Response to Issues Raised During Public Comment on April 2006 Draft Specifications for WaterSense® Labeling of Tank-Type High-Efficiency Toilets

November 15, 2006

Background

This document provides WaterSense's response to public comments received on the Draft Specification issued on April 7, 2006 for the WaterSense Labeling of Tank-Type High-Efficiency Toilets. These comments can be viewed at http://www.epa.gov/watersense/docs/het_comments508.pdf.

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I. Comments on the WaterSense Program

a. Several commenters expressed the opinion that manufacturers of products proposed for certification must agree to make all testing documentation available to EPA if and when requested, and that this requirement should be explicitly stated in the criteria.

   Response: Products will be certified by independent, ANSI accredited product certification bodies. The product certification bodies will be responsible for maintaining testing documentation for certified products. EPA will be notified when products are certified and labeled under the WaterSense Program.

b. One commenter noted that this proposed HET specification was not accompanied by any market analysis of this product. He believed that in order to better understand the "value added" and the potential benefits from various levels of efficiency that might be considered for specification, some basic characterization of the marketplace for the product would be very helpful.

   Response: EPA did conduct market research and concluded that there is a significant market opportunity and water saving potential associated with high-efficiency toilets. This research served as a starting point for the development of the HET specification.

c. One commenter expressed concern that toilets currently passing the existing 1.6 gallons per flush (gpf) standards are not performing well and are not meeting consumer expectations. He asked if it would not be more prudent to put more stringent performance requirements into the current standards rather than reducing the water consumption level of new toilets (i.e., 1.28 gpf for HETs).

   Response: WaterSense believes that these concerns are not significant issues for several reasons. First, the vast majority of the current 1.6 gpf toilets on the market are performing well as demonstrated by MaP testing over the past three years.[1] Manufacturers have done a good job of engineering and designing new products that perform at a high level of consistency and customer satisfaction within the current 1.6 gallon per flush requirements. WaterSense does acknowledge that early on after the switch to the 1.6 gpf limit there were concerns regarding the performance of these new ULF toilets. The underperforming products, however, for the most part have been removed from the market and replaced with better engineered and better performing products. Therefore, there is little reason to believe that putting a stringent waste clearance performance requirement within the existing 1.6 gpf standards would significantly reduce water consumption.

[1] Maximum Performance (MaP) testing protocols for toilet fixtures, development of which was sponsored by 22 water providers in the United States and Canada in 2003. Reports on the current performance of 1.6 gpf fixtures can be obtained at <www.cuwcc.org/maptesting.lasso>.

In addition to a reduced flush requirement, the HET specification was developed with a stringent waste clearance requirement to address this specific concern for this category of toilet products. A significant requirement of the specification is the consistent ability of the toilet to clear 350 grams of waste material. This requirement will ensure that only products that save water and perform well will carry the WaterSense label.

d. A manufacturer of a dual flush retrofit device requested that WaterSense amend the HET specification to include allowances for its device in WaterSense labeled HETs.

   Response: WaterSense is not addressing toilet trim or retrofit components separately at this time. The components used in toilets are covered in other plumbing fixture standards. The HET specification covers the entire toilet fixture functioning as a unit. WaterSense is neutral on which components a manufacturer uses and encourages manufacturers of trim components to market their products to toilet manufacturers.

e. Several commenters expressed a desire for WaterSense to develop a tiered ranking system or giving labeled products a “grams per gallon rating” (similar to miles per gallon rating) to provide incentives for manufacturers to go beyond the 1.28 gpf level.

   Response: At this time, WaterSense is not trying to differentiate between products in terms of their degree of water-efficiency. Rather, the goal of WaterSense is to clearly identify products in the marketplace that are water efficient when compared to their standard counterparts. The WaterSense label will clearly identify these products and give consumers an easily understood reference point for their purchasing decisions.

II. Comments on Section 1.0 — Scope and Objective

a. One issue raised by commenters was the concern that the listing of the types of toilets to which this specification is applicable could be considered an exclusive list that is meant to be restrictive. The commenters asked WaterSense to specify in this section that the list provided is not exclusive and that any other new technology that satisfies the criteria can meet the specification and receive the WaterSense label.

   Response: To clarify and address this concern, WaterSense has added a final bullet indicating that this specification also can apply to “any other comparable technologies that meet these performance standards.”

b. Several commenters asked whether valve-type toilets were intentionally excluded from this specification, and if so were they to be addressed separately by another specification at a later date.

Response: WaterSense did intentionally leave valve-type (a.k.a., flushometer valve) toilets off this list and does intend to address them at a later date with a separate specification. WaterSense's aim was initially to focus on the types of fixtures commonly found in residential and light commercial settings and address valve-type commercial fixtures in the future. Since there are very few residential valve-type toilets on the market at this time, WaterSense felt focusing this specification on tank-type toilets was the best approach. To clarify this intent, we have added "Tank-Type" to the specification title.

III. Comments on Section 3.0 — Water Efficiency Criteria

a. Several commenters believed that the specification should incorporate some sort of mechanism for gauging customer acceptance or satisfaction with HETs. They pointed out that many of these products are new and that current test and standards cannot address all customer concerns. They felt that customer feedback is essential to a robust program.

   Response: WaterSense agrees that measuring customer satisfaction and acceptance of high-efficiency products is essential to the program's long-term success. WaterSense does intend to undertake activities in the future to measure and track customer satisfaction. The exact mechanisms for doing this are still being reviewed and developed. WaterSense, however, feels that this is a programmatic issue that is best handled through program guidelines and policies. Performance requirements have been included in the specification to help ensure customer satisfaction. Actually measuring customer satisfaction falls outside the scope of product specifications.

b. One commenter raised the issue that many manufacturers use various tank and bowl combinations for two-piece toilets, and that could create some confusion as to how these products will be labeled by the program. The commenter believed that a qualifying model should consist of a specific combination of tank and bowl and that no single component (i.e., tank or bowl) of a two-piece toilet should be independently qualified as meeting the specification.

   Response: WaterSense recognizes this issue and agrees with the commenter that only specific tank and bowl combinations should receive the WaterSense label. The tested bowl and tank together as a unit constitute the certified and labeled product. Listings of labeled products should include the model number of the tank and bowl, as tested in combination.

c. Several commenters expressed concern with and questioned the basis of using a two reduced flush to one full flush ratio in determining the effective flush rate for dual flush toilets. Another commenter questioned the rationale for allowing dual flush toilets to have a full flush of 1.6 gpf, contending that most people do not use dual flush fixtures properly and predominantly rely on the full flush mode.

Response: In establishing the dual flush requirements in the specification, WaterSense examined the results of five field studies in which dual flush toilet performance was evaluated in residences. A summary of these studies, Dual-Flush Toilet Fixtures—Field Studies and Water Savings (Koeller and Company, December 2003), is available on the California Urban Water Conservation Council (CUWCC) Web site. The average reported flush volume, as used under field conditions in each study, ranged from 1.11 to 1.34 gpf. The median value among the studies was 1.25 gpf. These results demonstrate that dual flush toilets generally are used properly and their use does result in savings of 20 percent or more when compared to 1.6 gpf single-flush models. Defining the effective flush volume as the average of two reduced flushes and one full flush provides a sound basis to compare dual flush toilet performance to a single performance goal of 1.28 gpf (i.e., the arithmetic average of two 1.1 gallon reduced flushes and one 1.6 gallon full flush is 1.27 gallons). As discussed above, field studies indicate the ratio of reduced to full flushes in actual practice is such that a median value of 1.25 gpf is achieved.

d. Several commenters asked whether composting toilets could qualify under this specification.

   Response: A composting toilet would not meet the requirements of this specification as it would not have a tank-type flushing mechanism and would not conform to ASME A112.19.2. While they do not fall within the scope of this specification, WaterSense acknowledges that composting toilets are highly water efficient and a good choice for certain applications.

IV. Comments on Section 4.0 — Flush Performance Criteria

a. Many comments were received in regard to the test media sample size. All of the commenters agreed that the test media size should be higher than the UNAR standard of 250 grams to establish a higher level of performance for HETs. None of the commenters advocated reducing the threshold below the proposed 350 grams. Some commenters, however, recommended increasing the minimum requirement to 400 grams or more. These commenters believe increasing the test sample size will guarantee better performance and avoid customer satisfaction problems. Just as many commenters supported the 350 gram test media size and warned against increasing it. They believe that as test media loading increases a point is reached where toilets begin to be designed with attributes that serve only to meet the test requirements. This can become design restrictive and, in fact, negatively impact other aspects of toilet performance. They state that there is more than enough consumer satisfaction data available at the current 250 gram level for WaterSense to have confidence the HETs meeting a 350 gram requirement will perform well and live up to consumer expectations.

   Response: WaterSense believes that the best available data on human waste loading, as cited in the specification, supports the decision to use 350 grams as

the media sample size. WaterSense also concurs that increasing the media sample size above this level will not create a significant increase in performance and could become design restrictive.

b. Several commenters expressed concern with the variability in test results that they experienced using latex cased media. One commenter described widely varying results between several batches of the cased media when tested on the same fixtures. Many commenters believe that the justification for using cased media—reusability to save time and reduce costs—are really not critical in regards to this HET specification. They felt that since a maximum of only five tests are required, saving a relatively small amount of money by using cased media did not make sense if the test results could potentially be less reliable. Many commenters suggested switching to uncased media to avoid this issue. They feel that the uncased media has a well established track record and represents a more "real world" example of toilet performance. No commenters expressed any objection to switching to the use of an uncased media sample.

   Response: WaterSense supports switching the specification to uncased media for the reasons cited above. Consequently, the specification has been revised to incorporate the use of uncased media (also referred to as extruded media).

V. Comments on Section 5.0 — Supplementary Requirements for Flush Volume Adjustability

a. A few commenters expressed concern over the specification's 0.4 gpf trim adjustability allowance for single flush and the full flush mode of dual flush toilets. They feared that consumers would adjust the tank trim to set it at its maximum water use setting, thus undermining the water savings of the product. They recognize that toilet manufacturers need a tolerance level on maximum water settings in developing their HET product lines, but felt that creating an HET standard that allows for field adjustments that currently exceed the 1.6 gpf level for existing low-flow toilets is unreasonable.

   Response: The 0.4 gpf trim adjustability allowance takes into account the small vertical distance, typically less than one inch, between the marked water level in the tank and the overflow tube in a standard gravity flush toilet. We have retained this maximum trim adjustability factor to preserve the design flexibility associated with gravity flush toilets. It is important to note that this allowance is for a maximum field adjustment—the toilet as manufactured and sold must still comply with the effective flush volume requirement of 1.28 gpf indicated within Section 3.0 of the specification. As documented in the California Urban Water Conservation Council Toilet Flapper Study (December 2004), consumers typically do not make toilet trim adjustments and toilets do perform as designed. Therefore, while the maximum trim allowance of 0.4 gpf is retained to reflect the design characteristics of gravity flush toilets, we expect these toilets will flush an average of 1.28 gpf or better.

b. Another commenter expressed concern over the fact that the specification does not address the use and possible installation of after-market overflow tubes. The commenter points out that a consumer could easily replace the factory installed overflow tube with a longer after-market tube and increase the toilets effective flush volume by as much as 1.0 gpf.

   Response: As indicated above, the 2004 Toilet Flapper Study demonstrated that consumers typically do not make such modifications to their toilets. While there is a remote possibility that a consumer would consciously work to defeat the efficiency features of an HET, we find it highly unlikely that they would voluntarily choose a water-efficient product and then modify that product through significant effort to negate the benefits. In addition, the flushing performance of WaterSense labeled HETs will be superior, as demonstrated through compliance with Section 4.0 of the specification, so there will be no motivation to tamper with or modify the toilet.

c. Several commenters indicated that the Section 5.2.3.2 Flush Volume Adjustability limit of 1.10 gpf on the reduced flush mode was inadequate. They commented that this issue was critical to siphonic dual flush HETs. One commenter explained that most dual flush toilets on the market today are of European design and are capable of flushing below the 1.1 gpf limit in reduced flush mode. These models, however, are predominately non-siphonic designs and have very small water surface areas. U.S. customers, in general, have shown a preference for toilets with larger water surface areas in terms of reduced staining and general cleanliness. Siphonic dual flush toilets, which have a larger water surface area, require a reduced flush volume closer to the 1.1 gpf maximum value allowed by ASME A112.19.14 in the reduced mode. Consequently, siphonic dual flush toilets require a 0.3 gpf allowance in order to accommodate the adjustability of tank trim. By limiting the maximum adjusted flush volume to 1.1 gpf, WaterSense would effectively be requiring all dual flush HETs to be non-siphonic designs. This would be design restrictive and counter WaterSense's stated goal of expanding the market of water-efficient products.

   Response: WaterSense acknowledges the validity of these arguments and has increased the maximum tank trim allowance for the reduced flush mode to 0.3 gpf. As indicated above, it is important to note that this allowance is for a maximum field adjustment—the toilet as manufactured must still comply with the reduced flush requirement of 1.1 gpf in ASME A112.19.14. As documented in the California Urban Water Conservation Council Toilet Flapper Study, consumers typically do not make toilet trim adjustments and toilets do perform as designed. Therefore, while a maximum trim adjustability allowance of 0.3 gallons is provided to reflect the design characteristics of siphonic dual flush toilets, we expect these toilets will flush an average of 1.1 gpf or better in reduced flush mode.

VI. Comments on Section 6.0 — Qualified Testing Laboratories

a. Several commenters expressed concern with the requirement that qualified testing laboratories need to be recognized by a specific, private testing agency. Many believed this would unnecessarily force any laboratory interested in performing this testing to enter into a business relationship with one particular company. Commenters felt a more appropriate approach would be to require an interested laboratory to be accredited to ISO 17025—General Criteria for the Competence of Testing and Calibration Laboratories.

   Response: EPA further investigated the most appropriate way to assess that HETs conformed to the specification, before they are labeled under the WaterSense program. Based on this examination, EPA concluded that the best approach for WaterSense would be to have products certified to conform to the specification by certification bodies accredited by American National Standards Institute (ANSI) in accordance with ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*. Under this approach, the product testing laboratories used by the certification body must have the competence and capability to conduct tests in accordance with relevant WaterSense specifications. Specific details on how this conformity assessment approach will be implemented are provided in Appendix A of the WaterSense program guidelines. Under this approach, the manufacturers will be free to enter into a business relationship with any approved certification body that provides the service they require. Certification bodies will be free to use competent testing laboratories that meet their quality criteria.

   EPA selected this approach for several reasons. First, this approach provides for true third party certification, and is consistent with the current approach to product certification in the plumbing industry. As this certification approach is already used, it should lead to faster product approval times and provide consistency in product testing. Second, the WaterSense brand will benefit from the consumer confidence and credibility that independent certification will instill. Third, since conformity assessment and ongoing surveillance will be conducted primarily in the private sector under this approach, EPA resources can be used to focus on WaterSense brand marketing, product specification development, and program outreach, which will provide the greatest long term program benefits.

VII. Comments on Appendix C — Tank Trim Adjustability Protocol

a. One commenter expressed concern that the language in Appendix C, Section 3.2.2 requires that replacement seals available at hardware or building supply stores be used during this portion of the testing. The specific concern is that replacement flappers for some models may only be available from plumbing supply stores or from the manufacturer and that restricting the replacement flappers tested to those only available from hardware or building supply stores unnecessarily removes some flappers that may cause high flush volumes from consideration.

Response: WaterSense acknowledges this issue and has amended the specification to read "…one or more replacement seals available at hardware, plumbing supply, and building supply stores or from the manufacturer or other recognized source shall be used."

b. One commenter expressed concern that the language in Appendix C, Footnote 11, allowing the testing laboratory to decide which after market buoyant flappers should be used to test the flush volumes in cases where the specified flappers do not work or where the flush valve is of a non-standard size could create future problems. As written, a manufacturer could develop a toilet with a nonstandard sized early closure flapper for which there is no existing replacement flapper. At some later date, someone else could manufacture a replacement for this new flapper that undermines the water efficiency of the toilet. He expressed a need for incorporation of language to protect against this.

   Response: It should be noted that WaterSense can not exercise any control over the aftermarket for flappers. However, the testing laboratory must select a buoyant flapper for this component of the test. We do not expect that the variability in performance of buoyant flappers will be such that further definition is warranted at this time, and the professional judgment of laboratory personnel conducting this part of the test will be sufficient so that the test is conducted in an appropriate manner.

c. One commenter requested that WaterSense change the length of time the activator is maintained in the flushing position from one second (as required in Sections 2.2.4 and 3.2.5) to three or five seconds. He believes this will eliminate the possibility of manufacturers and users circumventing the maximum flush volume limits by holding the activator down to allow greater volumes of water to be used per flush.

   Response: Maintaining the activator in flushing position for one second is the requirement established in ASME A112.19.2 and A112.19.14. We have retained the one second hold down to be consistent with those existing standards.

VIII. Comments on Other Specification Related Issues

a. Commenters expressed concern over the lack of a realistic drainline carry test component in the HET specification. One commenter was critical of the current ASME A112.19.2 drainline carry test and questioned the validity of performing flushing performance tests into open air. He questioned whether any of the HET models currently identified as meeting the WaterSense Tank-Type HET Specification had drainline carry tests performed. He recommended performing the waste clearance testing portion of the specification with the toilet fixtures connected to a length of drainline via a floor flange and turning fitting. A passing score would require a minimum amount of test media to be evacuated from the toilet and transported a minimum distance through the drainline.

Response: WaterSense reviewed these comments and concluded that they raised legitimate questions about the drainline carry performance of HETs that warranted further investigation. In addition to providing superior water savings, WaterSense labeled toilet fixtures also should meet consumer expectations for flushing and drainline carry performance. To investigate whether qualifying HETs would meet reasonable expectations of drainline carry performance, WaterSense conducted a number of tests to evaluate both HET flushing (bowl clearance) and drainline carry performance. A test procedure was implemented to determine if HETs that passed the WaterSense specification would also adequately carry waste material in the drainline. To truly test performance, we selected a set of more difficult than average test conditions. Whereas most building and plumbing codes call for a 3-inch diameter drainline installed at a 2-percent slope to be used for a single toilet fixture, WaterSense used a 4-inch diameter drainline installed at a 1-percent slope. Even under these less than ideal conditions, the HET models tested all were able to meet or exceed the established performance criteria. For a more detailed presentation of this study, see Appendix A – WaterSense Drainline Carry Testing Results. Based on this evaluation, WaterSense concluded that toilets that conform to the WaterSense HET specification will perform well when installed in typical residential configurations and will provide sufficient drainline carry of waste material.

Appendix A — WaterSense Drainline Carry Testing Results

The U.S. EPA's water-efficient product labeling program, WaterSense, includes High-Efficiency Toilets (HETs), i.e., toilet models that flush with an effective flush volume of 1.28 gallons[2] or less.

The effective flush volume is the average flush volume of the toilet fixture under typical residential conditions. Two types of toilet fixtures meet this criteria: single-flush models that flush with 1.28 gallons or less, and dual-flush models that offer the user a choice between a "full flush" of 1.6 gallons to remove solid waste and a "reduced flush" of no more than 1.1 gallons to remove liquid-only waste. Studies have shown that dual-flush toilets can save at 20% or more water compared to single-flush 1.6-gallon models and, as such, are considered HETs.

After reviewing the WaterSense Toilet Testing Protocol, Dr. Larry Galowin (a guest researcher with NIST), commented that he was very pleased the EPA had decided to use a realistic test media (extruded soybean paste and toilet paper) for evaluating toilet flushing performance and that the testing protocol called for a complete evacuation of the media from the fixture in a single flush. Dr. Galowin has several criticisms of current ASME A112.19.2 certification requirements that he would like to see addressed by the EPA's WaterSense program, including:

1. ASME requires toilets to evacuate only 79 percent of test media (sponges and paper wads) to pass, whereas consumers want and expect toilets to evacuate virtually 100 percent of the waste. As such, a toilet model that leaves 20 percent of the waste behind may pass existing certification requirements but would certainly fail to meet consumer expectations.
2. Flushing performance testing is completed using sponges and paper wads; drainline carry testing is completed using three-quarter-inch plastic balls. Neither test media is even vaguely realistic (i.e., similar to human feces and toilet paper) and therefore test results may not be indicative of what would be expected in the field.
3. Totally different test media is used to evaluate flushing performance and drainline carry performance. His contention is that in the "real world" the same "media" is both flushed out of the toilet and transported through the drainline.
4. Flushing performance testing and drainline carry testing are completed as separate tests (and with different test media). His contention is that in the "real world" waste is evacuated from the bowl and transported down the drainline as part of the same event. Dr. Galowin proposes that to more accurately reflect "real world" conditions toilet fixtures be connected to a length of drainline via a floor flange and turning fitting, and a passing score require a minimum mass of test media to be evacuated from the toilet and transported a minimum distance through the drainline.

It is the intention of the EPA that WaterSense labeled toilet fixtures not only provide superior water savings but also meet consumer expectations for flushing and drainline carry

[2] Value equates to 80 percent of current maximum flush volume by code.

performance. For example, all WaterSense labeled toilet fixtures must be tested to ensure they can fully evacuate at least 350 grams of realistic test media in a single flush, and the results of the *Evaluation of Water-Efficient Toilet Technologies to Carry Waste in Drainlines*[3] project indicated that there should be no problem achieving sufficient drainline carry distances when using 3-inch diameter pipe installed at a 2 percent slope. However, Dr. Galowin's comments prompted EPA to consider the potential for drainage problems if a more *severe* installation was used, i.e., a 4-inch diameter pipe installed at a 1 percent slope.

As such, a number of tests were completed to evaluate the flushing and drainline carry conditions by flushing realistic media in several HET models connected to a 4-inch diameter drainline installed at a 1 percent slope.

Dr. Galowin: *"The toilet sample being tested should be connected to a drainline via a floor flange and turning fitting. The drainline should be of suitable diameter and of adequate length to provide meaningful data. While the test setup should not necessarily reflect the worst possible field conditions, it should reflect 'more difficult than average' conditions."*

The following is a description of the test set-up used to evaluate flushing/drainline performance.

Pipe Diameter: 4 inches

- Most building/plumbing codes call for a 3-inch diameter drain to be used for a single toilet fixture. The use of a 4-inch diameter drain will result in shorter overall carry distances and, therefore, meets the "more difficult than average conditions" condition.

Pipe Slope: 1 percent

- Most building/plumbing codes call for toilet drains to be installed at a 2-percent slope. The use of a 1-percent slope will result in shorter overall carry distances and, therefore, meets the "more difficult than average" condition.

Pipe Length: 4 meters

- Most residential toilet drainlines run only for a short distance before they connect to other pipes. In most cases there are supplemental flows (e.g., from showers, baths, sinks, clothes washers, etc.) in the drainline to help move solid waste through the line.

  Dr. Galowin suggested that toilet models be connected to a 3 meter to 5 meter (9.8 feet to 16.4 feet) length of drainline during performance / drainline testing completed in the lab. Personal discussions between one of EPA's sub-consultants[4] and a plumbing inspector for new homes suggested that he rarely sees horizontal drains.

- Lines of greater than 12 feet (3.7 meter) for toilets before they connect to other pipes or supplemental flows are introduced.
- A carry distance of 4 meters was selected as a suitable carry distance.

[3] Gauley and Koeller, March 2005
[4] Bill Gauley, Veritec Consulting Inc.

Supplemental Flows: None

- It is common for drainlines that service toilet fixtures to also service other fixtures or appliances, i.e., the flows from these other fixtures and appliances help to transport solid waste through the pipes.
- To be conservative, and to keep in line with the "more difficult than average" requirement, no simulated supplemental flows (i.e., from showers, baths, laundry, etc.) were introduced to the drainline during testing.

Following Flushes: A single liquid-only flush

- Toilets are normally subjected to multiple liquid-only flushes for every "solids" flush. Estimates of the ratio of liquid-to-solid flushes typically range from 3:1 to 5:1.
- To be conservative, and to keep in line with the "more difficult than average" requirement, the testing program used only a single liquid following flush.

Pipe Material: Clear plastic pipe

- Plastic drain piping is commonly used in new home construction. In older homes drain pipes were often made of cast iron. It is expected that drainline carry would be: a) less in cast iron pipes than in plastic pipes, and b) less in older pipes than in new pipes.
- Because it is important to be able to observe the waste flowing through the pipe (to properly assess performance levels) and because many of the other test parameters are "more difficult than average," e.g., the testing is being done using 4-inch diameter pipe installed at 1 percent slope with no supplemental flows and only a single following flush, it was considered suitable that the testing be completed using clear plastic piping.

Pipe Layout: Straight and true

- Because of building or ground settling or heaving, or because of improper installation, some drainlines in the field do not have the proper slope or may have a number of "dips and sags" along their length. Some older drain pipes may be partly blocked with grease, grit, tree roots, or other materials that would reduce the pipe's ability to transport waste.
- Because it is not possible or even necessary to assess every possible "negative" drainline condition, a laser level and string-line were used to install the test drainline in a straight line and at a constant slope.

Although dual-flush fixtures with a "full flush" volume of 1.6 gallons qualify as an HET, there is no concern regarding the ability of 1.6-gallon models to transport the waste and, as such, there was no need to include testing on 1.6-gallon flushes. Tests were completed on the following types of models:

- 1.2-gallon gravity washdown
- 1.28-gallon gravity siphonic
- 1.0-gallon pressure-assist

Although a carry distance of 4 meters (13 feet) was established as the benchmark for this study, a total of 9 meters (30 feet) of piping was installed. A "pass" was achieved if the waste from a

toilet sample was transported at least 4 meter after 350 grams of solids flush followed by one liquid only flush[5].

Tests were performed using two types of media: sinking and floating. The soybean paste used in MaP testing has a density greater than that of water and therefore sinks. To make the test media float, a small amount of powdered styrofoam was blended into the soybean paste. Four balls of six sheets of toilet paper were also added to each test. Five tests flushes were conducted for each scenario—a total of 60 tests were conducted. Carry distances identified in the following table are the average of the five tests.

Average Carry Distances

350g Sinking Waste

1.20-gallon Washdown		**1-gallon Pressure-Assist**		**1.28-gallon Gravity**	
1st Flush	2.9 m (9.4 ft)	1st Flush	1.3 m (4.2 ft)	1st Flush	3.7 m (12.2 ft)
2nd Flush	**7.4 m (24.1 ft)**	**2nd Flush**	**4.4 m (14.4 ft)**	**2nd Flush**	**6.2 m (20.3 ft)**

350g Floating Waste

1.20-gallon Washdown		**1-gallon Pressure-Assist**		**1.28-gallon Gravity**	
1st Flush	5.8 m (19.2 ft)	1st Flush	2.0 m (6.4 ft)	1st Flush	4.5 m (14.8 ft)
2nd Flush	**9.0 m (29.5 ft)**	**2nd Flush**	**4.9 m (16.1 ft)**	**2nd Flush**	**9.0 m (29.5 ft)**

Test Location

The above tests were conducted by Veritec Consulting, Inc., at their test facility in Mississauga, Ontario.

Conclusion

Although only a limited number of tests were conducted, the results above indicate that HETs (even 1-gallon models) should be able to exceed 4 meters in drainline carry under the adverse conditions described here. It is expected that carry distances under more typical conditions, e.g., 3-inch diameter pipe, 2 percent slope, with the inclusion of supplemental flows and more than one liquid-only following flush, would be greater than the average values identified above.

[5] The liquid-only flush occurred 60 seconds after the solids from the first flush came to a rest.