How You Can Apply the Benefits of the WDC to Your Upcoming Projects

Right-Sizing is the 2nd Domino

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What Are We Aiming For?

1. People want:
   - The water flowing from their showers and faucets to “feel” right.
   - Their toilets to flush first time, every time.
   - Clean clothes, dishes and bodies
   - The service of hot water, as efficiently as possible.
2. It does not make sense to discuss efficiency until the desired service has been provided.

Time-to-Tap is the 1st Domino

Increase Customer Satisfaction

Save money by:
Water efficient floor plans
Smaller diameter piping

Savings: ≈ $1,000-$2,000 per single-family dwelling

Code Changes and Implications of Residential Low-Flow Hot Water Fixtures
CEC-500-2021-043
https://www.energy.ca.gov/publications/2021/code-changes-and-implications-residential-low-flow-hot-water-fixtures

Reduce the Distance from Source to Use

- The shorter the pipe, the less time it takes.
  - The smaller the pipe diameter, the less time it takes too!
- ***But***, the lower the flow rate, the longer it takes.
- How long is too long?
  - 5 seconds? 10 seconds? Longer? Shorter?

Water, energy and time efficient hot water systems start with deciding how long we want people to wait.

The decision on the location of the wet-room(s) and the mechanical room(s) is made by the architect.

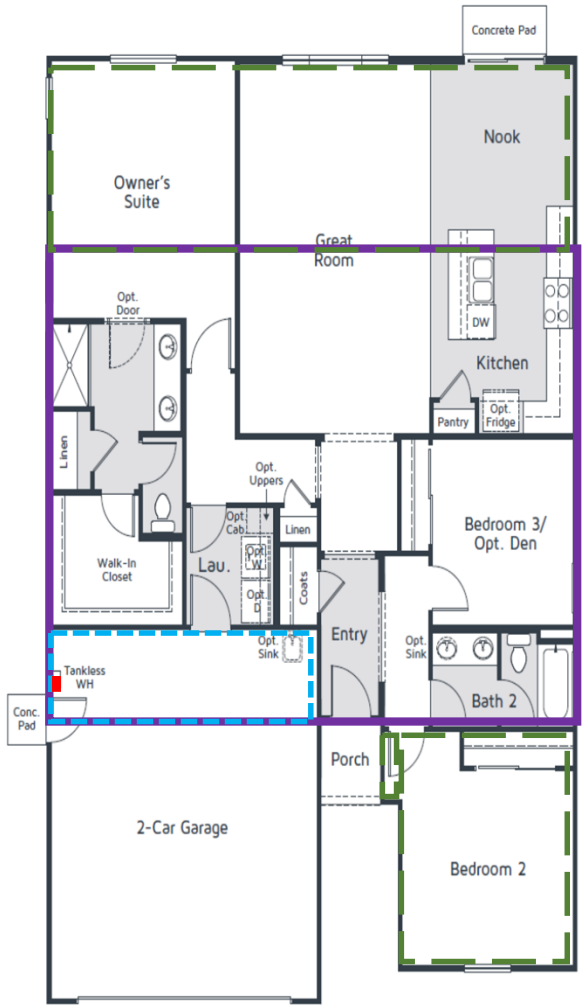
Better floor plans can lead to better hot water system performance.

Better floor plans decrease the residence time in the premise plumbing system (hot and cold) too!

Distance Between the Wet Rooms and the Water Heater

Example:

1 Story
3Br/2Ba
1,697 sq ft
Fresno, CA
~67% (1137 sq ft)



Relationship between the Hot Water System and the Floor Area – The Logical Worst Case

Number of Stories	Hot Water System/ Floor Area (%)
1-story	100%
2-story	50%
3-story	33.3%
4-story	25%
5-story	20%

Basements count as stories if they contain wet rooms.

How Long Should We Wait?

Volume in the Pipe (ounces)	Minimum Time-to-Tap (seconds) at Selected Flow Rates					
	0.25 gpm	0.5 gpm	1 gpm	1.5 gpm	2 gpm	2.5 gpm
2 1	4	1.9	0.9	0.6	0.5	0.4
4 2	8	4	1.9	1.3	0.9	0.8
8 4	15	8	4	2.5	1.9	1.5
16 8	30	15	8	5	4	3
24 12	45	23	11	8	6	5
32 16	60	30	15	10	8	6
64 32	120	60	30	20	15	12
128 64	240	120	60	40	30	24

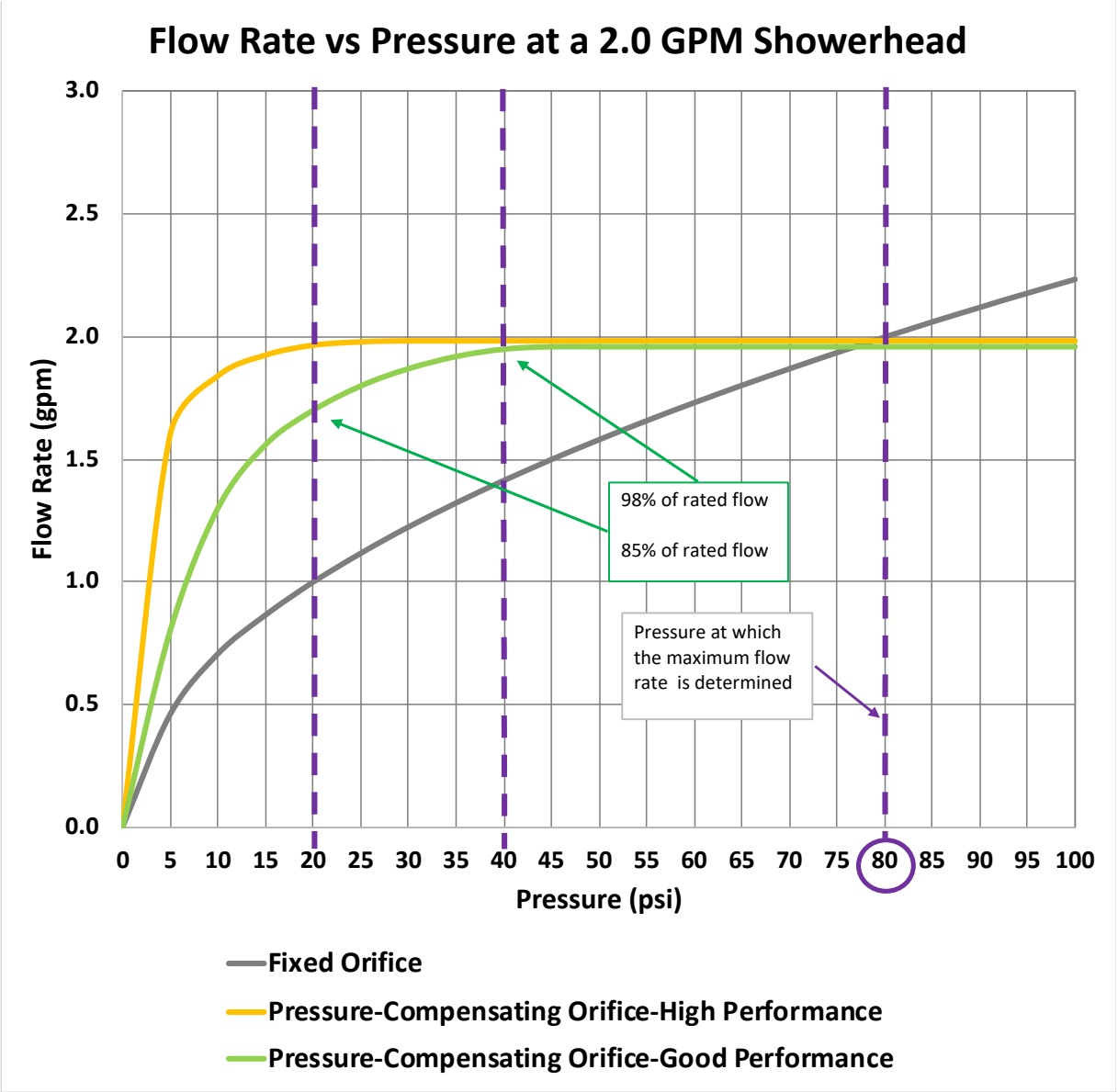
Cut the pipe volume in half to get these times

ASPE Time-to-Tap Performance Criteria

	Acceptable Performance	1 – 10 seconds
	Marginal Performance	11 – 30 seconds
	Unacceptable Performance	31+ seconds

Source: Domestic Water Heating Design Manual – 2nd Edition, ASPE, 2003, page 234

Which one do you want?



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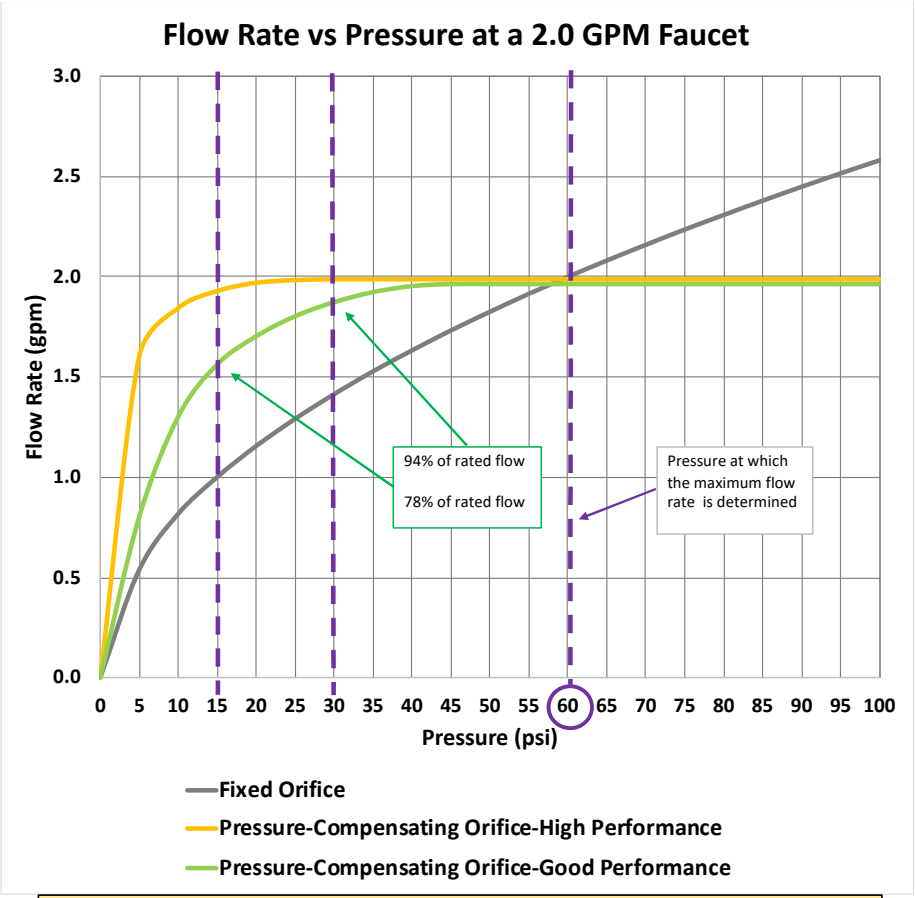


Select Good or High-Performance Faucet Aerators to Increase Customer Satisfaction.

Right-Sizing the Piping is the 2nd Domino

Pipe Savings both Hot and Cold

Feet: No change

Savings: ≈$5,000

$54/apartment

Meadows Senior Living – Phase I

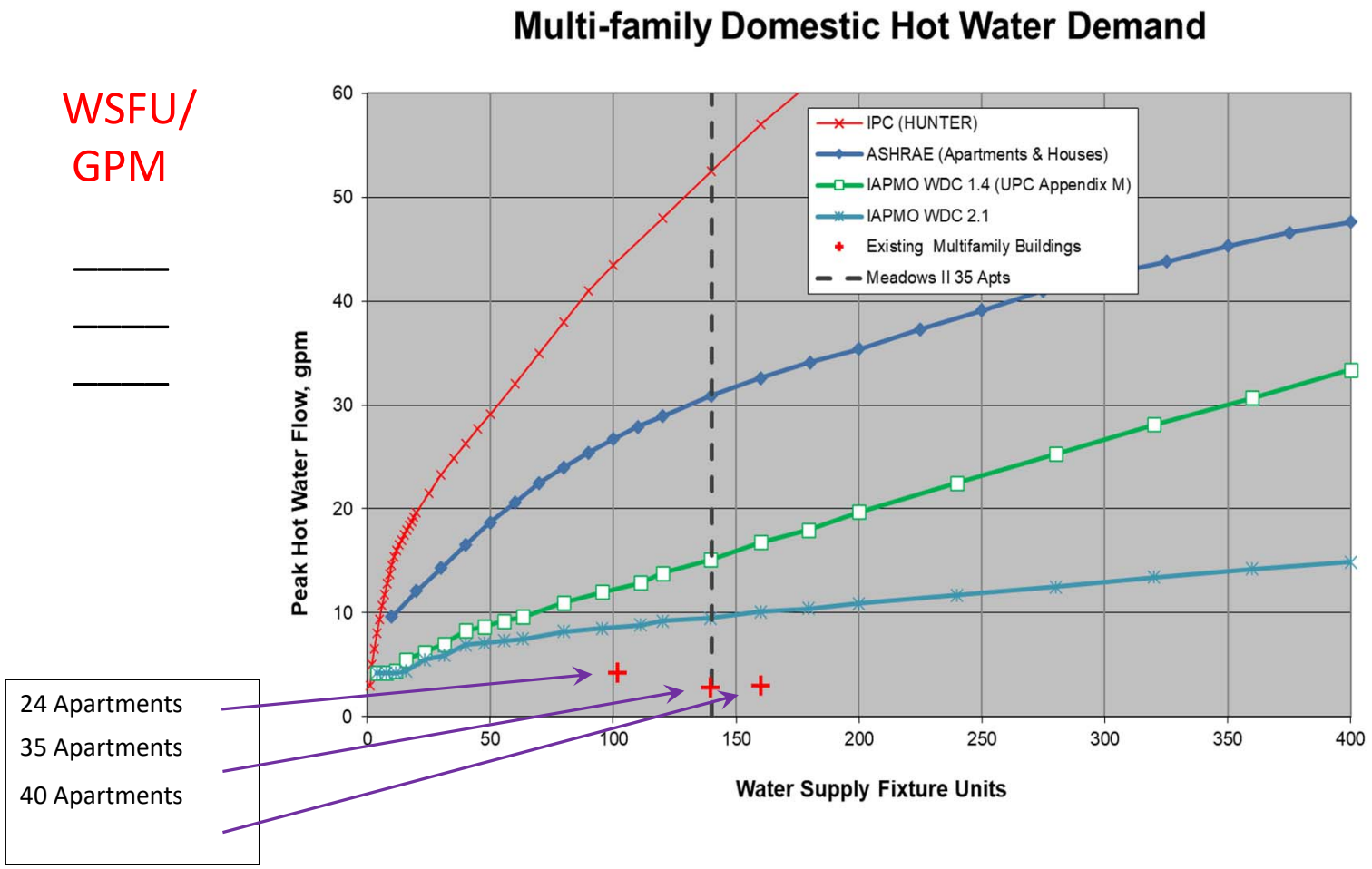
Meadows Senior Living – Phase II

Solara – 4 Building 24 Unit Multi-Family Project

How Big is the Peak Hot Water Flow Rate?

99th Percentile WSFU/ GPM

24 Apartments _____
35 Apartments _____
40 Apartments _____

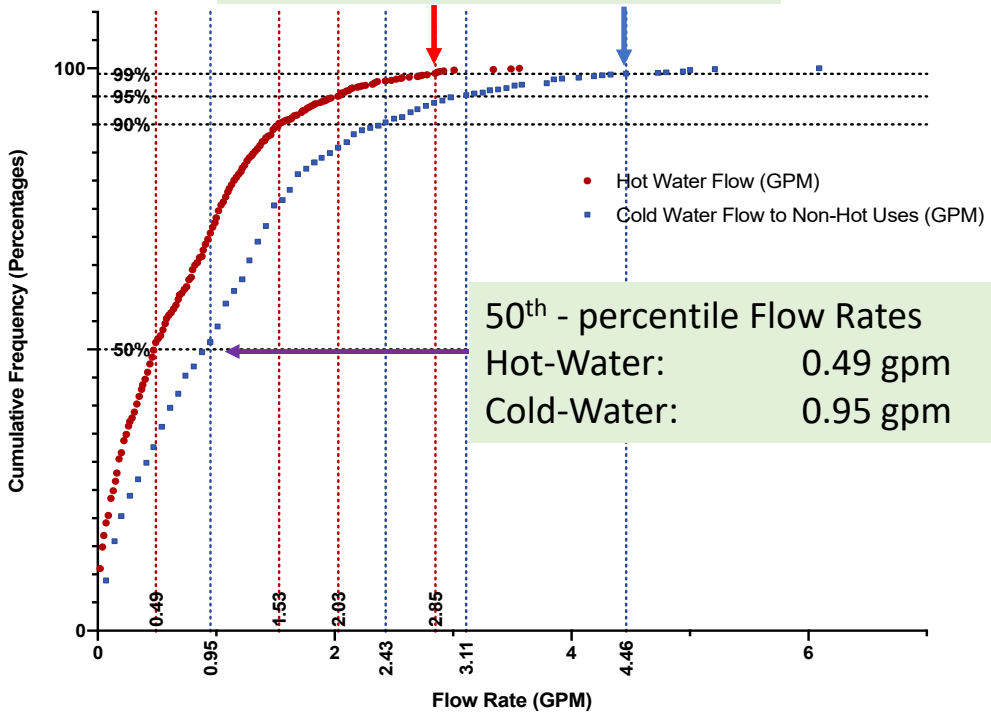


Meadows Phase I – Building E, Senior housing

Peak Flow Rates – 1 minute data, Typical Day

We use this to help size the piping

99th - percentile Peak Flow Rates
Hot-Water: 2.85 gpm
Cold-Water: 4.46 gpm



50th - percentile Flow Rates
Hot-Water: 0.49 gpm
Cold-Water: 0.95 gpm

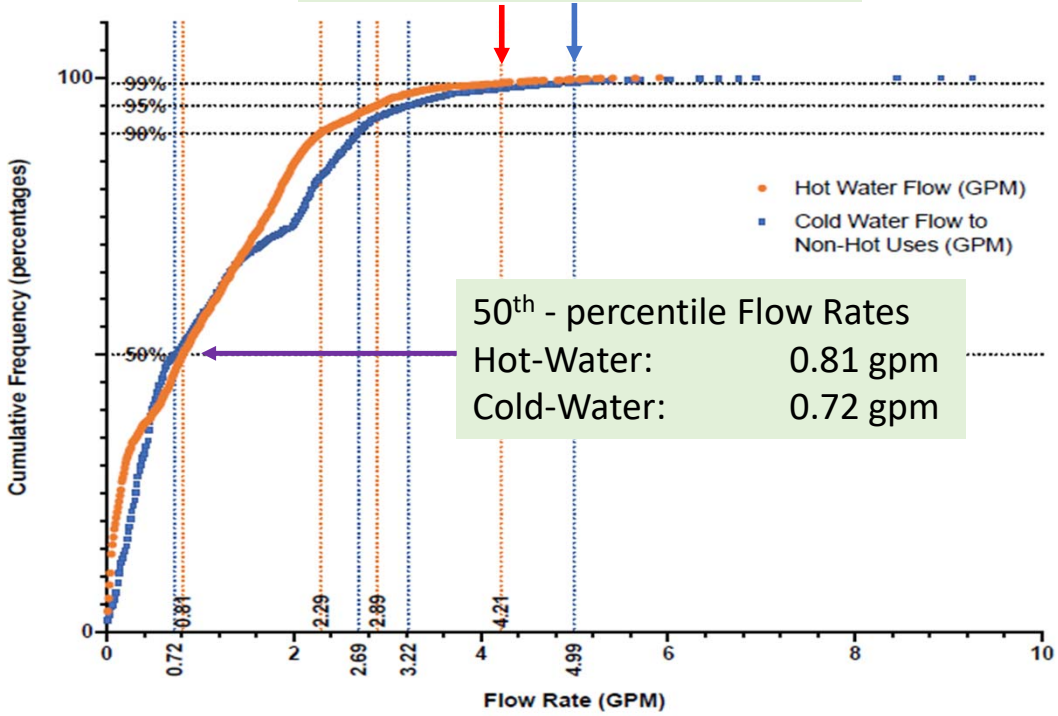
1-minute DHW draws Solara – Building 3 Rotterdam, NY

(24-unit family NetZero housing full occupancy – approx. 38 persons)

Statistics by William Skinner

Note: zero flows were removed.

99th - percentile Peak Flow Rates
Hot-Water: 4.21 gpm
Cold-Water: 4.99 gpm



50th - percentile Flow Rates
Hot-Water: 0.81 gpm
Cold-Water: 0.72 gpm

Pete's Epiphany

"If the flows are so low, why are the supply pipes so big?"

Peter Skinner, P.E. circa 2019
e2g@verizon.net

Todd's Corollary

"If the peak flow rate is only 20 gpm, why are the drains sized for 200 gpm?"

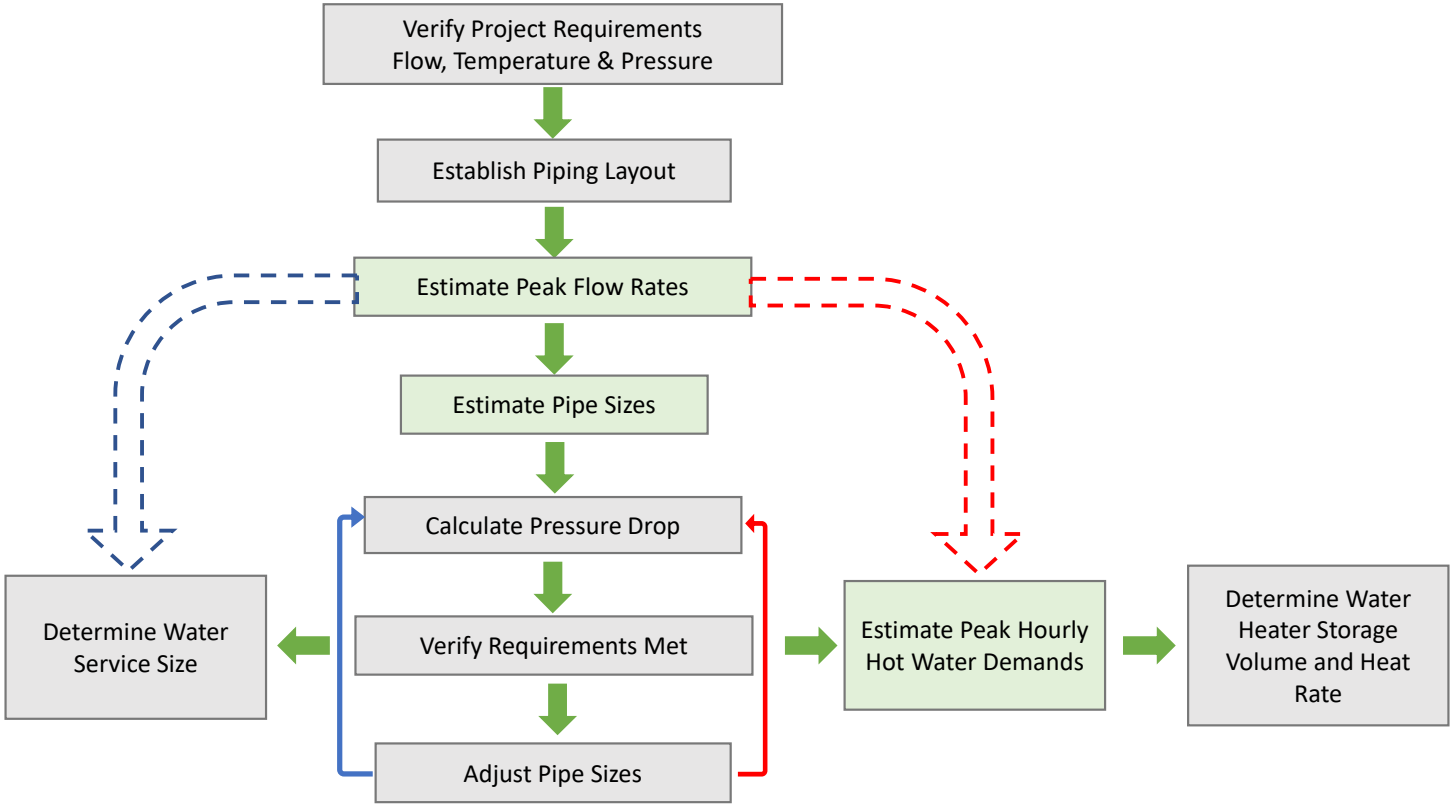
Todd Kuchta, P.E. December 2021
toddk@jwmcclenahanco.com

Right-Size the Plumbing

Which Pipe Sizing Method(s) do you use?

1. International Code Council (ICC)
    1. International Residential Code (IRC)
    2. International Plumbing Code (IPC)
    3. Local adoption as amended?
    4. NYS Stretch Code – IECC
2. International Association of Plumbing and Mechanical Officials (IAPMO)
    1. Uniform Plumbing Code (UPC)
    2. Local adoption as amended?
    3. UPC Appendix M – Water Demand Calculator
3. American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)
4. American Society of Plumbing Engineers (ASPE)
5. Others?

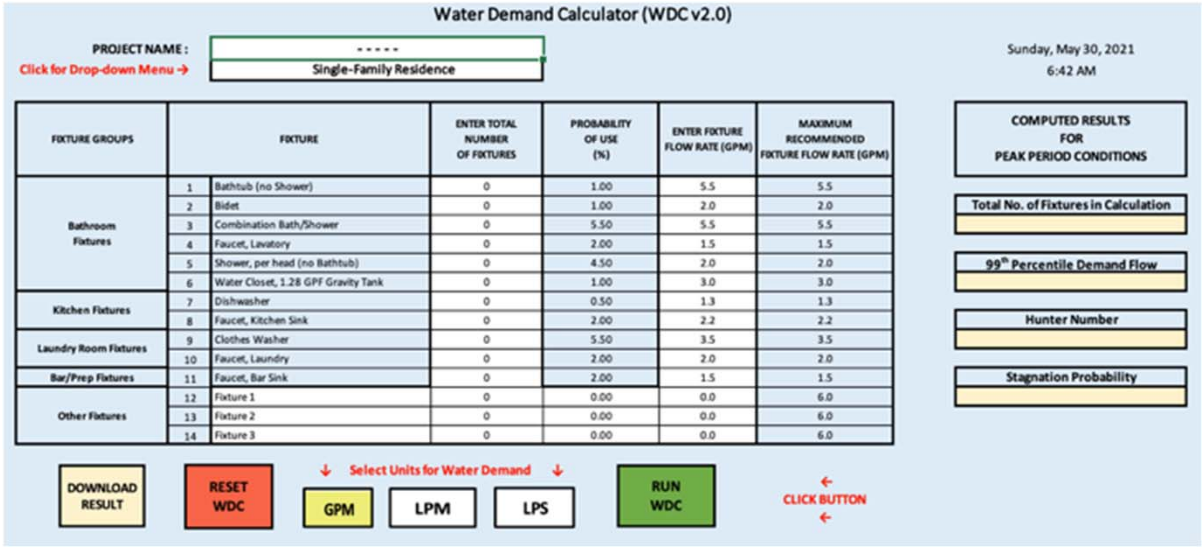
Domestic Water System Design Process



Which Sizing Methods Do You Use?

IAPMO Water Demand Calculator

WDC Version 2.0 and 2.1



Water Demand Calculator (WDC v2.0)

PROJECT NAME : - - - - -

Click for Drop-down Menu → Single-Family Residence

Sunday, May 30, 2021
6:42 AM

FIXTURE GROUPS		FIXTURE	ENTER TOTAL NUMBER OF FIXTURES	PROBABILITY OF USE (%)	ENTER FIXTURE FLOW RATE (GPM)	MAXIMUM RECOMMENDED FIXTURE FLOW RATE (GPM)
Bathroom Fixtures	1	Bathtub (no Shower)	0	1.00	5.5	5.5
	2	Bidet	0	1.00	2.0	2.0
	3	Combination Bath/Shower	0	5.50	5.5	5.5
	4	Faucet, Lavatory	0	2.00	1.5	1.5
	5	Shower, per head (no Bathtub)	0	4.50	2.0	2.0
	6	Water Closet, 1.28 GPF Gravity Tank	0	1.00	3.0	3.0
Kitchen Fixtures	7	Dishwasher	0	0.50	1.3	1.3
	8	Faucet, Kitchen Sink	0	2.00	2.2	2.2
Laundry Room Fixtures	9	Clothes Washer	0	5.50	3.5	3.5
	10	Faucet, Laundry	0	2.00	2.0	2.0
Bar/Prep Fixtures	11	Faucet, Bar Sink	0	2.00	1.5	1.5
Other Fixtures	12	Fixture 1	0	0.00	0.0	6.0
	13	Fixture 2	0	0.00	0.0	6.0
	14	Fixture 3	0	0.00	0.0	6.0

COMPUTED RESULTS FOR PEAK PERIOD CONDITIONS

Total No. of Fixtures in Calculation

99th Percentile Demand Flow

Hunter Number

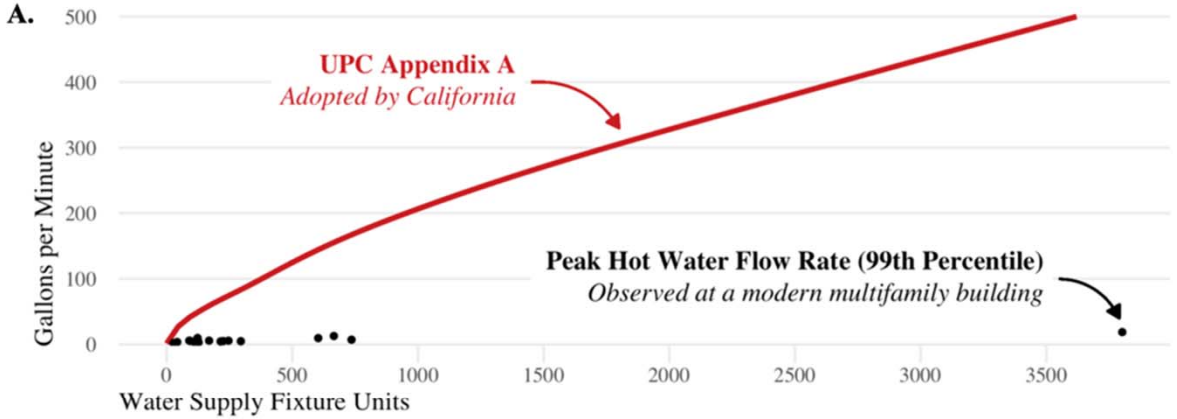
Stagnation Probability

DOWNLOAD RESULT | RESET WDC | ↓ Select Units for Water Demand ↓ GPM | LPM | LPS | RUN WDC | ← CLICK BUTTON ←

https://www.iapmo.org/water-demand-calculator/

Comparing Hunter's Curve to Actual Peak Flow Rates

Hunter's Curve (1940) is the basis of Uniform Plumbing Code Appendix A



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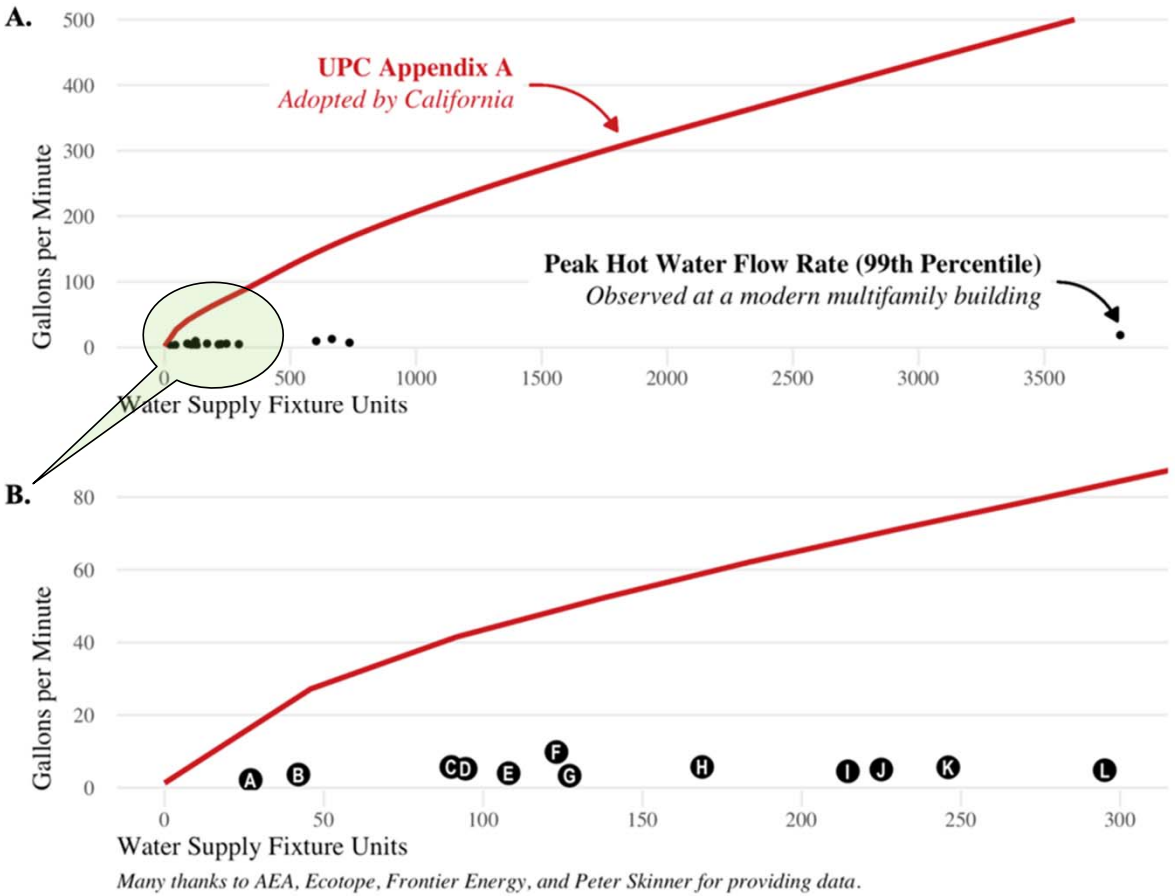
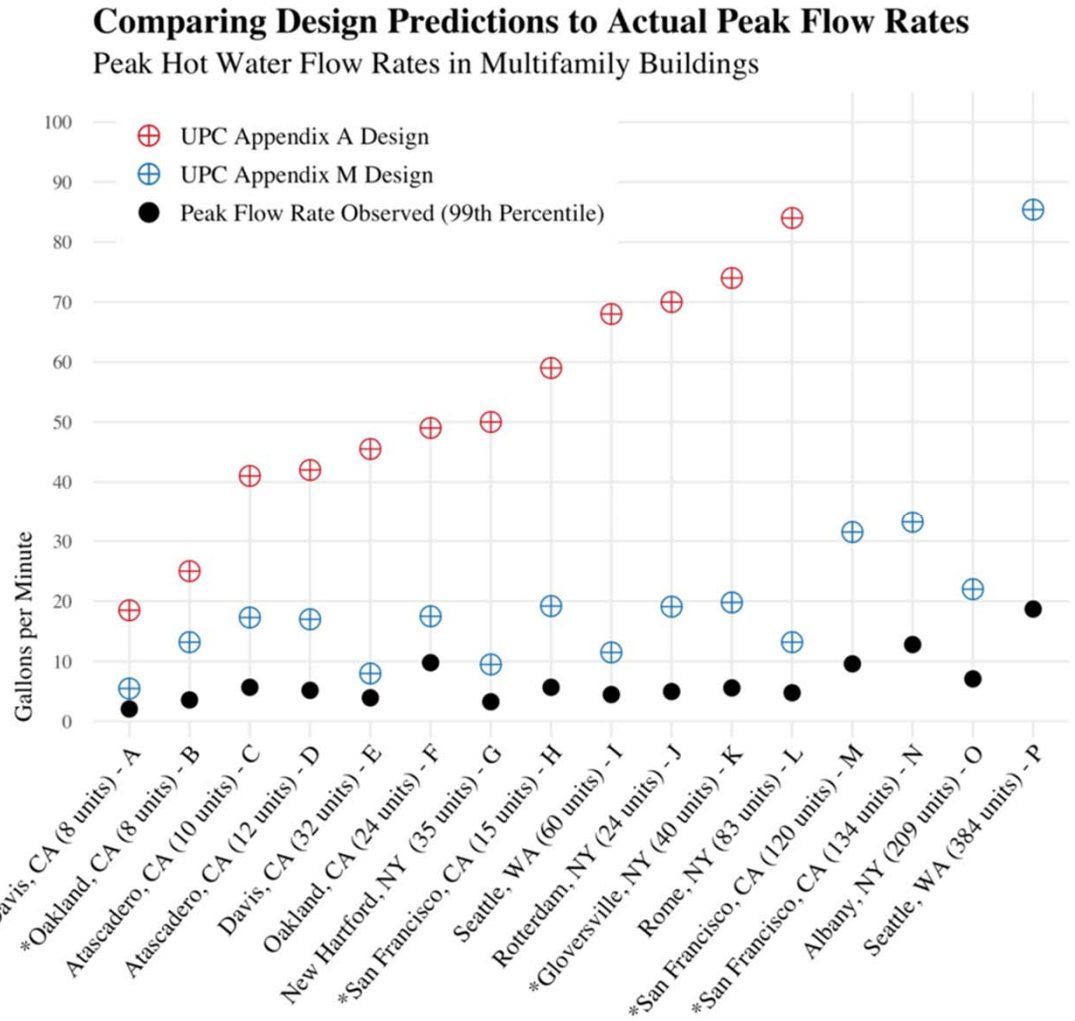


Many thanks to AEA, Ecotope, Frontier Energy, and Peter Skinner for providing data.


Comparing Design Predictions to Actual Peak Flow Rates
Peak Hot Water Flow Rates in Multifamily Buildings
UPC Appendix A Design
UPC Appendix M Design
Peak Flow Rate Observed (99th Percentile)
Gallons per Minute
100
90
80
70
60
50
40
30
20
10
0
Davis, CA (8 units) - A
*Oakland, CA (8 units) - B
Atascadero, CA (10 units) - C
Atascadero, CA (12 units) - D
Davis, CA (32 units) - E
Oakland, CA (24 units) - F
New Hartford, NY (35 units) - G
*San Francisco, CA (15 units) - H
Seattle, WA (60 units) - I
Rotterdam, NY (24 units) - J
*Gloversville, NY (40 units) - K
Rome, NY (83 units) - L
*San Francisco, CA (120 units) - M
*San Francisco, CA (134 units) - N
Albany, NY (209 units) - O
Seattle, WA (384 units) - P

Right-Sizing the Supply Piping Saves First Costs

Sizing Method	Peak Flow Rate (gpm)	Meter Size (inches)
WSFU	127	3
WDC v2.0	14	1

4-Story Apartment Building in Seattle, 92 units, 1 bath and 12 Washing Machines						
Nominal Dia. (in)	**Water Supply Fixture Unit Method**			**Water Demand Caculator V2.0**		
	Total (feet)	**Cost per Foot ($)**	**Cost per Dimension ($)**	**Total (feet)**	**Cost per Foot ($)**	**Cost per Dimension ($)**
3	20	$ 18.75	$ 375.00	0	$ 18.75	$ -
2.5	90	$ 13.81	$ 1,242.90	0	$ 13.81	$ -
2	114	$ 10.55	$ 1,202.70	0	$ 10.55	$ -
1.5	136	$ 5.26	$ 715.36	0	$ 5.26	$ -
1.25	346	$ 4.50	$ 1,557.00	0	$ 4.50	$ -
1	808	$ 1.70	$ 1,373.60	176	$ 1.70	$ 299.20
0.75	730	$ 0.94	$ 686.20	1908	$ 0.94	$ 1,793.52
0.5	70	$ 0.57	$ 39.90	230	$ 0.57	$ 131.10
Totals	2314		$ 7,192.66	2314		$ 2,223.82

Prices are for PEX piping taken from www.ferguson.com on September 18, 2020. Table shows only the differences in the cost of the pipe for both hot and cold.

Right-Sizing the Rest of the Piping is the 3rd Domino

Additional Savings

≈$5,000

$54/apartment

Right-Sizing the Water Heater is the 4th Domino

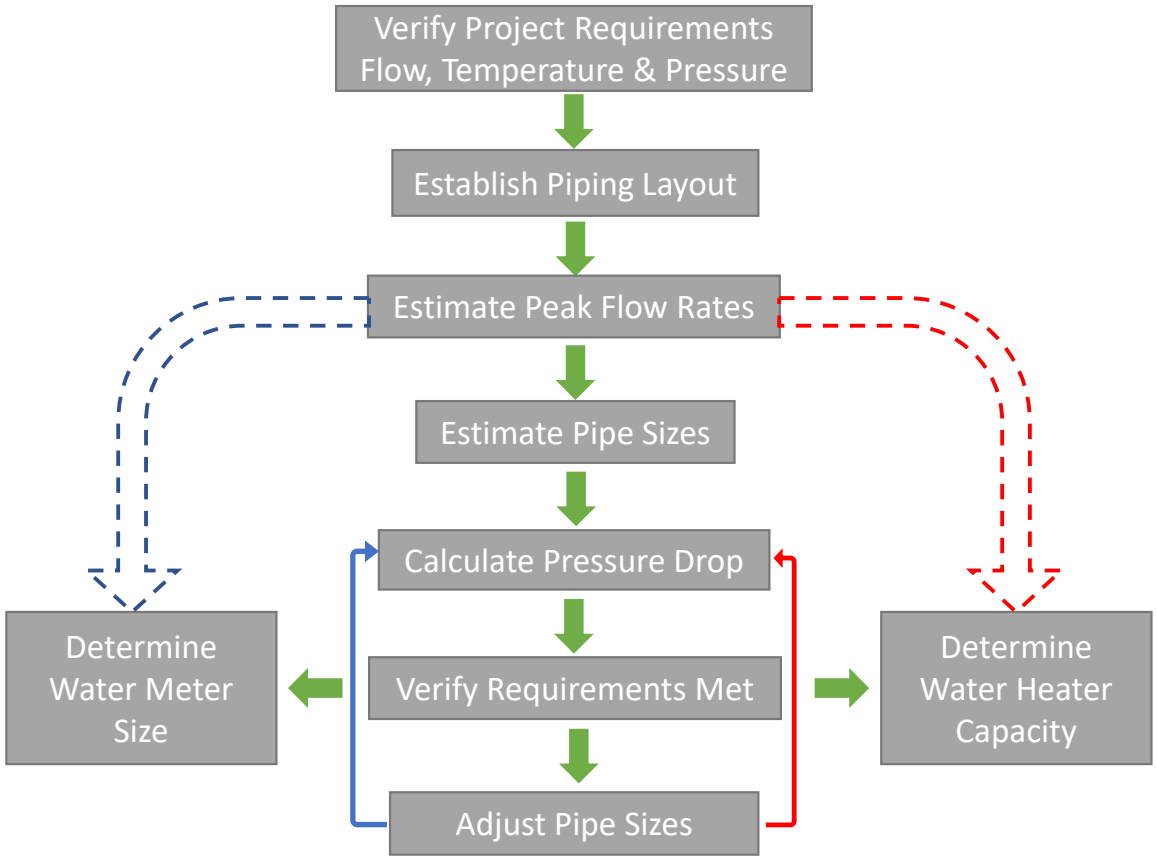
Additional Savings

≈$30,000

$320/apartment

Using the WDC makes Central Electric Heat Pump Water Heating much more viable!

Right-Sizing the Water Heater Saves First Costs



Sizing Method	Peak Hot Water Flow Rate
WSFU	105 gpm
WDC V2.0	11 gpm

Which Sizing Methods Do You Use?

Right-Sizing the Water Meter is the 5th Domino

Meter Size	Seattle Public Utilities			Skagit PUD	
	Connection Charge	Non-Arterial Installation Fee	Installation and Connection Fee	System Development Fees	
				5/8 inch	$ 5,020
3/4" and 5/8"	$ 1,700	$ 5,325	$ 7,025	3/4 inch	$ 7,530
1"	$ 2,890	$ 5,475	$ 8,365	1 inch	$ 12,550
1 1/2"	$ 5,610	$ 7,925	$ 13,535	1 1/2 inch	$ 25,100
2"	$ 9,010	$ 8,700	$ 17,710	2 inch	$ 40,160
2" High Flow	$ 14,110	$ 10,050	$ 24,160	3 inch	$ 80,320
4"	$ 28,900	Site Specific		4 inch	$ 125,500

Sizing Method	Meter Size	Seattle	Skagit
WSFU	3 inch	$24,160	$80,310
WDC V2.0	1 inch	$8,365	$12,550
	Savings	$15,795	$67,770
	Per Apartment	$172	$740

Ongoing Operation Savings is the 7th Domino

Meter Size	Seattle Public Utilities			Skagit PUD	
	Inside Seattle	Outside Seattle	Cities of Shoreline & Lake Forest Park		
				5/8-inch	$ 34.00
3/4" and less	$18.45	$21.05	$22.40	¾-inch	34.00
1"	$19.00	$21.65	$23.05	1-inch	56.62
1-1/2"	$29.35	$33.45	$35.60	1½-inch	112.90
2"	$32.50	$37.05	$39.40	2-inch	180.31
3"	$120.30	$137.15	$145.90	3-inch	338.05
4"	$172.35	$196.50	$209.00	4-inch	562.92

Sizing Method	Meter Size	Seattle	Skagit
WSFU	3 inch	$120	$338
WDC V2.0	1 inch	$19	$57
Monthly Savings		$101	$281
Annual Savings		$2,064	$3,372

92-Unit Apartment Building	Savings
Time-to-Tap	Increased Satisfaction
Right Size Piping	$5,000
Right Size the Rest of the Plumbing	$5,000
Right Size the Water Heater	$30,000
Right Size the Water Meter	$16,000 – $68,000
Total First Cost Savings	$58,000 – $108,000
First Cost Savings/Apartment	$600 – $1,200
Annual Operational Savings (Does not include energy and sewer)	$1,800 - $3,600

Additional Operational Savings

1. **In order to get the savings, the building needs to be built as designed.**
   a) Commissioning begins with the design, includes regular site inspections during construction, verification at completion and should continue for the life of the building.
2. **Water**
   a) Smaller meter reduced monthly fixed charges
   b) Less volume from the mechanical closets to the fixtures reduces water waste while waiting for hot water to arrive in the apartments.
3. **Sewer**
   a) Sewer charges are proportional to the water used.
   b) Less water means lower sewer costs
4. **Energy**
   a) Smaller piping in the apartments means less energy is lost when the pipes cool down.
   b) Less energy lost while waiting for hot water to arrive.
   c) Smaller, shorter, well-insulated circulation loops save energy to keep the piping hot near the apartments.

Increasing Customer Satisfaction

1. **It all starts with the floorplan**
   a) The closer the fixtures are to the mechanical closets, the less time it takes for hot water to arrive.
   b) Plumbing needs to be in on the schematic design meetings!
2. **Design for Modern pipe and fittings**
   a) Use up-to-date values to size the piping and minimize the loss of pressure from the mechanical room to the fixtures in the apartments
3. **Anti-scald shower and tub/shower valves**
   a) Specify those with least pressure drop and best maintenance record
4. **Pressure-Independent Faucets and Showerheads**
   a) Determine the flow rates you want.
   b) Specify pressure compensating aerators for faucets and flow regulators for showerheads.
   c) Result will be more consistent flow rates over the range of actual operating pressures.

Questions?