	Total	Flush	Residual	Total	Blue	White	Blue	White
Kohler 5 gallon	34.3	5.7	40.0	35.2	2.2	37.4	34.6	2.7	37.3	2.6	2.7	6.5	6.8
American Standard 5 gallon	31.7	4.7	36.4	31.3	2.2	33.5	32.4	2.2	34.6	2.9	1.8	8.0	4.9
Artesian model C-4850	23.6	6.7	30.3	23.1	2.2	25.3	23.4	2.8	26.2	5.0	4.1	16.5	13.5
Ambassador model R01	21.4	7.9	29.3	21.8	2.9	24.7	21.1	3.0	24.1	4.6	5.2	15.7	17.7
American Standard Cadet	20.7	7.9	28.6	21.2	2.1	23.3	21.6	2.8	24.4	5.3	4.2	18.5	14.7
Briggs model 4930	20.6	6.8	27.4	20.7	2.5	23.2	21.7	3.0	24.7	4.2	2.7	15.3	9.9
Crane Water Economy Tank	20.5	6.3	26.8	20.1	1.9	22.0	20.8	2.6	23.4	4.8	3.4	17.9	12.7
Kohler Water Gard Tank	17.3	6.0	23.3	16.8	2.4	19.2	18.1	2.4	20.5	4.1	2.8	17.6	12.0
Chinaware-Promo	17.4	5.4	22.8	16.8	2.3	19.1	17.6	2.4	20.0	3.7	2.8	16.2	12.3
Lamosa #GAM USA	16.1	5.5	21.6	15.9	1.9	17.8	15.7	2.2	17.9	3.8	3.7	17.6	17.1

Water volume in gallons (gals).

Product	Without Restrictor			With Blue Restrictor			With White Restrictor			Water saved		% water saved	
	Flush	Residual	Total	Flush	Residual	Total	Flush	Residual	Total	Blue	White	Blue	White
Kohler 5 gallon	4.11	0.69	4.80	4.22	0.27	4.49	4.15	0.32	4.47	0.31	0.33	6.5	6.8
American Standard 5 gallon	3.80	0.57	4.37	3.76	0.25	4.01	3.88	0.27	4.15	0.36	0.22	8.0	4.9
Artesian model C-4850	2.82	0.81	3.63	2.77	0.27	3.04	2.80	0.34	3.14	0.59	0.49	16.5	13.5
Ambassador model R01	2.56	0.96	3.52	2.61	0.36	2.97	2.53	0.36	2.89	0.55	0.63	15.7	17.7
American Standard Cadet	2.48	0.94	3.42	2.55	0.25	2.80	2.59	0.33	2.92	0.62	0.50	18.5	14.7
Briggs model 4930	2.46	0.83	3.29	2.49	0.29	2.78	2.60	0.36	2.96	0.51	0.33	15.3	9.9
Crane Water Economy Tank	2.46	0.76	3.21	2.41	0.23	2.64	2.50	0.31	2.81	0.58	0.41	17.9	12.7
Kohler Water Gard Tank	2.08	0.72	2.80	2.02	0.28	2.30	2.17	0.29	2.46	0.50	0.34	17.6	12.0
Chinaware-Promo	2.09	0.64	2.73	2.02	0.27	2.29	2.11	0.29	2.40	0.44	0.33	16.2	12.3
Lamosa #GAM USA	1.93	0.66	2.59	1.90	0.24	2.14	1.89	0.25	2.14	0.45	0.45	17.6	17.1



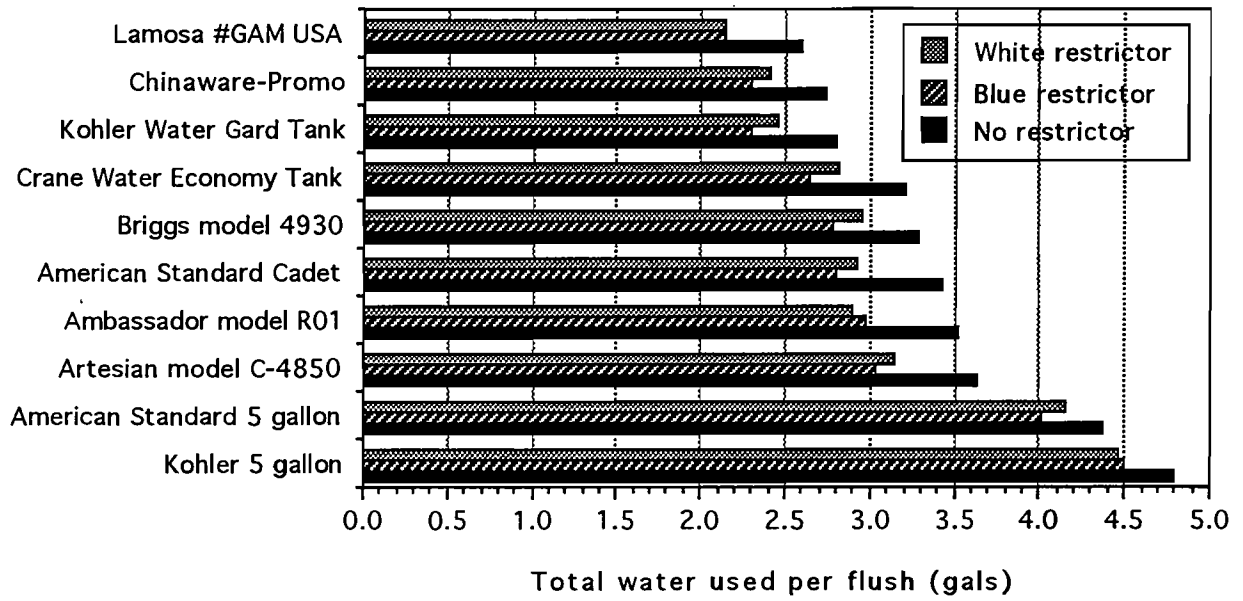


Figure 1. Total water used per flush with and without restrictors.

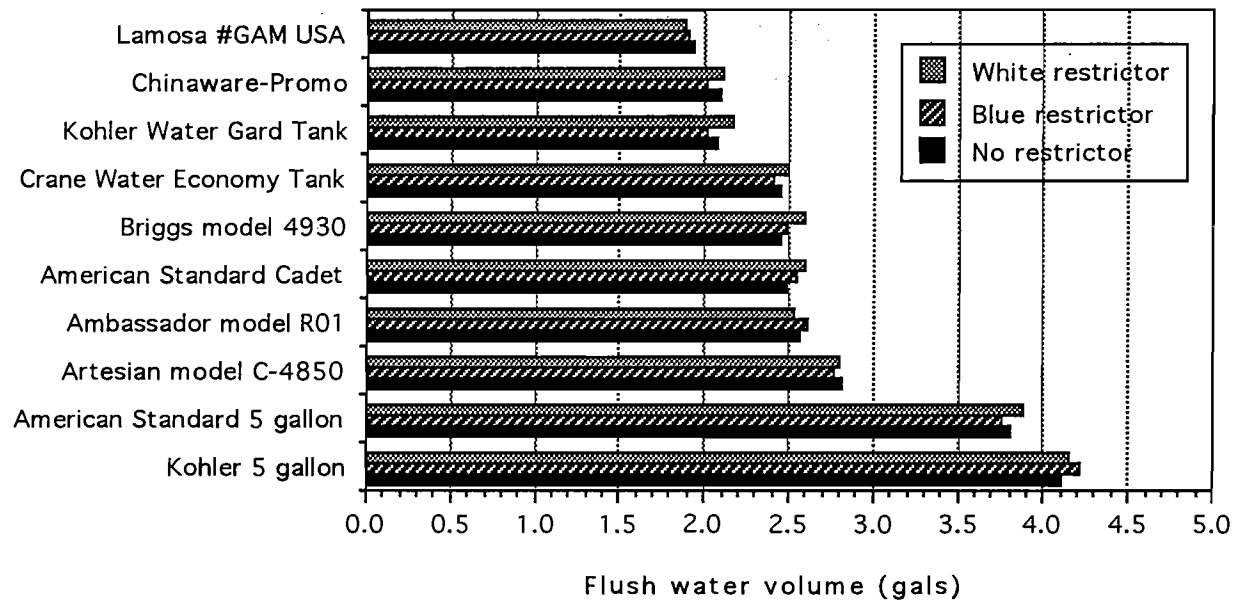


Figure 2. Water volume for initial flush, with and without restrictors.

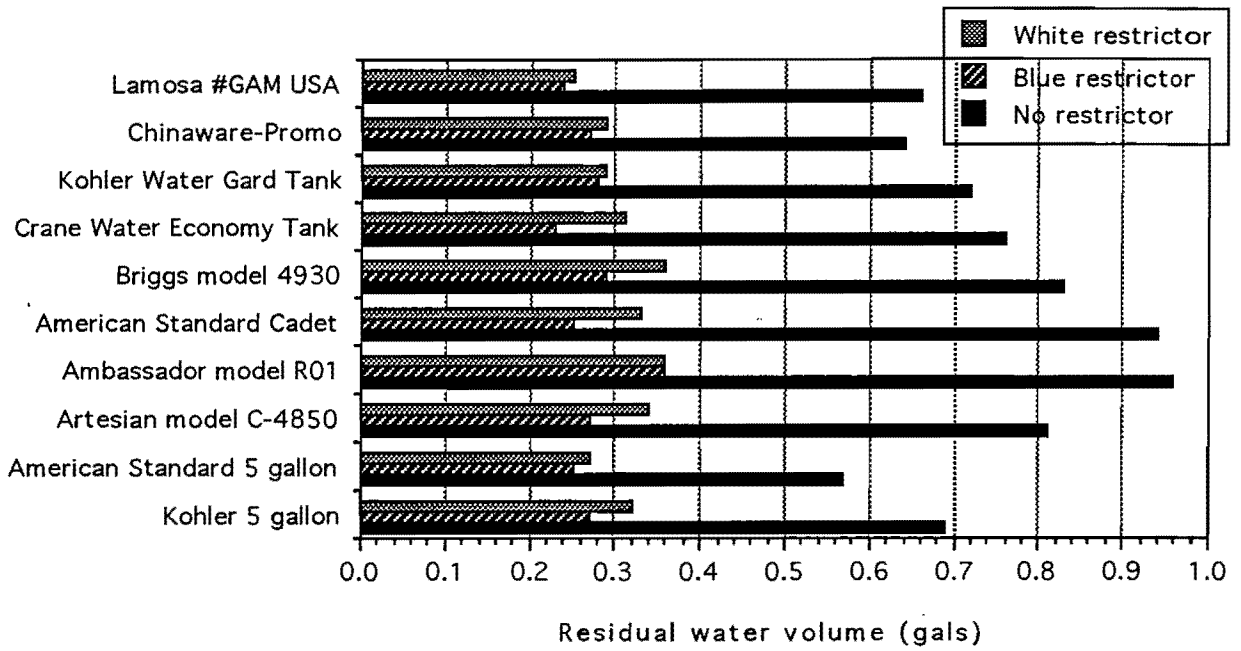


Figure 3. Overflow water volume with and without restrictors.

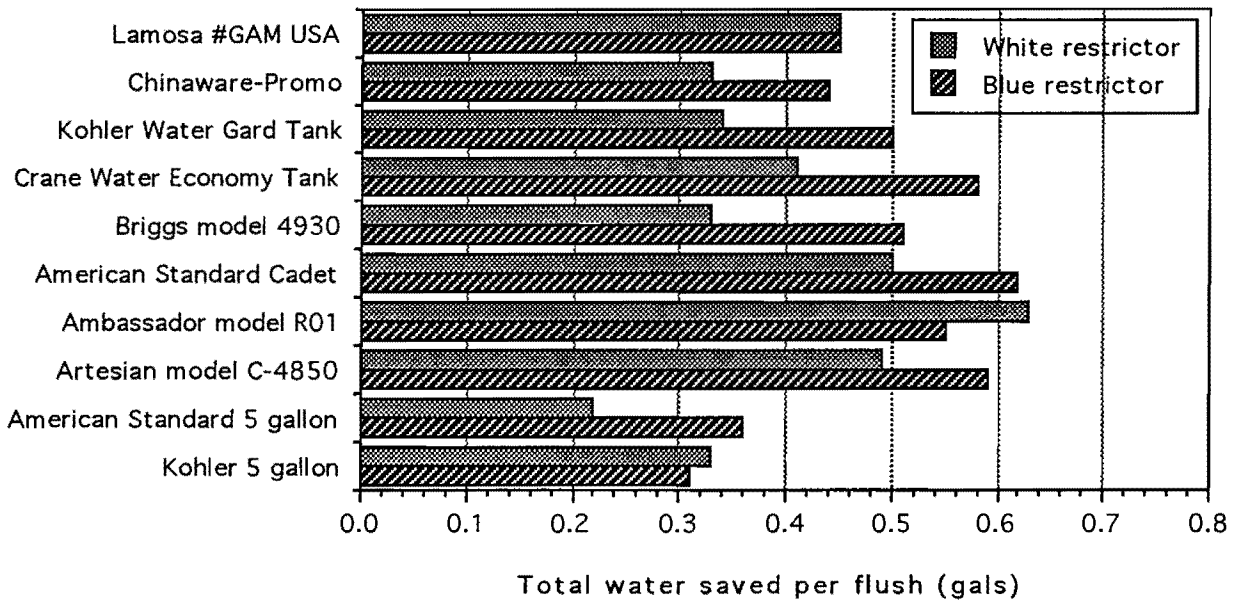


Figure 4. Total water saved per flush with restrictors.

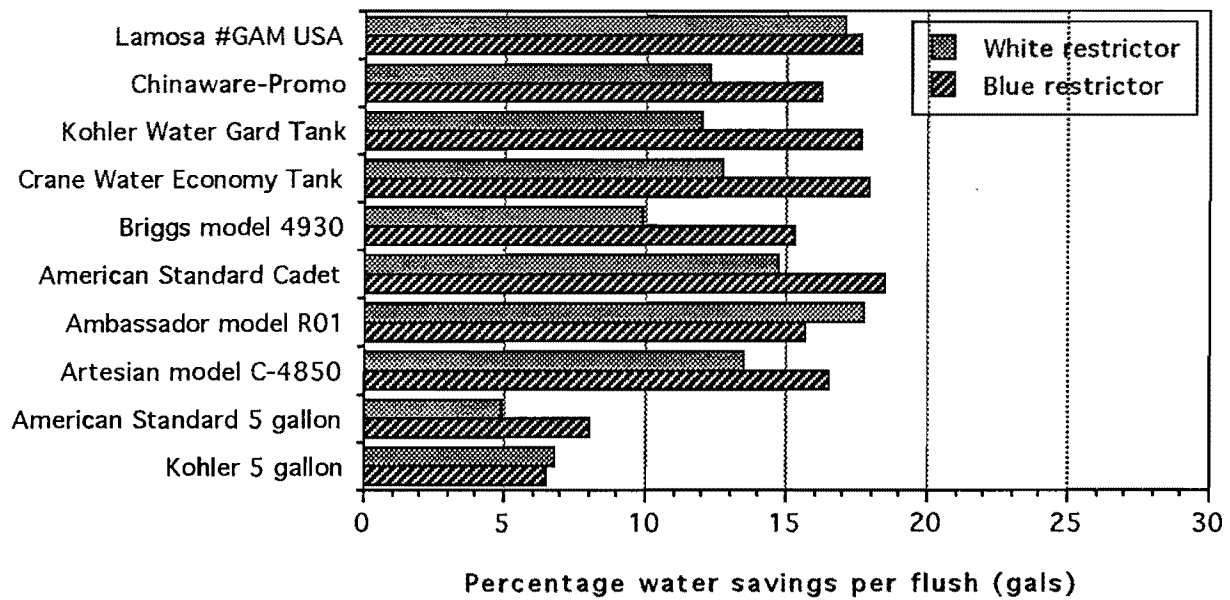


Figure 5. Percentage of total water saved per flush with restrictors.

## DISCUSSION OF RESULTS

The data and graphics show that there is a wide variation of water usage by toilets that are sold as 3.5 gallon units. This usage can be further varied in each unit by the water pressure to which it is subjected, and by the level at which the float is set in the toilet tank. Throughout these tests, the water pressure was maintained as nearly as possible at a constant value, and the water level in each tank was adjusted to the manufacturers' recommended level at the beginning of the test.

Figure 1 indicates total water used per flush which includes all water leaving the system from the time the flush handle is tripped until the tank refills and water stops flowing.

Figure 2 shows that in some instances the amount of water used for the initial flush (the amount that flows from the tank from the instant the flush handle is tripped until the stopper closes in the bottom of the tank) is increased by one or the other or both of the water savers, even though total water use for the flush is decreased. This may be caused by the restricted flow in the overflow tube causing a pressure change within the ballcock valve, allowing more water into the tank during the fill cycle before the valve closes.

The total amount of water going down the overflow tube after the stopper is closed in the

bottom of the tank is indicated in Figure 3. Note that in all instances each water restrictor decreases overflow water use by more than half.

Table 11 and Figures 4 and 5 show the total water saved per flush on each of the ten units tested, by each of the two water restrictors or savers. Both units are effective in restricting water use with savings varying from a low of 0.22 gallons per flush using the white restrictor on the American Standard 5-gal per flush unit to a high of 0.63 gallons per flush using the white restrictor on the Ambassador Model R01 3.5 gal per flush unit. The blue restrictor saved slightly more than the white one on 7 of the 10 units tested.

The endurance test consisted of running pressurized water through three of each of the two water saving units for more than 200,000 on-off cycles. At the end of the test, there was no visible damage to any of the test units. However, in real-life experience, if we assumed that a typical U.S. household flushes a toilet an average of 10 times per day, it would require 55 years to achieve 200,000 flushes. During that period of time, the plastic or tubing from which the water restrictors are made could very well deteriorate from age and might need to be replaced.

## CONCLUSIONS

Each of the flow restricting devices tested saves water, averaging slightly less than 1/2 gallon per flush. On the ten different brands tested, the blue restrictor saved an average of 0.491 gallons per flush, or 14.98% of the water normally used.

The white restrictor averaged a saving of 0.403 gallons per flush, or 12.16% of water normally used.

No damage of any kind was noted in either restrictor after more than 200,000 on-off cycles.