

# **Maximum Performance (MaP)**

## **Testing of Popular Toilet Models**

**A Cooperative Canadian and American Project**



by

**Veritec Consulting, Inc. & Koeller and Company**

## **Prepared by**

William Gauley, P.Eng.  
Veritec Consulting Inc.  
1495 Bonhill Rd., #12  
Mississauga, ON L5T 1M2  
Canada

Tel (905) 696-9391 x102

Fax (905) 696-9395

[bgauley@t5flushmeter.com](mailto:bgauley@t5flushmeter.com)

John Koeller, P.E.  
Koeller and Company  
5962 Sandra Drive  
Yorba Linda, CA 92886-5337  
U.S.A.

Tel (714) 777-2744

Fax (714) 777-2267

[koeller@earthlink.net](mailto:koeller@earthlink.net)

# TABLE OF CONTENTS

## Contributors

## Disclaimers

1.0	BACKGROUND.....	1
2.0	MAXIMUM PERFORMANCE (MAP) TEST .....	2
2.1	Critical Aspects of Test.....	2
2.2	Minimum Level of Acceptable Performance - Medical Data.....	2
2.3	Soybean Paste Test Media .....	3
2.4	Media Source .....	4
2.5	Test Protocol .....	4
3.0	CONCLUSIONS.....	4
4.0	RECOMMENDATIONS .....	4

## APPENDIX A

Protocol: Maximum Performance (MaP) Toilet Fixture Performance Testing

## APPENDIX B

MaP Results Sorted by Manufacturer

## APPENDIX C

MaP Results Sorted by Performance

## Contributors

Initiated in 2003 by municipalities and other interested organizations in Canada, the Maximum Performance (MaP) Testing program was a cooperative effort between Canadian and American partners, including:

### Canada

- Canadian Water and Wastewater Association (CWWA) – **LEAD AGENCY**
- B.C. Capital Regional District, Victoria, British Columbia
- B.C. Buildings Corporation, Victoria, British Columbia
- Canada Mortgage and Housing Corporation
- Calgary, Alberta
- Edmonton, Alberta
- Greater Vancouver Regional District, British Columbia
- Halifax, Nova Scotia
- Hamilton, Ontario
- Montreal, Quebec
- Ottawa, Ontario
- Region of Durham, Ontario
- Region of Halton, Ontario
- Region of Peel, Ontario
- Region of Waterloo, Ontario
- Toronto, Ontario
- Winnipeg, Manitoba

### U.S.A.

- California Urban Water Conservation Council, Sacramento, California
- East Bay Municipal Utility District, Oakland, California
- Los Angeles Department of Water and Power, Los Angeles, California
- Seattle Public Utilities, Seattle, Washington
- Tampa Bay Water, Clearwater, Florida

We gratefully acknowledge the contributions from these participating agencies and municipalities.

## Disclaimers

The information in this report is believed to be an accurate description of the units tested and the results obtained. Every effort was made to ensure the accuracy of the findings including, but not limited to, preparation of a detailed test protocol, careful selection and procurement of the products to be tested, and third-party oversight of testing protocol implementation. However, because only two units of each model were tested, these results should not be considered as fully representative of the typical or average production of the models tested. The results shown in this report should be viewed only as an indication of expected 'field' results.

Although the test protocol utilized a media whose physical properties closely resembles typical human waste, the reader is reminded that there is an enormous variation in human waste from person to person, and from one day to another.

Neither the authors, reviewers, project supporters, sponsoring partners, CWWA, nor their employees make any warranty, guarantee, or representation, expressed or implied, with respect to the accuracy, truth, effectiveness, or usefulness of any information, method, or material in this document, or assume any liability of the use of any information, methods, or material disclosed herein, or for any damages arising from such use. Readers use this report at their own risk.

Neither the authors, reviewers, project supporters, sponsoring partners, CWWA, nor their employees endorse products or manufacturers. Trade or manufacturers' names appear herein not as an endorsement but solely because they are considered important to the object of the project.

Readers are invited to distribute this report in whole or in part but any changes made to the document must be approved by the CWWA or one of its agents.

Readers are reminded that this report represents a 'snap shot' of the performance levels achieved by certain toilets at a particular time and with particular trim. Manufacturers sometimes make permanent or temporary changes to trim components or to model designs without changing the model names. As such, changes to the models tested in this report may have occurred since the testing was completed.

Manufacturers tend to make periodic changes and improvements to their various models. As such, it is expected that several models tested as part of this study may be improved over time (in fact several models were improved and re-tested even during the course of this project). Performance results, therefore, may need to be periodically updated.

The selection of toilets tested as part of this program is in no way intended to represent all of the various makes and models available, nor is it intended to provide a comprehensive list of all toilets that might be expected to perform either well or marginally in the field.

The results obtained during this testing program are not guarantees of performance.

The reader should be reminded that there are criteria *in addition* to solids removal that should be considered when selecting a toilet model, e.g., bowl wash, availability of replacement parts, potential for leakage, etc. MaP testing addresses only a single issue: the ability of a toilet model to completely remove solids in a single flush.

Both consumers and manufacturers are encouraged to provide feedback to the authors of this report, especially regarding issues such as incorrect model numbers, models that are listed but are no longer available, etc.

## 1.0 BACKGROUND

Although virtually all toilet models sold in Canada and the U.S. meet both the flush volume and performance requirements of the Canadian Standards Association (CSA) and the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME), there remains some question as to whether models that meet the minimum certification requirements meet the expectations of the consumer. What's more, since certification testing offers only a pass/fail grading, there is currently no easy way to distinguish between superior and marginal toilet models available in the market.

Most residential toilet models exceed customer performance expectations while flushing with no more than 6 litres (1.6 gallons). However, recent research in Canada and the U.S. conclude that there are also certified and commercially available models that do not meet customer expectations.

There are two key concerns:

- 1) Fixtures that fail to meet the maximum 6-litre flush requirements of the Canadian Standards Association (CSA) or the 1.6-gallon requirements of the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)<sup>1</sup> result in toilets that flush with either too much or too little water;
- 2) Fixtures that do not flush effectively result in customer complaints and the need for double flushing.

Currently, however, there is no convenient way for the customer to distinguish between good and marginal performers. In addition, this lack of information on toilet performance levels has served to create a negative perception regarding 6-litre (1.6-gallon) technology in general, as opposed to identifying only those "bad apples".

Although other toilet performance studies have been completed, none of these have been performed using test media as realistic as that used in this test, nor has a quantifiable performance benchmark – based on the results of relevant medical data – been established.

The Maximum Performance (MaP) testing project was developed to identify how well popular toilets models perform using a realistic test media, and to grade each toilet model based on this performance. A soybean paste having similar physical properties (density, moisture content) to human waste was used in combination with toilet paper as the test media. In addition to using a realistic test media, all toilet samples rated at 6 litres (1.6 gallons) were adjusted to flush at that volume prior to testing to ensure a level playing field.

The developed testing protocol required the soybean paste to be extruded through a 7/8-inch (22-mm) die and cut into 50-gram specimens (each specimen approximately 100 mm or 4 inches in length). Toilet models were subjected to progressively larger loadings (in 50-gram increments) until the unit failed to completely clear the bowl in two of three attempts.

---

<sup>1</sup> Certification testing is intended to ensure that each model meets a specific set of minimum requirements for health and safety, product integrity, and performance. There is no differentiation in certification between a toilet model that just meets the minimum requirements and one that surpasses those requirements.

This third edition of the MaP testing report supersedes earlier versions of the report. Unlike earlier versions, this edition does not include data for prototypes, models where only single samples were provided (two samples are required as per MaP testing protocol), nor does this edition include data on flapper compatibility and flush volumes with ‘standard’ buoyant flappers (this data can still be viewed in original MaP report). Data pertaining to changes in flush volume with the installation of a ‘standard’ flapper can be found in the current L.A. Supplemental Purchase Specification <http://www.cuwcc.com/Uploads/product/LADWP-SPS-ULFTReqs.pdf> and eventually in Uniform North American Requirements (UNAR) for Toilet Replacement Programs report (expected early in 2005).

The performance benchmark adopted by MaP is 250g. This value is based on the results of a British medical study (*Variability of Colonic Function in Healthy Subjects*) that identified 250g as the average maximum fecal size of the male participants in the study. Any toilet that meets or exceeds the 250g performance threshold should meet customer expectations for flushing.

Overall, the MaP testing protocol appears to be well received by both water providers and manufacturers alike. It is expected that many agencies and municipalities will consider the results of MaP testing when evaluating which toilet models to subsidize or rebate.

## **2.0 MAXIMUM PERFORMANCE (MAP) TEST**

### **2.1 Critical Aspects of Test**

MaP testing includes four significant advancements from earlier studies:

- Non-realistic test media (sponges, plastic balls and beads, kraft paper, etc.) replaced with combination of extruded soybean paste and wads of toilet paper. Most agree this media more accurately replicates “real-world” demands upon a toilet fixture.
- All models are adjusted to rated volume, generally 6 litres (1.6 gallons), prior to testing.
- A minimum level of acceptable performance was identified.<sup>2</sup>
- Results are presented by flush type to help assess whether differing flush technologies impact toilet performance.

### **2.2 Minimum Level of Acceptable Performance - Medical Data**

A British medical report<sup>3</sup> outlines the results of fecal tests completed on 10 male and 10 female subjects eating normal diets. The study identified the *average maximum*<sup>4</sup> fecal size of the male participants to be approximately 250 grams and the 95<sup>th</sup> percentile size to be 305 grams<sup>5</sup>. The

---

<sup>2</sup> Although the NAHBRC report scored performance levels from 0 to 82, there was no indication of what score would constitute an acceptable level of performance.

<sup>3</sup> J.B. Wyman, K.W. Heaton, A.P. Manning, and A.C.B. Wicks of the University Department of Medicine, Bristol Royal Infirmary, *Variability of colonic function in healthy subjects*, 1978.

<sup>4</sup> The average of the largest sample collected from each participant during the program.

<sup>5</sup> It would be expected that only 5% of male samples would be larger than 305g.

*average maximum* for women was slightly less at 237 grams, with the 95<sup>th</sup> percentile at 275 grams. The *average fecal size of all participants* was 130 grams<sup>6</sup>.

Based on this study, it appears that for sanitary reasons as well as for customer satisfaction, toilets should flush a *minimum* of approximately 250 grams of solids. Therefore, for the purposes of this study, 250 grams (250g) was set as a performance benchmark..

The photos below help to illustrate some of the aspects involved in MaP testing.



Test rig (top left), bulk & extruded media (top right), media (bottom left), and adding media to bowl (bottom right).

### 2.3 Soybean Paste Test Media

Soybean paste was selected as a test media because its physical characteristics (density, moisture content) are reasonably similar to those of human waste. The test media has the following properties: moisture content 51.5 percent, pH 4.78, and density 1.16 grams/mL. The media is extruded through a 7/8-inch (22mm) diameter die, each specimen being approximately four inches (100mm) long and weighing 50 grams ( $\pm 5$  grams).

<sup>6</sup> A toilet only capable of flushing the *average* loading (130g) would be expected to plug/clog or fail about 50% of the time, therefore, the benchmark of 250g (average male maximum) was selected for this project.

## 2.4 Media Source

Although several media with varying physical characteristics were evaluated during initial project development, the specific media used in the MaP testing was obtained in 20-kg (44-lb) containers from a single Canadian importer (the product originates in Japan). Readers wishing further information regarding the paste should contact Veritec directly.

## 2.5 Test Protocol

The complete MaP test protocol is included in **Appendix A**. All toilet fixtures are assembled, placed on the test stand, and connected to a water supply (50 psi static pressure). Tank water levels are set to the water line and flush volumes recorded. Adjustments made, if necessary, to ensure all samples flushed with the rated volume, generally 6 litres (1.6 gallons).

The ability of a toilet to completely remove waste in a single flush without plugging or clogging is considered by many to be one of the most important test criteria. Testing was conducted by loading the fixture in 50-gram increments of test media until it failed to pass 100 percent of the media in two of three attempts. Four loosely crumpled balls of toilet paper (six sheets each) were included in each test. The toilet paper used in testing had the following specifications: single ply toilet paper conforming to ASME A112.19.14–2001, section 3.2.5.1.2. Minimum level of acceptable performance was set at 250g. Test results sorted by manufacturer are presented in **Appendix B** and sorted by performance level are presented in **Appendix C**.

## 3.0 CONCLUSIONS

The test program revealed a significant range in the maximum performance levels of the toilet fixtures tested – yet all of these toilets are certified as meeting the minimum standards set forth by CSA and ANSI/ASME.

All of these fixtures met the water exchange requirements of the national standards – indicating that this test may not be meaningful in determining overall effectiveness of flush performance.

**Appendix B** and **Appendix C** identify models clearing less than 250g of media, models clearing between 250 and 500g, and models clearing greater than 500g. Pressure-assisted models, both 6- and 4-L (1.6- and 1.1-G) are also identified.

## 4.0 RECOMMENDATIONS

1. All toilet models should be required to remove at least 250g of solids as part of qualification or certification.
2. Municipalities and other rebating agencies should consider giving priority to toilet models that use standard flappers or those that meet the L.A. SPS as these toilets are more likely to sustain water savings over their lifetime. Proprietary flappers (unique to the particular toilet model) are preferred to early-closing models as they are more likely to be replaced with the correct flapper. They are, however, more difficult to locate and purchase.

## Appendix A: Protocol for Maximum Performance (MaP) Toilet Fixture Testing

### Scope of Protocol:

- Maximum media loading (in 50g increments<sup>7</sup>) at which toilet successfully clears all media from bowl without clogging or plugging in two of three tests.
- Percentage of water exchanged when flushing toilet without a media load.

### A. Solid Media Performance Test

- Media specifications: Fermented bean curd paste having a moisture content of 51.5%, a pH of 4.78, density of 1.16 g/mL<sup>8</sup>, extruded through 7/8" diameter die<sup>9</sup>, each specimen approximately 100 mm<sup>10</sup> in length and weighing 50g (±5g).
- Toilet paper specifications: Each ball of paper comprises six sheets of single ply toilet paper conforming to ASME A112.19.14–2001, section 3.2.5.1.2.
- Drop guide specifications (used to ensure media is dropped into bowl in same manner for all toilets): Plexiglas rectangle large enough to fit across the top of the bowl, 3mm<sup>11</sup> thick with a 50mm<sup>12</sup> diameter opening to be placed directly over the sump of the bowl.
- Remove tank and bowl from packaging; assemble on test rig according to manufacturer's instructions. Ensure that tank and bowl are level.
- All tests are completed at 50 PSI<sup>13</sup> static pressure.
- Set tank water level at waterline; flush three times taking note of the flush volume. Adjust volume to 6 litres/1.6 gallons if possible. If unable to set the volume to 6 litres/1.6 gallons, measure and record the actual flush volume.
- Flush the fixture two times to remove all solids, if any, from the fixture.
- Media shall be created in 50g (±5g) increments for testing
- Mass of media selected for initial (first round) testing shall be based on the Flush Performance Index (FPI) results from the NAHBRC testing (i.e., toilets that scored well in the FPI are initially tested at a greater mass).
- Place drop guide across the top of the bowl, with the opening aligned directly over the toilet sump (approximately one half inch in front of the trap entrance).
- Drop individual 50g media specimens through opening until the desired mass of media is in the bowl.
- Drop four balls of toilet paper into the bowl water (where possible) or onto solid media (if required). Wait 10 seconds. Flush the toilet fixture.
- If a successful test (all media removed from the bowl), increase media loading by 50g and repeat test.
- NOTE: Each toilet is also flushed without media between each test to ensure that all media has been removed from bowl and trap, and that the bowl water is properly recharged.
- If a failed test (waste remains in bowl or trap), decrease media loading by 50g and repeat test.
- Repeat process until toilet successfully removes the entire media loading from the bowl in two of three attempts.
- Record the weight of the bean curd paste media successfully removed from the bowl.

---

<sup>7</sup> Approximately 0.11 lb.

<sup>8</sup> Approximately 72.4 lb/ft<sup>3</sup>

<sup>9</sup> Approximately 22.2 mm

<sup>10</sup> Approximately 4.0 inches

<sup>11</sup> Approximately 1/8 inches

<sup>12</sup> Approximately 2 inches

<sup>13</sup> Approximately 0.34 megapascals

## Appendix A: Protocol for Maximum Performance (MaP) Toilet Fixture Testing

### B. Water Change-Out Capability Test

- Flush the fixture two times to remove all solids, if any, from the fixture.
- Conductivity of the clean bowl water is measured using a conductivity meter (municipal water supply at test facility has conductivity range of approximately 310-330  $\mu\text{S}$ ).
- Add approximately 20 mL<sup>14</sup> of an 18 g/L<sup>15</sup> salt solution to the bowl and stir gently to ensure uniform mixing, while assuring that there is no water loss over weir.
- Measure conductivity of diluted salt solution in bowl.
- Flush toilet, wait for flush cycle to complete.
- Measure new conductivity of water in bowl, i.e., volume of residual salt solution present.
- Determine approximate water change-out efficiency as percentage.

---

<sup>14</sup> Approximately 0.68 oz.

<sup>15</sup> Approximately 2.4 oz/gal

## Appendix B: Results Sorted by Manufacturer

Make	Model	Model Number	MaP Performance	1 pc model	2 pc model	Flapper size (in.)	No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted
Am. Std.	Cadet	2898.012, with 4112.016 tank & 3459.016 bowl	125		*	2			*		*						*	
Am. Std.	Cadet	2798.012, with 4112.016 tank & 3454.016 bowl	150		*	2		*			*						*	
Am. Std.	Cadet	4098.100.020 tank & 3099.016.020 bowl	750		*	-			*					*			*	
Am. Std.	Champion	3110.016.020 bowl & 4260.016.020 tank	475		*	-	*	*			*						*	
Am. Std.	Champion	3225.016.020 bowl & 4260.016.020 tank	500		*	3	*		*	*	*						*	
Am. Std.	Champion	3121.016.020 Bowl, 4260.016.020 tank	575		*	3	*		*		*						*	
Am. Std.	Colony Afton	4392.500.020 tank & 3038.016.020 bowl	375		*	2		*			*						*	
Am. Std.	Glenwall	3402016.021 bowl, 4097100.021 tank	800		*	-			*					*		*		*
Am. Std.	Hamilton	2092-0170-20	150	*		2			*		*						*	
Am. Std.	Plebe	4392.312 tank & 3344.312 bowl	225		*	2			*		*						*	
Am. Std.	Ravenna	4096.516.020 tank & 3454.016 bowl	200		*	2		*			*						*	
Am. Std.	Sonoma	4392.562.020 tank & 3338.012.020 bowl	325		*	2		*			*						*	
Briggs	Abingdon III	4229 = 4440t/4875b	150	*		2		*			*						*	
Briggs	Altima III	4232 = 4430t/4320b	150		*	2		*			*						*	
Briggs	Hathaway Vacuity	4360-130 bowl, 4460-130 tank	700		*	2			*			*					*	
Briggs	Vacuity	4200	375		*	2			*			*					*	
Briggs	Vacuity	4400-130 tank & 4310-130 bowl	500		*	2		*			*						*	
Briggs	Vacuity	4345-130 bowl, 4400-130 tank	650		*	2			*		*					*	*	*
Capizzi	Capizzi	0778-2 bowl, 1278 tank	475		*	-			*					*			*	
Caroma	Caravelle	2000 tank & 270 Bowl	500		*	-	*	*			*		*				*	
Caroma	Tasman	270	550		*	-	*	*			*		*				*	
Corona	Orchid	8510	200		*	2		*			*						*	
Crane	Canada	3372 bowl, 3742 tank	375		*	2			*		*						*	
Crane	Canada	3352 bowl, 3742 tank	450		*	2		*			*						*	
Crane	Cranada	3503 tank & 3415 bowl	150		*	2		*			*						*	
Crane	Cranada II	3742/3743 tank & 3503 bowl	150		*	2		*			*						*	
Crane	Economiser	3825 bowl, 3612 tank	725		*	-			*					*			*	
Crane	Economiser	3612 tank & 3824 bowl	750		*	-		*						*			*	

## Appendix B: Results Sorted by Manufacturer

Make	Model	Model Number	MaP Performance	1 pc model	2 pc model	Flapper size (in.)	No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted	
<div style="border: 1px solid black; padding: 5px;"> <p> <span style="display: inline-block; width: 15px; height: 10px; background-color: #e0f7fa; border: 1px solid black;"></span> Less Than 250g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #fff9c4; border: 1px solid black;"></span> 250g to 500g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #ffe0b2; border: 1px solid black;"></span> Greater Than 500g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #f8bbd0; border: 1px solid black;"></span> 6-L (1.6-G) Pressure-Assist  <span style="display: inline-block; width: 15px; height: 10px; background-color: #e8f5e9; border: 1px solid black;"></span> 4-L (1.1-G) Pressure-Assist                 </p> </div>																			
Crane	Flormont	3992 bowl, 3976 tank	550		*	2		*				*				*	*		
Crane	SureFlush	31192 bowl, 31242 tank	350		*	3	*	*			*						*		
Crane	SureFlush	31212 bowl, 31242 tank	500		*	3	*		*	*	*						*		
Crane	SureFlush	31202 bowl, 31242 tank	500		*	3	*		*		*						*		
Crane	VIP Flush	3976 tank & 3991 bowl	350		*	2			*			*					*		
Crane	VIP Flush	3995: 3990 bowl, 3976 tank	725		*	2		*				*					*		
Eljer	Aquasaver	1417-00000/137-7025-00	550		*	-			*					*			*		
Eljer	Canterbury	081-1620-00	150	*		2		*			*						*		
Eljer	Patriot	091-2120, with 141-2120 tank/131-2120 bowl	150		*	2		*			*						*		
Eljer	Patriot	141-0220-00 tank & 131-2175-00 bowl	425		*	2			*	*	*						*		
Eljer	Patriot Savoy	131-2120-00 bowl, 141-0220-00 tank	425		*	2		*			*						*		
Eljer	Patriot Savoy	131-2120-00 bowl, 141-0223-00 tank	500		*	2			*		*						*		
Eljer	Savoy	141-0260-82 tank & 131-2120-82 bowl	325		*	2		*			*						*		
Foremost	Premier	T-8207-W tank & LL-8207-W bowl	375		*	2		*			*						*		
Foremost	Premier	LL-8207-HC bowl, T-8207 tank	850		*	2			*	*	*						*		
Foremost	Regent	T-5207-W tank & LL-5207-W bowl	350		*	2		*			*						*		
Foremost	Victorian	T-1207-W tank & LL-1207-W bowl	275		*	2		*			*						*		
Gerber	Aquasaver	21-712, with 28-790 tank	150		*	2			*		*						*		
Gerber	Ultra Flush	28-380 tank & 21-374 bowl	625		*	-			*					*		*	*		
Gerber	Ultra Flush	21-302: 21-342 bowl, 28-380 tank	900		*	-			*					*			*		
Glacier Bay	Aragon IV	164963	175		*	2		*			*						*		
Glacier Bay	Westminster	455-685 tank (lined) and 445-684 bowl	550		*	2		*			*						*		
Kohler	Cimarron	4286-0 bowl, 4634-0 tank	675		*	3			*	*	*						*		
		(larger value @ 1.6G, smaller value @ 1.4G)	450																
Kohler	Cimarron	4287-0 bowl, 4634-0 tank	675		*	3		*			*						*		
		(larger value @ 1.6G, smaller value @ 1.4G)	425																
Kohler	Devonshire	4269-0 bowl & 4619-0 tank	250		*	2			*		*						*		
Kohler	Memoirs	4257-0 bowl & 4454-U-0 tank	125		*	2		*			*						*		

## Appendix B: Results Sorted by Manufacturer

Make	Model	Model Number	MaP Performance	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px; height: 10px; background-color: #e0f2f1;"></td> <td>Less Than 250g</td> </tr> <tr> <td style="width: 20px; height: 10px; background-color: #fff9c4;"></td> <td>250g to 500g</td> </tr> <tr> <td style="width: 20px; height: 10px; background-color: #ffe0b2;"></td> <td>Greater Than 500g</td> </tr> <tr> <td style="width: 20px; height: 10px; background-color: #f48fb1;"></td> <td>6-L (1.6-G) Pressure-Assist</td> </tr> <tr> <td style="width: 20px; height: 10px; background-color: #e8f5e9;"></td> <td>4-L (1.1-G) Pressure-Assist</td> </tr> </table>														Less Than 250g		250g to 500g		Greater Than 500g		6-L (1.6-G) Pressure-Assist		4-L (1.1-G) Pressure-Assist	1 pc model	2 pc model	Flapper size (in.)	No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted
					Less Than 250g																																				
	250g to 500g																																								
	Greater Than 500g																																								
	6-L (1.6-G) Pressure-Assist																																								
	4-L (1.1-G) Pressure-Assist																																								
Kohler	Santa Rosa	3323-0	500	*		2			*						*																										
Kohler	Sterling Rockton	402021-0 bowl, 402022-0 tank	325		*	-	*	*			*				*																										
Kohler	Wellworth	K3422 toilet, with 4620 tank/4276 bowl	125		*	2			*						*																										
Kohler	Wellworth	K3423 toilet, with 4620 tank/4277 bowl	250		*	2			*						*																										
Komet	Deco	DE 611 tank and DE 627 bowl	75		*	2			*						*																										
Mancesa	Cyclone	2282W bowl	650		*	-			*				*		*																										
Mancesa	San Marino	2262W bowl & 2261W tank	200		*	2			*						*																										
Mancesa	St. Michelle	4260 tank, 2360 bowl	350		*	2			*						*																										
Mancesa	Windsor	2700W bowl & 2711W tank	225		*	2			*						*																										
Mansfield	Alto	130-160	275		*	-	*	*							*																										
Mansfield	EcoQuantum @ 1 gal	146 bowl, 119 tank	600		*	-		*			*	*	*		*																										
Mansfield	EcoQuantum @ 1 gal	148 bowl, 119 tank	650		*	-		*	*		*	*	*		*																										
Mansfield	EcoQuantum @ 1 gal	147 bowl, 119 tank	750		*	-		*			*	*	*		*																										
Mansfield	Quantum	147-123 (tank, bowl)	825		*	-		*			*	*	*		*																										
Mansfield	Quantum	146-123 (tank, bowl)	850		*	-		*			*	*	*		*																										
Mansfield	Quantum	148-123 (tank, bowl)	925		*	-		*	*		*	*	*		*																										
Niagara	Flapperless	N2216	725		*	-	*	*			*				*																										
Niagara	Niagara Turbo	N2220	150		*	2		*			*				*																										
Orion	Iris	51073 tank & 50073 bowl	150		*	2		*			*				*																										
St. Thomas	Marathon	6201.01	200		*	2		*			*				*																										
TOTO	Carlyle	MS874114SG	625	*		3			*		*				*																										
TOTO	Carusoe	ST706 tank & C715 bowl	650		*	2		*			*				*																										
TOTO	Clayton (nee Baldwin)	ST784S tank & C784SF bowl	675		*	3			*	*	*				*																										
TOTO	CST703	CST703	550		*	2			*		*				*																										
TOTO	Dalton	ST733 tank & C734F bowl	650		*	2			*	*	*				*																										
TOTO	Drake	CST744S	900		*	3			*		*				*																										
TOTO	Plymouth	MS924154F	675	*		3			*		*				*																										

## Appendix B: Results Sorted by Manufacturer

Make	Model	Model Number	MaP Performance	Flapper size (in.)		No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted
				1 pc model	2 pc model												
TOTO	Ultimate	MS854114	325	*		3		*		*						*	
TOTO	Ultimate	MS853113	400	*		3		*		*						*	
TOTO	Ultramax	MS854114S	700	*		3		*		*						*	
Vitra	Altantis	5051 bowl, 6853 tank	750		*	2		*		*						*	
Vitra	Altantis	5050 bowl, 6853 tank	800		*	2		*		*						*	
Vitra	Corina	5068-003-0075 bowl, 5070-003-0122 tank	825		*	3		*		*						*	
Vitra	Corina	5069-003-0075 bowl, 5070-003-0122 tank	850		*	3		*		*						*	
Vitra	Dual Flush	5076 bowl, 5055 tank	475		*	-	*	*		*		*				*	
Vortens	Dual Flush	3208-02-V bowl & 3420-02-V tank	375		*	-	*	*		*		*				*	
Vortens	Genova	3421-02-V tank & 3121-02-V bowl	450		*	2		*		*						*	
Vortens	GTA	3412 tank, 3200 bowl	300		*	2		*		*						*	
Vortens	Vienna II	3412 tank, 3207 bowl	550		*	2		*		*						*	
Western Pottery	Aris	822	375		*	2		*		*						*	
Western Pottery	Clinton	832 bowl	300		*	2		*		*						*	

## Appendix C: Results Sorted by Performance

Make	Model	Model Number	MaP Performance	1 pc model	2 pc model	Flapper size (in.)	No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted	
<div style="border: 1px solid black; padding: 5px;"> <p> <span style="display: inline-block; width: 15px; height: 10px; background-color: #e0ffff; border: 1px solid black;"></span> Less Than 250g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #ffff00; border: 1px solid black;"></span> 250g to 500g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #ffa500; border: 1px solid black;"></span> Greater Than 500g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #ffb6c1; border: 1px solid black;"></span> 6-L (1.6-G) Pressure-Assist  <span style="display: inline-block; width: 15px; height: 10px; background-color: #90ee90; border: 1px solid black;"></span> 4-L (1.1-G) Pressure-Assist                 </p> </div>																			
Komet	Deco	DE 611 tank and DE 627 bowl	75		*	2		*			*						*		
Am. Std.	Cadet	2898.012, with 4112.016 tank & 3459.016 bowl	125		*	2			*		*						*		
Kohler	Memoirs	4257-0 bowl & 4454-U-0 tank	125		*	2		*			*						*		
Kohler	Wellworth	K3422 toilet, with 4620 tank/4276 bowl	125		*	2			*		*						*		
Am. Std.	Cadet	2798.012, with 4112.016 tank & 3454.016 bowl	150		*	2		*			*						*		
Am. Std.	Hamilton	2092-0170-20	150	*		2			*		*						*		
Briggs	Abingdon III	4229 = 4440t/4875b	150	*		2		*			*						*		
Briggs	Altima III	4232 = 4430t/4320b	150		*	2		*			*						*		
Crane	Cranada	3503 tank & 3415 bowl	150		*	2		*			*						*		
Crane	Cranada II	3742/3743 tank & 3503 bowl	150		*	2		*			*						*		
Eljer	Canterbury	081-1620-00	150	*		2		*			*						*		
Eljer	Patriot	091-2120, with 141-2120 tank/131-2120 bowl	150		*	2		*			*						*		
Gerber	Aquasaver	21-712, with 28-790 tank	150		*	2			*		*						*		
Niagara	Niagara Turbo	N2220	150		*	2		*			*						*		
Orion	Iris	51073 tank & 50073 bowl	150		*	2		*			*						*		
Glacier Bay	Aragon IV	164963	175		*	2		*			*						*		
Am. Std.	Ravenna	4096.516.020 tank & 3454.016 bowl	200		*	2		*			*						*		
Corona	Orchid	8510	200		*	2		*			*						*		
Mancesa	San Marino	2262W bowl & 2261W tank	200		*	2			*		*						*		
St. Thomas	Marathon	6201.01	200		*	2		*			*						*		
Am. Std.	Plebe	4392.312 tank & 3344.312 bowl	225		*	2			*		*						*		
Mancesa	Windsor	2700W bowl & 2711W tank	225		*	2		*			*						*		
Kohler	Devonshire	4269-0 bowl & 4619-0 tank	250		*	2			*		*						*		
Kohler	Wellworth	K3423 toilet, with 4620 tank/4277 bowl	250		*	2		*			*						*		
Foremost	Victorian	T-1207-W tank & LL-1207-W bowl	275		*	2		*			*						*		
Mansfield	Alto	130-160	275		*	-	*	*			*						*		
Vortens	GTA	3412 tank, 3200 bowl	300		*	2		*			*						*		
Western Pottery	Clinton	832 bowl	300		*	2			*		*						*		

## Appendix C: Results Sorted by Performance

Make	Model	Model Number	MaP Performance	1 pc model	2 pc model	Flapper size (in.)	No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted
Am. Std.	Sonoma	4392.562.020 tank & 3338.012.020 bowl	325		*	2		*			*						*	
Eljer	Savoy	141-0260-82 tank & 131-2120-82 bowl	325		*	2		*			*						*	
Kohler	Sterling Rockton	402021-0 bowl, 402022-0 tank	325		*	-	*	*			*		*				*	
TOTO	Ultimate	MS854114	325	*		3			*		*						*	
Crane	SureFlush	31192 bowl, 31242 tank	350		*	3	*	*			*						*	
Crane	VIP Flush	3976 tank & 3991 bowl	350		*	2			*			*					*	
Foremost	Regent	T-5207-W tank & LL-5207-W bowl	350		*	2		*			*						*	
Mancesa	St. Michelle	4260 tank, 2360 bowl	350		*	2		*			*						*	
Am. Std.	Colony Afton	4392.500.020 tank & 3038.016.020 bowl	375		*	2		*			*						*	
Briggs	Vacuity	4200	375		*	2			*			*					*	
Crane	Canada	3372 bowl, 3742 tank	375		*	2			*		*						*	
Foremost	Premier	T-8207-W tank & LL-8207-W bowl	375		*	2		*			*						*	
Vortens	Dual Flush	3208-02-V bowl & 3420-02-V tank	375		*	-	*	*			*		*				*	
Western Pottery	Aris	822	375		*	2		*			*						*	
TOTO	Ultimate	MS853113	400	*		3		*			*						*	
Eljer	Patriot	141-0220-00 tank & 131-2175-00 bowl	425		*	2			*	*	*						*	
Eljer	Patriot Savoy	131-2120-00 bowl, 141-0220-00 tank	425		*	2		*			*						*	
Crane	Canada	3352 bowl, 3742 tank	450		*	2		*			*						*	
Vortens	Genova	3421-02-V tank & 3121-02-V bowl	450		*	2			*		*						*	
Am. Std.	Champion	3110.016.020 bowl & 4260.016.020 tank	475		*	-	*	*			*						*	
Capizzi	Capizzi	0778-2 bowl, 1278 tank	475		*	-			*						*		*	
Vitra	Dual Flush	5076 bowl, 5055 tank	475		*	-	*	*			*		*				*	
Am. Std.	Champion	3225.016.020 bowl & 4260.016.020 tank	500		*	3	*		*	*	*						*	
Briggs	Vacuity	4400-130 tank & 4310-130 bowl	500		*	2		*				*					*	
Caroma	Caravelle	2000 tank & 270 Bowl	500		*	-	*	*			*		*				*	
Crane	SureFlush	31212 bowl, 31242 tank	500		*	3	*		*	*	*						*	
Crane	SureFlush	31202 bowl, 31242 tank	500		*	3	*		*		*						*	
Eljer	Patriot Savoy	131-2120-00 bowl, 141-0223-00 tank	500		*	2			*		*						*	

## Appendix C: Results Sorted by Performance

Make	Model	Model Number	MaP Performance	Flapper size (in.)		No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted	Wall Mounted
				1 pc model	2 pc model												
Kohler	Santa Rosa	3323-0	500	*		2		*		*						*	
Caroma	Tasman	270	550		*	-	*	*		*		*				*	
Crane	Flormont	3992 bowl, 3976 tank	550		*	2		*			*				*	*	
Eljer	Aquasaver	1417-00000/137-7025-00	550		*	-		*					*			*	
Glacier Bay	Westminster	455-685 tank (lined) and 445-684 bowl	550		*	2		*		*						*	
TOTO	CST703	CST703	550		*	2		*		*						*	
Vortens	Vienna II	3412 tank, 3207 bowl	550		*	2		*		*						*	
Am. Std.	Champion	3121.016.020 Bowl, 4260.016.020 tank	575		*	3	*	*		*						*	
Mansfield	EcoQuantum @ 1 gal	146 bowl, 119 tank	600		*	-		*				*	*	*		*	
Gerber	Ultra Flush	28-380 tank & 21-374 bowl	625		*	-		*					*		*	*	
TOTO	Carlyle	MS874114SG	625	*		3		*		*						*	
Briggs	Vacuity	4345-130 bowl, 4400-130 tank	650		*	2		*			*				*	*	
Mancesa	Cyclone	2282W bowl	650		*	-		*								*	
Mansfield	EcoQuantum @ 1 gal	148 bowl, 119 tank	650		*	-		*	*			*	*	*		*	
TOTO	Carusoe	ST706 tank & C715 bowl	650		*	2		*		*						*	
TOTO	Dalton	ST733 tank & C734F bowl	650		*	2		*	*	*						*	
Kohler	Cimarron	4286-0 bowl, 4634-0 tank (larger value @ 1.6G, smaller value @ 1.4G)	675 450		*	3		*	*	*						*	
Kohler	Cimarron	4287-0 bowl, 4634-0 tank (larger value @ 1.6G, smaller value @ 1.4G)	675 425		*	3		*		*						*	
TOTO	Clayton (nee Baldwin)	ST784S tank & C784SF bowl	675		*	3		*	*	*						*	
TOTO	Plymouth	MS924154F	675	*		3		*		*						*	
Briggs	Hathaway Vacuity	4360-130 bowl, 4460-130 tank	700		*	2		*			*					*	
TOTO	Ultramax	MS854114S	700	*		3		*		*						*	
Crane	Economiser	3825 bowl, 3612 tank	725		*	-		*					*			*	
Crane	VIP Flush	3995: 3990 bowl, 3976 tank	725		*	2		*			*					*	
Niagara	Flapperless	N2216	725		*	-	*	*		*						*	

## Appendix C: Results Sorted by Performance

Make	Model	Model Number	MaP Performance	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p> <span style="display: inline-block; width: 15px; height: 10px; background-color: #ADD8E6; border: 1px solid black;"></span> Less Than 250g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #FFFF00; border: 1px solid black;"></span> 250g to 500g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #FFA500; border: 1px solid black;"></span> Greater Than 500g  <span style="display: inline-block; width: 15px; height: 10px; background-color: #FF69B4; border: 1px solid black;"></span> 6-L (1.6-G) Pressure-Assist  <span style="display: inline-block; width: 15px; height: 10px; background-color: #90EE90; border: 1px solid black;"></span> 4-L (1.1-G) Pressure-Assist                 </p> </div>													
				1 pc model	2 pc model	Flapper size (in.)	No flapper / Non-traditional flapper	Round Front Bowl	Elongated Bowl	ADA / Comfort Height	Gravity-flush	Vacuum-Assist	Dual-Flush	1.6-G (6-L) Pressure-Assist	1.1-G (4-L) Pressure-Assist	Rear Discharge	Floor Mounted
Am. Std.	Cadet	4098.100.020 tank & 3099.016.020 bowl	750	*	-			*				*			*		
Crane	Economiser	3612 tank & 3824 bowl	750	*	-		*					*			*		
Mansfield	EcoQuantum @ 1 gal	147 bowl, 119 tank	750	*	-			*			*	*			*		
Vitra	Altantis	5051 bowl, 6853 tank	750	*	2			*	*						*		
Am. Std.	Glenwall	3402016.021 bowl, 4097100.021 tank	800	*	-			*				*		*		*	
Vitra	Altantis	5050 bowl, 6853 tank	800	*	2		*		*						*		
Mansfield	Quantum	147-123 (tank, bowl)	825	*	-			*				*			*		
Vitra	Corina	5068-003-0075 bowl, 5070-003-0122 tank	825	*	3		*		*						*		
Foremost	Premier	LL-8207-HC bowl, T-8207 tank	850	*	2			*	*	*					*		
Mansfield	Quantum	146-123 (tank, bowl)	850	*	-		*					*			*		
Vitra	Corina	5069-003-0075 bowl, 5070-003-0122 tank	850	*	3			*	*						*		
Gerber	Ultra Flush	21-302: 21-342 bowl, 28-380 tank	900	*	-			*				*			*		
TOTO	Drake	CST744S	900	*	3			*	*						*		
Mansfield	Quantum	148-123 (tank, bowl)	925	*	-			*	*			*			*		