United States Environmental Protection Agency
Office of Water Washington, D.C.
EPA 832-F-00-047 September 2000

# Wastewater Technology Fact Sheet
## High-Efficiency Toilets

### INTRODUCTION

In 1992, Congress passed legislation requiring that all toilets sold in the United States meet a new water conservation standard of 1.6 gallons per flush (gpf). By 1992, in response to the growing need for conservation of drinking water supply resources, a number of metropolitan regions and 17 states had already instituted water conservation programs which included high-efficiency toilet requirements.

A national water use standard for a high-efficiency toilet was necessary to address the problems with different states and communities having established different toilet water use standards. A national standard eliminated the need for plumbing fixture firms to manufacture, stock, and deliver different products, and the difficulty for states in preventing the importation of high-water-use fixtures.

High efficiency designs have significantly improved since they were first introduced. Despite the improvements, the industry continues to refine this technology. Based on consumer surveys, the majority of users are satisfied with the performance of the current designs.

Because toilets use is the largest proportion of indoor water used in a household, high-efficiency toilets achieve real water savings.

The national high-efficiency toilet standard brings a range of questions and concerns for. This fact sheet is intended to assist in answering the questions that the consumer, property manager, plumbing contractor, and utility manager might have about the high-efficiency toilet standards.

### ENVIRONMENTAL, PUBLIC, AND CONSUMER BENEFITS

Studies indicate that converting to water efficient toilets, showers and clothes washers, results in a household water savings of about 30% compared to conventional fixtures. A change to high-efficiency toilets alone, reduces toilet water use by over 50% and indoor water use by an average of 16%. This translates into a savings of 15,000 to 20,000 gallons per year for a family of four. Furthermore, more efficient plumbing products result in lower wastewater flow and increase the available capacity of sewage treatment plants and onsite wastewater disposal systems.

The general public also benefits directly from water conservation measures. Practiced on a wide basis, efficient use of water resources helps reduce the potential need during drought periods for water restrictions such as bans on lawn watering and car-washing. Savings to the consumer from lower water bills, depending on local water rates and actual use, can range from $50 to $100 per year. Many hotels, motels, and office buildings are finding that new fixtures are saving them 20 percent on water and wastewater costs.

### DESCRIPTION OF THE TECHNOLOGY

The principles of high-efficiency toilet design and operation reflect the shift from remvoing waste by using flushwater *volume* to increasing flushwater *velocity* to remove waste.

The design of the bowl contour became more vertical design to achieve the necessary increased downward velocity. Nevertheless, the bowl contour must ensure a shallow but large water surface

towards the front of the bowl for adequate waste immersion. Many consumers notice that high-efficiency bowl designs result in a flush that tends to swirl less than their previous toilet. This is because the drag, or friction, resulting from swirling water reduces the essential velocity.

Some manufacturers use an enhanced front jet towards the bottom of the bowl to assist in waste removal. But other toilets that have received top consumer survey ratings use no jet at the bottom.

**Gravity-flow or pressure-assisted?**

Two types of technology are available for both residential and commercial uses. The most widely available is a high-efficiency modification of the conventional gravity flow toilet. The other, the pressure-assisted toilet, utilizes pressurized air in the tank to achieve additional force.

The choice between gravity and pressurized toilets usually hinges on two factors: noise, and the distinction between whether the maintenance is provided by the homeowner or by a building manager. Pressure-assisted toilets are much less likely to clog than even the older, 3.5 gpf gravity toilets. While many of the more recent models of high-efficiency gravity toilets perform as well as pressure-assisted models in tests, maintenance issues for heavy-duty use, or responsibility for maintaining multiple toilets, may lead to the decision to install pressure-assisted toilets. Some states, such as New Jersey, require pressure-assisted toilets in commercial use.

Gravity toilets in buildings with cast-iron waste lines may clog more readily, because of the roughness of the interior of the pipe. New buildings use PVC pipe, through which waste flows more easily. Choosing pressure-assisted toilets for buildings served by cast-iron pipe may reduce maintenance needs.

However, the greater noise from pressure-assisted toilets is a factor to consider when locating toilets near sleeping or working quarters. And the pressure-assisted toilet is generally more costly than gravity-flow.

Gravity-flow toilets achieve the necessary enhanced water velocity largely through coordinated improvements of the siphoning features of the fixture. Indeed, some of the early experiences with high-efficiency toilets that clogged too easily were the result of designs that increased siphoning by choking down on the trap size. Manufacturers responded by re-sizing the trap diameter nearer its original dimensions, and instead are coordinating the rim dimensions, bowl contour, and trap size to work in concert to enhance the force of the water and the siphoning function.

**Pipe slope standards**

The issue has been raised as to whether existing pipe slope standards are adequate to carry these reduced flows. American Society of Mechanical Engineers (ASME) tests indicate that the existing standards exceed performance requirements for drainline carry minimums. Field studies similarly report very few complaints, representing problems with a few individual buildings. The standards are under constant review, and any changes indicated would be recommended through normal procedures.

**HIGH-EFFICIENCY TOILET PERFORMANCE**

Consumer surveys, performed by utilities that have been implementing high-efficiency toilet programs (such as rebates), have shown that the vast majority of 1.6 GPF, high-efficiency toilets work well. For example, 90 percent of San Diego, CA, customers, and 95 percent of Austin, TX, customers reported that they were "satisfied" or "very satisfied" with their high-efficiency toilets; 91 percent of Tampa, FL, ratepayers said they would purchase the 1.6 gallon toilet again. A review of multiple metropolitan area customer satisfaction surveys for the 1995-1998 period shows that, while performance among individual high-efficiency toilet models varied, the large majority were rated at least satisfactory in performance, with most rated better than satisfactory.

Some brands and models have drawn more positive responses from consumers than others, with specific models being withdrawn and added as research and design progress. Since 1992, when the national law

was first passed, plumbing products have gone through several cycles of improvements, with each new generation bringing improved product performance and customer acceptance. The marketplace has responded to the move to the high-efficiency toilet standard so as to better serve customer requirements.

The two complaints most often made against the high-efficiency fixture are somewhat more frequent clogging, and the perceived need for more frequent double-flushing. A 1996 survey in New York City on customer satisfaction reported that building managers--who are responsible for maintaining a number of toilets--reported more frequent clogging, probably due to the smaller trap size of the toilet (designed to increase siphoning). The high-efficiency toilet designs, as discussed in the section on operation and maintenance, cannot accommodate extraneous waste materials and non-flushables such as paper towels. Building managers should communicate this to their tenants.

In a study of 100 homes in each of 12 North American cities, the incidence of double-flushing was virtually the same for homes with high-efficiency toilets as for those with conventional toilets.

**LIMITATIONS**

The consumer choice of a particular high-efficiency toilet model must take into account the specifics of the application. Key considerations include:

- To be sure the new toilet will cover the area, check the dimensions of the space in which the toilet is to be installed, including the 'footprint' of the old toilet.

- If the drainlines are made of cast-iron rather than PVC pipe, the toilet may be more likely to clog. Ensure adequate maintenance, or consider a pressure-assisted model.

- Pressure-assisted models tend to be more noisy than gravity-flush, so use caution when installing this type adjacent to sleeping quarters.

- Ensure the availability of electricity for electric-assisted models.

- Some toilets have a taller seat height, which should be evaluated based on anticipated users (some higher seats will be less accessible to children).

- Users in areas with high mineral content in the water should check rim hole dimensions, or consider a toilet with a holeless rim.

**CONSUMER TIPS**

*Purchase:* The buyer of the high-efficiency toilet should carry out the same type of research necessary for any significant purchase intended to be used for a long time. Refer to current issues of consumer magazines that evaluate water-efficient toilets (frequently under article listings for water conservation fixtures). Your water utility, individual plumbers, and the local plumbers' union or association may also be able to recommend certain models. Look for manufacturers' guarantees. By following these tips, purchasers of water conservation toilets can be fairly assured of getting a satisfactory product.

*Installation:* Proper installation is especially important for high-efficiency toilets. Licensed plumbers who guarantee their work will make sure fixtures are installed correctly. It is very important to follow the manufacturer's instructions. The proper flow cycle for high-efficiency toilets is shorter--usually about 45 seconds--than previous models.

If installing a water-conserving toilet to replace an old one, use new mounting bolts of the proper length, and be sure the old wax seal is completely removed before installing the new one. Check and clear drain lines while accessibility is open.

*Operation and Maintenance*: The common advice "Don't use your toilet as a trash bin" is especially important. High-efficiency toilets will not perform well if non-flushables, such as paper towels, are sent down the fixture. There has always been a need for plungers and plumbing "snakes," and their

use should be considered first when the toilet overflows or does not refill completely.

Since flapper valves require replacement about every five years, proper selection of replacement valves is a key maintenance consideration. A study conducted by the Metropolitan Water District of Southern California found that proper flapper valve model selection is essential for continued performance. Of the physically compatible replacement flapper valves, half the models left a toilet with *less* than 1.6 gpf--and the resulting incomplete flush had insufficient water to do the job the toilet was designed to do. Since most hardware stores can stock only a few brands, there is no guarantee of compatibility. Industry standards groups are working to insure that after-market flappers will perform properly. Getting the right replacement flapper value is worth the effort.

A key problem affecting 1.6 gpf toilets is a result of the use of chemical in-tank toilet cleaners. All U.S. toilet manufacturers recommend against the use of chemical in-tank toilet cleaners, as the strong chemicals degrade the works within the toilet. Even with current toilets that include chemical-resistant materials, chemical cleaners still increase the specific gravity of water and slow flushing velocity, interfering with performance.

NOTE: Most major toilet manufacturers maintain 1-800 number Consumer Hotlines (call the distributor or 1-800-555-1212). These hotlines are set up to address both non-technical and technical questions relating to installation, operation, and maintenance of high-efficiency toilets.

## COSTS

A wide range of toilets that perform well are available in all price ranges, although very inexpensive (less than $100) imports may not carry the American National Standards Institute (ANSI) design standard (different from the water conservation 1.6 gpf standard) and not function properly. In most cases, there is little relationship between price and performance. The consumer choice recommendations listed above under "Limitations" will help customers select the right model for them.

The choice to retrofit based on cost recovery from water savings can be easily calculated at the local level based on water rates and the price of the toilet. For average water/sewer rates, household savings for a typical four-person household is about $50/year.

## REFERENCES

### Other Related Fact Sheets

Other EPA Fact Sheets can be found at the following web address:

http://www.epa.gov/owmitnet/mtbfact.htm


1. Austin, TX "Common Questions and Answers about 1.6 gpf Toilets." Internet site at: [http://www.ci.austin.tx.us/watercon/toiletq.htm].

2. *Consumers Digest*, July/August: 51-52; Geary, D., 1997. Low-Flush Toilets.

3. *Consumer Reports*, "Low-Flow Toilets". February, 1995: 121-124.

4. *Consumer Reports*, "In Search of a Better Toilet." Internet site at [http://www.consumerreports.org/Categories/YourHome/Reports/9805toi0.htm].

5. DeOreo, W.B., P.W. Mayer, and P. Lander. Evaluating Conservation Retrofit Savings With Precise End-Use Data. 1998 Annual Conference, *Water Resources*, Vol. B - (2 of 5 Volumes) June 21-25, 1998, pp. 479-505, Dallas, Texas

6. Koeller, J. M., W.P. McDonnell, and H.O. Webster, III. After-Market Replacement of Flush Valve Flappers in Ultra-Low-Flush Toilets: A Study of Compatibility and Flush Volumes.

7. National Trade Association of Plumbing Products Manufacturers, April 1998. Press Release. *Report Credits Low-Flow Plumbing Products with Saving Water and Satisfying Customers.* Glen Ellyn, Illinois.

8. Nelson, J.O., N. Orrett, and J. Weber. A "Choice" ULF Toilet Replacement Strategy. 1996 Annual Conference, *Water Resources*, June 23-27, 1996, pp. 175-197, Toronto, Ontario, Canada.

9. Osann, E.R. and J.E. Young. April 1988. *Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters.* Prepared for American Council for an Energy-Efficient Economy, Washington, D.C.

10. Peak International, April 1996. *Ultra Low Flush Toilet Program, Customer Satisfaction Surveys.* Prepared for the Metropolitan Water District of Southern California.

11. Plumbing-Heating-Cooling Contractors (PHCC) - National Association. 1996. *"Water Conservation"*. Falls Church, Virginia.

12. Swaffield, J.A. and L.S. Galowin. "Solid Waste Transport Design Requirements. Design Engineering Charts for Drainage System Pipe Sizing". Research Proposal to the American Society of Plumbing Engineers Research Foundation. Heriot-Watt University, Edinburgh, Scotland.

*13.* *Water Resources*, 1998 Annual Conference, Vol. B - (2 of 5 Volumes) June 21-25, 1998, pp. 165-173, Dallas, Texas.

14. Wirthlin Group, October 1995. *A Survey of Ultra-Low-Flush Toilet Users.* Prepared for The Los Angeles Department of Water and Power.

The mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Environmental Protection Agency.

For more information contact:

Municipal Technology Branch
U.S. EPA
Mail Code 4204
1200 Pennsylvania Ave., NW
Washington, D.C., 20460

OWM MTB
Excellence in compliance through optimal technical solutions
MUNICIPAL TECHNOLOGY BRANCH