California Urban Water Conservation Council

Evaluation of Potential Best Management Practices - High-Efficiency Plumbing Fixtures – Toilets & Urinals

Prepared for

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High-Efficiency Plumbing Fixtures – Toilets and Urinals

1. Background

Advent of Low-Flow Fixtures

Beginning in 1992, a new water-efficiency standard for toilets and urinals became the law in California. The maximum flush volume for each of these fixtures was lowered to 1.6 gallons and 1.0 gallons, respectively. This action closely followed or was coincident with similar requirements imposed by other state and local jurisdictions throughout the U.S. A patchwork pattern of requirements resulted, forcing the plumbing industry to develop and market two separate product lines…those for the "efficient states" and those for "not-so-efficient states." Consequently, the plumbing industry, the water and wastewater industry, and environmental organizations all encouraged the U.S. Congress to adopt uniform standards for the entire country. (A more complete history of this evolutionary process may be found in separate reports by the U.S. General Accounting Office[1] and by Potomac Resources, Inc.[2])

The products that resulted from this process were given the various labels of ultra-low-flow, ultra-low-flush, low-flow, and similar. Although most early versions of the toilet fixtures flushed at 1.6 gallons or less, they did not necessarily perform well and, thus, did not always result in satisfied customers and users. To this day, the reputation of some early "low flow" toilet fixtures still exists and influences water conservation programs[3]. As a result of early problems, the plumbing industry embarked upon fresh product development to improve performance and thereby restore customer confidence and satisfaction. By 1997, fixture performance had improved significantly.

High-Efficiency Definition

In the absence of any clear definition or stratification of toilet and urinal fixtures that perform *more efficiently* than the prescribed maximums, the Council worked with selected member water providers[4] in 2004 to establish such a definition for toilets. The High-Efficiency Toilet (HET) is defined as a fixture that flushes at 20 percent below the 1.6-gpf/6.0-lpf maximum or less, equating to a maximum of 1.3-gpf/4.8-lpf.

For the purpose of this analysis, the High-Efficiency Urinal (HEU) is defined as a fixture that flushes at 0.5-gallons (1.9-lpf) or less. This definition includes existing 0.5-gpf urinals and non-

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[1] U.S. Government Accounting Office, 2000. *Report to Congressional Requesters, WATER INFRASTRUCTURE, Water-Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows,* GAO/RCED-00-232, August.

[2] Osann, Edward R. and Young, John E., Potomac Resources, Inc. 1998. *Saving Water, Saving Dollars: Efficient Plumbing Products and Protection of America's Waters,* April.

[3] This is particularly important as manufacturers and the water industry attempt to "convince" customers that high-efficiency fixtures with even lower flush volumes are going to perform.

[4] Some member water providers (EBMUD, Santa Clara Valley Water District, and MWDSC) were in the process of constructing or implementing toilet programs for high-efficiency toilets and needed to have criteria established in order to qualify fixtures for their respective programs.

water urinals as well as the one-quart and one-liter urinals currently in development by several manufacturers.

High-Efficiency Toilets (HETs)

Three types of HETs currently exist in the marketplace.

Table 1. Types of high-efficiency toilet technologies

Technology	Certified Flush Volumes
Dual-flush	0.8-1.1-gpf and 1.6-gpf
Pressure-assist single flush	1.0-gpf
Gravity-fed single flush	1.28-gpf and less

Dual-Flush

In late 1998, the first gravity-fed dual-flush toilet fixture was introduced into the U.S. market by Caroma International, Ltd.[5] While the dual-flush concept of efficiency was well-established in Australia and the European continent, it was new to North America[6]. As such, education of the specifiers, builders, building operators, and consumers as to its benefits was (and remains) critical to successful market penetration of this technology. The most persuasive argument in favor of the technology was the entry of other manufacturers as competitors to Caroma.

While Caroma attempted to establish its presence in the marketplace with the "green building" and water-efficiency practitioners, other manufacturers saw the potential of these sectors and began development of their own dual-flush products. In 2003, the first competing gravity-fed dual-flush fixture was introduced by Vortens, a brand of the Lamosa Group, based in Monterrey Mexico. For the first time in five years, Caroma was about to experience competitive pressure on their fixture prices which, at that time, had been significantly higher than conventional gravity-fed 1.6-gallon toilets. It is well-known that this pricing discrepancy had discouraged the purchase of dual-flush toilets by the marketplace.

From 2003 to 2005, more manufacturers entered the marketplace and today, the following manufacturers have a total of 48 dual-flush fixture models in their North American product lines:

[5] Prior to this time, Kohler had developed and introduced into the marketplace the Power-Lite™ dual-flush toilet, powered by an electrically operated pump (which therefore requires an electrical service in the vicinity of the toilet). The Power- Lite™ line of fixtures exists today but is expensive.

[6] The dual-flush option on a toilet fixture provides the user with two flushing choices, a full 1.6-gallon flush for solids and liquids or a reduced ("short") flush for liquids only. The reduced flush ranges between 0.8 and 1.1 gallons depending upon the design of the fixture.

Table 2. Dual-Flush HETs

Manufacturer	Number of Product Offerings
Caroma	13
Duravit	2
Gerber	11
Kohler	6
Mancesa	1
Mansfield	7
Pegasus (Home Depot)	1
Toto	1
Vitra	2
Vortens	3
Western Pottery	1
TOTAL	48

Dual-flush fixtures are best suited to residential applications or commercial non-public applications. The installation of dual-flush fixtures in public facilities is not recommended until such time as the public is aware and educated about dual-flush, a condition which may take many years to achieve.

Pressure-Assist Single-Flush

The second category of HETs consists of the 1.0-gpf pressure-assist technology introduced in California in 2000. Sloan Flushmate, a division of Sloan Valve Company, developed a 1.0-gpf (3.8-lpf) pressure-assist system based upon their already-proven 1.6-gpf pressure-assist technology. The prototype 1.0-gpf Flushmate system was installed in approximately 36 fixtures from St. Thomas Creations and other manufacturers, field tested, and evaluated by California water agencies. The marginal results from that field study[7] led to improvements in both the Flushmate product and the bowls to which it delivered water. Sloan then marketed the system to all manufacturers. Today, six manufacturers produce 12 models of the 1.0-gpf pressure-assist toilet fixture. In addition, WDI International, a competitor to Sloan, supplies a similar device for 11 models from another manufacturer.

This technology is suited to both residential and light commercial applications. Although the pressure-assist toilet fixture has a long-standing reputation for being noisy, the latest models approach conventional gravity-fed fixtures in terms of noise associated with the flushing action. That is, noise levels have been reduced through the redesign of the toilet bowls.

There are currently 23 different models of 1.0-gpf (3.8-lpf) pressure-assist toilets available from the seven manufacturers, with additional manufacturers likely to introduce products in this category in the near future.

[7] Koeller, Muir, Davies, De La Piedra, 2001. *A Field Study of 4.0-liter (1.0-gallon) Toilet Fixtures,* paper prepared for and presented at AWWA Water Sources Conference, January 2002.

Table 3. Pressure-Assist 1.0-gpf Single-Flush HETs

Manufacturer	Number of Product Offerings
Capizzi	3
Gerber	11
Mancesa	1
Mansfield	4
Peerless Pottery	2
St. Thomas Creations	1
Vortens	1
TOTAL	23

Conventional Gravity-Fed

This next category consists of conventional gravity-fed fixtures with a flush volume meeting the HET criteria. Only one model currently exists in the marketplace, although other manufacturers are capable of developing or have already developed such a prototype fixture. More toilet fixtures of this type will likely be introduced into the marketplace within the next several years[8].

Table 4. Single-Flush HET

Manufacturer	Number of Product Offerings
American Standard	1

One would expect that because the gravity-fed technology has been in existence in the U.S for decades and does not require special devices, linkage, or equipment, the cost of this type of fixture would be the least of all three technologies. Intense competition among the HET manufacturers, coupled with the demand for HETs by "green building programs" and water-efficiency initiatives, and the sourcing of product from a variety of locations all over the world, is dramatically influencing pricing trends. Overall, pricing trends are downward, but not always in a logical or predictable pattern.

Flushometer Valve & Bowl

The last category of HETs is that of flushometer valve and bowl toilets for CII applications. No valve and bowl combinations are yet available in the marketplace that are designed for either dual-flush or for single-flush consumption below the 1.3-gpf HET threshold. However, Sloan Valve Company is currently marketing a dual-flush flushometer valve with a view toward opening the CII market to these types of installations.

[8] One competing manufacturer intends to introduce two such gravity-fed single-flush models in 2005.

High-Efficiency Urinals (HEUs)

Two types of HEUs currently exist in the marketplace, 0.5-gpf flushing urinals and non-water urinals. Several manufacturers are developing flushing urinals to be rated at one liter, one quart, or less. By Spring 2006, such advanced products will be available within the U.S. marketplace.

Half-Gallon Urinals

Three manufacturers each produce and sell a single model of a 0.5-gpf urinal in the U.S. marketplace. Those manufacturers are American Standard, Kohler, and Mansfield with the following products:

Table 5. Half-Gallon HEUs

Manufacturer	Model
American Standard	Innsbrook Model 6520
Kohler	Bardon™ K-4915
Mansfield Plumbing	Adam™ 401[9]

Unlike conventional urinals, both the American Standard and the Kohler products house an integrated sensor-operated flush valve. The Mansfield product[9], on the other hand, must be coupled with a 0.5-gpf flushometer valve from one of the valve manufacturers. Other manufacturers have urinals in their existing product lines that are certified at 1.0-gpf but are claimed to meet all performance requirements at 0.7-gpf and above.

1-Quart and 1-Liter Urinals

Several manufacturers are in the process of researching and/or developing urinals that flush on one liter or less, in some cases as low as one pint of water[10]. Although one-liter flushing urinals have recently been publicly introduced in Europe, these fixtures are not yet available in North America. It is highly probable that such products will appear in the marketplace within the next several years. One impediment may be that certification requirements may have to be modified, a process that could forestall their appearance here. Because one-liter (or less) urinals are a distinct possibility, we have included them in our analysis.

Non-Water Urinals

Two manufacturers, Falcon Waterfree and Waterless Company, dominate in the U.S. market with non-water urinals. Both manufacturers offer urinal fixtures in a choice of materials: vitreous china and composite materials. Zurn Plumbing Products recently introduced a single model of a vitreous china non-water urinal as well. Table 6 lists the number of models currently within the product offerings of all three companies.

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[9] The Mansfield Adam™ 401 urinal is only certified at 1.0-gpf, but the company claims that it will meet ANSI/ASME requirements at 0.5-gpf.

[10] One manufacturer currently offers a urinal system that is claimed to adjust the flush volume in accordance with the "demand" upon the urinal fixture. By internally calculating the actual "need" for water, the fixture varies the flush volume based upon that calculation. They are thus able to offer an "effective flush volume" below 0.5-gpf, according to the manufacturer.

Table 6. Non-Water HEUs

Manufacturer	Number of Product Offerings	
	Vitreous China	Composite Materials
Waterless Company	1	5
Falcon Waterfree	4	1
Zurn Plumbing Products	1	0

Uridan-USA previously offered non-water urinals through a distributor based in Florida. That distributor has abandoned the product, citing the high cost in the U.S. of the European product and the lack of a vitreous china model.[11] The distributor has gone on to introduce the **ZeroFlush** non-water urinal[10], although the product is not available in California. Finally, the German company, **Duravit**, has been offering the McDry non-water urinal[12] for several years in the U.S. marketplace, although marketing is spotty at best and we have seen no McDry's in California buildings. Other manufacturers of non-water urinals exist in Europe and elsewhere, some of which may choose to enter the U.S. market at some future date.

2. Inventory of Installed Fixtures

One important key to assessing the water savings potential of HETs and HEUs is to establish the baseline from which water use reductions may be measured. While HET flush volumes currently vary from as low as 1.0-gpf to as high as 1.3-gpf, so does the baseline for comparison vary from as low as 1.6-gpf up to as much as 7.0-gpf. The installed base of residential and commercial toilets in California has been estimated in a few recent studies. A similar case exists for urinals, where flush volumes of as high as five (5.0) gallons and above characterize older models that may still be in use.

Residential Toilet Fixtures

Three recent estimates are available of installed toilet fixtures in California. The first estimate (Table 7) from the Pacific Institute[13] was based upon the relationship of toilets to population at a ratio of 0.76 toilets per person. Population was then used to establish the installed base of toilets in each category of fixture, supplemented with data from the California Urban Water Conservation Council (Council) on actual water conservation program replacements.

Table 7. Estimate of Residential Toilets Installed in California-Pacific Institute

Year	6.0 gallons per flush	3.5 gallons per flush	1.6 gallons per flush	TOTAL
2003	7.3 million	13.0 million	7.3 million	27.6 million
2020	3.7 million	6.7 million	24.0 million	34.4 million

[11] Environmental Building News, 2005. "U.S. Distributor Abandons Uridan and Launches ZeroFlush," Volume 14, No. 6, June 2005.

[12] Duravit McDry Model No. 084435

[13] Pacific Institute, 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*, November.

The second estimate, by Koeller and Company[14] used new construction data from 1970 forward to 2001, including data on bathrooms per new dwelling unit, supplemented with a natural replacement rate of four (4.0) percent annually and data from the Council on actual water conservation program replacements. Projections forward from 2001 were made using California Department of Finance projections of population and assume no ongoing water conservation initiatives focused on residential toilet replacement after 2001.

Table 8. Estimate of Residential Toilets Installed in California - Koeller

Year	5.0+ gallons per flush	3.5 gallons per flush	1.6 gallons per flush & less	TOTAL
2001	5.6 million	4.6 million	9.4 million	19.6 million
2005	4.8 million	3.9 million	12.5 million	21.2 million
2015	3.1 million	2.6 million	18.5 million	24.2 million
2020	2.6 million	2.1 million	21.4 million	26.1 million
2030	1.7 million	1.4 million	26.7 million	29.8 million
2040	1.1 million	0.9 million	32.1 million	34.1 million

The third estimate of residential fixtures was developed independently by Mitchell of M.Cubed, Inc. for CALFED and projects to the year 2030[15]. It uses fixture count data from the 1998 American Housing Survey, together with dwelling unit counts from the 1990 and 2000 U.S. Census and population projections from the California Department of Finance. It anticipates a five (5.0) percent natural annual replacement rate and uses the population forecast to estimate the expected new construction.

Table 9. Estimate of Residential Toilets Installed in California - Mitchell

Year	Over 1.6 gallons per flush	1.6 gallons per flush & less	TOTAL
2001	11.1 million	10.2 million	21.3 million
2005	9.3 million	13.3 million	22.6 million
2015	6.2 million	19.5 million	25.7 million
2020	5.0 million	22.1 million	27.1 million
2030	3.3 million	26.5 million	29.8 million

Figures 1, 2 and 3 compare the three estimates. The two estimates shown in Tables 8 and 9, each of which was developed with different input variables and approaches, are in substantial agreement. Therefore, they will be used as the most accurate indicator of today's conditions.

[14] Koeller and Company, 2003a. Unpublished report on the impact of dual-flush toilets on California water use, June.
[15] Mitchell, David, for M.Cubed, Inc., no date. "Toilet Forecast" (spreadsheet analysis).

Figure 1. ESTIMATE AND PROJECTION OF INSTALLED RESIDENTIAL TOILET FIXTURES IN CALIFORNIA

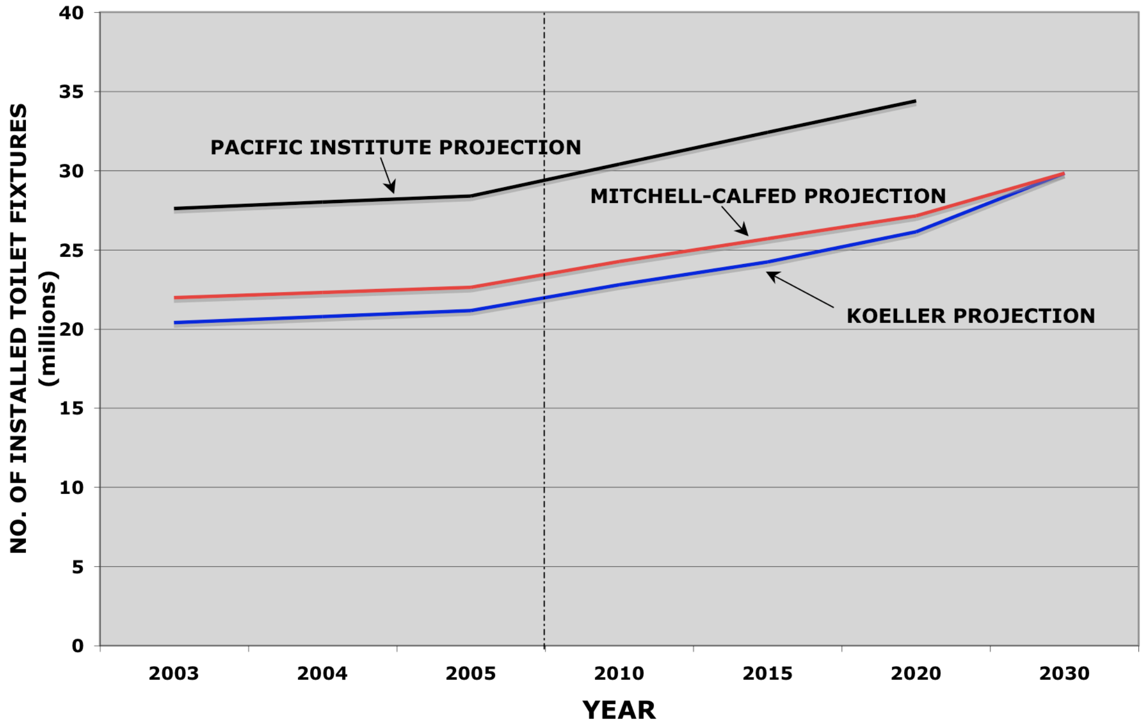
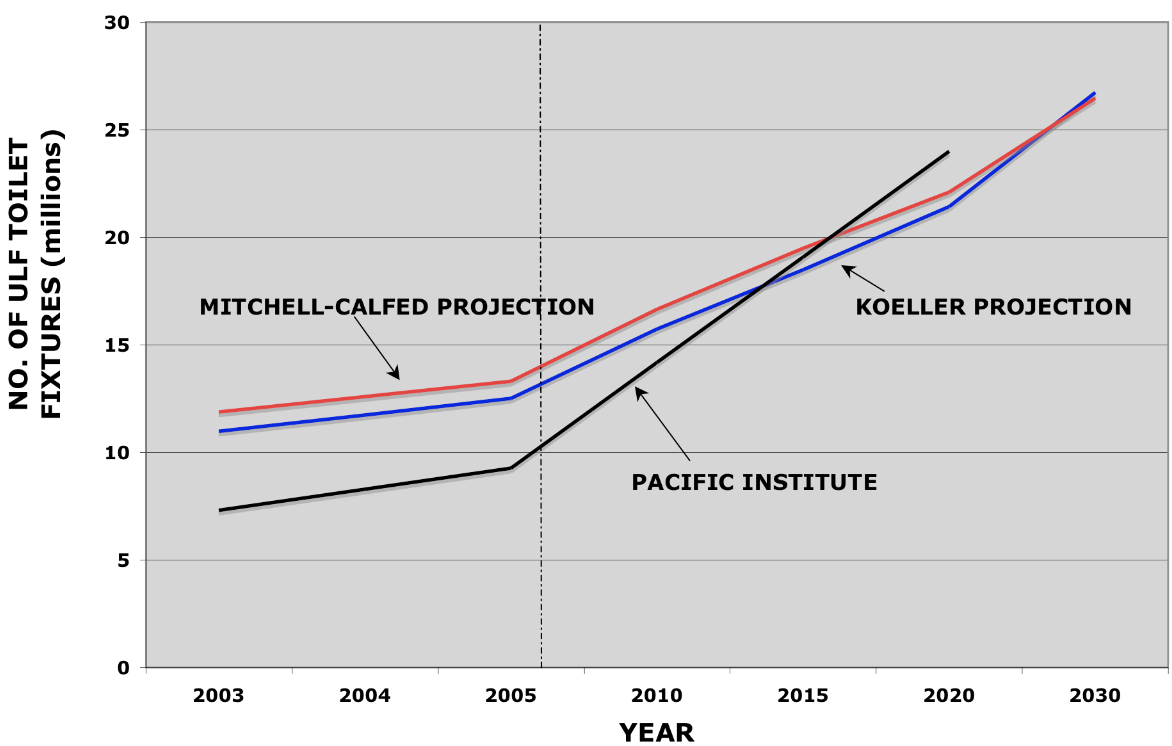


Figure 2. PROJECTION OF INSTALLED ULF TOILET FIXTURES - CALIFORNIA (ULF toilet fixtures at 1.6-gpf and below)



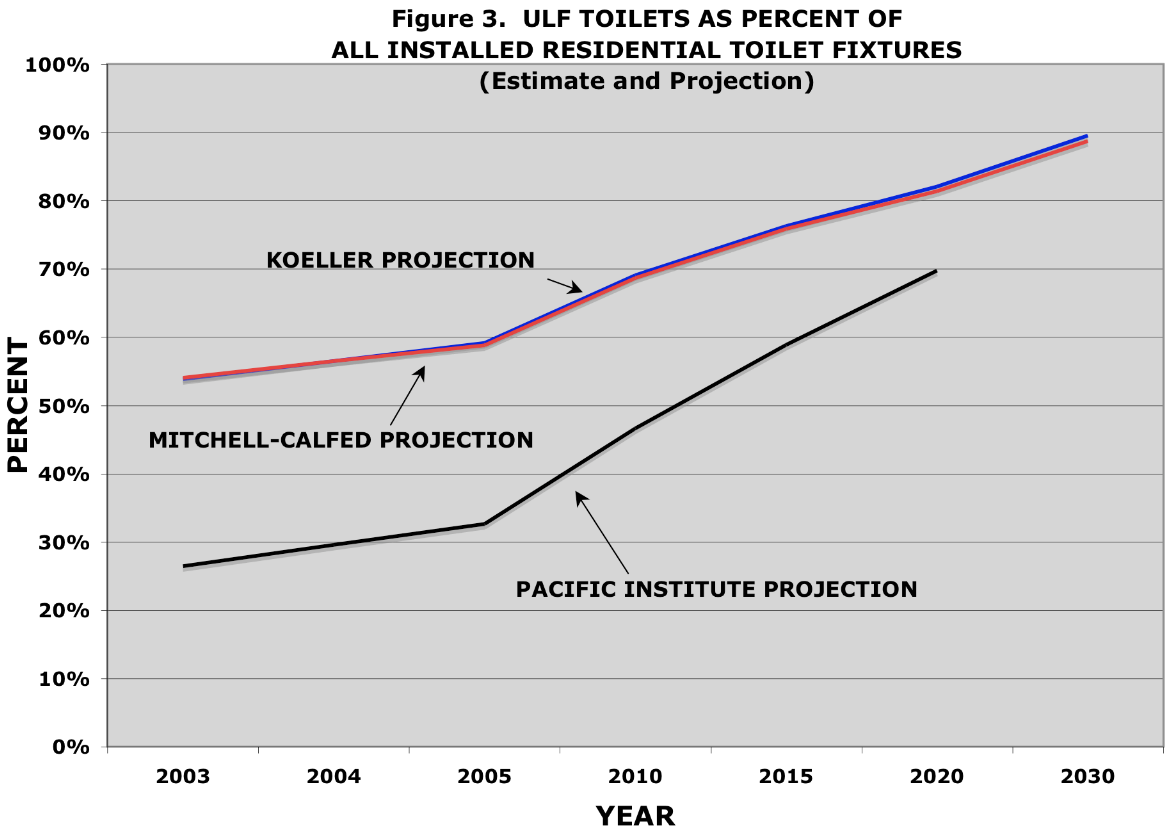


Figure 3. ULF TOILETS AS PERCENT OF
ALL INSTALLED RESIDENTIAL TOILET FIXTURES
(Estimate and Projection)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENT
KOELLER PROJECTION
MITCHELL-CALFED PROJECTION
PACIFIC INSTITUTE PROJECTION
2003
2004
2005
2010
2015
2020
2030
YEAR

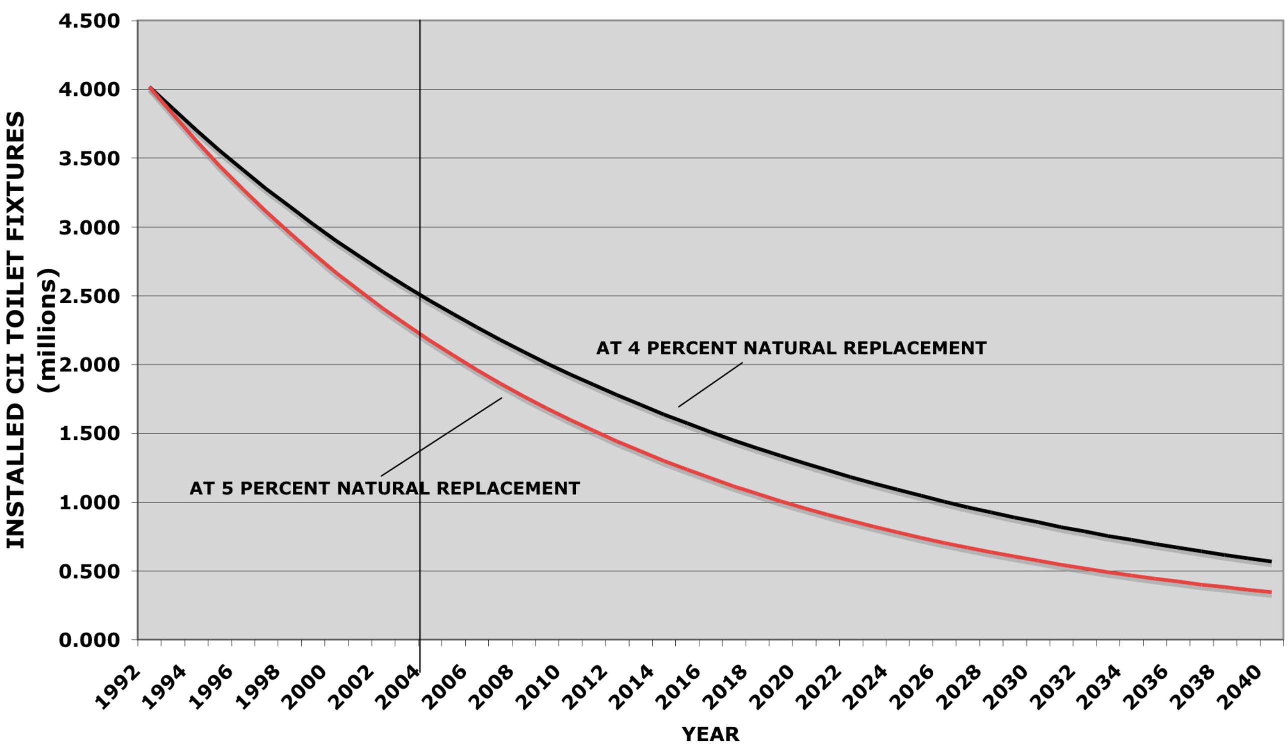
CII Toilet Fixtures

The installed base of non-efficient toilet fixtures in commercial, institutional, and industrial (CII) applications in California has been estimated as between 2.1 and 2.4 million fixtures. In 1992, prior to the effective date of EPAct legislation, it was estimated that approximately 4.001 million fixtures were installed in CII applications[16], all of which would be considered (today) as non-efficient. In the absence of reliable data for years after 1992, projections were made from 1992 using two different natural replacement rates.

Assuming a natural replacement rate of five (5.0) percent annually, Mitchell estimates that the current (2005) inventory of non-efficient fixtures in this category is approximately 2.1 million fixtures. At a more conservative natural replacement rate of four (4.0) percent[17], the 2005 inventory would be about 2.4 million fixtures.

Figure 4 illustrates the trend in replacements and inventory at the two replacement rates. For the purpose of a potential savings analysis, the more conservative 2.1 million fixtures will be used.

Figure 4. ESTIMATE AND PROJECTION OF NON-EFFICIENT CII TOILETS INSTALLED IN CALIFORNIA



[16] Mitchell, David, for M.Cubed, Inc., no date. "CII Toilet Data" (spreadsheet analysis).
[17] The CII sector includes all types of toilet fixture, gravity-fed tank-type, flushometer tank pressure-assist, and flushometer valve. They are generally assumed to have physical lives of 20, 25, and 30 years, respectively. An overall average of 25 years is assumed, leading to a 4.0 percent annual replacement rate.

No field survey or similar estimate is known to exist as to the current inventory of 1.6-gpf toilet fixtures in the CII sectors. However, using employment growth as an indicator of facility growth, an estimate was developed for 2005. Based upon statewide employment of 13.9 million persons in 1992[18], and 16.8 million today[19], a rough estimate of toilet fixtures in 2005 would be about 4.9 million, of which between 2.1 and 2.4 million are of the non-efficient type as noted earlier.

Using population growth projections for California to the year 2030[20] and assuming that employment will grow at the same rate, we estimate that the inventory of CII toilets will grow by about 1.5 million by 2030, resulting in an installed base of about 6.4 million fixtures at that time.

CII Urinals

We have not found a reliable field survey or other count of urinals installed in CII applications in California. Therefore, for a very rough planning estimate of installations, the installed base of CII toilets was used as an indicator. Over the years, the requirements of the applicable plumbing code(s) have changed with respect ratios of toilets and urinals to building population. As an example, however, the Uniform Plumbing Code currently requires the following ratios of fixtures for 150 occupants (including customers) in these selected and typical applications:

Table 10. Typical Code Requirements for Plumbing Fixtures

Type of Building or Occupancy	Female Restroom - Toilet Fixtures	Male Restroom	
		Toilet Fixtures	Urinal Fixtures
Office or public buildings	8	2	2
Office or public buildings-employee use	7	6	3
Colleges and universities	5	4	5
Institutional (other than hospitals)	8	6	3
Restaurants, pubs, lounges	2	2	1
Hospitals-employee use	7	6	3
Assembly places-public use	8	2	2

From the table above, it appears that, with today's code requirements, urinal fixtures in men's restrooms are approximately 26 percent of the total number of toilet fixtures for the occupancies shown. Although history has seen changes in the mix, we conservatively estimate that today the number of urinals in CII facilities would approximate 25 to 30 percent of the total number of toilet fixtures (men and women). Therefore, we further estimate that the number of urinals installed in California CII facilities to be in the range of 1.3 to 1.5 million fixtures.[21] Of these, an estimated 25 percent are of the 1.0-gpf type, having been installed since that flush volume limit became effective in California.

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[18] State of California, Employment Development Department, 2005a. March 204 Benchmark, Data from 1990 to 2005, June 17.

[19] State of California, Employment Development Department, 2005b. "Quick Statistics" (web page)

[20] State of California, Department of Finance, 2004. *Population Projections by Race/Ethnicity for California and Its Counties 2000–2050,* Sacramento, California, May.

[21] At 25 to 30 percent of 4.9 million toilet fixtures. Subsequent analyses were performed at 1.4 million.

California population growth to 2030 indicates that the installed base of urinal fixtures will grow from 1.4 million to approximately 1.83 million by that date, assuming that employment growth and new construction generally follow population growth at the same pace.

3. Water Savings Estimates

Residential Applications – Toilet Fixtures

Because HETs are a relatively new product (except for dual-flush), reliable field studies of water savings are scarce. For the purpose of this analysis, the savings assessment for residential applications is divided into the two main fixture categories, dual-flush and 1.0-gpf pressure-assist.

All of the dual-flush studies conducted to date have involved Caroma fixtures, which offer the 0.8-gpf and 1.6-gpf flush options. It should be noted that other dual-flush fixtures now in the marketplace offer other volume options, such as 1.0- and 1.6-gpf.

The key to reducing average flush volumes is convincing users to use the "short" flush mode when possible. The weighted average of "short" and full flushes (combined) is determined by the ratio of flush counts for each of the two options. As summarized in a 2003 paper[22] covering the results of five previous field studies, the flush ratio and flush volume of the 0.8/1.6-gpf dual-flush fixtures installed in residential applications ranged as follows:

Table 11. Dual-Flush Toilet Fixtures in Residential Applications

Study	No. of dual-flush fixtures studied	Ratio of "short" to full flushes	Average water consumption per flush
Canada Mortgage & Housing Corp.	60	1.6 to 1 – SF 4.0 to 1 - MF	1.11-gpf
Seattle Home Water Cons. Study	40	not measured	1.25-gpf
Oakland – Residential Water Study	35	not measured	1.34-gpf
Oregon SWEEP Study	50	1.9 to 1	1.30-gpf
Jordan Valley Study	61	1.48 to 1	1.20-gpf

Overall, the weighted average of the flush volumes for all 246 test fixtures was 1.23-gpf. Newer dual-flush toilets, some of which rate the "short" flush at 1.0 or 1.1 gallons will have higher flush volumes, probably averaging between 1.25 and 1.30.

The 1.0-gpf pressure-assist fixtures are also well-suited to residential applications, particularly single family. In fact, representatives of Sloan Flushmate report that over 50 percent of all Flushmate pressure-assist systems are sold for residential installations.[23] This phenomena is largely attributable to two factors that have only recently affected the trend toward residential use:

[22] Koeller and Company, 2003b. Dual-Flush Toilet Fixtures – Field Studies and Water Saviings, December 17. Available for download from: **http://www.cuwcc.org/products_tech.lasso**
[23] Personal communication, Paul Deboo, Sloan Flushmate.

(a) The HGTV (Home and Garden TV) channel, which is widely viewed by do-it-yourselfers and others remodeling or upgrading residential bathrooms. The portrayal of pressure-assist as possessing excellent flush performance and long-term reliability has resulted in increased residential installations.

(b) The reduction of noise associated with the flush action of the typical pressure-assist toilet. New models, including the HETs, are substantially quieter than similar models of the 1990s, thereby making them more acceptable in the home.

However, no independently developed, authoritative studies of water savings from pressure-assist HETs in residential applications have yet been conducted. Therefore, our analysis of these units was based solely upon the certification measurements of 1.0-gpf.

Table 8 shows that approximately 4.8 million toilets with flush volumes of 5.0 gallons or more are installed in California residential dwellings today. The estimated inventory of 3.5-gallon toilet fixtures is 3.9 million. The remainder of the installed inventory is 1.6-gallon toilets, for which we estimate that 12.5 million exist.

Vickers and Mayer both cite the Residential End Uses of Water Study and estimate that the average number of daily flushes per person in residential applications is 5.1[24]. Other studies showed slightly higher counts, in some cases as high as 6.4. However, we have used the 5.1 count as a conservative indicator of consumer habits.

Several alternative scenarios were evaluated for their impact upon California water use:

(a) Replacement of all existing residential 1.6-gpf and above toilets with HETs
(b) Replacement of all existing residential 3.5-gpf and above toilets with HETs
(c) All new residential construction mandated with HETs
(d) Combination of a. and c.

Alternative a

The replacement of 21.16 million existing residential toilets (of all flush volumes) with HETs would yield water savings as follows:

- Replacing with 1.0-gpf HETs – 367,000 acre-feet per year (AFY)[25]
- Replacing with 1.25-gpf HETs – 314,000 AFY

[24] Vickers, Amy, 2001. Handbook of Water Use and Conservation, WaterPlow Press. AND Mayer, Peter, 2005, personal communication, July 21.

[25] Calculated on the basis of a current statewide population of 34.47 million persons and a total installed inventory of 21.16 million toilet fixtures, divided as follows:

5.0-gpf and above	4.77 million
3.5-gpf	3.88 million
1.6-gpf	12.51 million
Total	21.16 million

Alternative b

The replacement of ONLY non-efficient toilets (4.8 million 5.0+-gpf toilets and 3.9 million 3.5-gpf toilets) with HETs would yield water savings as follows:

- Replacing with 1.0-gpf HETs – 291,000 AFY
- Replacing with 1.25-gpf HETs – 269,000 AFY

Alternative c

All new residential construction mandated with HETs. Yields water savings as follows:

- All HETs at 1.0-gpf – 52,000 AFY by 2030
- All HETs at 1.25-gpf – 31,000 AFY by 2030

Alternative d

Table 12 shows the results of combining alternatives a or b together with c to secure conversion of existing toilets to HET technology AND mandate that all new construction install HETs only.

Table 12. Summary of Residential HET Initiative Combinations (AFY of Water Savings - 2030)

Existing Installed Base Alternatives		Alternative c - New Construction Mandate 1.0-gpf	1.25-gpf
Alternative a – Replace all Existing Residential Toilets	1.0-gpf	419,000	398,000
	1.25-gpf	366,000	344,000
Alternative b – Replace all Existing Non-Efficient Resid Toilets Only	1.0-gpf	343,000	322,000
	1.25-gpf	321,000	300,000

CII Applications – Toilet Fixtures

Because of the wide variations in the end-use applications within the CII sector, and because authoritative data on the installed base is less available, the determination of potential water savings is based upon more assumptions and, as such, is less reliable.

As noted earlier, between 2.1 and 2.4 million non-efficient toilets are estimated to exist in the CII sector. We have used the 2.1 million figure as a conservative measure of replacement opportunities. However, data are not available that would stratify the 2.1 million by flush volume. Therefore, because all of these toilets were installed prior to California's 1.6-gpf mandate, we know that these fixtures all flush at 3.5-gpf and above and, as such, use that figure for this analysis.

An undetermined number of the non-efficient CII fixtures are of the flushometer valve type. In order to convert these toilets to an HET classification, the entire bowl would require replacement and the valve retrofitted with a diaphragm kit rated at 1.0-gpf. Yet, while 1.0-gpf valves exist in the marketplace, 1.0-gpf flushometer bowls do not. Therefore, to predict savings based upon an

HET scenario for these toilets must assume that at such time as a replacement program begins there will be product available.

For all of the other non-efficient CII toilet fixtures (all of which are tank-type), there exist numerous HET models in the current marketplace, as shown in Tables 2, 3, and 4.

Vickers states that employee's toilet use in the workplace is three flushes per day for women and one flush per day for men.[26] Using this information, the current California employment data discussed earlier, population growth data[27], and the inventory of efficient and non-efficient CII toilet fixtures, the same four alternatives were evaluated for the CII sector.

Alternative a

The replacement of all 4.9 million existing CII toilets (of all flush volumes) with HETs would yield water savings as follows:

- Replacing with 1.0-gpf HETs – 38,000 acre-feet per year (AFY)
- Replacing with 1.25-gpf HETs – 32,000 AFY

Alternative b

The replacement of ONLY the 2.1 million non-efficient toilets with HETs would yield water savings as follows:

- Replacing with 1.0-gpf HETs – 29,000 AFY
- Replacing with 1.25-gpf HETs – 26,000 AFY

Alternative c

All new CII construction mandated with HETs. Yields water savings as follows:

- All HETs at 1.0-gpf – 5,000 AFY by 2030
- All HETs at 1.25-gpf – 3,000 AFY by 2030

Alternative d

Table 13 describes the effects of combining alternatives a or b with c to secure full or partial conversion of 4.9 million existing toilets to HET technology and mandate that all new construction (1.5 million additional toilets) install HETs only.

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[26] Vickers, Amy, ibid.

[27] State of California, Department of Finance, 2004. *Population Projections by Race/Ethnicity for California and Its Counties 2000–2050,* Sacramento, California, May.
State of California, Department of Finance, 2005. *E-1 City / County Population Estimates, with Annual percent Change, January 1, 2004 and 2005.* Sacramento, California, May.

Table 13. Summary of CII HET Initiative Combinations (AFY of Water Savings - 2030)

Existing Installed Base Alternatives		Alternative c - New Construction Mandate 1.0-gpf	Alternative c - New Construction Mandate 1.25-gpf
Alternative a – Replace all Existing CII Toilets	1.0-gpf	43,000	41,000
	1.25-gpf	37,000	35,000
Alternative b – Replace all Existing Non-Efficient CII Toilets Only	1.0-gpf	34,000	32,000
	1.25-gpf	31,000	29,000

CII Applications – Urinal Fixtures

Addressing the category of urinals and, specifically, the impact of HEUs, is somewhat more difficult due to the lack of authoritative information on the installed base of urinal fixtures in California. However, we estimated in Section 2 of this report that between 1.3 and 1.5 million urinals currently exist in CII applications in the state. Vickers reports that the average use of a urinal is two times per day by the average male.[28] Again, based upon current employment in California and the current inventory of installed urinals, we estimate current urinal water usage to be 28,000 AFY, growing to 32,000 AFY by 2030 without further urinal flush volume reductions or significant urinal replacement programs.

The estimates of potential savings were developed for four implementation alternatives:

(a) Replacement of all existing urinals of 1.0-gpf and above with HEUs
(b) Replacement of all ONLY the existing non-efficient urinals (>1.0-gpf) with HEUs
(c) All new CII construction mandated with HEUs
(d) Combination of a or b with c.

Alternative a

The replacement of ALL 1.4 million existing CII urinals (of all flush volumes) with HEUs would yield estimated water savings today as follows:

- Replacing with 0.5-gpf HEUs – 21,000 AFY
- Replacing with 0.26-gpf HEUs – 24,000 AFY
- Replacing with 0-gpf non-water HEUs – 28,000 AFY

Alternative b

The replacement with HEUs of ONLY the 1.05 million CII urinals that currently flush at greater than 1.0-gpf, yielding estimated water savings today as follows:

- Replacing with 0.5-gpf HEUs – 20,000 AFY
- Replacing with 0.26-gpf HEUs – 22,000 AFY
- Replacing with 0-gpf non-water HEUs – 25,000 AFY

[28] Vickers, Amy, ibid.

Alternative c

All new CII construction mandated with HEUs[29], yielding water savings[30] as follows:

- All HEUs at 0.5-gpf – 2,000 AFY by 2030
- All HEUs at 0.26-gpf – 3,000 AFY by 2030
- All HEUs at 0-gpf non-water type – 4,000 AFY by 2030

Alternative d

Table 14 shows the water savings potential of combining alternatives a or b with c to secure conversion of all or a portion of the 1.4 million existing urinals to HEU technology AND mandate that all new construction install HEUs only.

Table 14. Summary of CII HEU Initiative Combinations (AFY of Water Savings - 2030)

Existing Installed Base Alternatives		Alternative c - New Construction Mandate		
		0.5-gpf	0.26-gpf	Non-water
Alternative a – Replace all Existing Urinals	0.5-gpf	23,000	24,000	25,000
	0.26-gpf	26,000	27,000	28,000
	Non-water	30,000	31,000	32,000
Alternative b – Replace all Existing Non-Efficient Urinals Only	0.5-gpf	22,000	23,000	24,000
	0.26-gpf	24,000	25,000	26,000
	Non-water	27,000	28,000	29,000

[29] As noted earlier, new statewide construction to 2030 is forecasted to require an additional 430,000 urinals.
[30] Assumes all 1.0-gpf urinals in new construction, which would add 4,032 AFY of water use by 2030.

4. Cost-Benefit Analyses

More experience probably exists within the water conservation community in the implementation of residential toilet replacement programs than any other water-efficiency initiative. Costs have been well-defined for a number of outreach and implementation approaches, most of which have been tried, fine-tuned, and very successful in California. These include:

- Rebate programs
- Voucher programs
- Full-service direct-installation programs
- Giveaway free-distribution programs
- Combinations of the above

Water agencies and municipalities have chosen their particular approach based upon a variety of factors: economics and budget, the demographics of their constituency, age of housing, urgency of water use reductions, involvement of the constituent business community (retailers, distributors, etc.), customer relations policies and impacts, and, of course, politics, to name a few. Over the years, many water agencies and municipalities have refined their programs to a point where they became very unique to their situation, but extremely effective in reaching their community and accomplishing their water use efficiency goals.

On the other hand, broad experience with large CII toilet replacement programs does not exist, other than dealing with the lodging industry, where the replacement of all toilets within a particular establishment is attractive to the toilet manufacturer and to the water agency or municipality.[31] In this case, most agencies and municipalities offer rebates to the owners, rather than become involved directly in the purchase and/or installation process.

It is not the purpose of this paper to detail all of the nuances and costs of toilet replacement programs. Rather, the analysis of economics was focused on general costs of implementation at a planning level. Recent experience was used to apply cost factors to the various alternatives discussed earlier.

With regard to urinals, however, there has been little experience (and limited success) within the water conservation community with massive urinal replacement or retrofit programs[32]. Therefore, much of the economic analyses here is based upon general assumptions as to costs.

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[31] This occurs even though the data gathered through a study sponsored by the Council showed that the replacement of toilets within hotel-motel sector yielded some of the lowest water savings per installed ULF toilet:
California Urban Water Conservation Council, 1997. *The CII ULFT Savings Study, Final Report*, Table S-1, by Hagler Bailly Services, Inc., August 5.

[32] When the term "replacement" is used, it is in the context of complete replacement of a urinal fixture and of the diaphragm within the flush valve serving it; when the term "retrofit" is used, it is in the context of replacing parts within a urinal flush valve (the diaphragm, for example) to reduce the flush volume of the fixture without replacing the vitreous china. It is rare that merely throttling down a urinal flush valve from 1.0-gpf (or greater) to 0.5-gpf will result in a urinal that actually performs satisfactorily. In fact, some urinal manufacturers agree that their 1.0-gpf products can be flushed at as low as 0.7-gpf and still meet the minimum performance standards referenced in the plumbing codes. However, they do not

Residential Applications – Toilet Fixtures

Whereas the existing BMP14 is targeted at the replacement of residential toilet fixtures, this analysis is essentially directed at evaluating a more aggressive stance, that is, replacing residential toilet fixtures with HETs, rather than with conventional 1.6-gallon toilet fixtures.

Costs for HETs are declining steadily as more product enters the marketplace. As noted in Section 1 of this paper, 13 manufacturers are currently competing at the HET level. This is very significant, given that only one manufacturer addressed this market sector just seven years ago. Consequently, competition is very intense, both on product performance and on cost, thereby benefiting the consumer, as well as the water agencies and municipalities and the programs they sponsor.

Table 15a summarizes cost and savings information for the three alternatives[33] under the residential category. Because the method of implementation of any alternative is undetermined at this time, an average cost of $200 per toilet replacement was assumed[34]. In addition, it was assumed that the water provider implementing a program would include the entire cost of the toilet fixture within the rebate (or other subsidy) amount.

Table 15a. Summary of Expected Water Savings and Costs - Residential Toilets

		With 1.0-gpf Toilet Fixtures			With 1.25-gpf Toilet Fixtures		
Alternative	No. of residential fixtures in category (millions)	AF Savings (millions) (a)	Implementation Cost to Water Authorities ($ millions)	$ per AF (c)	AF Savings (millions) (b)	Implementation Cost to Water Authorities ($ millions)	$ per AF (c)
a – Replace all existing toilets with HETs	21.2	9.18	$4,240	$462	6.28	$4,240	$675
b- Replace existing non-efficient toilets with HETs	8.7	7.28	$1,740	$239	5.38	$1,740	$323
c – Mandate HETs in new construction	8.6	1.30	$43	$33	0.62	$43	$69

(a) Savings accumulated over 25-year life of pressure-assist toilet fixture
(b) Savings accumulated over 20-life of gravity-fed toilet fixture
(c) Assumes that rebate (or other subsidy) covers **ENTIRE** cost of the fixture

recommend installing a 0.5-gpf kit into a flushometer valve (a retrofit) and expecting fully satisfactory performance. As such, the analyses in this paper assume that all urinal initiatives will be replacements, rather than retrofits.

[33] The effect of combining either alternative (a) or alternative (b) with the mandate of alternative (c) may derived by adding the cost and savings data and computing the overall cost per acre-foot.

[34] Assumes a rebate program with an implementation and administrative cost of $50 per replaced fixture; full purchase cost of the fixture estimated at $150, for a total cost of $200. Installation cost is not included. The rebate amount may, however, be less than the purchase cost of the fixture and, as such, the overall cost of the program would then be less than $200.

The cost per acre-foot (to the program implementer) of water saved would be reduced significantly if the subsidy was limited, for example, to one-half the cost of the fixture plus program administrative costs. With that revised assumption, costs and benefits would be as shown in Table 15b.

Table 15b. Summary of Expected Water Savings and Costs - Residential Toilets

Alternative	No. of residential fixtures in category (millions)	With 1.0-gpf Toilet Fixtures			With 1.25-gpf Toilet Fixtures		
		AF Savings (millions) (a)	Implementation Cost to Water Authorities ($ millions)	$ per AF (c)	AF Savings (millions) (b)	Implementation Cost to Water Authorities ($ millions)	$ per AF (c)
a – Replace all existing toilets with HETs	21.2	9.18	$2,650	$289	6.28	$2,650	$422
b- Replace existing non-efficient toilets with HETs	8.7	7.28	$1,088	$149	5.38	$1,088	$202
c – Mandate HETs in new construction	8.6	1.30	$43	$33	0.62	$43	$69

(a) Savings accumulated over 25-year life of pressure-assist toilet fixture
(b) Savings accumulated over 20-life of gravity-fed toilet fixture
(c) Assumes that rebate (or other subsidy) covers **ONE-HALF** the cost of the fixture

As stated in the Council's draft Cost and Savings Study[35] (p. 54-64), program costs range from $155 to $230 per toilet replacement. That study is designed to evaluate factors related to BMP 14. As such, it does not incorporate the higher cost of HET fixtures and instead cites historical information (some of which is very dated) for conventional 1.6-gpf toilet replacement programs as anticipated in BMP 14. Whereas conventional fixtures are shown in the study to cost between $60 and $120, HETs are currently priced in the range from $150 to $300, depending upon the type of fixture and current conditions in the marketplace (i.e., pricing "what the market will bear"). As noted earlier, prices are dropping significantly and water agencies and municipalities willing and able to negotiate quantity purchases of HETs have been able to purchase quality HET products at $150 for their free distribution and direct installation programs. On the other hand, the retail customer (who is the candidate for a rebate program) visiting their local retail supplier today should expect to pay near $200 for the same fixture. Because of these vast cost differences (to both the water provider and to the end use customer), it was necessary to use an overall average for Tables 15a and 15b.

[35] California Urban Water Conservation Council, 2005. *Draft Revision, BMP Cost & Savings Study*, by A&N Technical Services, March.

CII Applications – Toilet Fixtures

Opportunities for the replacement of conventional toilet fixtures in the CII sector are much more limited than in residential applications. Several factors contribute to this:

- A smaller installed base of existing fixtures, i.e., 4.9 million as compared to 21.2 million residential fixtures today.
- Higher costs of fixtures, due to more stringent code, permitting, and installation requirements, as well as a large number of flushometer valve and bowl fixtures, which require more installation effort and higher resulting costs.
- The lack of HETs in the flushometer valve and bowl category.
- The reluctance of many end-users to permit replacement of existing, well-functioning fixtures, particularly when doing so may interrupt business operations or cause other restroom modifications to be required.
- The need for significant capital to replace large numbers of fixtures; rebates by themselves are usually insufficient to cover a significant portion of the replacement cost.
- The reputation of "low-flow" toilet fixtures that follows from the bad experiences of the early to mid-1990s; frequently, that reputation overshadows any willingness that a business owner might have to take a "risk" and replace toilet fixtures UNLESS the existing fixtures are causing problems.
- The difficulty that water agencies and municipalities have in reaching out to business owners and managers, whose attention is more focused on day-to-day business operations than the efficiencies that might be gained in the area of water.

Because of these factors (and others), the success of CII toilet replacement programs in achieving meaningful water use reductions has been marginal. Costs to develop and execute effective programs, whether of the rebate, voucher, or direct-installation type, are higher than for residential programs. Based again upon experience with past and existing programs, and considering the higher prices of HETs today, we have assumed a cost of $250 per rebated HET for the purpose of this analysis.[36]

Table 16a summarizes cost and savings information for the same three alternatives under the commercial category. For this analysis, it was assumed that the water provider implementing a program would include the entire cost of the toilet fixture within the rebate (or other subsidy) amount.

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[36] The BMP Cost and Savings Study (CUWCC, 2005) cites the Santa Clara Valley Water District CII program as costing $270 per HET installation on a direct-install basis. However, this program is directed only at tank-type installations and is using a pressure-assist 1.0-gpf HET as a replacement toilet. While this is definitely representative of the cost for both pressure-assist 1.0-gpf and gravity-fed dual-flush HETs, it is not necessarily going to be representative of the cost for flushometer valve and bowl installations, for which replacement HET product is yet to be introduced to the marketplace.

The $250 cost is assumed for a typical rebate program. In this analysis, the cost is based upon a $75 per unit program implementation cost and an average purchase cost of the fixture at $175. The rebate amount may, however, be less than the purchase cost of the fixture and, as such, the overall cost of the program would then be less than $250.

Table 16a. Summary of Expected Water Savings and Costs - CII Toilets

Alternative	No. of CII fixtures in category (millions)	With 1.0-gpf Toilet Fixtures: AF Savings (millions) (a)	With 1.0-gpf Toilet Fixtures: Implementation Cost to Water Authorities ($ millions)	With 1.0-gpf Toilet Fixtures: $ per AF (c)	With 1.25-gpf Toilet Fixtures: AF Savings (millions) (b)	With 1.25-gpf Toilet Fixtures: Implementation Cost to Water Authorities ($ millions)	With 1.25-gpf Toilet Fixtures: $ per AF (c)
a – Replace all existing toilets with HETs	4.9	0.95	$1,225	$1,289	0.64	$1,225	$1,914
b- Replace existing non-efficient toilets with HETs	2.1	0.73	$525	$724	0.52	$525	$1,010
c – Mandate HETs in new construction	1.5	0.13	$8	$60	0.06	$8	$125

(a) Savings accumulated over 25-year life of pressure-assist toilet fixture
(b) Savings accumulated over 20-life of gravity-fed toilet fixture
(c) Assumes that rebate (or other subsidy) covers **ENTIRE** cost of the fixture

As would be the case with a residential program, the cost per acre-foot (to the program implementer) of water saved would be reduced significantly if the subsidy was limited to one-half the cost of the fixture plus program administrative costs[37]. With that revised assumption, costs and benefits would be as shown in Table 16b.

Table 16b. Summary of Expected Water Savings and Costs - CII Toilets

Alternative	No. of CII fixtures in category (millions)	With 1.0-gpf Toilet Fixtures: AF Savings (millions) (a)	With 1.0-gpf Toilet Fixtures: Implementation Cost to Water Authorities ($ millions)	With 1.0-gpf Toilet Fixtures: $ per AF (c)	With 1.25-gpf Toilet Fixtures: AF Savings (millions) (b)	With 1.25-gpf Toilet Fixtures: Implementation Cost to Water Authorities ($ millions)	With 1.25-gpf Toilet Fixtures: $ per AF (c)
a – Replace all existing toilets with HETs	4.9	0.95	$796	$838	0.64	$796	$1,244
b- Replace existing non-efficient toilets with HETs	2.1	0.73	$341	$471	0.52	$341	$656
c – Mandate HETs in new construction	1.5	0.13	$8	$60	0.06	$8	$125

(a) Savings accumulated over 25-year life of pressure-assist toilet fixture
(b) Savings accumulated over 20-life of gravity-fed toilet fixture
(c) Assumes that rebate (or other subsidy) covers **ONE-HALF** the cost of the fixture

[37] Amounting to an average cost of $87.50 attributable to the fixture (at one-half) plus $75 for administrative and implementation costs, for a total cost of $162.50 per toilet fixture.

CII Applications – Urinal Fixtures

The replacement within water conservation programs of existing urinals with HEUs is a rarity, with the exception of replacement with non-water urinals. The cost of replacement of the full fixture with a non-water urinal was documented by Orrett[38] as costing between $333 and $590 (including tax and installation), depending upon which model of urinal was chosen. Prices have declined since that study, however, and the average cost for a non-water urinal is approximately $275. Adding a $75 per unit cost for program administration and implementation brings the average total cost to $350 for this analysis.

The only urinals certified at 0.5-gpf are those manufactured by American Standard, Kohler, and Mansfield (refer to Table 5), two of which house an integrated sensor-operated flush valve. The list price of the fixtures and the integrated valve is as follows[39]:

American Standard Innsbook - $901 to $1,195
Kohler Bardon™ Touchless™ - $1,241

While the list prices today would not necessarily be the quantity purchase costs for an aggressive or massive urinal replacement program, the do provide an upper boundary for these types of fixtures. Assuming that, at some future date, water agencies and municipalities were to undertake HEU programs as a part of BMP compliance, it is extremely likely that competition would drive more manufacturers into this sector and prices would drop. For the purpose of this analysis, we have therefore assumed that 0.5-gpf and 0.26-gpf urinals (including the requisite flush valves) would ultimately cost approximately $375 each. A $75 program implementation cost would bring the total cost to $450 per urinal for this analysis.

Fixture life for all categories of urinals was assumed at 30 years, based upon analyses by a team of water conservation professionals on behalf of the Metropolitan Water District.[40]

Table 17a summarizes cost and savings information for the same three alternatives as evaluated for toilet fixtures. Within this table, it was assumed that the water provider implementing a program would include the entire cost of the urinal fixture within the rebate (or other subsidy) amount.

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[38] Orrett, Edwin B., 2001. City of Petaluma, Financial Analysis (of waterless urinals), spreadsheet document. January 27.
[39] List prices for the urinal fixtures taken from the websites of the respective firms on July 23, 2005.
[40] April 2005 spreadsheet documents prepared by a Project Advisory Committee of member water agencies analyzing the potential savings from 0.5-gpf and non-water urinals for the derivation of recommended subsidy levels for these types of fixtures.

Table 17a. Summary of Expected Water Savings and Costs - CII Urinals

Alternative	No. of CII urinal fixtures in category (millions)	With 0.5-gpf Urinals: AF Savings (millions) (a)	With 0.5-gpf Urinals: Implementation Cost to Water Authorities ($ millions)	With 0.5-gpf Urinals: $ per AF (b)	With 0.26-gpf Urinals: AF Savings (millions) (b)	With 0.26-gpf Urinals: Implementation Cost to Water Authorities ($ millions)	With 0.26-gpf Urinals: $ per AF (b)
a – Replace all existing urinals with HEUs	1.40	0.63	$630	$1,000	0.72	$630	$875
b- Replace existing non-efficient urinals with HEUs	1.05	0.60	$473	$788	0.66	$473	$716
c – Mandate HEUs in new construction	0.43	0.06	$0.10	$2	0.09	$0.10	$1

Alternative	No. of CII urinal fixtures in category (millions)	With Non-Water Urinals: AF Savings (millions) (a)	With Non-Water Urinals: Implementation Cost to Water Authorities ($ millions)	With Non-Water Urinals: $ per AF (b)
a – Replace all existing urinals with HEUs	1.40	0.84	$490	$583
b- Replace existing non-efficient urinals with HEUs	1.05	0.75	$368	$490
c – Mandate HEUs in new construction	0.43	0.12	$0.20	$2

(a) Savings accumulated over 30-year life of urinal

(b) Assumes that rebate (or other subsidy) covers **ENTIRE** cost of fixture

As would be the case with a toilet replacement program, the cost per acre-foot (to the program implementer) of water saved would be reduced significantly if the subsidy was limited to one-half the cost of the fixture plus program administrative costs[41]. With that revised assumption, costs and benefits would be as shown in Table 17b.

[41] Amounting to an average cost of $87.50 attributable to the fixture (at one-half) plus $75 for administrative and implementation costs, for a total cost of $162.50 per toilet fixture.

Table 17b. Summary of Expected Water Savings and Costs - CII Urinals

Alternative	No. of CII urinal fixtures in category (millions)	With 0.5-gpf Urinals: AF Savings (millions) (a)	With 0.5-gpf Urinals: Implementation Cost to Water Authorities ($ millions)	With 0.5-gpf Urinals: $ per AF (b)	With 0.26-gpf Urinals: AF Savings (millions) (b)	With 0.26-gpf Urinals: Implementation Cost to Water Authorities ($ millions)	With 0.26-gpf Urinals: $ per AF (b)
a – Replace all existing urinals with HEUs	1.40	0.63	$354	$561	0.72	$354	$491
b- Replace existing non-efficient urinals with HEUs	1.05	0.60	$265	$442	0.66	$265	$402
c – Mandate HEUs in new construction	0.43	0.06	$0.10	$2	0.09	$0.10	$1

Alternative	No. of CII urinal fixtures in category (millions)	With Non-Water Urinals: AF Savings (millions) (a)	With Non-Water Urinals: Implementation Cost to Water Authorities ($ millions)	With Non-Water Urinals: $ per AF (b)
a – Replace all existing urinals with HEUs	1.40	0.84	$298	$354
b- Replace existing non-efficient urinals with HEUs	1.05	0.75	$223	$298
c – Mandate HEUs in new construction	0.43	0.12	$0.20	$2

(a) Savings accumulated over 30-year life of urinal
(b) Assumes that rebate (or other subsidy) covers ONE-HALF the cost of the fixture

5. California Potential

Residential Applications – Toilet Fixtures

Over 26 million toilet fixtures exist in California, of which nearly 11 million are estimated to be non-efficient, i.e., rated at a flush volume in excess of 1.6-gpf. Water conservation programs directed at the residential sector have been very successful in some municipalities and agency service areas where toilet replacement has been seriously and aggressively addressed. According to Council data on BMP 14, approximately 2 million residential toilets have been replaced through water conservation programs through 2004.

Ample opportunity exists to target the remaining 3.5-, 5.0-, and 7.0-gpf non-efficient toilets in the state, totaling an estimated 8.7 million fixtures. While saturation is approached in some areas, thus making program marketing somewhat more difficult and costly, many areas are largely untouched by significant residential toilet replacement initiatives. Some argue that freeridership is too high in a typical rebate program to make such a program cost effective. However, HET-focused programs will not experience freeridership until such time as HETs become commonplace and the consumer is aware of the benefits. Until then, it appears that as a first priority and as a legitimate PBMP, the existing 8.7 million non-efficient residential toilets all represent viable potential for future programs. As a second priority, we would recommend that, apart from the PBMP process, the Council examine the feasibility of supporting legislation that would mandate HETs in new residential construction statewide.

CII Applications – Toilet Fixtures

CII toilet replacement programs are quite a different story. As noted earlier, marketing a rebate or voucher program to the various CII sectors is difficult in most cases and takes a degree of special expertise. Program and fixture costs are higher and rebates are less attractive to business owners occupied with day-to-day business operations. Direct-installation programs wherein a "full service" replacement is provided are probably the most successful.

Furthermore, HETs are only available for certain replacements (i.e., tank-type installations), because there is no flushometer valve fixture (yet) in the marketplace. Of the 2.1 million non-efficient CII toilets, probably one-half are of the tank-type and, as such, represent viable potential for programs similar to the direct-install HET program of the Santa Clara Valley Water District, that currently targets CII customers. The cost of this program (excluding district staff time) is $269 per installed HET[42].

In this category, we recommend that the Council monitor the toilet fixture market and, at such time as suitable HETs for flushometer valve installations become available (which is likely in 2006), that BMP 9 incorporate HETs as a feasible means to achieve the required water savings. Until that time, examine the feasibility of legislation mandating HETs in new CII construction[43].

[42] Personal communication, Karen Morvay, July 25, 2005.
[43] Effective at such time as acceptable flushometer valve and bowl HETs are widely available.

CII Applications – Urinal Fixtures

The total acre-feet savings associated with the various urinal alternatives discussed in this paper are very similar to those for CII toilet fixtures. The difficulty of marketing fixture replacement programs to the CII sector are the same for urinals as they are for toilets. Up to now, the replacement of urinal fixtures with HEUs has been left to the manufacturers of the non-water urinals. Given the plumbing code issues associated with non-water urinals, the manufacturers have done moderately well without significant help from the water conservation community (other than very modest rebates). It would appear that the CII sector is best approached and convinced when a "package" of improvements are made available AND the water agency, municipality, and/or product manufacturer can provide full-service installation. That is, removing the business owner, manager, or operator from the details of specifications, permits, purchase, and installation.

Therefore, we recommend that CII HETs and HEUs be included as a unit when creating programs and when considering them for PBMP status. In addition, as with CII HETs, we recommend that the Council consider supporting legislation mandating HEUs in future new construction.