Water Savings Rates for Urban Water Conservation BMPs

James P. Heaney
Dept. of Environmental Engineering Sciences
University of Florida
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UF Environmental Engineering Sciences
UNIVERSITY of FLORIDA

Conserve Florida Water
Promoting Conservation in Our Public Water Supplies

Current Approach to Conservation Analysis

- Use a single savings rate for all retrofits in a given category
- Don't group customers into subgroups based on similar water use patterns
- Don't include a calibrated end use analysis based on historical water use patterns

Limitations of Existing Water Savings Estimates

- Water savings = pre – post usage
- Current methods just present the savings without specifying the basis for the calculation
- Single savings estimate is provided for all customers in a single sector, e.g., 26.6 gallons per account per day for a toilet retrofit as shown in the next slide

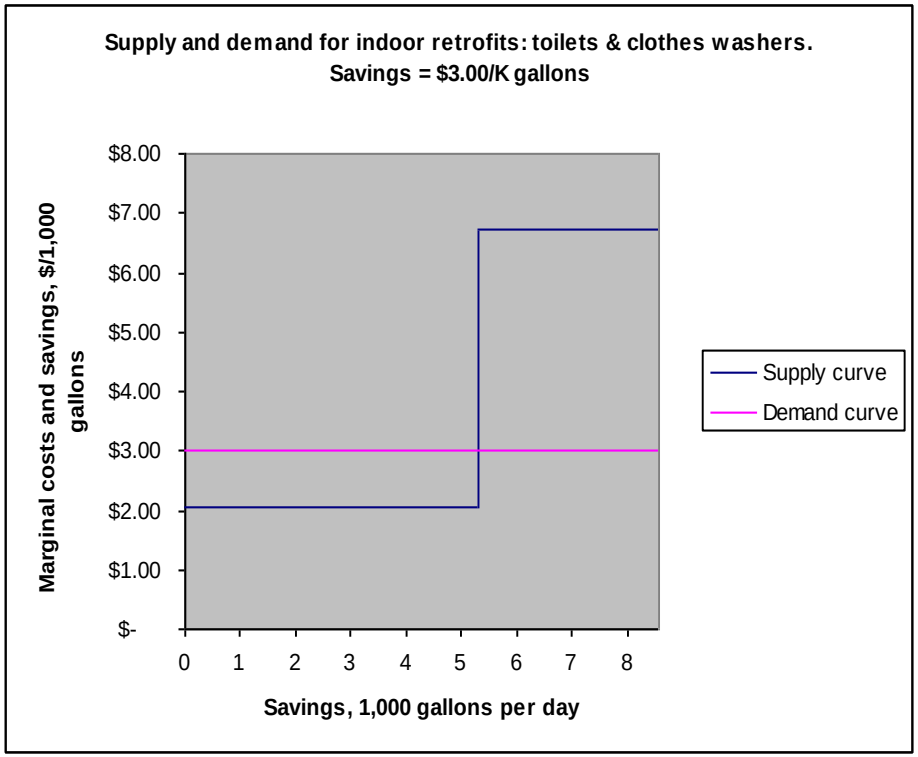
Savings Rates Used in Original Guide

	Best Management Practice	Category	Sector	Savings Rate	Units of Savings Rate
1	Non-Potable Irrigation Source Replacement or Rebates	All Categories	SF	300	gpad
			MF	713	gpad
			NR	9,232	gpad
2	Water-Efficient Landscape and Irrigation Evaluations and Rebates	All Categories	SF	140	gpad
			MF	143	gpad
			NR	978	gpad
3	High-Efficiency Clothes Washer Rebates	No Categories	SF	16.3	gpad
			MF_{in}	10.8	gpud
			MF_{com}	3.7	gpud
			NR	1,536	gpad
4	Ultra Low Flush (ULF) Toilet Rebates	No Categories	SF	26.6	gpad
			MF	20.3	gpud
			NR	26	gpmd
5	Urinal Rebates	Waterless Urinal	NR	117	gpad
		ULF Urinal		70	gpad
6	Industrial, Commercial and Institutional Water-Use Evaluations/Implementation	No Categories	NR	To be defined	gpad

Simple Benefit-cost Analysis Existing Guide

SFR customers. Changing toilets and/or clothes washers

Category	Toilets	CWs
Inputs		
Savings rate: gal./account-day	26.6	16.3
Number of accounts	200	200
Persons per account	3	3
Fixtures per account	2	1
Cost per fixture,$	$ 200	$ 600
Service life, years	20	15
Value of water saved, $/1,000 gal.	$ 3.00	$ 3.00
Outputs		
Potential savings, gal./day	5,320	3,260
Daily gallons saved/fixture	13.3	16.3
Savings/toilet in $/day	$ 0.0399	$ 0.0489
Cost/toilet in $/day	$ 0.0274	$ 0.1096
Net benefit, $/day	$ 0.0125	$ (0.0607)
Marginal cost, $/1,000 gal. saved	$ 2.06	$ 6.72



Limitations of Simple Approach

- Using a single average savings for each BMP, the model simply ranks them from best to worst based on the marginal cost in $/1,000 gallons and the total potential savings, and compares this supply curve with a single savings value.
- If the marginal savings >= marginal costs, then retrofit all fixtures in this category

CFWC Approach

- A calibrated end use water budget based on recent historical data is used to evaluate how water is used at present
- Users in a given sector, e.g., single family residential, are tallied into three age groups:
  - Pre-1980
  - 1980-1994
  - 1995-present
- Savings occur when a customer switches from a less efficient to a more efficient fixture

CFWC Fixture Use Intensities and Frequencies

Table 4.7. Gallons Per Use for Toilets, Clothes Washers, Showerheads and Faucets.

	Fixture and Unit of Intensity			
Year Built Group	Toilets (gal/flush)	Clothes Washers (gal./ load)	Showerheads (gal./ min.)	Faucets (gal./ min.)
Pre 1980	4.50	55.0	2.0	2.0
1980-1994	3.50	50.0	1.9	1.8
1995-2008	1.60	36.0	1.8	1.5
High Efficiency	1.28	18.0	1.7	1.0

	Fixture and Unit of Frequency			
Year Built Group	Toilets (flushes/ person/ day)	Clothes Washers (gal/ load)	Showerheads* (showers/ person/ day)	Faucets (min./ person/ day)
Pre 1980	5.1	0.25	0.7	8.1
1980-1994	5.1	0.30	0.7	8.1
1995-2008	5.1	0.37	0.7	8.1
High Efficiency	5.1	0.37	0.7	8.1

* Showerheads also have a duration of 8 min per shower

General daily water use per capita for indoor fixtures as a function of age

Table 4.9. Daily Water Use Per Capita for Toilets, Clothes Washers, Showerheads, Faucets, Other and Estimated Leakage Rates.

	Fixture						
Year Built Group	Toilets	Clothes Washers	Showerheads	Faucets	Other	Leakage	Total
Pre 1980	23.0	13.8	11.2	16.2	4.5	12	80.6
1980-1994	17.9	15.0	10.6	14.6	4.0	11	73.1
1995-2008	8.2	13.3	10.1	12.2	3.5	9	56.2
High Efficiency	6.5	6.7	9.5	8.1	3.0	8	41.8

Table 4.10. Daily Water Use Per Capita for Toilets, Clothes Washers, Showerheads, Faucets, and Other Including Prorated Leakage.

	Fixture					
Year Built Group	Toilets	Clothes Washers	Showerheads	Faucets	Other	Total
Pre 1980	27.0	16.2	13.2	19.0	5.3	80.6
1980-1994	21.0	17.7	12.5	17.2	4.7	73.1
1995-2008	9.7	15.9	12.0	14.5	4.2	56.2
High Efficiency	8.1	8.2	11.8	10.0	3.7	41.8

Average indoor gpcd for 20 metropolitan statistical areas in Florida

Table 4.11 . Proportion of population in each year built group for 20 Metropolitan Statistical Areas in Florida

http://edr.state.fl.us/population/Population%20MSA%20Estimates.pdf

	% population in each increment				Weighted
Metroplitan Statistical Area	Pre-1980	1980 to 1994	1995 to 2008	Sum	gpcd
All MSA's in Florida	51.9%	25.3%	22.8%	100.0%	73.1
Bradenton-Sarasota-Venice	49.6%	26.6%	23.8%	100.0%	72.8
Cape Coral-Ft. Myers	33.3%	29.8%	36.9%	100.0%	69.4
Deltona-Daytona Beach-Ormond Beach	42.1%	24.1%	33.8%	100.0%	70.5
Ft. Walton Beach-Crestview-Destin	56.1%	24.0%	19.9%	100.0%	73.9
Gainesville	57.3%	19.9%	22.8%	100.0%	73.5
Jacksonville	53.9%	20.9%	25.2%	100.0%	72.9
Lakeland-Winter Haven	55.1%	21.0%	23.9%	100.0%	73.2
Miami-Ft. Lauderdale-Pompano Beach	58.5%	23.8%	17.6%	100.0%	74.5
Naples-Marco Island	25.8%	34.7%	39.5%	100.0%	68.4
Ocala	37.0%	31.8%	31.2%	100.0%	70.6
Orlando-Kissimmee	38.3%	30.0%	31.6%	100.0%	70.6
Palm Bay-Melbourne-Titusville	49.1%	29.6%	21.3%	100.0%	73.2
Palm Coast	11.6%	30.0%	58.4%	100.0%	64.1
Panama City-Lynn Haven-Panama City Beach	57.6%	23.2%	19.1%	100.0%	74.2
Pensacola-Ferry Pass-Brent	63.3%	19.2%	17.5%	100.0%	74.9
Port St. Lucie	36.2%	32.1%	31.7%	100.0%	70.5
Punta Gorda	35.2%	41.5%	23.3%	100.0%	71.8
Sebastian-Vero Beach	42.3%	29.2%	28.5%	100.0%	71.4
Tallahassee	57.1%	20.9%	22.0%	100.0%	73.7
Tampa-St. Petersburg-Clearwater	59.0%	22.6%	18.3%	100.0%	74.4
Default gpcd	80.6	73.1	56.2		

- Average gpcd ranges from a low of 64.1 for newer MSA's to 74.5 for older SMAs

CFWC Toilet Evaluation Methodology

1. End use analysis of toilets
2. Current water use by existing toilets
3. Calculate water savings if existing toilets are retrofit to 1.28 gpf toilets
4. Sort the results from highest to lowest savings rates and plot the performance function
5. Determine the supply curve for toilet retrofits
6. Determine the optimal number of toilets to retrofit for a given savings rate

1. End Use Analysis of Toilets

A. Toilet Inventory

Table 1. Count of Homes in GRU with Given Number of Bathrooms

		Bathrooms					
Period	Total SFRs	1	1.5	2	2.5	3	>3
Pre 1980	12,846	2,745	681	7,822	765	616	217
1980-1994	10,199	542	368	6,862	1,116	901	410
1995-2008	7,858	20	14	5,025	606	1,301	892
Total	30,903	3,307	1,063	19,709	2,487	2,818	1,519

Table 2. Count of Homes with Given Number of Bathrooms

		Homes with Indicated Number of Toilets			
Period	Total SFRs	1	2	3	4
Pre 1980	12,846	2,745	8,503	1,381	217
1980-1994	10,199	542	7,230	2,017	410
1995-2008	7,858	20	5,039	1,907	892
total	30,903	3,307	20,772	5,305	1,519

Table 3. Count of Toilets in Homes with Given Number of Bathrooms

Period	Total	1	2	3	4
Pre 1980	24,762	2,745	17,006	4,143	868
1980-1994	22,693	542	14,460	6,051	1,640
1995-2008	19,387	20	10,078	5,721	3,568
total	66,842	3,307	41,544	15,915	6,076
Wgt. Avg.					

2. Current Water Use by Existing Toilets

B. Current water usage

Table 4. Persons per toilet with a given number of toilets per house

Period	Persons/ house	1	2	3	4
Pre 1980	2.53	2.53	1.27	0.84	0.63
1980-1994	2.60	2.60	1.30	0.87	0.65
1995-2008	2.70	2.70	1.35	0.90	0.68

Table 5. Current usage in gallons per toilet per day

Period	Toilets/ house >	1	2	3	4	Toilet Attributes		
All	Persons/ toilet >	2.53	1.27	0.84	0.63	Gallons/ flush	Flushes/ person-day	Gal./ person/ day
Pre 1980		58.1	29.0	19.4	14.5	4.5	5.1	22.95
1980-1994		46.4	23.2	15.5	11.6	3.5	5.1	17.85
1995-2008		22.0	11.0	7.34	5.51	1.6	5.1	8.16

3. Determine Savings if All Toilets are Converted to 1.28 gpf

Table 5. Current usage in gallons per toilet per day

Period	Toilets/ house >	1	2	3	4	Toilet Attributes		
All	Persons/ toilet >	2.53	1.27	0.84	0.63	Gallons/ flush	Flushes/ person-day	Gal./ person/ day
Pre 1980		58.1	29.0	19.4	14.5	4.5	5.1	22.95
1980-1994		46.4	23.2	15.5	11.6	3.5	5.1	17.85
1995-2008		22.0	11.0	7.34	5.51	1.6	5.1	8.16

C. Determine Savings by converting all toilets to 1.28 gallon per flush toilets

New gpf = 1.28

Flushes/person/day = 5.1

Table 6. Usage with 1.28 gpf toilets for all customers in gallons per toilet per day

Period	Toilets/ house >	1	2	3	4
All	Persons/ toilet >	2.53	1.27	0.84	0.63
Pre 1980		16.52	8.26	5.51	4.13
1980-1994		16.52	8.26	5.51	4.13
1995-2008		16.52	8.26	5.51	4.13

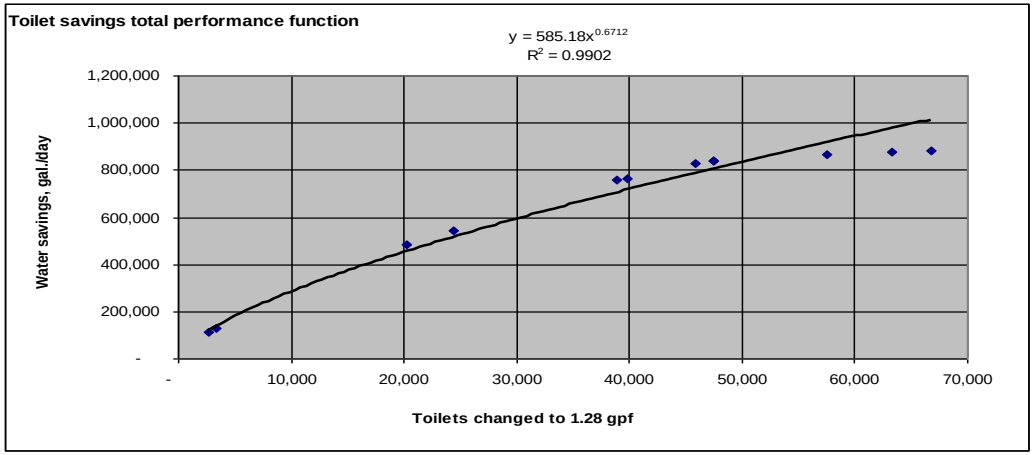
Table 7. Savings in gallons per toilet switched to 1.28 gpf = existing use - use at 1.28 gpf

Period	Toilets/ house >	1	2	3	4
All	Persons/ toilet >	2.53	1.27	0.84	0.63
Pre 1980		41.55	20.77	13.85	10.39
1980-1994		29.89	14.95	9.96	7.47
1995-2008		5.52	2.76	1.84	1.38

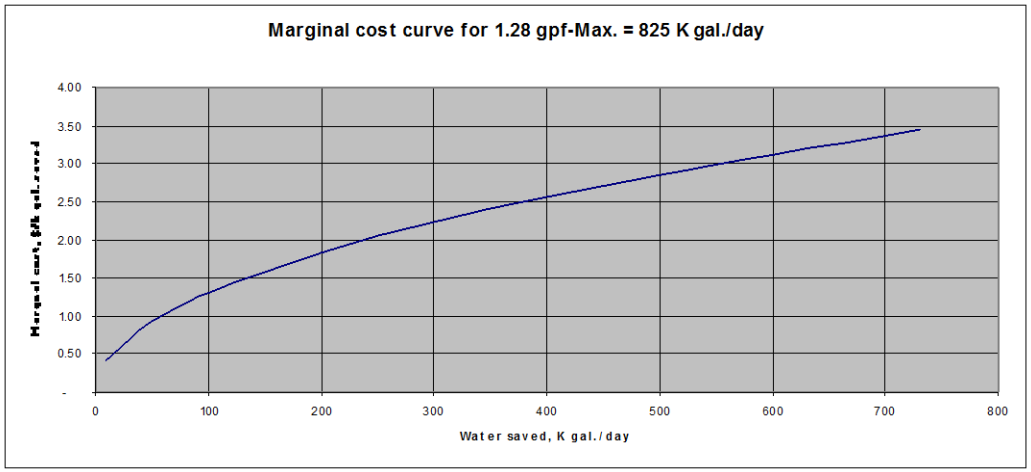
4. Sort the Results from Highest to Lowest Savings Rates and Plot the Performance Function

Table 8. Development of the toilet performance function-1.28 gpf.

Rank	Period	Baths	Toilets	Sum Toilets	Unit savings gal./ toilet	Unit savings gal./day	Sum savings gal./day
1	Pre 1980	1	2,745	2,745	41.55	114,048	114,048
2	1980-1994	1	542	3,287	29.89	16,203	130,251
3	Pre 1980	2	17,006	20,293	20.77	353,280	483,531
4	1980-1994	2	14,460	38,896	14.95	216,135	757,043
5	Pre 1980	3	4,143	24,436	13.85	57,377	540,908
6	Pre 1980	4	868	39,764	10.39	9,016	766,059
7	1980-1994	3	6,051	45,815	9.96	60,297	826,355
8	1980-1994	4	1,640	47,455	7.47	12,257	838,612
9	1995-2008	1	20	47,475	5.52	110	838,722
10	1995-2008	2	10,078	57,553	2.76	27,796	866,518
11	1995-2008	3	5,721	63,274	1.84	10,519	877,037
12	1995-2008	4	3,568	66,842	1.38	4,920	881,958



5. Determine the Supply Curve for Toilet Retrofits



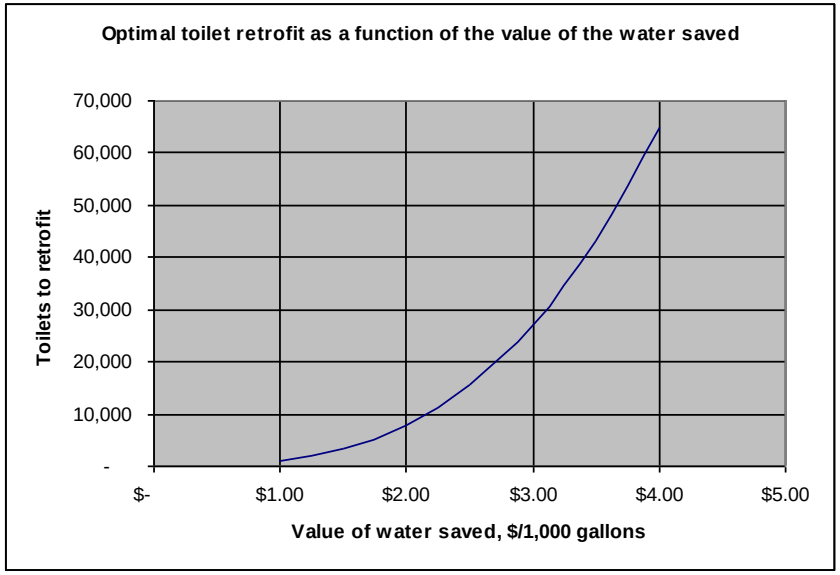
- Marginal cost curve shows how much water could be saved depending on its market value, e.g., if the price of water is $2.00/1,000 gallons, then about 250,000 gallons per day could be saved

6. Determine the Optimal Number of Toilets to Retrofit for a Given Savings Rate

- Maximize Z = py-cx
- Subject to $y = ax^b$
- p = value of water saved, $/gallon
- c = cost of a new toilet, $/day
- a = coefficient from the performance equation
- b = exponent of the performance equation
- Substitute a,b, c, and p into the equation to find the optimal value, x*

$$x^* = \left(\frac{c}{pab} \right)^{\frac{1}{b-1}}$$

Effect of Value of Water on Optimal Toilet Retrofit



- If value exceeds $4.00/K gal., replace all 66,862 toilets
- If value is $2.00/K gal., replace 7,900 toilets. From Step 4, replace the pre-1980 1 and 2 bath toilets and some of the 1 bath 1980-1994 toilets

Savings Estimates in EZ Guide 2.0 for Single Family Residences

- Estimate the number of customers in three groups:
  - Pre-1980
  - 1980-1994
  - 1995-present
- Estimate the number of fixtures per establishment
- Specify the water use per fixture in transitioning from the beginning to the end states
- Method is possible due to availability of parcel level data in Florida

Next Refinement

- Estimate the proportion of users who have upgraded their fixtures based on recent historical water use patterns