

SBW Consulting, Inc.
Report No. 0712

Urinal Baseline Study Final Report

Submitted to

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Submitted by

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Executive Summary

The Saving Water Partnership (SWP) is considering an expanded water efficiency program effort in 2008 for urinal upgrades and replacements. Seattle Public Utilities (SPU) administers the regional conservation program on behalf of the Saving Water Partnership. This study was conducted by SBW Consulting Inc. (SBW) to determine the baseline characteristics of existing urinals in the SWP service area and investigate the feasibility of retrofitting the existing urinal stock with alternative water efficiency measures. The data collected in the study was analyzed and used to form a series of observations and recommendations regarding preferred efficiency options. These will be used as a basis for the 2008 urinal program design and implementation decision.

This study was completed as a series of five tasks. The first task included the compilation of the initial inventory of existing urinals and toilets throughout the SWP service area. To the extent possible SBW selected restrooms that were geographically representative of the commercial business districts and building types within the SWP service area. The inventory was collected for 179 male restrooms in 137 buildings for a total of 341 urinals.

In the interest of time and cost efficiency tasks two and four, and three and five were conducted in parallel. The second task involved development of a customer survey form, and forms and protocols for urinal testing for flush volume and effectiveness. The fourth task involved development of a protocol for testing the feasibility of several alternative efficiency options and selecting the most viable options for further testing on a representative sample of urinals, in task five. SBW staff worked in cooperation with, Roger van Gelder, a consultant working under a separate contract to SPU, and SPU staff, to select the three options carried forward for final analysis.

Under the third task SBW obtained responses to the customer surveys, collected additional urinal characteristics data, and measured flush volume and performance. Four of the sites that had been contacted for Tasks 3 and 5 data collection, were not willing to allow measurements in their restrooms. As a result, four substitute restrooms were added. The owners at these four substitute sites allowed Roger van Gelder to take measurements based on a prior working relationship with him. Additional urinal characteristics were collected for total of 48 urinals at 20 sites. Flush volume and conductivity measurements were taken at 33 of these urinals. Completed customer surveys were returned for five sites.

The fifth task involved conducting efficiency tests for the two selected efficiency options. At one of the four additional sites, field staff encountered three 1/8th gpf high efficiency urinals (HEUs), which they found consistently performed at the manufacturer (Zurn) marketed low flush volumes, and produced significant savings. The HEUs were added as a third efficiency option. Urinal efficiency options were tested at 28 urinals for the flush valve replacement, at 33 urinals for the diaphragm replacement, and at 3 urinals for the HEU replacement.

Data collected from all the five tasks was summarized in a spreadsheet and tabulated in this report to show frequency distributions. Based on these observations, the following three options for improving urinal efficiency were carried forward for detailed analysis:

- A) Replacement of existing urinals with new 1/8th gallons per flush HEU urinals.
- B) Replacing manual exposed flush valves with adjustable pistons with new more efficient flush valves.
- C) Replacing the diaphragms in the flush valves with lower flow diaphragms.

The analysis showed that Option A could provide the highest and most guaranteed savings, but is the most expensive option. Option B and C have shorter lives, since they can be easily removed by maintenance staff. They may also, in a small percentage of cases, increase the flush volume; however, they have a substantially lower cost. Each efficiency option analyzed had installation barriers that could impact the feasibility of widespread customer participation in a more comprehensive program.

1. Introduction

The Saving Water Partnership (SWP) is considering an expanded program effort in 2008 for urinal upgrades and replacements. Existing market data suggested that urinals in the Partnership service area were generally inefficient. A representative inventory of existing urinals, urinal owner opinions, flow measurements, and an options menu of possible efficiency improvements were needed to refine estimates for potential water savings and program costs.

The purpose of this study was to determine the baseline characteristics of existing urinals in the SWP service area and investigate the feasibility of retrofitting the existing urinal stock with alternative water efficiency measures. The study also determined important characteristics of existing toilets in commercial establishments throughout the SWP service area. The existing stock of urinals and toilets were characterized through an equipment inventory at a sample of businesses that were representative of the diversity of business types and geography across the SWP service area. The existing urinal stock was further characterized through information collected in a customer survey and a series of performance measurements. The feasibility of urinal water efficiency options were investigated through additional performance measurements made on alternative urinal water conservation retrofits at selected businesses. The data collected in the study was analyzed and used to form a series of observations and recommendations regarding preferred efficiency options. These will be used as a basis for the 2008 urinal program design and implementation decision.

The research objectives were:

1. Complete an initial inventory of “representative” urinals from up to 200 commercial customer restrooms to provide baseline data and aid in selecting urinals for testing.
2. Take advantage of the field inventory of urinals to also collect limited data on toilets at these locations.
3. Test up to 50 selected urinals (at up to 20 sites) using an adopted testing protocol. This protocol was developed in close cooperation with another SPU consultant, Roger van Gelder.
4. Survey owners or owner representatives on urinal characteristics at sites selected for urinal testing.
5. Create a list of selected urinal efficiency options for possible analysis.
6. Analyze the selected urinal efficiency options and analyze the results.
7. Provide all raw data in an electronic database and provide a written summary of the findings and any recommendations.

This study was completed as a series of five tasks. The first task included the compilation of the initial inventory of existing urinals and toilets throughout the SWP service area. A Task 1 report was prepared to document the methodology that was used in the first task and observations made regarding baseline urinal and toilet characteristics. In the interest of time and cost efficiency tasks two and four, and three and five were conducted in parallel. The second task involved development of a customer survey form, and forms and protocols for urinal testing for flush volume and effectiveness. The fourth task involved development of an efficiency testing protocol. Under the third task SBW obtained responses to the customer surveys, collected additional urinal characteristics data, and measured flush volume and performance. The fifth task involved conducting efficiency tests for the selected efficiency options.

This report summarizes the methodology and findings from all five tasks and provides some urinal retrofit recommendations developed from observations made during the study.

2. Methodology

The study was performed as a series of five tasks that are described below.

2.1 Task 1 Clarification of Roles and Initial Inventory

The first task included the selection of a sample of restrooms that represented the SWP service area and the collection of selected urinal and toilet characteristics data in these restrooms to establish a baseline for program planning purposes. The method used to complete Task 1 is described below.

2.1.1 Kickoff Meeting

The work began with a kickoff meeting that was attended by SBW staff, SPU's consultant Roger van Gelder, and a representative from Seattle Public Utilities (SPU). At the meeting we reviewed the scope of work and timetable and clarified the roles and responsibilities for SBW, Roger van Gelder and SPU. The meeting focused on the refinement of the Task 1 data collection procedures for the initial inventory of the existing urinal and toilet stock at a sample of businesses that are representative of the commercial sector within the SWP service area. A second meeting was held via conference call and attended by SBW staff, Roger van Gelder, and SPU staff. The meeting discussed challenges and questions that came up after the first two days of data collection.

2.1.2 Sample Selection

SBW developed a sampling plan that was used to select representative samples of urinals to support the initial inventory. The sampling plan also addressed downstream tasks that included a customer survey, flush volume and performance testing; and field testing of alternative water efficiency options. The sampling plan considered the diversity of commercial business types and geography across the SWP service area.

SBW prepared a list of prevalent commercial business types that are likely to have urinals. SPU and Roger van Gelder then edited the list to include the thirteen business types below, which were represented in the samples. Appendix A provides a detailed description of each business type listed below.

- Grocery
- Health (Hospitals and Other Medical)
- Office
- Other
- Public Gathering
- Large retail
- Lodging
- Recreation
- Restaurant
- Schools
- Shopping malls
- Small retail
- Warehouse and Storage

For the initial inventory, SBW collected urinal and toilet characteristics data at up to 200 restrooms with urinals, within the budget constraints, throughout the SWP service area. While a minimum count of restrooms per business type was not established, SBW made a special effort to ensure that the sample selected for the initial inventory included all the listed business types.

To the extent possible, SBW also selected restrooms that were geographically representative of the commercial business districts within the SWP service area. To determine the geographically representative business districts, SBW reviewed 132 metropolitan Seattle neighborhoods from the Seattle Municipal Archives map index and identified 12 key business districts for selecting the representative sample. SPU reviewed and edited the list to the ten business districts shown in Table 1 below. SBW also defined an approximate perimeter for each of the business districts, so that field staff could distinguish between adjacent districts and ensure that restrooms in major districts are included in the selected sample.

Table 1: Selected 10 Business Districts with Street Perimeters

Business District	Boundaries			
	North	South	West	East
Ballard	NW 56th St.	NW Market St.	32nd Ave. NW	15th Ave. NW
Burien	SW 152nd St.	SW 160th St.	10th Ave. SW	1st Ave. SW
Capitol Hill	E Howe St.	E Pike St.	Broadway	Broadway
Central (Seattle downtown)	Olive Way	Columbia St.	Alaskan Way	7th Ave.
First Hill	E Pike St.	(E) Alder St.	9th Ave.	Broadway
SeaTac	S 160th St.	S. 188th St.	International Blvd	I-5
Shoreline	N 175th St.	N 145th St.	Aurora Ave. N (including W side)	Meridian Ave N
South Lake Union	Fairview Ave. N	Denny Way.	Broad St.	Eastlake Ave. E
Woodinville	139th Ave. NE	NE 175th St. (including S side)	131st Ave NE	140th Ave NE
University	NE Ravenna	NE Pacific St.	Roosevelt Way. NE	15th Ave. NE

While a minimum count of restrooms per business district was not established, SBW made an effort to ensure that the sample selected for the initial inventory represented as many of the above business district as possible within budget constraints. The data was collected and recorded on the data collection forms, as described below.

2.1.3 Data Collection Procedures

After the sampling plan was approved by SPU, SBW followed the Task 1 sampling protocol to select sites for the initial inventory. SBW field staff visited as many of the sampled sites as possible within budget constraints, collected the required data, and recorded it on the data collection forms. Data was collected only from businesses that had urinals. The detailed data collection procedures and forms are provided in Appendix B. At each site a form was completed for up to two male restrooms per building, or business type if the building has multiple business types (e.g., small retail and office).

The data collection procedures that were applied to each restroom are as follows.

Identify Contact

For hospitals and schools where permission to perform the inventory was unlikely without prior communications, the field staff contacted the site by phone prior to the site visit and determined the contact information for the person who can grant permission to perform the inventory. This person was contacted and asked to participate. SPU provided some contact information to assist with this process (e.g., Beth Dolan at Seattle Public Schools). A maximum of 15 minutes were spent in attempting to talk with the decision maker before moving onto another site. If permission was granted, an appointment was made with the appropriate party and the inventory was completed. The contact information was entered onto the inventory form for possible use in future tasks.

SBW took a similar approach for large office buildings with high levels of security. Roger van Gelder provided contact information for 15 large office buildings in the central business district. SBW staff contacted the site contact prior to the site visit and obtained permission to perform the inventory. Field staff only visited buildings where the site contact had granted permission.

For business types where pre-recruitment was not necessary, field staff visited the site unannounced and attempted to identify a contact that could grant permission to perform the inventory. Field staff started this process by approaching an individual who could be a contact or might be able to help locate a contact. The field staff introduced himself to the individual and gave a brief description of the nature of the urinal study. If the individual was the correct person and granted permission, then data was collected. If the individual was not the contact but provided information to help find a contact, the field staff tried to use the information to find the right contact. When possible, the field staff tried to limit the time spent in finding the right contact to 15 minutes. If the field staff failed to locate a contact, he moved to the next site. In some cases where the field staff felt comfortable collecting data without getting permission, no contact information was collected.

Restroom Selection

Data collection at each site was limited to two male restrooms with at least one urinal each. If more than two male restrooms were present, the field staff discussed the range of urinal types with the contact and selected the two male restrooms with the most common (representative) urinal types. If this information was not available, the field staff used their judgment to select the two male restrooms that appeared to be most representative. For multiuse buildings (e.g., office and retail), data was collected for up to two male restrooms per business type.

Form 1 Data Collection

Field staff observed and collect data for the variables listed in each of the three sections of Form 1, provided in Appendix B. Appendix B also provides detailed instructions used to complete the form. The data elements collected for each section of the form are listed below:

General:

- By
- Date
- Building
- Room

Building Information

- Building Name
- Business Name
- Business Address and Zip
- Business Type
- Contact Name and Phone (if available)
- Restroom Location

Urinal Data

- Urinal Style
- Urinal Photo
- Urinal Standard Height and ADA
- Urinal Manufacturer and Model (if available)
- Urinal Gallons per Flush Marking (gpf) (if available)
- Flush Valve Mounting
- Flush Valve Spud Diameter and Height
- Flush Valve Manufacturer and Model (if available)
- Flush Valve Volume Markings (if available)
- Estimated Gallons per Flush (gpf)
- Candidate Urinal

Toilet Data

- Toilet Style
- Toilet Quantity
- Toilet Bowl Manufacturer (if available)
- Toilet Bowl Markings (if available)
- Flush Valve Manufacturer (if available)
- Toilet Flush Valve Volume Markings (if available)
- Probable Rated Gallons per Flush (gpf)

Data Analysis

SBW developed a spreadsheet to compile all the inventoried data. SBW entered all data from the field data collection forms into this spreadsheet. The data was subjected to quality control procedures to ensure that the information was accurate and reasonable. SBW prepared frequency distributions for the important characteristics. The information was summarized in tables for inclusion in this report.

2.2 Task 2 Survey Design, Testing Protocols and Scheduling

Based on the results from Task 1, SPU and SBW identified sites for the customer survey and urinal testing (flush volume and effectiveness). Roger van Gelder developed a urinal flow and performance measurement protocol that was reviewed by SBW. The protocol included the measurement of existing urinal flush volume and effectiveness, and the performance of alternative efficiency improvements that were tested. The test protocol assigned an individual testing number keyed to its building location, in the event that additional follow up testing was needed. Two tests were conducted for each urinal, 1) the dilution test and 2) the flush volume test. Test protocol for both tests is shown in Appendix C.

The dilution test established baseline conditions for the urinal by measuring change in conductivity of the water in the urinal before and after a flush, using a hand held conductivity tester and a standardized solution developed by Roger van Gelder. Field staff flushed the urinal twice; tested conductivity; added

measured quantity of standardized solution; flushed the urinal again – once; and then retested conductivity.

The flush volume test measured baseline gallons per flush (gpf) for the urinal. Field staff recorded how open the flush valve was in terms of the number of rotations before the valve was completely closed; installed a flow meter between the flush valve and the urinal; adjusted flush valve to original level of open position; and flushed the urinal twice recording flow for each flush. Field staff also measured flush volume when the flush valves was almost full open, to check if there was any negative or positive impact on the flush volume.

Some additional characteristics data was also collected for this second sample. This data provided more detailed information on the urinals than was warranted in the initial inventory. Field staff observed and collected data for the variables listed in form 2, shown in Appendix D. Appendix D also provides detailed instructions used to complete form 2. The data elements that were collected are listed below:

- Contact information, if not collected during first visit
- Public or Private restroom
- Urinal Style and photo (optional)
- Shutoff Access
- Urinal Material
- Urinal Mount
- Urinal Type
- Flush Valve Type
- Flush Valve Activation
- Urinals per Flush Valve
- Flush Valve Stop Connection
- Flush Valve Flush Volume
- Urinal Condition (e.g., leaking, running, etc)
- Height off floor (distance between floor and waste outlet of urinal and/or mounting bolts)
- Lip height off floor (distance between floor and flood rim of urinal)
- Supply height off floor (distance between floor and center of water supply line)
- Approximate Age

SBW developed a customer survey instrument that was used to collect customer information that will be helpful to SPU in program planning. The survey collected information from the owner or owner's representative regarding current urinal maintenance practices, urinal change-out and performance history, and other information that relates to the site, satisfaction, urinal retention, and urinal water efficiency. Topics addressed in the survey included:

- Satisfaction with the current urinals
- Problems with the current urinals
- Maintenance frequency and schedule
- Estimated male occupancy (including variations by day of week and season)
- Recent efficiency retrofits or change outs of the current urinals
- In-house or contract maintenance of the existing urinals
- New urinals installed by maintenance or contractor
- Receptiveness to installing new high efficiency urinals (noting barriers)

Both the test protocol and survey instrument was approved by SPU prior to use.

2.3 Task 3 Urinal Measurements and Customer Survey

SBW followed the sampling protocols for the second sample to contact the owners or owner representatives for the selected sites to recruit and schedule cooperative customers for voluntary testing. If a customer was not available or hard to schedule, SBW moved on to another customer to make effective use of time and reduce data collection costs. Some of the sites that had been contacted for Tasks 3 and 5 data collection, denied permission to take measurements at their site. They were substituted by four sites at which Roger van Gelder had an existing relationship and was given permission to take measurements. Initial efforts to obtain written authorization for each site, (using the application form provided by SPU) proved to be a barrier to the success of the project, so SPU dropped the authorization requirement for participation. For the sites where the owner or owner representative was willing, available, and cooperative, SBW used the final data collection protocol developed in Task 2 to administer the customer survey, collect the additional characteristics data and measure flush volume and performance. The measurements were limited to cases where the plumbing system was in good working order and SBW could get proper access to the affected portion of the plumbing system. Roger van Gelder accompanied SBW staff for all but two of the 17 site visits to assist with the data collection and verify that the appropriate protocol was being used. Data was documented on the field data collection form developed in Task 2.

SBW recorded the collected data in a spreadsheet and then computed the flush volumes from the collected volume and time measurements. The data was subjected to quality control procedures to ensure that the information was accurate and reasonable. SBW computed minimum, maximum, and mean values for the measured variables as applicable and prepared a frequency distribution for important characteristics variables. The computed information was summarized in tables for inclusion in this report.

2.4 Task 4 Urinal Efficiency Improvement Options

The project team developed a list of practical urinal efficiency improvement options. These options were reviewed with SPU and SPU then selected two viable efficient options for testing with the Task 5 sample population. These two options were: 1) replacing the flush valve with an adjustable piston style valve and 2) replacing the existing diaphragm with a lower flow diaphragm. The flush valve replacement option could be tested for all urinals with exposed flush valves. The diaphragm replacement option could be tested for urinals with manual or sensor valves that used standard diaphragms only. At one of the four additional sites, field staff encountered three 1/8th gpf high efficiency urinals (HEUs), which they found consistently performed at the manufacturer (Zurn) marketed low flush volumes, and produced significant savings (as discussed under observations). HEUs were added as a third efficiency option considered for analysis by evaluating the ease of conversion using mounting bolt and water supply height field measurements from the urinal inventory.

The testing protocol assigned an individual testing number keyed to building and urinal location, to allow for any future follow up. It also established procedures to be followed to run the tests correctly. In consideration of time and cost efficiency, most of the task 4 work was completed in conjunction with task 2. This allowed the field staff to conduct efficiency option tests, described in task 5, along with task 3 flush volume measurement collection.

2.5 Task 5 Test Urinal Efficiency Options

As mentioned above, most of the Task 5 efficiency testing was completed with the Task 3 measurements. The project team identified sites where testing of efficiency options was feasible while taking measurements for Task 3 and then tested the efficiency options during the same visit.

Appendix E shows the data collection protocol form that was used to collect the test data. SBW entered all the data from the forms into a spreadsheet and computed the flush volumes from the collected volume and time measurements. The data was subjected to quality control procedures to ensure that the information was accurate and reasonable. Where appropriate, SBW computed minimum, maximum, and mean values for the measured variables and prepared frequency distributions. The computed information was summarized in tables for inclusion in this report. The project team then estimated total costs to install or utilize these options, including removal costs for any existing equipment that needed to be removed. SBW also determined if these options had limited application due to urinal diversity or any site installation barriers.

2.6 Task 6 Final Database and Results

SBW combined the spreadsheets for Tasks 1, 3 and 5. The final spreadsheet had three sections. The first section documented data collected during the initial inventory in Task 1. The second section documented the additional characteristics collected under Task 3; flow and measurement data also collected for Task 3; and efficiency test data collected under Task 5. The third section recorded the information collected through the customer survey under Task 3. The data was subjected to quality control procedures to ensure that the information was accurate and reasonable. Where appropriate, SBW computed minimum, maximum, and mean values for each of the measured variables and prepared frequency distributions, both of which are shown in this report.

3. Findings

3.1 Initial Inventory

The methodology described in Task 1 above was applied to a representative sample of 179 male restrooms (in 137 buildings) throughout the SWP service area. Throughout the selection of the sample, an attempt was made to achieve the distribution of business types and business centers that were included in the sampling plan. The ability to achieve this distribution was limited by the budget and access to sites. Table 2 shows the distribution of sample restrooms across the desired business types and commercial centers.

Table 2: Count of Male Restrooms by Business Type and Business District

Business District	Grocery	Hospital, Other medical (health)	Large retail	Office	Public Gathering	Recreation	Restaurant	School	Shopping malls	Small retail	Warehouse	Health (Hospital, Other medical)	Hotel, motel, nursing homes	Other Businesses	Grand Total
Ballard		1	1	2	1	1	4	2		2				2	16
Burien	1		1	2			10								14
Capitol Hill	1		3	2		1	11	5		6					29
Central District			2	11	6	2	4		3	4			9		41
First Hill		6													6
Other Districts								7				1			8
SeaTac							1				1		3	3	8
Shoreline	1		2			2	8			1					14
South Lake Union			5	14	1		2			1	1				24
Woodinville	2		6	2		1	7			1					19
Grand Total	5	7	20	33	8	7	47	14	3	15	2	1	12	5	179

During the first visit to the central business district (downtown Seattle), SBW field staff had difficulty in collecting data at large office buildings, due to heavy security in these facilities. To mitigate this problem Roger van Gelder provided site contacts for 15 office buildings. SBW staff was able to recruit and get security clearance over the phone for 11 of these office buildings. SBW field staff then revisited the Central District to complete these additional buildings. Due to budget constraints SBW field staff did not visit the University District. Based on field experience from the nine business districts visited by the field staff, it was determined that the urinal density and characteristics in the University District were similar to those in Ballard and South Lake Union. During the implementation of Task 3, when four new sites were added to the sample population, we collected Task 1 data for 2 buildings in the University district. This later addition is not reflected in the discussions below.

SBW staff visited 14 restrooms in school buildings and a representative restroom in Safeco field in South Downtown (SODO). Some of the schools and Safeco field are not located within the geography of the pre-selected business districts and are listed under an additional category called ‘Other Districts’. Similarly, some of the businesses such as parking garage and fire station could not be grouped under any of the pre-defined building types and are placed under a new business type called ‘Other Businesses’.

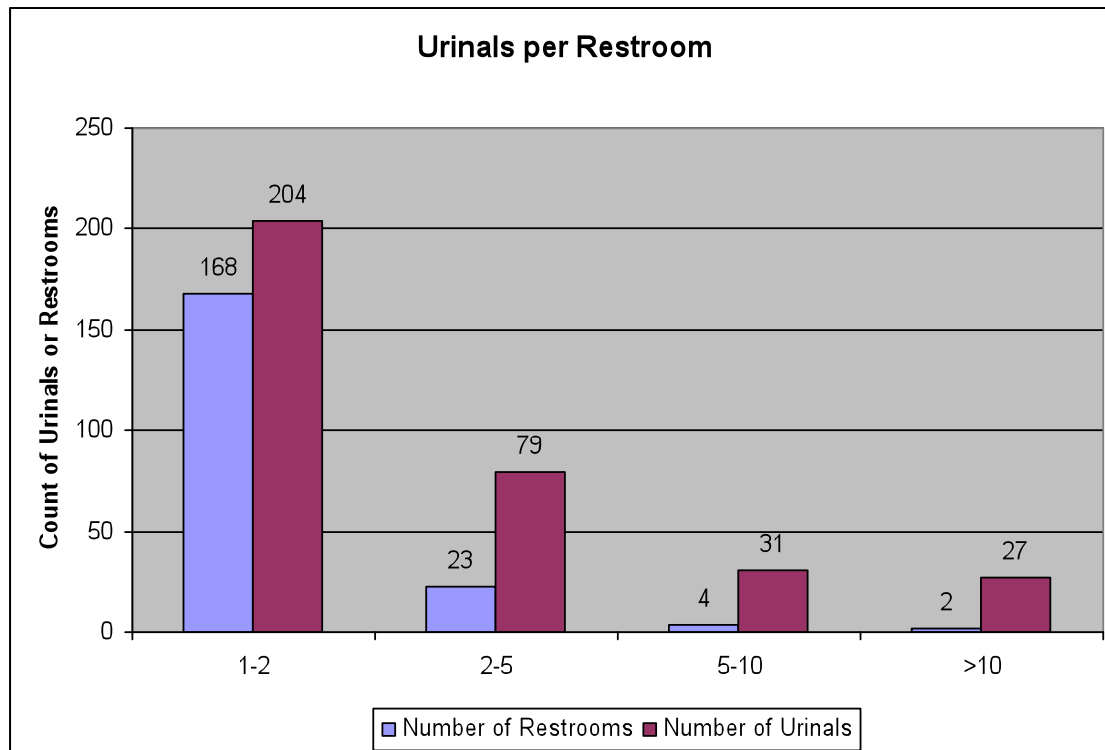
For each restroom in the sample SBW staff recorded all the unique urinal types and the number of urinals for each type. Data was collected for 341 urinals and 290 toilets in 179 male restrooms. Table 3 shows the distribution of sample urinals across the desired business types and business districts. Figure 1 shows the distribution of urinals per restrooms.

As seen in Table 3, restaurants, retail and offices are found in most business districts. Due to budget constraints, field staff only visited hospitals for which the site visits had been pre scheduled. The Central District has the highest urinal density and a good representation of a least eight of the 13 business types.

Table 3: Count of Total Urinals by Business Type and Business District

Business District	Grocery	Hospital, Other medical (health)	Large retail	Office	Public Gathering	Recreation	Restaurant	School	Shopping malls	Small retail	Warehouse	Health (Hospital, Other medical)	Hotel, motel, nursing homes	Other Businesses	Grand Total
Ballard		1	1	2	1	2	5	7		3				3	25
Burien	1		1	2			15								19
Capitol Hill	1		3	2		7	14	13		10					50
Central District			2	18	16	5	6		6	8			22		83
First Hill		8													8
SeaTac							1				1		8	3	13
Shoreline	1		4			4	10			1					20
South Lake Union			9	19	1		2			1	1				33
Other Districts								45				10			55
Woodinville	2		7	2		10	13			1					35
Grand Total	5	9	27	45	18	28	66	65	6	24	2	10	30	6	341

Table 2 and Table 3 also show that three business types, recreation, school and health, have a high count of urinals per restroom. As seen in Figure 1, most restrooms have between one and two urinals.

Figure 1: Distribution of Number of Urinals per Restrooms

During the site visits, SBW field staff completed the Task 1 data collection form with as much information as was available at the site. SBW staff was able to get a contact name and telephone number or email for 131 restrooms.

3.1.1 Urinal Data

Figure 2 and Figure 3 show the frequency distribution of urinal bowls and flush valves by manufacturer. As seen in Figure 2, American Standard, Kohler and Standard dominate 85% of the market as represented by the urinals in this sample, with almost 50% of the urinals from the three manufacturers being from Kohler. SBW field staff did not find any stamped model numbers for the urinals. As seen in Figure 3, almost 93% of the flush valves are manufactured by Sloan (80%) and Zurn (13%). Figure 4 shows distribution of models for Sloan. ‘Not Known’ shows the flush valves for which SBW field staff was able to identify the manufacturer but not the model number.

Figure 2: Distribution of Urinals Bowls by Manufacturer

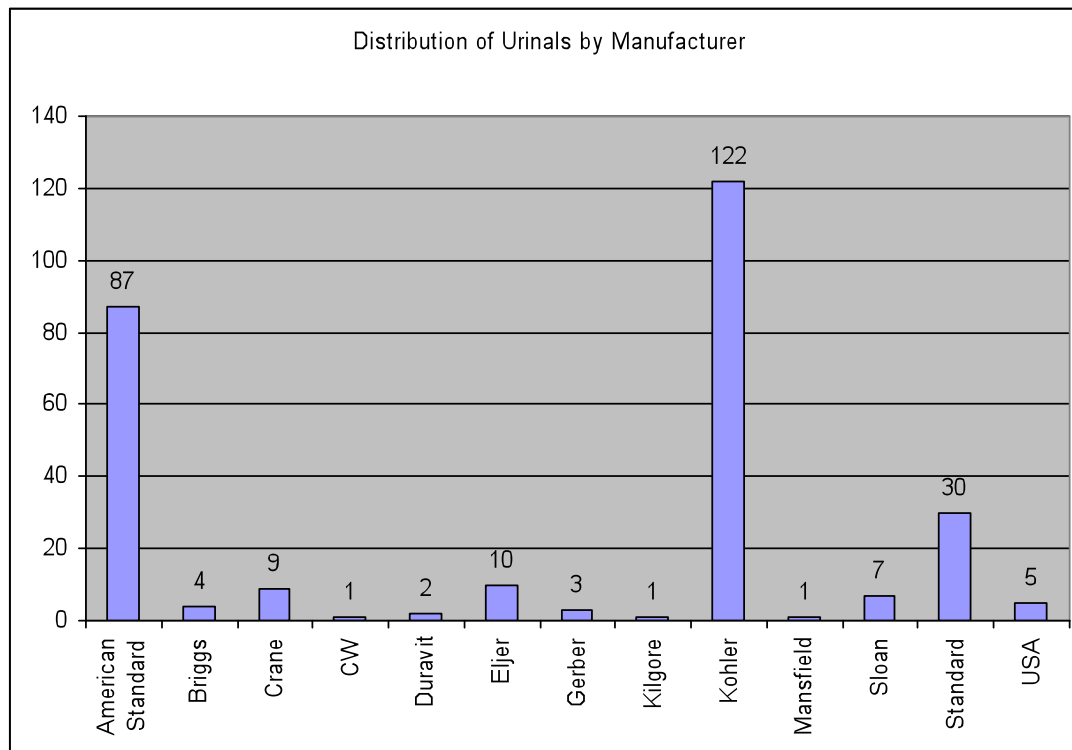


Figure 3: Distribution of Urinal Flush Valves by Manufacturer

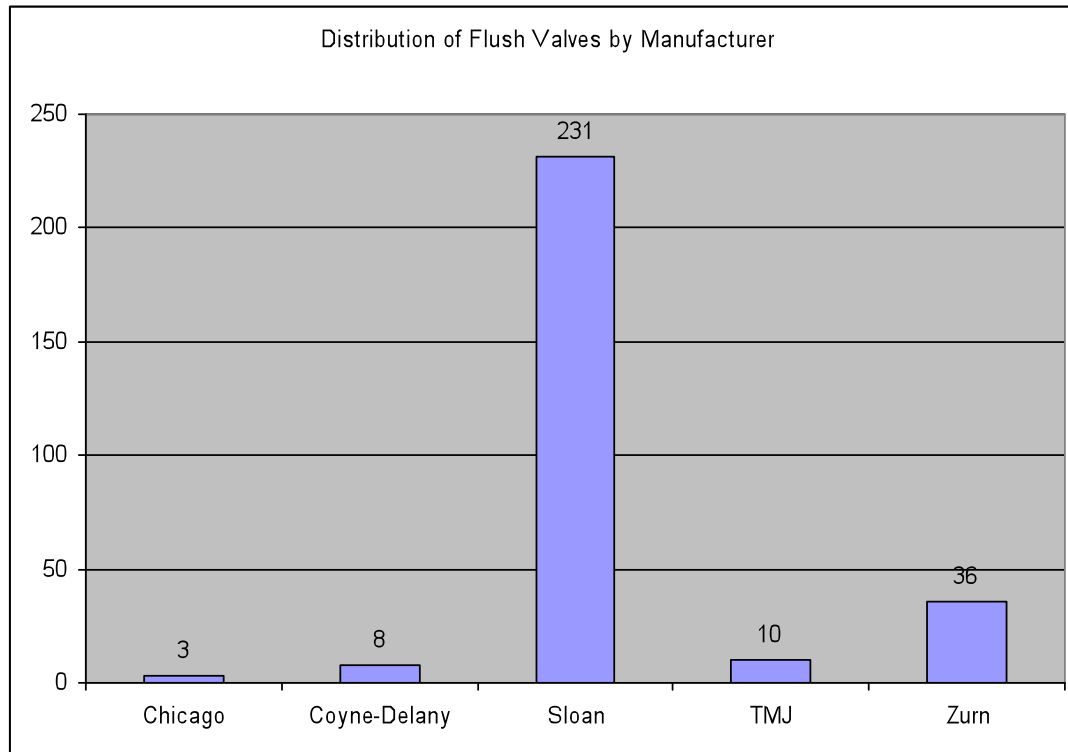
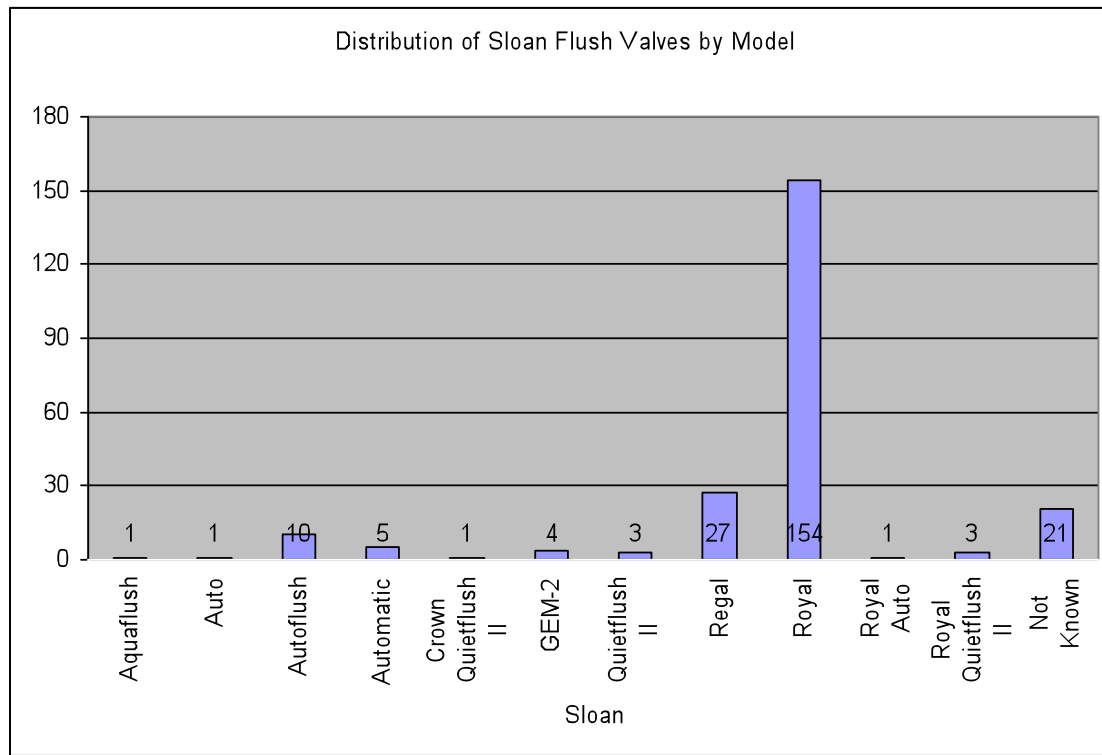


Figure 4: Distribution of Urinals with Sloan Flush Valves by Model



Field observations from this first task showed that almost 80% of the urinals were of standard height of greater than 17 inches from the floor, as shown in Table 4 below.

Table 4: Urinal Distribution by Height

Urinal Height	n	%
Standard Height	268	78.6%
ADA Height	73	21.4%
Total	341	100.0%

Over 80% of the flush valves were exposed and none of the flush valves are integral to the fixture. The mounting was not recorded for nine of the waterless urinals. Table 5 provides a urinal distribution summary for flush valve mounting. During the implementation of Task 3, when four new sites were added to the sample population we found three Zurn HEU 1/8th gpf urinals with flush valves integral to the fixture.

Table 5: Urinal Distribution Flush Valve Mounting

Mounting Type	n	%
Concealed(in wall)	52	15.2%
Exposed	280	82.1%
Integral to fixture	0	0.0%
Waterless Urinals	9	2.6%
Total	341	100.0%

Less than 4% of the observed urinals have a vacuum breaker tail (VB tail) height of less than 5 inches and could not be used to make measurements. About 66% of the urinals have a spud diameter of 3/4". Figure 5 and Figure 6 below show the distribution of urinals by VB tail height and spud diameter, respectively. Spud height and VB tail height are not available for 36 of urinals because they either did not use water or had concealed plumbing.

Figure 5: Urinal Distribution by Vacuum Breaker (VB) Tail Height

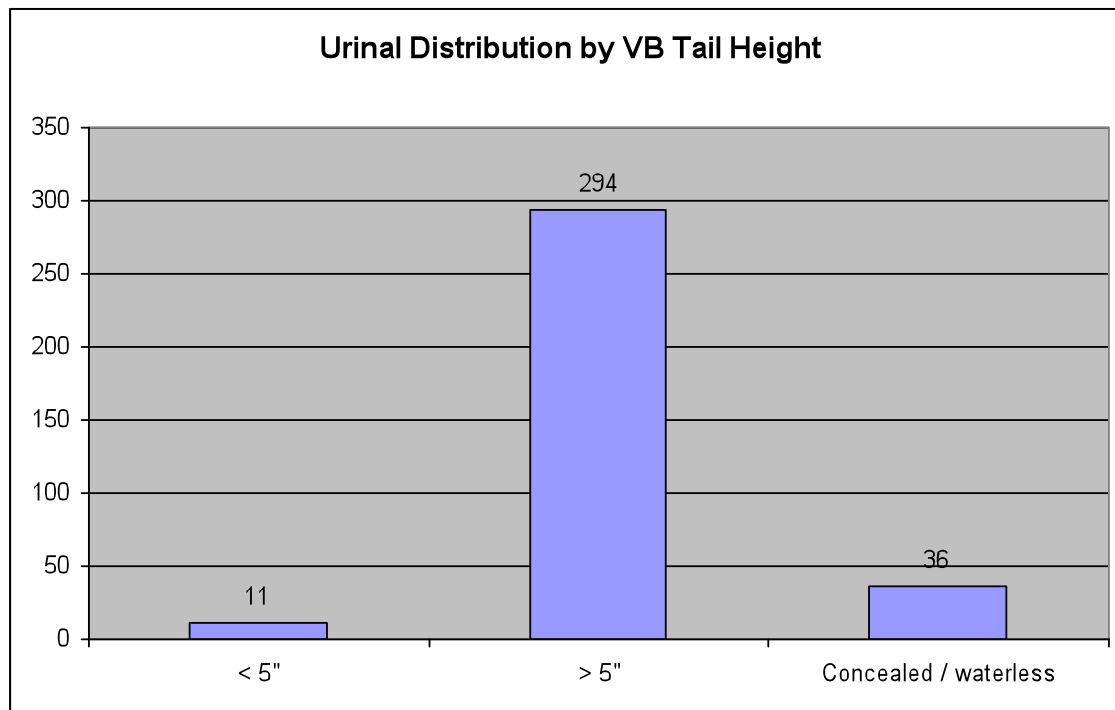
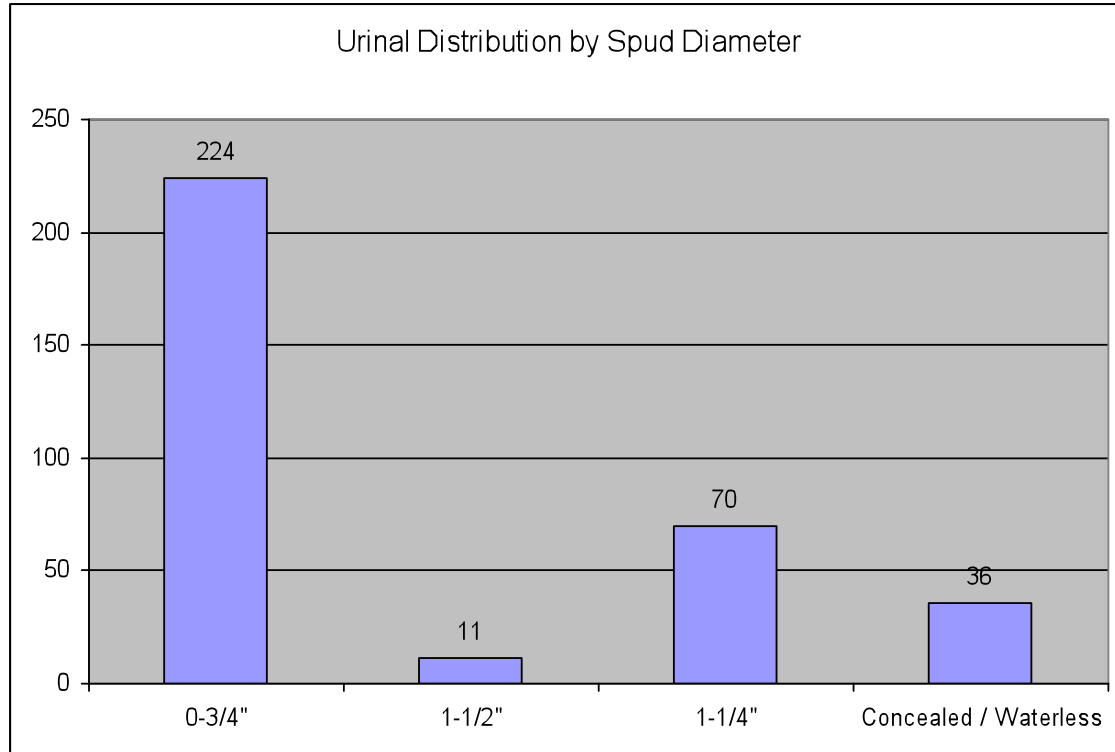


Figure 6: Urinal Distribution by Spud Diameter



Very few urinal flush valves had flush volume markings. Field staff found that the water flow was turned down for most flush valves, so that the estimated flush volume was generally quite low even in old style, high water use urinals. Figure 7 below shows the distribution of urinals by the flush volume marked on the flush valves. Almost 70% of the flush valves had no volume markings. Of the 30% with volume markings, 98% were marked as LC.

Figure 7: Urinal Distribution by Flush Valve Volume Markings (in Gallons per Flush)

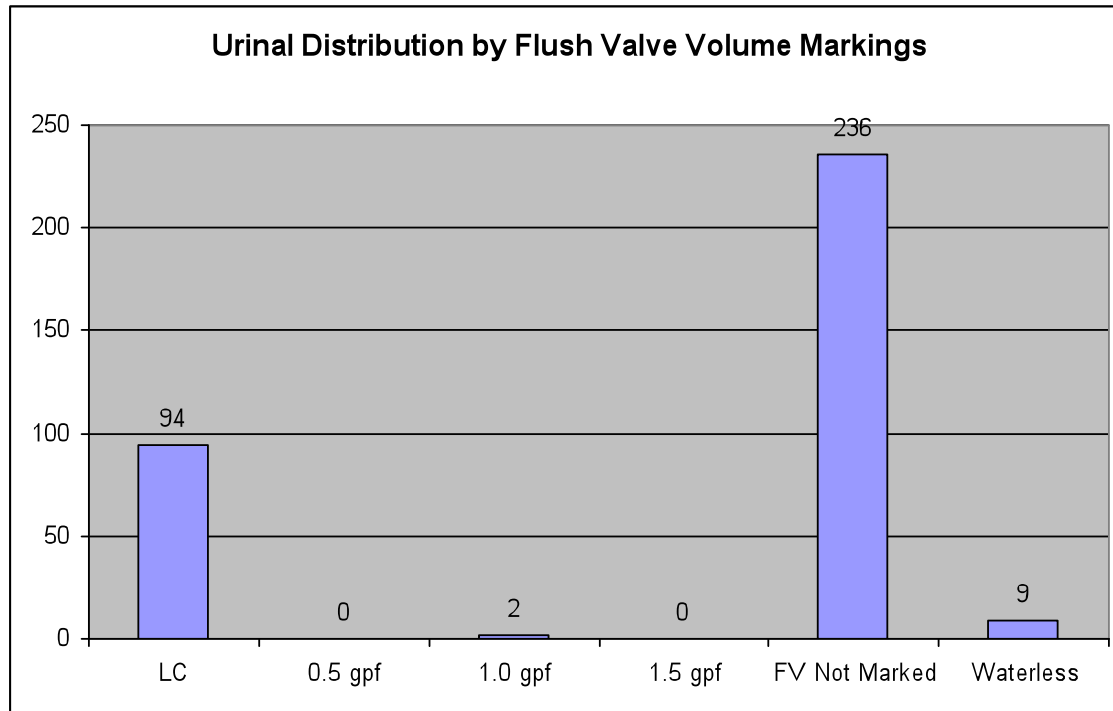
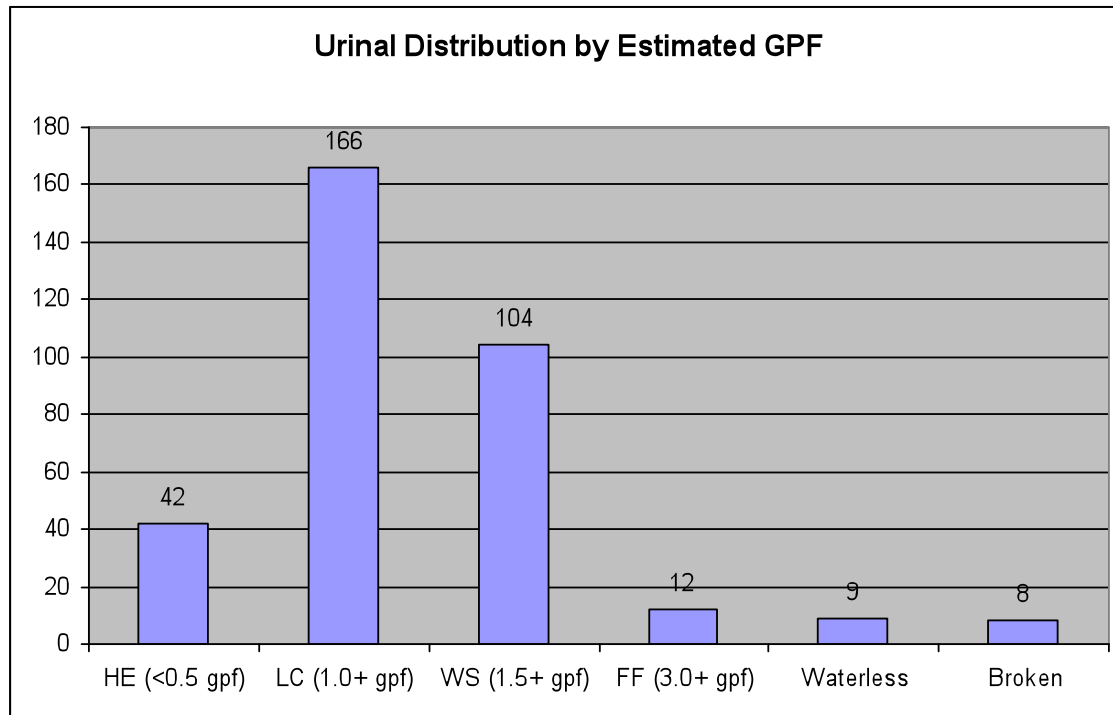
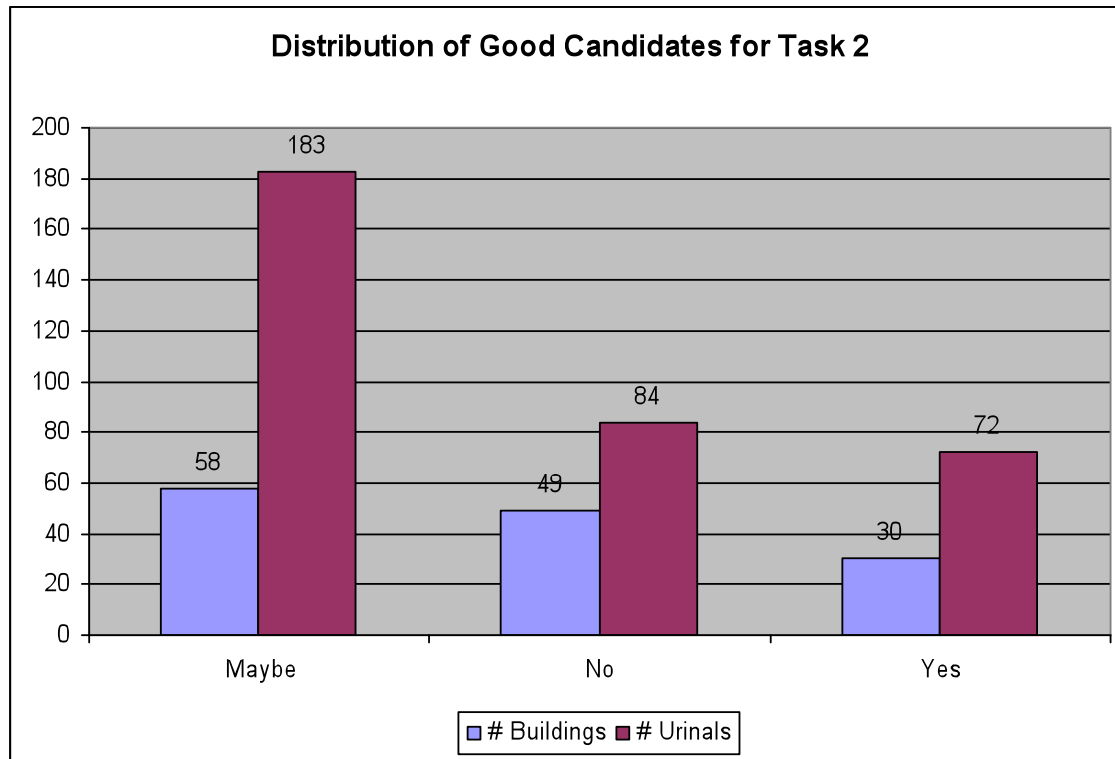


Figure 8 below shows the distribution of urinals by the flush volume as estimated by the SBW field staff. Observations could not be made for 17 urinals. These included 9 waterless urinals and 8 urinals where the flush valve was broken or the urinal did not flush.

Figure 8: Urinal Distribution by Visually Estimated Gallons per Flush

The field staff identified restrooms and corresponding urinals as good candidates for Tasks 2 and 3 of this study. A good candidate was one for which the facility contact showed enthusiasm, the urinal was in sound condition, and the urinals and flush vales represented the most common models observed during the initial inventory. 30 restrooms with a total of 72 urinals were identified as good candidates for the further testing. An additional 58 restrooms with 183 urinals were identified as additional potential recruits ('Maybe') for further testing. These urinals or flush valves were not ideal candidates for further testing, but SBW in conference with Roger van Gelder could choose to test them. Restrooms in buildings where the site contact expressed reluctance to participate in the next phase of study were identified as bad candidates (No). Figure 9 below provides a summary of candidate restrooms and toilets.

Figure 9: Summary of Good Candidate Restrooms and Urinals

3.1.2 Toilet Data

Information on toilets was collected during the field visits to better understand the distribution of models and estimated flush volumes. This information will be used by SPU as they consider options for toilet upgrades. SPU wanted to collect this data during the urinal field visits as an economy to a return survey of toilets by themselves.

The next five tables and figures summarize frequency distributions for important toilet baseline characteristics, observed during the site visits. The study examined 290 toilets in 179 restrooms. Three toilets were in use at the time of the site visit and no additional data was collected for them.

Table 6 below shows the distribution of toilets types by business types. Two-thirds of toilets are flush valve types. The gravity type toilets are most commonly found in restaurants. There are very few pressure assist toilets. The summary does not include three toilets that were in use during the site visits.

Table 6: Distribution of Toilet Type

Type	Grocery	Hospital, Other medical (health)	Large retail	Office	Public Gathering	Recreation	Restaurant	School	Shopping malls	Small retail	Warehouse	Health (Hospital, Other medical)	Hotel, motel, nursing homes	Other Businesses	Grand Total
Flush valve	1	7	15	30	12	22	21	33	8	14		3	23	4	193
Gravity tank	4		10	17	3	3	30	1		6	2		6		82
Pressure assist	2		3	1			3							3	12
Grand Total	7	7	28	48	15	25	54	34	8	20	2	3	29	7	287

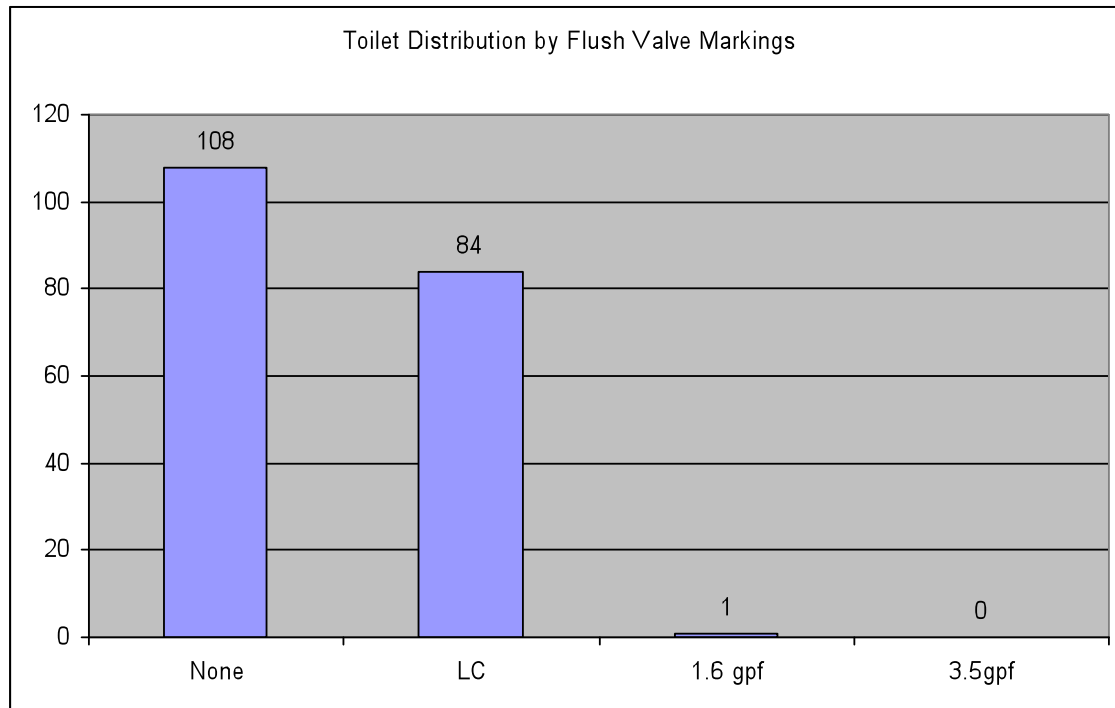
Almost 60% of the toilets bowls were marked for a flush volume of 1.6 gpf. All the other bowls were unmarked. Table 7 below provides a distribution summary of toilet bowl markings.

Table 7: Distribution of Toilets by Bowl Marking

Toilet Bowl Marking	n	%
1.6 gpf (6 lpf)	167	58.2%
3.5 gpf	0	0.0%
None	120	41.8%
Total	287	100.0%

Flush valve markings were not listed for more than half the toilets with flush valves. Almost all the marked flush valves were marked 'LC'. Figure 10 below provides a distribution summary of toilets by flush valve marking.

Figure 10: Toilet Distribution by Flush Valve Markings (in Gallons per Flush)



SBW field staff flushed toilets to provide a visual estimate of the flush volume. A majority of the toilets flushed around 1.6 gpf (LC). Figure 11 below provides a distribution summary for estimated flush volumes. The summary below does not include the three toilets that were in use during the site inspection.

Figure 11: Distribution of Toilets by Estimated Gallons per Flush

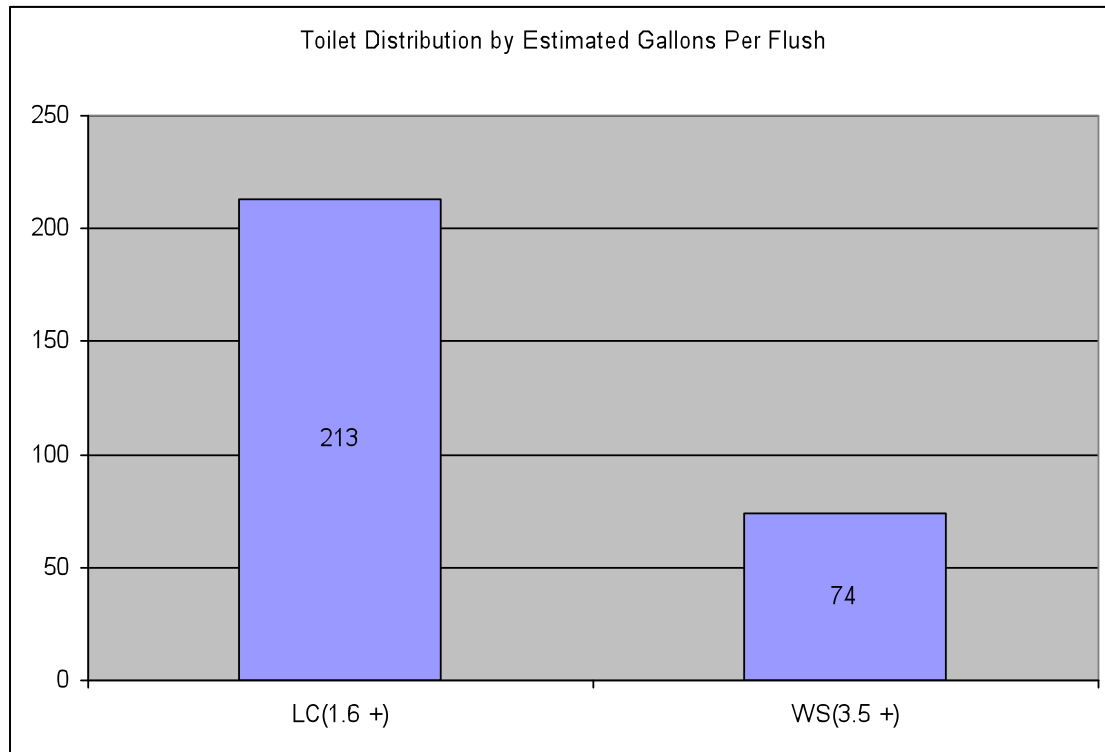


Figure 12 and Figure 13 below show the distribution of toilets by toilet bowl manufacturer and flush valve manufacturer. Kohler and American Standard are the lead toilet manufacturers, with 76% of the market as represented by this sample. 95% of the toilets with flush valves used Sloan or Zurn flush valves.

Figure 12: Distribution of Toilets Bowls by Manufacturer

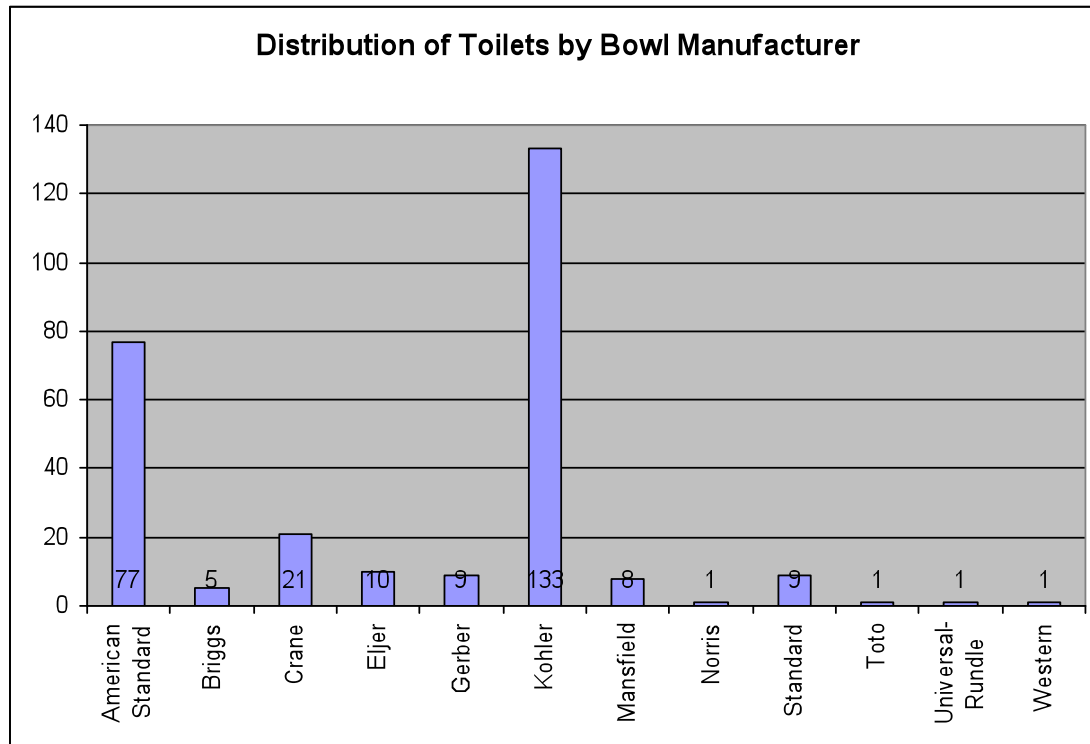
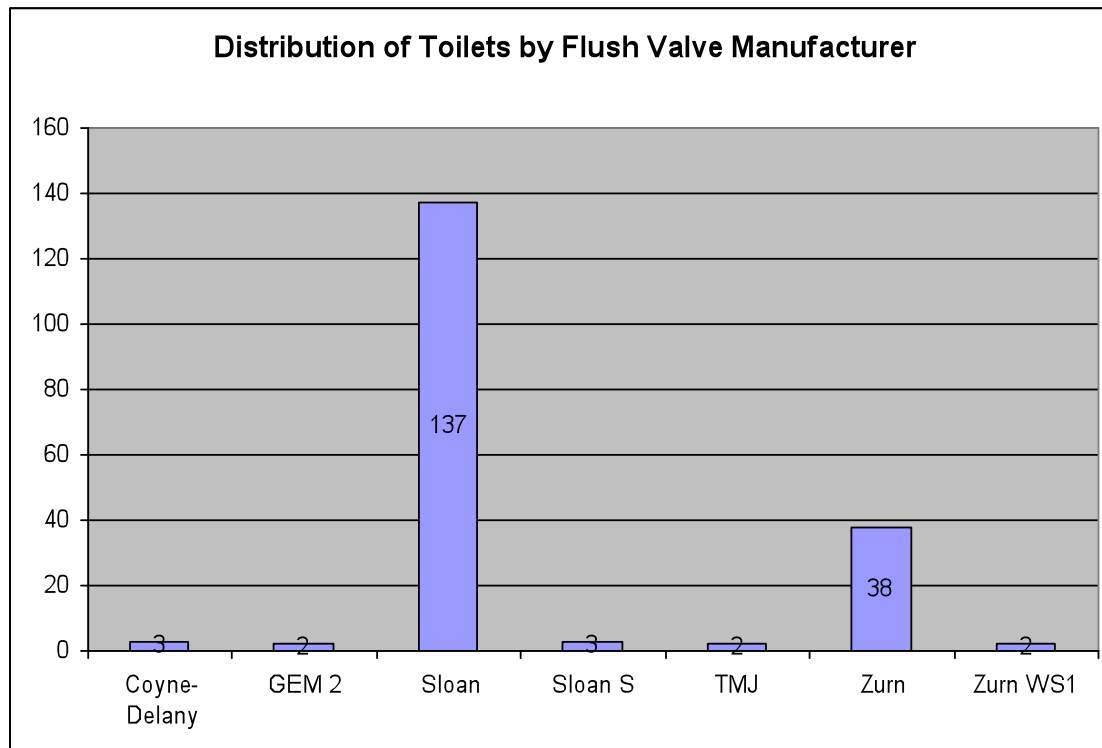


Figure 13: Distribution of Toilet Flush Valves by Manufacturer



3.2 Existing Urinal Measurements

SBW took urinal measurements for a total of 48 urinals at 20 sites. Four of the 20 sites were new additions beyond the Task 1 inventory. Four of the ‘good candidate’ sites from the inventory had not given SBW permission to take measurements at their site. As such they were substituted by four sites, at which Roger van Gelder had an existing relationship and permission to take measurements was easily granted. These sites include the University of Washington, Seattle Union Gospel Mission, Capital Hill Union Gospel Mission, and Miller Community Center. 15 of the total 48 urinals were measured at these four sites.

3.2.1 General Characteristics

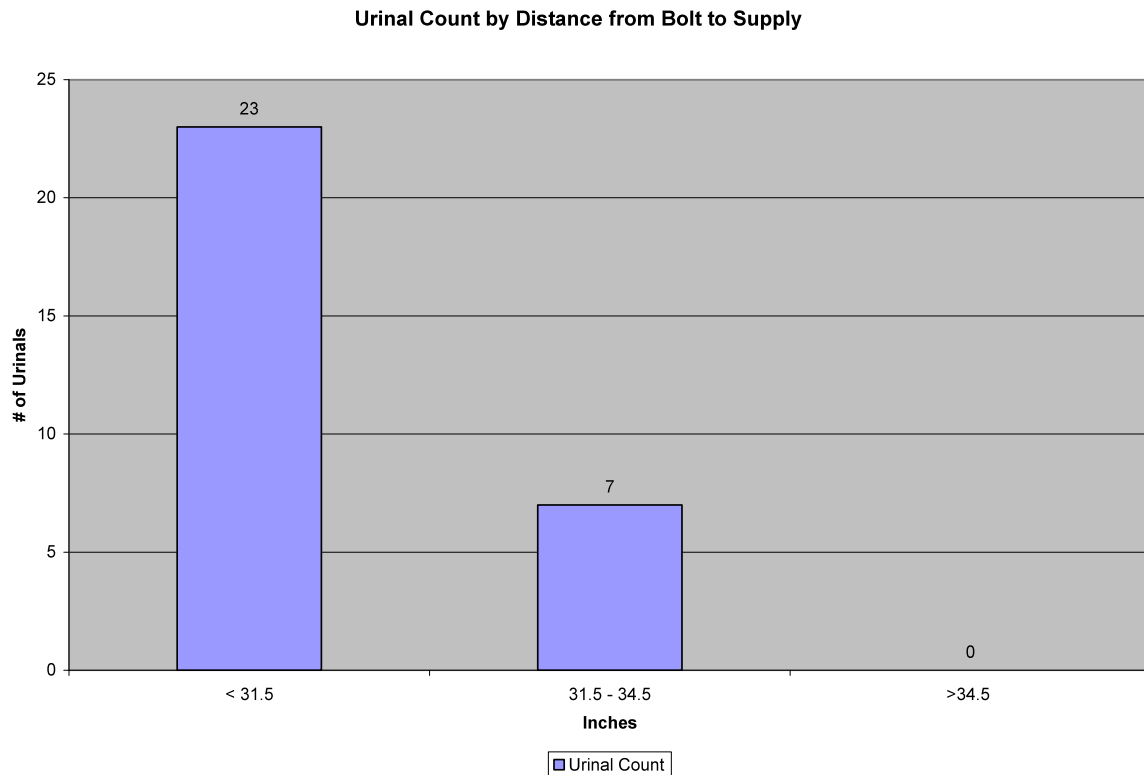
Field staff found no change in urinal style in the 33 urinals that were examined during Task 1 and again in Task 3. Most of the urinals were in good condition. Urinals that were in fair condition were found to be over 35 years old. The two identified in poor condition were over 50 years old. Two-thirds of the urinals were located in public spaces, and the rest in private spaces. All urinals were made of porcelain and field staff had shutoff access to all of them. All but two urinals had a wall-back outlet mount. About half of the urinal models were siphon-jets, the others were washdowns or blowout-extended. Detailed description of these model types is provided in Appendix D.

All but six of the flush valve models were diaphragm type. Every urinal was controlled by its own flush valve. All the flush valves had a slip joint stop connection, allowing for an easy retrofit if a urinal retrofit program was to be implemented. Three-fourths of the flush valves were activated manually, the balance were activated with sensors. A little over half the urinals were observed to have minimal flush volumes, and only one had a long flush volume. Facility staff at about half the sites kept replacement diaphragms for repair and maintenance. The above data is summarized with frequency distribution in Table 8 below.

Table 8: Summary of General Urinal and Flush Valve Characteristics

Urinal Data	#	%
Urinal Location		
Public	34	70.8%
Private	14	29.2%
Urinal Mount		
Wall-back outlet	46	95.8%
Wall-bottom outlet	2	4.2%
Urinal Style		
Washdown	12	25.0%
Siphon-jet	25	52.1%
Blowout-ext	11	22.9%
Flush Valve Type		
Diaphragm	42	87.5%
Unknown	0	0.0%
Piston	3	6.3%
Flush Valve Activation		
Manual	36	75.0%
Sensor	12	25.0%
Urinal Condition		
Good	42	87.5%
Fair	4	8.3%
Poor	2	4.2%
Flush Volume		
Minimum	26	54.2%
Moderate	21	43.8%
Long	1	2.1%
Vintage		
Less than 35 years	42	87.5%
35 to 50 years	3	6.3%
More than 50 years	3	6.3%

For the 30 urinals for which bolt height from the floor and supply height data were both collected, we computed the difference between the two. One of the recommendation options proposed in Section 4 includes replacement of urinals with new HEU 1/8th gpf Zurn urinals. The current Zurn design will fit into existing plumbing if the distance between ranges from 31.5 inches to 34.5 inches. [Figure 14](#) shows that only seven of the 30 urinals (23%) qualify for this option. However, we note that Zurn is working on reducing this distance by a couple more inches. As such, if the lower end of the range is reduced to 29.5 inches, about 40% of the sample population will qualify for this retrofit.

Figure 14: Urinal Distribution by Distance between the Waste Outlet Center Line and Supply Height

3.2.2 Urinal Flow and Performance Measurement

Urinal flow and performance measurement data was collected for a smaller subset of 33 urinals. They were collected at sites where time was available to run the tests and field staff was allowed to open up the flush valve to connect a flow meter.

The data collection included a dilution test and flush volume measurement for different valve settings. An initial conductivity threshold of 110 uS was set for the dilution test. After a few initial tests, field staff reduced this threshold to 85 uS. With three exceptions, all urinals passed the conductivity test. Of the three that did not pass, two urinals were 45-years old and one was 11-years old. It was not possible to change the flush valve settings for one of the 45-year old since the flush valve was already wide open. The other 45-year old passed the test when the flush valve was rotated to wide-open; however, this also increased the flush volume from 0.38 gpf to 1.79 gpf. The 11-year urinal old did not pass the test even after the flush valve was rotated to wide-open.

The average baseline flush volume for the urinals was 1.15 gpf. About 80 percent of the urinals used more than 0.5 gpf. These flush volumes are based on site settings for the stop valves. Only seven of the flush valves were already set at or close to wide open. For the 26 flush valves not already wide-open, the testing protocols included a second flush volume measurement after rotating them to wide-open. We observed that flow actually reduced at five of these urinals and remained the same at two others. We suspect that opening up the flush valve allows for a higher pressure and a shorter flow time, which may have reduced the net flow. The distribution of urinals by average flush volumes and the range of flush volume for each distribution group are shown in Figure 15 and Figure 16 below.

Figure 15: Distribution of Urinals by Flush volume

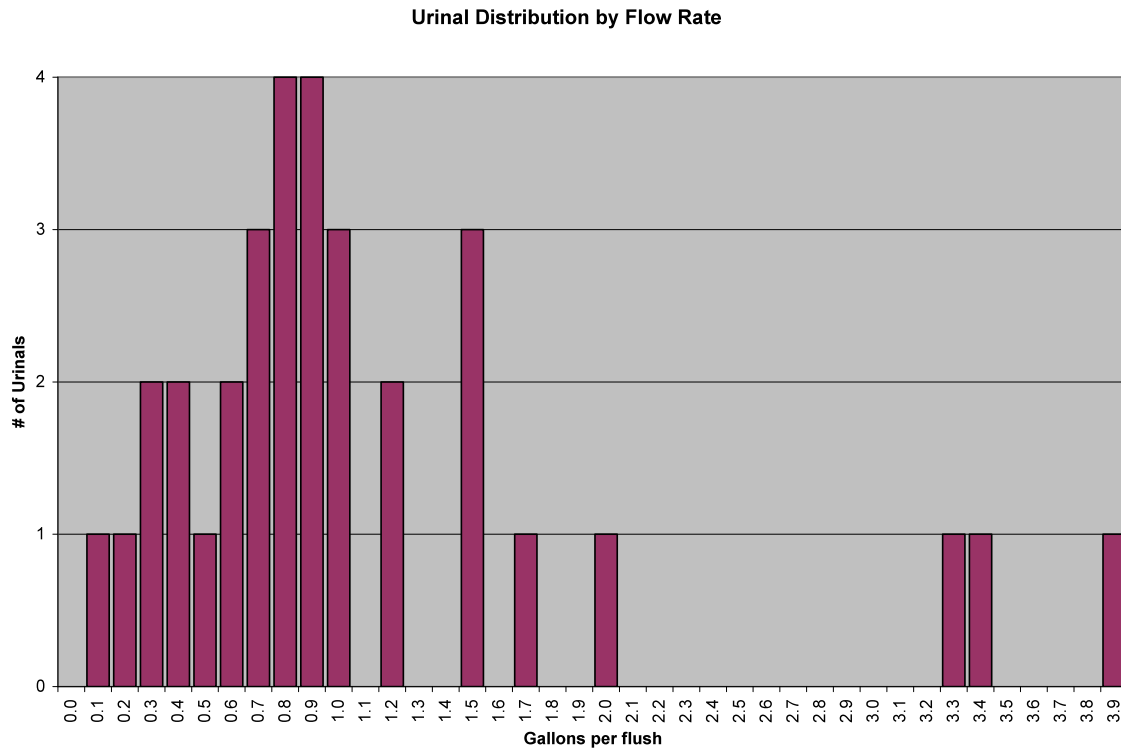
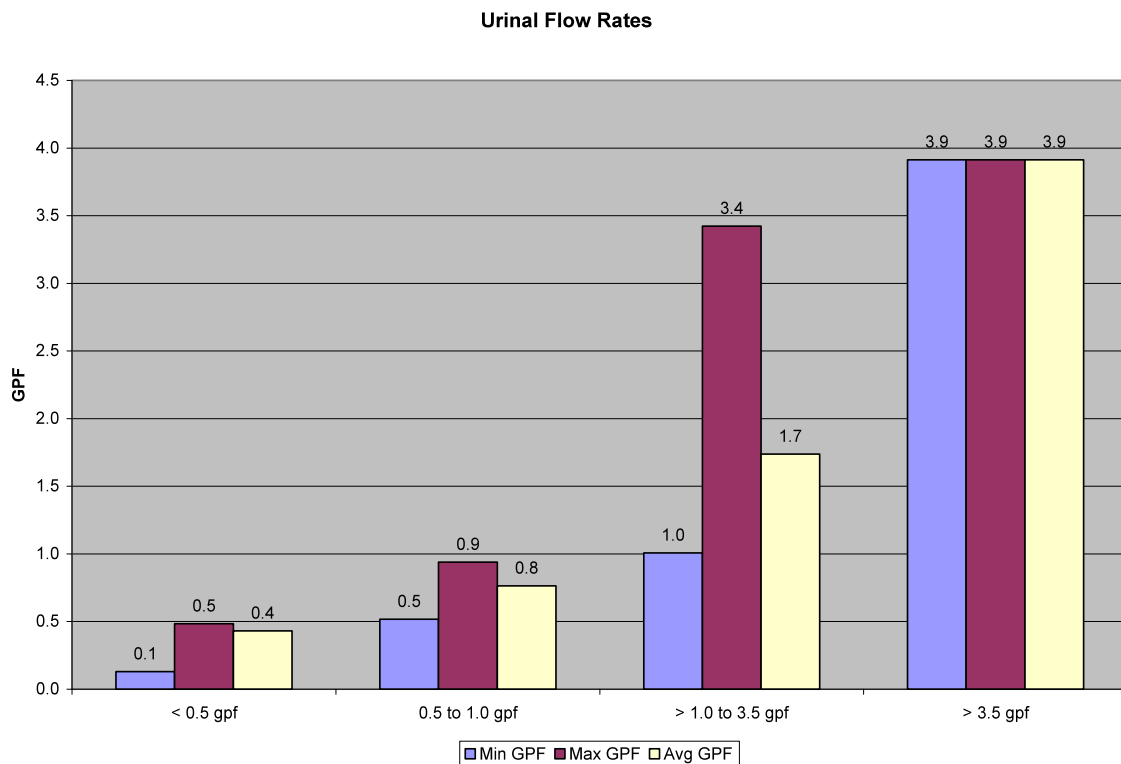


Figure 16: Minimum, Maximum and Average Flush volume for Urinals by Flush volume Group



3.3 Customer Survey

SBW sent out survey forms to 18 sites via email. Of these only five sites completed the survey and returned them to SBW. We suspected that this may be because the survey form was sent out with the participation agreement, and facility contacts who did not want to sign the agreement chose not to return the survey. SBW staff followed up with all the facility contacts, after the agreement requirement was dropped, to encourage them to complete the survey. However, no more surveys were returned.

The five surveys returned include those from Seattle Central Community College (SCCC), Pacific Place Mall, the Galland building, Walgreens and the Seattle Hilton. A data set of five sites was too small to identify any trend or plot frequency distributions. However, we have summarized the survey information in Table 9 below.

Performance History

With the exception of SCCC, the facility staffs were fairly satisfied with their urinals. SCCC had leak problems that cause power failures. They attributed this to piping that does not meet the plumbing code. We also note that the urinals at SCCC are very old. Three sites reported having problems with flush valves stuck open or leakages. Pacific Place had problems with odor and plugged drains.

Maintenance Practice:

Two sites had a monthly maintenance program, and the other three urinals were maintained on an as-needed basis. With the exception of Walgreens, urinals were maintained by facility staff. Urinal usage matched expectations. SCCC and Pacific Place saw high usage with about 100 urinal uses per day, with seasonal change in usage. The more private buildings saw a lower usage of between 11 to 50 urinal uses per day, with no seasonal changes.

Retrofit Receptiveness

All sites except Walgreens expressed interest in replacing existing urinals with more efficient models. Walgreens cannot replace urinals because it is contracted to work with a corporate chosen contractor.

Table 9: Summary of Survey Questionnaire

BLDG/BUSINESS NAME	Seattle Central Community Coll.	Walgreens	Galland Building Office	Seattle Hilton	Pacific Place
BUSINESS TYPE	School	Large retail	Office	Hotel, motel, nursing homes	Shopping malls
PERFORMANCE HISTORY					
1. On a scale of 1 to 5 how satisfied are you with the current urinals in your facility? (1= not satisfied, 5= very satisfied)	1	4	3	4	4
2. Circle the most common urinal problems for facility personnel. Estimate the Frequency. Stuck Open Flush Valve Splashing of Urinal Odors Excessive Cleaning Leaks Other	2/yr --- --- --- 3/yr Not plumbed correctly. Piping does not conform to plumbing code.	--- --- --- --- --- ---	12/yr --- --- --- 12/yr ---	1-3/yr --- --- --- 1-3/yr ---	--- --- 1/wk --- --- plugged drain: 4/yr
3. Do the tenants/customers have any common complaints about the urinals?	They have caused power to go out. Leaked onto electrical panel.	---	Only when they don't work	---	---
MAINTENANCE PRACTICES					
4. How long ago were any urinals replaced?	Last week I installed a new Zurn 1/8 th gpf urinal.	5/8/2007	---	At least 10 yrs	9 yrs
5. Who replaces the urinals, the internal maintenance staff or a contracted plumber?	Licensed commercial plumbers.	Maintenance staff	Maintenance staff	Maintenance staff	Maintenance staff
6. How frequently are the urinals serviced?	When maintenance warrants.	1/mnth	Daily	As needed	1/mnth
7. Do you have a maintenance contract or are the urinals maintained by facility staff?	Facility staff	Contract	Facility staff	Facility staff	Facility staff
8. How many men use the restroom during a typical weekday?	>100	11-50	11-50	11-50	>100
9. a. Does the usage change during a typical weekend day?	Yes	No	Yes	No	Yes
9. b. If Yes, how many men use the restroom during the weekend?	0-10	---	0-10	---	>100
10. Is the usage higher during some months of the year? If yes, which months?	Winter mnths	no change	no change	no change	May - Aug
RETROFIT RECEPTIVENESS					
11. If it was cost effective to do so, would your business be interested in retrofitting the existing urinals to reduce water consumption?	Yes	No	Yes	Yes	Yes
11a. If no, is there a reason why the urinals in this building could not be retrofitted or replaced.	---	Under contract with corporate chosen contractor.	---	---	---
11b. If yes, who should we contact to retrofit or replace the urinals to make them more water efficient?	Eng. dept. - we currently are doing research for best options to conserve water and maintain functionality of existing urinals vs. new 1/8 gpf Zurn.	---	Chris Ulrich 206-253-3175	Chief Eng: Jess Hagerman	Operations Manager: Tom Nance 206-470-8315

3.4 Urinal Efficiency Options

Option A, the replacement of urinals with HEUs, was analyzed without retrofitting any of the test cases. The analysis was based on actual field measurements of replacement urinals already installed at some sites. For options B and C the urinals were retrofitted and tested for each efficiency options. In option B we replaced the flush valve with a new adjustable Toto flush valve. It was tested on a subset of 27 of the total 33 Task 3 urinals, at 15 sites. The adjustable Toto flush valve helped to identify an optimal flush volume

to be achieved in option C. In option C we replaced the diaphragm in the flush valve with one of six replacement diaphragms to attain the optimal flush rate established by the adjustable Toto flush valve. It was tested for all 33 Task 3 urinals, at 18 sites.

3.4.1 Replacing Existing Urinal with a High Efficiency Urinals (Option A)

The performance and flush volume of the HEUs was tested at the three urinals that were installed a year ago at the University of Washington's Lander Hall. The HEUs consistently performed at manufacturer advertised flush volumes of 1/8th gpf. The average savings from HEUs was computed at 1.03 gpf for each urinal.

Based on data collected in this study, about 96% of the urinals in the market have exposed plumbing to allow easy urinal replacement. The sample population of 30 urinals is limited to urinals with exposed plumbing only. Of these, the current Zurn design will fit into existing plumbing if the distance between ranges from 31.5 inches to 34.5 inches and the plumbing is not concealed. Figure 14 shows that seven urinals – about 22% of the total population qualified for this option. However, we note that Zurn is working on reducing this distance by a couple more inches. As such, if the lower end of the range is reduced to 29.5 inches, about 38% of the total population may qualify for this retrofit.

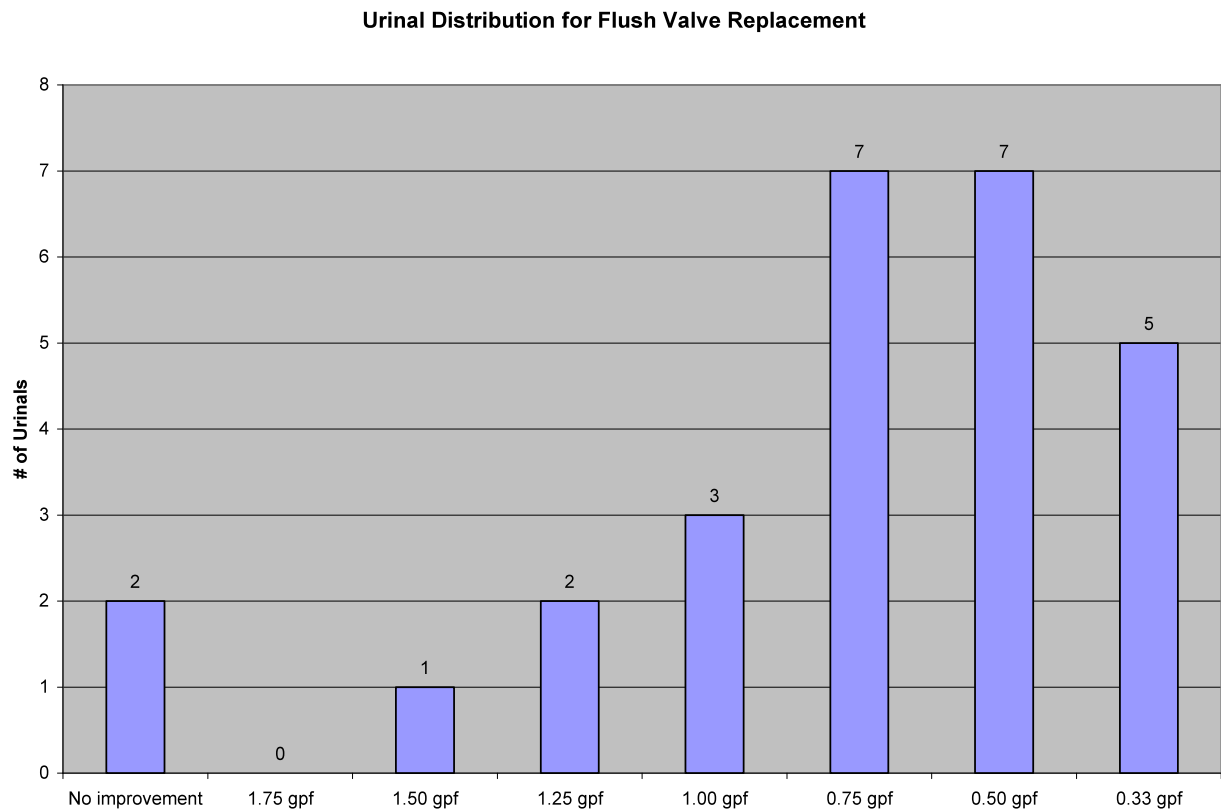
3.4.2 Water Pressure Measurement and Flush Valve Replacement (Option B)

Field staff measured both static and minimum flowing pressures at the urinal. Static pressure ranged from 40 psig to 110 psig with an average of 76 psig. 18 urinals at ten sites had more than 80 psig pressure.

Existing flush valves were replaced by an adjustable Toto flush valve with a flush volume range of 0.3 gpf to 1.5 gpf. Field staff tested the flush valve replacement in 27 urinals. The new flush valve was able to reduce flush volume in 20 urinals with an average savings of 0.52 gpf. It had no impact on the flush volume for 2 other urinals. In addition, it increased flow-rate at 5 urinals where the baseline flush volume was already very low. The flush volume at these five urinals increased on average by 0.27 gpf. The average savings for the entire sample including urinals with negative savings was computed at 0.34 gpf for each urinal. The Toto flush valve was able to adjust down flush volume to 0.5 gpf or less for about 40% of the urinals, for two of which this was an increase from the baseline. Figure 17 below summarizes the count of urinals by flush volume after installing the new flush valve.

The Toto flush valve replacement can be made in urinals with exposed, manually operated flush valves. Based on data collected in this study about 72% of the market may qualify for a flush valve retrofit.

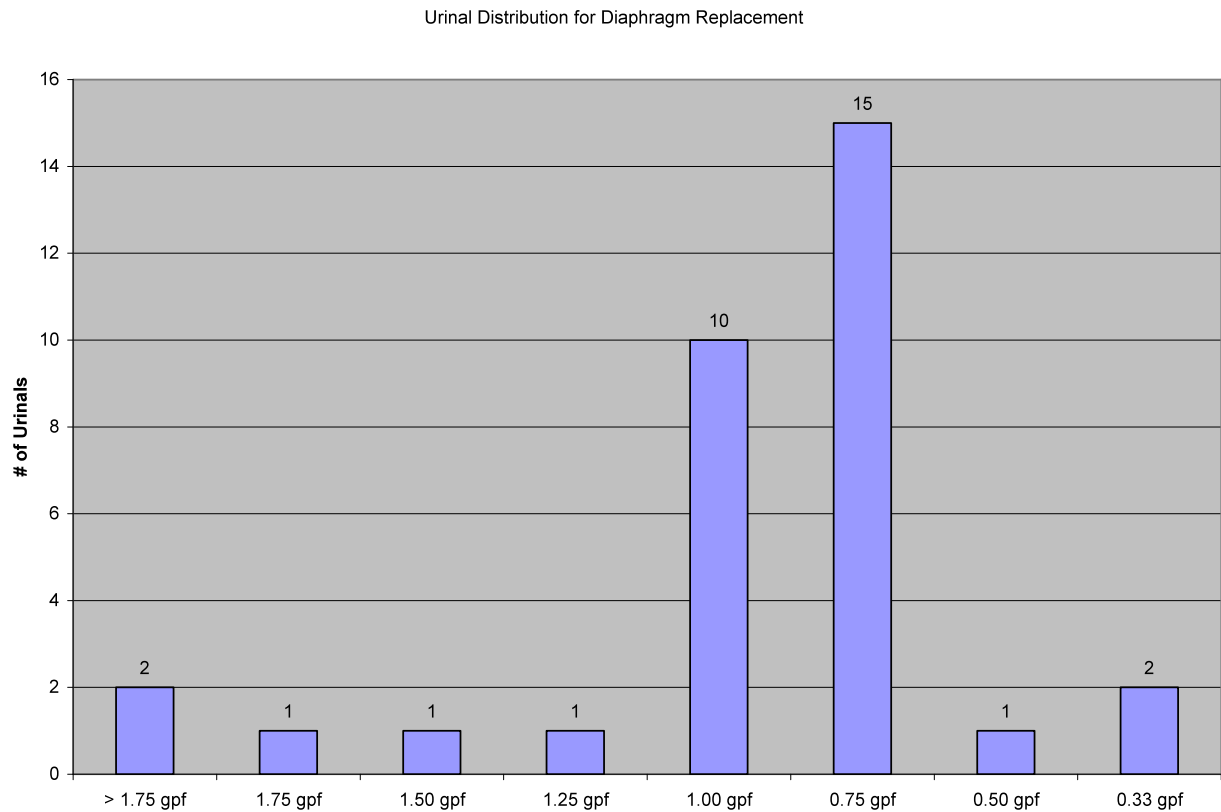
The field staff was equipped to leave the flush valve behind if it reduced flush volume and the facility contact was interested in reducing water use. However, they found that several facility managers declined the free equipment since they either had a third party maintenance contract or preferred to keep the same equipment in all the urinals.

Figure 17 Urinals Flow Volume Distribution, following Flush Valve Replacement

3.4.3 Flush Valve Diaphragm Replacement (Option C)

We replaced the diaphragm in the flush valve with one of six replacement diaphragms to attain the optimal flush rate established by the adjustable Toto flush valve. The six diaphragms included 0.5 gpf, 1.0 gpf, and 1.5 gpf standard (single filter) urinal diaphragms, and 0.5 gpf, 1.0 gpf, and 1.5 gpf duel filtered urinal diaphragms. The new diaphragms were able to reduce flush volume in 26 urinals of the 32 urinals for which a comparison with the baseline was possible. They provided average savings of 0.39 gpf. Like the flush valve, the diaphragm increased flow-rate at seven urinals. Five of the urinals were the same ones for which the flush valve gave negative savings due to a very low baseline flush volume. The flush volume at these five urinals increased on average by 0.16 gpf. The average savings for the entire sample including urinals with negative savings was computed at 0.20 gpf for each urinal. The flush valve replacement was able to adjust flush volume to 0.5 gpf or less for less than 10% of the urinals. Figure 18 summarizes the count of urinals by flush volume after installing the new diaphragm.

The diaphragms can be replaced in flush valves with a diaphragm flush type. While all such exposed flush valves can be retrofitted, it is also possible to replace the diaphragm in concealed flush valves that are easily accessible for retrofit. Based on data collected in this study and assuming that at least 25% of the concealed flush valves are accessible for retrofit, 64% of the market may qualify for a diaphragm replacement.

Figure 18: Count of Urinals for Diaphragm Flush volume Adjustment

4. Observations and Recommendations

4.1 Observations:

Below is a summary of some key observations made from the field testing of urinals under Tasks 3 and 5:

1. Stop valves are quite often used by maintenance personnel to minimize actual flush volume, regardless of the nominal gpf rating of the diaphragms installed. Many older urinals are already operated at close to their maximum efficiency, often less than the maximum allowed by the code at the time of installation.
2. The new diaphragms typically exceeded nominal flow by 20% or more. The single filter diaphragms have a brass orifice to control the flow volume. Over time the orifice corrodes, creating a larger opening for a quicker flush that uses less water. These single filter diaphragms may not flush well over the years as the flush volume drops below recommended nominal flush volume. In comparison, the dual filter diaphragms use a plastic orifice that provides a more consistent, reliable flush volume.

Secondly, the initial flush volume in the single filter diaphragms is decreased from 0.75 gpf to 0.6 gpf after the original green colored relief valve is replaced with a lower flow, black colored relief valve. This on-site design modification may not be possible for a larger conservation program. The dual filter valves are already fitted with a relief valve for an initial flush volume of 0.6 gpf.

As such the dual filter flush valves provide better immediate savings and give more consistent savings over its lifetime.

3. With the stop valve fully open, many older existing diaphragms flushed with substantially lower gpf than the nominal flush volume, particularly with the single filtered type diaphragms. We suspect that the actual flush volume for a particular diaphragm may slowly but substantially decreases over time.
4. The wide variety and vintage of urinal models, many of which are unmarked, makes identification difficult. This when combined with differing valves and water pressures, makes it a complex task to develop standard diaphragm selections for every situation.

4.2 Bottom-line Water Savings

The average savings from a 1/8th gpf HEUs was computed at 1.03 gpf for each urinal. These urinals had been installed for over a year and have been consistently flushing at 1/8th gpf. Based on data collected in this study, about 38% of the market may be eligible for an HEU replacement

The new flush valve reduced flush volume in 20 urinals with an average savings of 0.52 gpf and had no impact on the flush volume for 2 other urinals. It increased flow-rate on average by 0.27 gpf at 5 urinals where the baseline flush volume was already very low. The average savings for the entire sample, including urinals with negative savings, was computed at 0.34 gpf for each urinal. Based on data collected in this study, about 72% of the market may be eligible for a flush valve replacement.

The new diaphragm reduced flush volume by an average of 0.39 gpf in 26 urinals of the 32 urinals for which a comparison with the baseline was possible. Like the flush valve, it increased flow-rate by an average of 0.16 gpf at seven urinals. The average savings for the entire sample including urinals with negative savings was computed at 0.20 gpf for each urinal. Based on data collected in this study, about 64% of the market may be eligible for a diaphragm replacement.

4.3 Recommendations

Based on the findings of this study, we recommend that three program options be seriously considered by SWP for the 2008 program.

4.3.1 Program Option A

Promote 1/8th gpf HEUs as replacement of existing urinals and for new construction. This may be done with a combination of utility incentives and bulk purchasing agreements to reduce purchase costs. A direct install program using licensed plumbers at bulk labor costs may also be an option for many businesses.

Advantages:

1. Longest expected measure life (20+ years).
2. Market transformation value.
3. Greatest water savings per urinal.
4. Good customer acceptance.
5. Guaranteed savings as the flush valves cannot be replaced with higher flow systems.

Disadvantages:

1. Highest cost per urinal.

2. Applicable to a portion of the market for which the new Zurn models can fit into the existing plumbing.
3. Potential liabilities involved with a direct install option or requires customer to arrange installation.

4.3.2 Program Option B

Provide direct install replacement of existing manual exposed flush valves with adjustable piston type flush valves having a range of 0.3 - 1.5 gpf. Set flush valves to optimum efficiency using conductivity measurements.

Advantages:

1. Moderate equipment cost.
2. Relatively quick to install and to set to optimum efficiency due to use of simple adjustment screw rather than having to repeatedly turn off stop and reopen flush valve as would be the case with trying different diaphragms.
3. Ability to zero in to whatever gpf provides maximum efficiency, down to a minimum of 0.32 gpf.

Disadvantages:

1. Applicable to a portion of the market with manual exposed flush valves and adjustable pistons
2. May increase water use in a small percentage of cases
3. Piston technology unfamiliar to some users
4. May be user adjusted within limits.
5. Lower savings than option A.
6. Facility managers with third party maintenance contracts may refuse direct installation of the new flush valve.

4.3.3 Program Option C

Provide direct install replacement of existing flush valve diaphragms with lower volume diaphragms where applicable. Select diaphragm model with maximum chlorine resistance and minimum gpf drift over time.

Advantages:

1. Lowest equipment cost.
2. Good customer acceptance. No external changes to equipment, using familiar parts.

Disadvantages:

1. Short measure life (2+ years).
2. May increase water use in a small percentage of cases.
3. If flush volume decreases over time, customers may eventually end up with poorly flushing urinals.
4. May easily be replaced with higher flow diaphragms by maintenance staff.
5. Lower savings than options A and B.

6. May take installer substantial time to install and test diaphragms of various gpf ratings to ascertain optimum selection.

4.3.4 Estimated Costs

Table 10 provides a comparison of preliminary cost estimates for each of the three efficiency options.

1. Equipment cost for the HEUs was based on an initial estimate from a local Zurn distributor. It is partially adjusted for bulk pricing, but the costs can be further lowered through more negotiation and competitive pricing. Currently, Zurn is the only manufacturer with a 1/8th gpf HEU model. Two more urinal manufacturers plan to release 1/8th gpf models next year. Equipment prices can be further reduced, with competitive pricing. We recommend that SPU contact the urinal manufacturer directly to negotiate volume hardware cost for deeper discounts
2. Equipment costs for the flush valve and diaphragms are based on actual costs incurred to purchase equipment for the purpose of this study. Costs for the diaphragm are listed for the recommended, better performance, double filter model, which is more expensive than the alternative single filter model. These costs are not adjusted for bulk pricing and also need to be refined through further investigation.
3. Labor costs were computed at \$100/hour for all three options. This was based on an initial estimate provided by a local plumbing contractor. We believe that as with the equipment costs, these costs can be lowered through more negotiation. Costs are calculated at calculated at three hours per urinal for option A, and 15-minutes per urinal for options B and C. We recommend that SPU contact reliable large, local contractors, to negotiate volume plumber labor costs.
4. Administrative costs are calculated as ten percent of all other costs. However, actual costs may vary with program delivery options.
5. The flush valves may have a rated life of 20-years. However, in reality these valves may be more frequently replaced by maintenance staff when a commercial facility is renovated or a new tenant moves in. We have assumed a conservative effective useful life of 15-years.
6. Effective useful life for the diaphragms is hard to estimate. In general, staff at sites with a regular maintenance program may replace diaphragms every 2-3 years. However, field staff found some very old diaphragms at some sites. We have assumed an effective life of two-years.

Table 10: Summary of costs for each program option

Option	Efficiency Option Description	Avg Savings (gpf)	Market Share (%)	Equipment Costs (\$)	Labor Costs (\$)	Admin Costs (\$)	EUL (yrs)	Cost Over Measure Life (\$/yr)
A	New 1/8th gpf HEU	1.03	38%	\$ 545	\$ 300	\$ 80	20	\$ 46
B	New 0.6 gpf Flush Valves	0.34	72%	\$ 45	\$ 25	\$ 20	15	\$ 6
C	New 0.3 to 1.5 gpf Diaphragm	0.20	64%	\$ 25	\$ 25	\$ 20	2	\$ 35

Appendix A

Description of Prevalent Business Types

Office – Facilities used for general office space, professional office, or administrative offices. Doctor's or dentist's office are included if they do not use any type of diagnostic medical equipment.

Examples: bank, other financial institution, doctor's or dentist's office, government office, administrative or professional office, research and development building.

Large retail – Facilities 5,000 square feet or greater that are used for retail, such as sale and display of goods other than food, or sale of a service. For this study floor area is defined as the areas served by a restroom with a urinal. This type includes restrooms with urinals serving strip mall stores over 5,000 square feet (excludes central area public restrooms). An establishment with a separate restroom (with a urinal) will be treated independent of the other establishments.

Examples: auto service or auto repair shop, repair shop, car dealership or showroom, freestanding store such as a department, furniture, clothing, hardware, drugstore, or bookstore.

Small retail – Facilities smaller than 5,000 square foot that are used for retail, such as sale and display of goods other than food, or sale of a service. For this study floor area is defined as the areas served by a restroom with a urinal. This type includes restrooms with urinals serving strip mall floor area less than 5000 square feet and central area public restrooms. For strip malls the floor area is the sum of the areas of all establishments served by a restroom with a urinal. An establishment with a separate restroom (with a urinal) will be treated independent of the other establishments.

Examples: auto service or auto repair shop, beauty parlor, barber shop, car wash, copy center, dry cleaner, gas station, post office, repair shop.

Shopping malls – Facilities comprised of multiple connected establishments enclosed in a single or internally connected multiple buildings, called out as malls. This does not include strip malls.

Examples: enclosed malls.

Grocery – Facilities used for retail or wholesale of food.

Examples: grocery store, food market, convenience store, gas/mini-mart.

Restaurant – Facilities used for preparation and sale of food and beverages for consumption.

Examples: restaurant, bar, fast food chain, cafeteria.

Lodging (hotel, motel, nursing homes) – Facilities used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings.

Examples: hotel, motel, inn, resort, retirement home, shelter, orphanage or children's home, dormitory, fraternity, or sorority, nursing home, assisted living, halfway house.

Warehouse and Storage – Facilities used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).

Examples: refrigerated or non-refrigerated warehouse.

Schools – Facilities used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of "Office," dormitories are "Lodging," and libraries are "Public Gathering."

Examples: preschool, daycare, elementary, middle school, high school, college, university.

Recreation – Facilities in which people gather for social or recreational activities, whether in private or non-private meeting halls.

Examples: theater, cinema, sports arena, casino, nightclub, gymnasium, health club, bowling alley, other recreational sports facility.

Public Gathering – Facilities in which people gather for social activities, whether in private or non-private meeting halls

Examples: social meeting center, meeting hall, convention center, library, museum, transportation terminal, funeral home, parks, places of religious worship.

Health (Hospitals and Other Medical) – Facilities used as diagnostic and treatment facilities for inpatient and outpatient care.

Examples: hospital, other inpatient health care, mental health institution, inpatient rehabilitation, outpatient rehabilitation, veterinarian's office.

Other – Facilities that do not fall under any of the above building types.

Examples: parking lot, firestation.

Appendix B

Task 1 Data Collection Form

Form 1: SWP Urinal Baseline Study		By: _____	Date: _____	Bld: _____	Rm: _____	Page / _____
BUILDING INFO						
Building Name: _____						
Business Name: _____						
Business Address: _____				Business ZIP: _____		
Business Type: Office / Large retail/ Small retail / Shopping malls / Grocery / School / Hotel,motel,nursing homes / Restaurant / Warehouse / Hospital, Other medical (health) / Recreation / Public Gathering						
Contact: (if available) _____				Contact Phone: _____		
Location: _____						
URINAL DATA						
URINAL STYLE : _____ / _____ Photo				URINAL STYLE : _____ / _____ Photo		
Qty: Std. Height _____ / ADA _____				Qty: Std. Height _____ / ADA _____		
Mfg:(if known): _____				Mfg:(if known): _____		
Model (if known): _____				Model (if known): _____		
GPF Marking: 1.0 gpf (3.8 lpf) / None / Other				GPF Marking: 1.0 gpf (3.8 lpf) / None / Other		
FLUSH VALVE (leave blank for no-water urinals):				FLUSH VALVE (leave blank for no-water urinals):		
Mounting: Exposed / Concealed(in wall) / Integral to fixture				Mounting: Exposed / Concealed(in wall) / Integral to fixture		
Spud dia.(in): 1-1/2 1-1/4 3/4 Spud lg (in) _____				Spud dia.(in): 1-1/2 1-1/4 3/4 Spud lg (in) _____		
Mfg:(if known): _____				Mfg:(if known): _____		
Model (if known): _____				Model (if known): _____		
Volume Marking(s): LC / 0.5 gpf / 1.0 gpf / 1.5 gpf / None / Other				Volume Marking(s): LC / 0.5 gpf / 1.0 gpf / 1.5 gpf / None / Other		
GPF. Est.(N/T):HE(≤0.5) ____ /LC(1.0±) ____ /WS(1.5±) ____ /FF(3.0±) ____				GPF. Est.(N/T):HE(≤0.5) ____ /LC(1.0±) ____ /WS(1.5±) ____ /FF(3.0±) ____		
Candidate Urinal: YES MAYBE NO				Candidate Urinal: YES MAYBE NO		
TOILET DATA						
TOILET STYLE : _____ / _____				TOILET STYLE : _____ / _____		
Quantity: _____				Quantity: _____		
Type: Flush valve / Gravity tank / Pressure assist				Type: Flush valve / Gravity tank / Pressure assist		
Bowl Mfg:(if known): _____				Bowl Mfg:(if known): _____		
Bowl Marking: 1.6 gpf (6 lpf) / None				Bowl Marking: 1.6 gpf (6 lpf) / None		
FV Mfg:(if known): _____				FV Mfg:(if known): _____		
FV Marking(s): LC / 1.6 gpf / 3.5gpf / None / NA				FV Marking(s): LC / 1.6 gpf / 3.5gpf / None / NA		
Probable Rated GPF: HE(≤1.28) / LC(1.6 ±) / WS(3.5 ±)				Probable Rated GPF: HE(≤1.28) / LC(1.6 ±) / WS(3.5 ±)		
NOTES: (Suitability for sample and other information)						

Form 1 page 2	
URINAL DATA	
URINAL STYLE : ____ / ____ Photo Qty: Std. Height ____ / ADA ____ Mfg: (if known): _____ Model (if known): _____ GPF Marking: 1.0 gpf (3.8 lpf) / None / Other FLUSH VALVE (leave blank for no-water urinals): Mounting: Exposed / Concealed(in wall) / Integral to fixture Spud dia.(in): 1-1/2 1-1/4 3/4 Spud lg (in) _____ Mfg: Sloan / Zurn / Delaney / Mansfield / Toto / UKN / Other Model (if known): _____ Volume Marking(s): LC / 0.5 gpf / 1.0 gpf / 1.5 gpf / None / Other GPF. Est.(N/T): HE(≤ 0.5) ____ / LC(1.0 $\pm$) ____ / WS(1.5 $\pm$) ____ / FF(3.0 $\pm$) ____ Candidate Urinal: YES MAYBE NO	URINAL STYLE : ____ / ____ Photo Qty: Std. Height ____ / ADA ____ Mfg: (if known): _____ Model (if known): _____ GPF Marking: 1.0 gpf (3.8 lpf) / None / Other FLUSH VALVE (leave blank for no-water urinals): Mounting: Exposed / Concealed(in wall) / Integral to fixture Spud dia.(in): 1-1/2 1-1/4 3/4 Spud lg (in) _____ Mfg: Sloan / Zurn / Delaney / Mansfield / Toto / UKN / Other Model (if known): _____ Volume Marking(s): LC / 0.5 gpf / 1.0 gpf / 1.5 gpf / None / Other GPF. Est.(N/T): HE(≤ 0.5) ____ / LC(1.0 $\pm$) ____ / WS(1.5 $\pm$) ____ / FF(3.0 $\pm$) ____ Candidate Urinal: YES MAYBE NO
TOILET DATA	
TOILET STYLE : ____ / ____ Quantity: ____ Type: Flush valve / Gravity tank / Pressure assist Bowl Mfg.: Am Std / Crane / Eljer / Gerber / Kohler / UKN / Other Bowl Marking: 1.6 gpf (6 lpf) / None FV Mfg: (if known): _____ FV Marking(s): LC / 1.6 gpf / 3.5gpf / None / NA Probable Rated GPF: HE(≤ 1.28) / LC(1.6 $\pm$) / WS(3.5 $\pm$)	TOILET STYLE : ____ / ____ Quantity: ____ Type: Flush valve / Gravity tank / Pressure assist Bowl Mfg.: Am Std / Crane / Eljer / Gerber / Kohler / UKN / Other Bowl Marking: 1.6 gpf (6 lpf) / None FV Mfg: (if known): _____ FV Marking(s): LC / 1.6 gpf / 3.5gpf / None / NA Probable Rated GPF: HE(≤ 1.28) / LC(1.6 $\pm$) / WS(3.5 $\pm$)
NOTES: (Suitability for sample and other information)	

Instructions to Complete Task 1 Data Collection Form

General

By: Three letter initials of SBW field staff

Date: Date field staff visited the site

Bld: The sequential number of the site visited on a particular day. The site number starts from one each day. Each subsequent site takes the next number in order.

Rm: The restroom number within each site visited. The field staff can use up to 2 restrooms per business type.

The urinal or toilet style combined with the date, building number and room number creates an exclusive identifier for each urinal observed, as show below:

First 2 characters: “U_” for urinal ID and “T_” for toilet ID

Next 9 characters – Date of site visit in mmddyy format

Next 2 characters – Sequential number of the site visited on a particular day, starting with ‘01’

Next 1 character – Sequential number of restroom in a site.

Next 1 characters – Sequential number of urinal or toilet in the restroom.

For example, ‘U_080407_2111’ represents the first urinal, in the first restroom of the twenty-first site visited on August 04, 2007.

Building Information

Building Name: Enter the name of the building, if it has a unique name.

Business Name: Enter the name of the business.

Business Address: Enter the street address of the business.

Business Zip: Enter the 5-digit postal zip code for the building.

Business Type: Circle one of 13 possible business types. Choices include Office, Large retail, Small retail, Shopping malls, Grocery, School, Hotel,motel,nursing homes, Restaurant, Warehouse, Hospital, Other medical (health), Recreation, and Public Gathering. See Appendix A for a definition of each business type.

Contact: Enter the contact name, if a contact person is identified or provided.

Contact Phone: If the contact name is entered, also enter the contact phone number (if available).

Location: A brief description of the restroom location in the building.

Urinal Data

Urinal Style [# / #]: Starting with 1, sequentially number each unique urinal style using the method sequential number / total number of unique urinals in restroom. The urinal style combined with the date, building number and room number creates an exclusive identifier for each urinal observed.

Photo: If the urinal or flush valve is unusual or cannot be identified, take a photo and circle the photo text. Using the unique site ID plus the urinal style number name the photo for later use.

Qty: Record the quantity for each of the Standard Height and ADA Height urinals of this urinal style. The rim of an ADA accessible urinal must be no higher than 17 inches above the finished floor. The rim must be elongated, but a minimum horizontal projection is not specified.

Mfg: If available, determine the urinal manufacturer and record it on this line. Examples: American Standard, Crane, Eljer, Falcon (Sloan), Kohler, Standard.

Model: If available, determine the urinal model and record it on this line.

GPF Marking: If listed, observe the gallons per flush on the urinal and circle the appropriate value. Choices include 1.0 gpf (3.8lpf), none and other.

Flush Valve Mounting: Determine the flush valve mounting and circle the appropriate value. Possible mounting types include:

Exposed – A type of flush valve in which the flush activator and the flush mechanism are exposed in the room.

Concealed (in wall) – A type of flush valve in which the flush activator is the only portion exposed in the room and the flush mechanism is hidden behind the wall.

Integral to fixture – A type of flush valve in which the flush activator and the flush mechanism are contained within the urinal fixture and only the flush activator is exposed in the room.

Flush Valve Mfg: If possible, determine the flush valve manufacturer record it on this line. Examples: Sloan, Zurn, Delaney, Mansfield, and Toto.

Flush Valve Model: If possible, determine the flush valve model record it on this line.

Flush Valve Volume Marking(s): If the flush valve has a stamped volume marking, circle the appropriate value. Choices include:

LC – Flush valve is marked LC (Low Consumption)

0.5 gpf – Flush valve is marked 0.5 gpf

1.0 gpf – Flush valve is marked 1.0 gpf

1.5 gpf – Flush valve is marked 1.5 gpf

None – No markings are found on flush valve

Other – Flush valve is marked something other than the four choices. Record the marking in the notes section. Example: ‘sensor’ for flush valves operated by motion sensors.

Flush Valve GPF Est.(N/T): Estimate the gallons per flush for each urinal flush valve in the restroom. Record the number of flush valves that fall into each flush range. Flush range choices are:

HE (< 0.5) – Flush valve gpf estimate is 0.5 gpf or less (High Efficiency).

LC (1.0+) – Flush valve gpf estimate is 1.0 gpf to 1.4gpf (Low Consumption).

WS (1.5+) – Flush valve gpf estimate is 1.5 gpf to 2.9gpf.

FF (3.0+) – Flush valve gpf estimate is 3.0 or greater.

Candidate Urinal: Determine if the restroom is a good candidate for the second sample and circle the appropriate choice. Appropriate choices are Yes, Maybe and No. Any additional information can be provided under the notes section. Good candidates are those where:

- The facility contact showed enthusiasm for the study and is likely to be cooperative.
- The urinal equipment is in sound condition
- The urinal type is of a common variety as observed during the initial inventory
- The flush valve type is of a common variety as observed during the initial inventory

Toilet Data:

Toilet Style [# / #]: Starting with 1 sequential number each unique toilet style using the method sequential number / total number of unique toilets in restroom. The toilet style combined with the date, building number and room number creates an exclusive identifier for each urinal observed.

Quantity: Record the quantity of toilets for this toilet style on this line.

Type: Determine the toilet type and circle the appropriate value. Choices include flush valve, gravity tank, and pressure assist.

Bowl Mfg: If possible, determine the urinal manufacturer and record it on this line. Examples: American Standard, Crane, Eljer, Gerber, and Kohler.

Bowl Marking: If stamped on the toilet bowl, provide the gallons per flush on this line. Choices include 1.6 gpf (6 lpf), and none.

Flush Valve Mfg: If possible, determine the flush valve manufacturer on this line. Example: Sloan, Zurn, Delaney, Mansfield, and Toto.

Flush Valve Marking(s): If the toilet flush valve has a stamped GPF marking record it on this line. Choices include 1.6 gpf, 3.5 gpf, none, and not applicable.

Probable Rated GPF: Estimate the gallons per flush for each toilet flush valve in the restroom. Record the number of flush valves that fall into each flush range. Flush range choices are:

HE(<1.28) – Flush valve gpf estimate is 1.28 gpf or less (High Efficiency).

LC (1.6+) – Flush valve gpf estimate is 1.6 to 2 gpf (Low Consumption).

WS (3.5+) – Flush valve gpf estimate is 3.5 gpf or higher.

Appendix C

Task 3 Urinal Flow and Performance Measurement Protocol

Urinal Flow and Performance Measurement Protocol

Facility: _____ Date: _____

Urinal ID _____ Urinal Location _____

Task 3 Test Protocol (Existing Urinals)

2.0 Dilution – Existing Conditions:

2.1 Flush urinal twice.

2.2 Add 100 cc prepared 3500 uS NaCl solution to bowl.

2.3 Stir, measure and record conductivity in the bowl.

_____ uS (preflush)

2.4 Flush once.

2.5 Re-measure and record conductivity.

_____ uS (post flush)

3.0 Flush Volume – Existing Conditions:

3.1 Remove stop valve cover (if present) and, with a marker pen, mark the position of the valve adjustment slot. Then turn valve clockwise until it is completely closed, counting and recording the number of turns.

_____ Turns

3.2 Loosen (but do not remove) the flush valve from the stop valve, and remove the vacuum breaker assembly tail piece between the flush valve and urinal. In place of tail piece, install flow meter and vacuum breaker assembly provided by Roger van Gelder, and re-tighten flush valve connection to urinal. Place drip container directly below vacuum breaker assembly. (Note: If for some reason the flow meter assembly cannot be used, use the diversion hose assembly, bucket, scales, and back pressure meter, also provided by Roger van Gelder, to measure flush volume.)

3.3 Open stop valve to its original position.

3.4 Zero flow meter, and with one hand pushing down on the connection of the flow meter hose to the urinal spud, flush the urinal, and record flush volume. Repeat twice, zeroing flow meter each time, for a total of three flow volume measurements, and take the average.

_____ gpf, _____ gpf, _____ gpf, _____ Avg. gpf

3.5 Repeat step #3.4 above, except with stop valve within one half turn of wide open, unless this was the position in which it was originally found.

_____ gpf, _____ gpf, _____ gpf, _____ Avg. gpf

3.6 Repeat dilution test with stop valve within one half turn of wide open.

_____ uS (preflush), _____ uS (post flush)

Appendix D

Task 3 Data Collection Form

Form 2: SWP Urinal Baseline Study		By: _____	Date: _____	Bld: _____	Rm: _____	Page / _____
BUILDING INFO						
Building Name: _____						
Business Name: _____						
Business Address: _____					Business ZIP: _____	
Contact: (if available) _____				Contact Phone: _____		
Public	Private	Location: _____				
URINAL DATA						
URINAL STYLE : _____ / _____		Style Edit	Photo	URINAL STYLE : _____ / _____		Style Edit Photo
Shutoff Access: Yes No		Shutoff Access: Yes No				
Material: Porcelain / Stainless / Composite / Other		Material: Porcelain / Stainless / Composite / Other				
Mount: Wall-back outlet / Wall-bottom outlet / Flr-full ht / Flr-ped		Mount: Wall-concealed trap / Wall-exposed trap / Flr-full ht / Flr-ped				
Type: Washdown / Siphon-jet / Blowout-ext / Blowout-std / Trough / No-water		Type: Washdown / Siphon-jet / Blowout-ext / Blowout-std / Trough / No-water				
FLUSH VALVE (leave blank for no-water urinals):		FLUSH VALVE (leave blank for no-water urinals):				
Type: Diaphragm / Piston / Spring loaded / Tank / UKN / Other		Type: Diaphragm / Piston / Spring loaded / Tank / UKN / Other				
Activation: Manual / Sensor / Periodic / Continuous		Activation: Manual / Sensor / Periodic / Continuous				
Urinals per FV: Single / Multiple: _____		Urinals per FV: Single / Multiple: _____				
Stop Connection: Slip joint / Ground joint / Threaded / UKN		Stop Connection: Slip joint / Ground joint / Threaded / UKN				
Flush Vol(N/T): Minimal _____ / Moderate _____ / Long _____		Flush Vol(N/T): Minimal _____ / Moderate _____ / Long _____				
Urinal Condition: _____		Urinal Condition: _____				
Bolt Height (in.): _____		Bolt Height (in.): _____				
Lip Height (in.): _____		Lip Height (in.): _____				
Approximate Age (yrs): _____		Approximate Age (yrs): _____				
Repair Parts: _____		Repair Parts: _____				
NOTES:						

Note: With the exception of a few sites where this was missed, field staff also collected supply height even though it is not listed on the form. Early in the data collection process it was recognized that is critical to know the urinal dimension and location of plumbing in the wall – important for a urinal retrofit program.

Instructions to Complete Task 3 Data Collection Form

Building Identification, Building Information and Urinal Style are retrieved from Form1 of the Initial Inventory.

Building Identification:

Enter the Building Identification as it appears at the top of Form1 of the Initial Inventory for the selected building.

Building Information:

Building Name: Enter the name of the building as it appears on Form1 of the Initial Inventory for the selected building..

Business Name: Enter the name of the business as it appears on Form1 of the Initial Inventory for the selected building..

Business Address: Enter the street address of the business as it appears on Form1 of the Initial Inventory for the selected building..

Business Zip Code: Enter the 5-digit postal zip code for the building as it appears on Form1 of the Initial Inventory for the selected building..

Contact: Enter the contact name as it appears on Form1 of the Initial Inventory for the selected building.

Phone Number: Enter the contact phone number as it appears on Form1 of the Initial Inventory for the selected building.

Location: Enter the Location as it appears on Form1 of the Initial Inventory for the selected building.

Public or Private: Determine if the restroom is Public or Private and circle the appropriate answer. A public restroom is one that is available for use by the general public.

Urinal Data:

Collect Task3 Form 1 Urinal Data for each urinal in the room.

Urinal Style # / #: Enter the Urinal Style as it appears on Form1 of the Initial Inventory for the selected building. If more than one urinal per style include a note using a unique identifier for each urinal (left, right, Std, ADA, etc.)

Style Edit: Circle the Style Edit text if any change in the urinal style has occurred since the Initial Inventory site visit. Enter Yes in the database if a Style Edit has been circled, enter No if not circled.

Photo: If a Style Edit has been indicated take a new photo of the urinal and circle the Photo text. Enter Yes in the database if Photo has been circled, enter No if not circled..

Shutoff Access: Determine if the water feeding the urinals can be turned off and restarted without incident. Enter yes or no.

Material: Determine the type of material the urinal bowl is made of and circle the appropriate answer. Common materials to be observed are Porcelain, Stainless Steel, Composite (High Performance

Composites and fiberglass). Other types of materials could include copper and concrete. If an other type is encountered, circle Other and write the material type in the notes section at the bottom of the page.

Mount: Determine the urinal mount type and circle the appropriate answer. Possible mount types include:

Wall-back outlet – Urinals with integrated trap systems which attaches at a wall drain.

Wall-bottom outlet – Urinal that does not have an integrated trap system and attaches at to a wall drain.

Floor-full height – A chest high urinal extending to the floor and incorporating a below floor trap.

Floor-pedal – A urinal that looks much like a floor toilet bowl without a seat. These types of urinals normally have an integrated trap and drain into the floor.

Type: Determine the urinal flush type and circle the appropriate value. Possible flush types include:

Washdown – No jet in trapway, no audible “glug” at finish of flush. For concealed trap wall mount, bottom bolts are generally 3” – 5” below rim. All exposed trap wall mount and full length floor mount are washdown.

Siphon-jet – Audible “glug” at finish of flush. Bottom bolts generally 6” – 7.5” below lip. May have visible jet in trapway.

Blowout-extended – Loud flush. May be 4-bolt or 2-bolt. Bottom bolts generally less than 3” below rim. Extends around 20” from wall, with top surface of urinal only 7” – 8” above front of rim.

Blowout-standard – Loud flush. Bottom bolts generally less than 3” below rim. Extends less than 14” from wall. May have nipple at bottom (exterior) or trap.

Flush Valves

Type: Determine the flush valve type and circle the appropriate text.

Diaphragm: Most common, with mushroom top. May be sensor or manual operated. Sensor may be on top, at side in place of handle, or recessed in wall. Models include:

- Sloan “Royal” (angular, sloped cap)
- Sloan “Regal” (round edged vertical sided cap)
- Sloan “Optima” (sensor in cap)
- Zurn “Aquavantage” (manual or side/wall sensor. Side sensor has square “eye” and short battery compartment)
- Zurn “Aquasense” (side mount sensor only, with round “eye” and battery compartment extending behind valve)
- Delaney “Flushboy” (generally with ground joint connection)

Piston – Cylindrical, with handle coming out at 90 degrees to side. May have adjustment screw on top. Generally manual operated, but some sensor operated models.

- Sloan “Gem 2”
- Sloan “Naval” or “Crown” (with adjustment screw on top)
- Sloan “Crown II” (LC only, no adjustment screw)
- Zurn “Metroflush”
- Toto “TMU” (manual, with adjustment screw on top)
- Toto “TEU” (with battery operated integral sensor)
- Toto “TET” (with turbine battery recharger)

Spring Loaded – Manual push button or handle operated. Flush volume depends on manual adjustment, water pressure, and how far button or handle is pushed. Side handle may extend with an upward angle. May have threaded stop connection.

- Sloan “Dolphin” (handle angles upward. May be adjusted up to 16 gpf)
- Mansfield “190” (push button, straight through, ½” threaded pipe connection)
- Mansfield “Torpedo” (push button, angle stop, ¾” threaded pipe connection)

Tank – Wall mounted gravity tank in same room or behind wall, with float valve. Generally operates multiple urinals and may be pull chain or timer operated.

Unknown – Valve types encounter by field staff that may be inaccessible.

Other (Electro-Mechanical) – Sensor operated with internal solenoid. Volume of flush depends on pressure and dip switch setting. Manufacturers include Moen and Geberit (discontinued).

Activation: Determine the flush valve activation type and circle the appropriate value. Possible activation types include:

Manual – The activator is manually moved to initiate a flush.

Sensor – A motion detector is used to initiate a flush.

Periodic – A timer is used to periodically flush the urinal.

Continuous – The urinal is kept clean by water flowing continuously.

Urinals per FV: Determine if the flush valve activates a single urinal or multiple urinals and circle the appropriate value. If the flush valve activates multiple urinals record the number in the blank provided.

Stop Connection: Determine the flush valve stop connection type and circle the appropriate value. Possible entries include:

Slip Joint – A type of joint that uses a compression ring to join two pieces of pipe together.

Ground Joint – A type of joint that uses machined surfaces to join two pieces of pipe together.

Threaded – A type of joint that uses threaded surfaces to join two pieces of pipe together.

Unknown – Connection types not described above

Flush Vol. (N/T): Estimate the flush volume and circle the appropriate value.

Minimal – Appears to flush with minimum necessary volume, or less, for this type of fixture. Savings potential, without changing fixture, may be minimal.

Moderate – Does not flush with excessive volume, but may have potential for savings of 0.5 gpf or more through adjustments to flush valve.

Long – Appears to use significantly greater volume than necessary for this type of fixture, with savings potential of 1.0 gpf or more likely through adjustments to flush valve.

Urinal Condition: Record the overall condition of the urinal. Note items such as running continuously, plugged, leaking, etc.

Bolt Height: Measure the distance between floor and trap mounting bolts (in inches) and record it on the line provided.

Lip Height: Measure the distance between floor and flood rim of urinal (in inches) and record it on the line provided.

Supply Height: Measure the distance between floor and the center of the water supply line (in inches) and record it on the line provided.

Approximate Age: Estimate the approximate age of the urinal (years) and record it on the line provided.

Repair Parts: Record on the line provided the make and model of replacement diaphragms (or pistons) kept on-site.

Appendix E

Task 5 Urinal Test Protocol for Efficiency Options

Facility: _____ Date: _____

Urinal ID _____ Urinal Location _____

Task 5 Test Protocol (Efficiency Options)

1.0 Existing Conditions, with stop valve wide open. (All Valves)

- 1.1 Unless Task 5 is being done immediately subsequent to Task 3, repeat steps 3.3 through 3.6 above.

2.0 Water Pressure Measurement and Flush Valve Replacement Option (All Valves)

- 2.1 Turn off stop valve, remove existing flush valve, and install adjustable flush valve with pressure gauge along with flow meter and vacuum breaker assembly.
- 2.2 Turn on stop valve and record approximate average static pressure. Flush and record minimum flowing pressure.

_____ psi Avg. Static, _____ psi Min. Flowing

- 2.3 Determine and repeatedly test using prepared salt solution and conductivity meter to determine minimum flush volume required to achieve minimum post flush conductivity reading of 110 uS (or approx. 99% dilution of test solution). Record minimum flush volume and number of turns from all the way in for the adjustment screw on top of the flush valve to achieve a maximum of 110 uS post flush conductivity. Start at an expected flush volume and then increase or decrease in 0.25 gpf increments or as appropriate (it is not necessary to complete measurements for all values given below.)

1.75 gpf, _____ uS, _____ Turns
1.50 gpf, _____ uS, _____ Turns
1.25 gpf, _____ uS, _____ Turns
1.00 gpf, _____ uS, _____ Turns
0.75 gpf, _____ uS, _____ Turns
0.50 gpf, _____ uS, _____ Turns
0.33 gpf, _____ uS, _____ 0 _____ Turns
_____ gpf, _____ uS, _____ Turns

3.0 Diaphragm Option (Manual or Sensor Valves Using Standard Diaphragms Only)

- 3.1 Reinstall original flush valve, leaving flow meter assembly attached.
- 3.2 Replace existing diaphragm with a new diaphragm with expected flush volume closest to the minimum flush volume determined in step 2.3 above. If rated volume for existing diaphragm is closest, replace existing diaphragm with new diaphragm with same rated volume.
- 3.3 With stop valve within one half turn of wide open, flush and record new flush volume three times.

_____ gpf, _____ gpf, _____ gpf, _____ Avg. gpf

Perform the dilution test with stop valve within one half turn of wide open.

_____ uS, _____ Turns

Note: Maximum target for post flush conductivity readings was lowered from 110 uS to around 85uS.