This presentation premiered at WaterSmart Innovations

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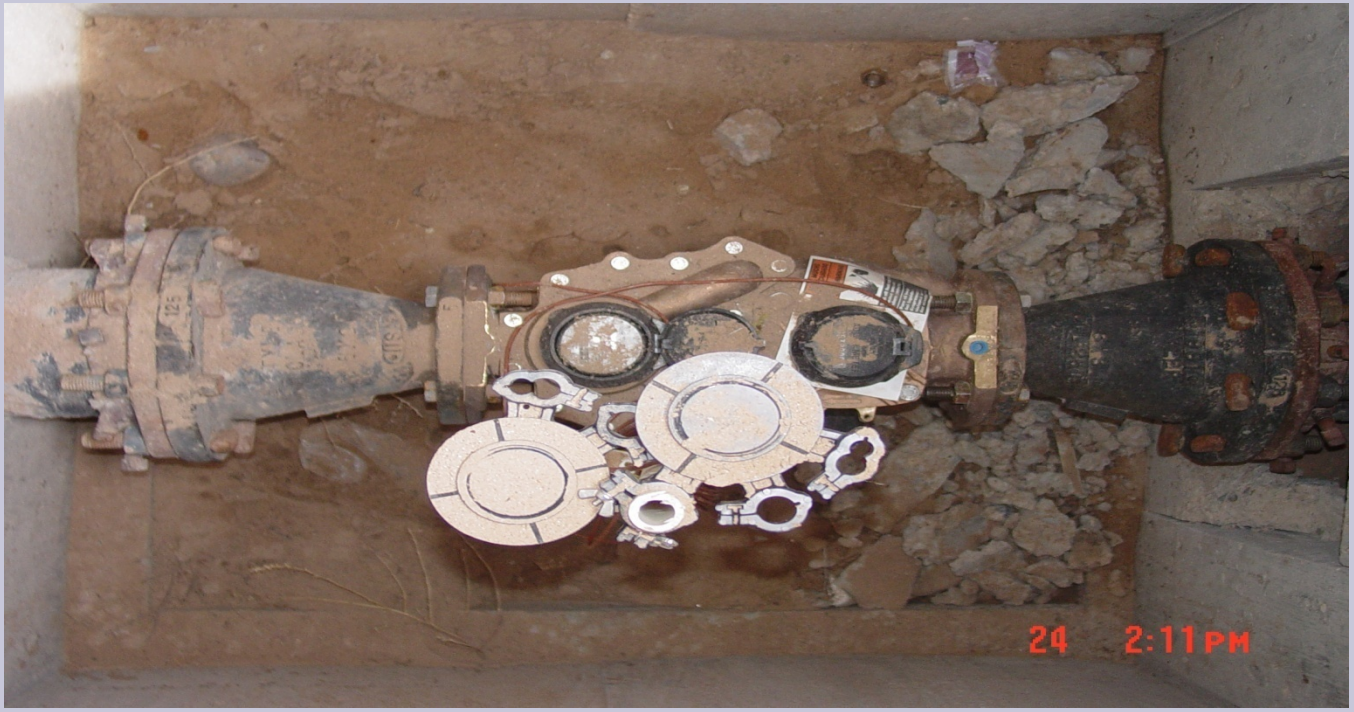
INNOVATIONS

Lonnie Burke

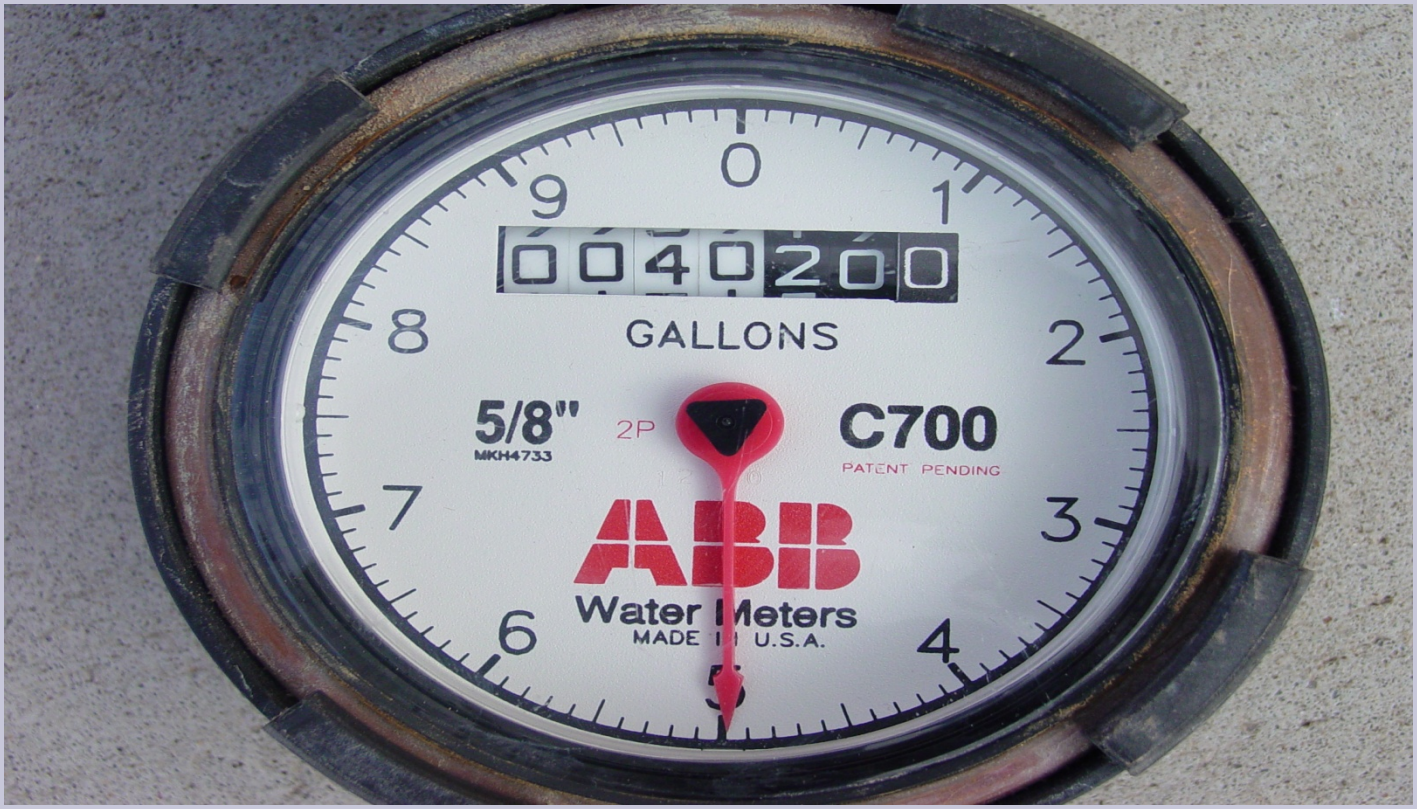
Water Management Inc.

Size Does Matter:
The Proper Sizing of Meters.



Water Meters

The Cash Register of The Water Purveyor



A Good Metering Program Is Necessary for Water Accountability

- You Can Not Manage What You Can Not Track

“ Under the right conditions, each meter is accurate and under the wrong conditions, each meter is inaccurate”

“In the United States it is not uncommon to see lost water associated with meter error approaching 20 to 30 times the direct value of lost water associated with leakage.”

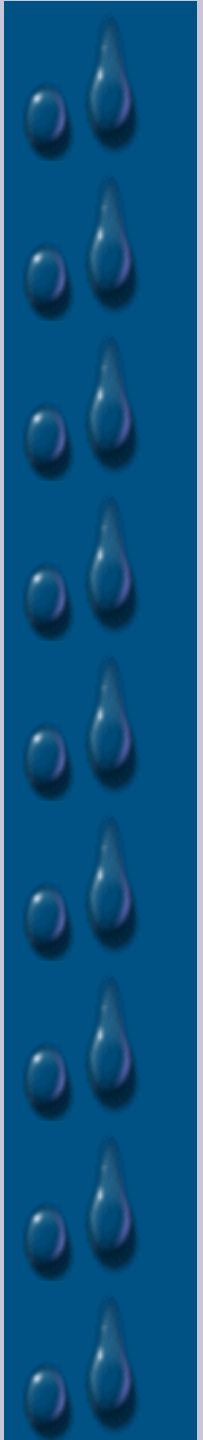
Author James B. Smith

JBS Associates, Inc

Over Sizing

What Can Happen

- The Cost to the Utility
- Non Revenue Water
- Cost to Building Owner



The Cost of the Meter

Meter Size	PD	Turbo	Compound
5/8” x 3/4	$85	n/a	n/a
1"	$134	n/a	n/a
1 ½”	$270	$525	n/a
2"	$395	$650	$1,200
3"	n/a	$750	$1,500
4"	n/a	$1,500	$2,500
6"	n/a	$2,500	$3,500
8"	n/a	$4,000	$4,500

2” Compound Meter installed on a 5 unit apartment.

Cost $6,500 Installed

Projected usage, 20,000 gallons a month.

Water Cost

$3.00 per thousand

$5.00 Waste Water

Over three years just to recover the cost of the meter installation.

3” Turbine installed on a 50 unit apartment.

Leaks average three gallons a minute.

Annual loss well over 1,000,000 gallons a year or $8,000

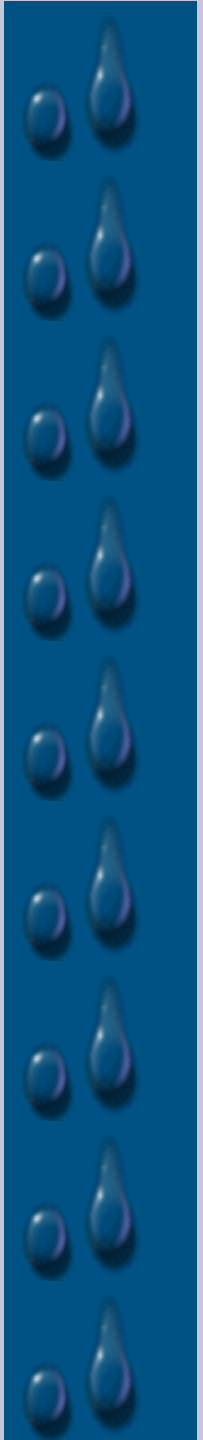
2” PD Meter installed on an office building with 6 bathrooms and 3 break rooms.

2 toilets leaking at ¾ gallons a minute.

Adds up to 350,000 gallons of water loss a year.

Under Sizing What Can Happen

- Excessive Pressure Loss
- Reduced Flow
- Water Hammer
- High-flow velocity
- Noise
- Meter Failure
- Non Revenue Water



A park has a 2” PD meter that runs two zones at a time. The zones require 75 gallons per minute per zone.

Is the meter sized right?

	Meter Model	Meter Size (Inches)	Bore Dia. (Inches)	Meter Length Inches		Safe Max. Oper. Capacity, GPM	Maximum Pressure Loss PSI At Rate Shown
				Thread. Spud Ends	Flang. Ends		
2"	AWWA C700-02 STANDARDS	2	2	15 1/4	17	160 GPM	15 PSI @ 160 GPM
		2	2	15 1/4	15 1/4,17	170 GPM	8.6 PSI @ 160 GPM

SPECIFICATIONS

Typical Operating Range (100% ± 1.5%)	2 1/2 -170 GPM (.57 to 39 m³/hr)
Low Flow (Min. 95%)	1 1/2 GPM (.34 m³/hr)
Maximum Continuous Operation	100 GPM (23 m³/hr)
Pressure Loss at Maximum Continuous Operation	3.3 PSI at 100 GPM (.23 bar at 23 m³/hr)
Maximum Operating Temperature	80°F (26°C)
Maximum Operating Pressure	150 PSI (10 bar)
Measuring Element	Nutating disc, positive displacement
Register Type	Straight reading, permanently sealed magnetic drive standard. Remote reading or Automatic Meter Reading units optional.
Registration	100 Gallons, 10 Cubic Feet, 1 m³
Register Capacity	100,000,000 Gallons, 10,000,000 Cubic Feet, 1,000,000 m³. 6 odometer wheels.
Meter Connections	2" AWWA two bolt elliptical flange, drilled, or 2" - 11 1/2 NPT internal pipe threads.
Optional Test Plug	1" NPT test plug (TP) available on elliptical long and short versions.

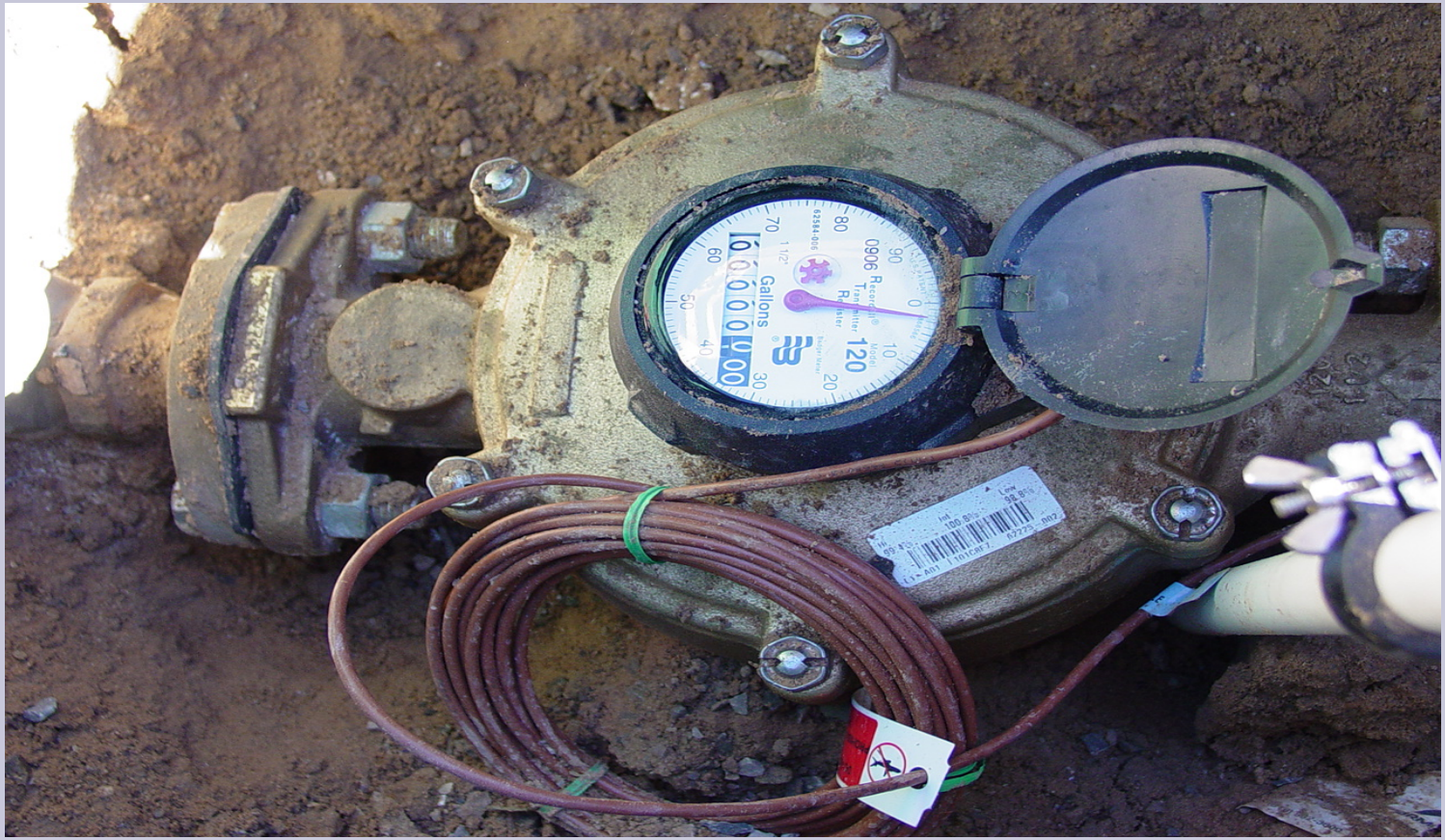
Over Sized or Undersized
Which occurs more often?

The following table summarizes the findings. A composite of all sizes shows that approximately 80% of all 1-inch (25mm) and larger are considered oversized or may be inaccurate. Oversized meters contribute not only to the unaccounted for water problem, but more importantly may contribute to lost revenue as well. The water tariff structure will determine this.

Meter Sizing Summary - I inch (25mm) and Larger

Meter Size	No. Accounts	Accts OK	Accts Undersized	Accts Oversized	Accts Unknown	% Oversized
1	9,976	1,349	78	8,303	246	83.2%
1.5	1,604	211	160	1,224	9	76.3%
2	2,471	633	33	1,679	126	67.9%
3	199	26	5	164	4	82.4%
4	121	19	-	96	6	79.3%
6	85	36	6	42	1	49.4%
8	42	25	-	17	-	40.5%
10	5	5	-	-	0	0.0%
Totals	14,503	2,304	282	11,525	392	79.5%

Types of Meters



Water Meters, By Zane Satterfield. And Vipin Bhardwaj, engineering scientists

Positive Displacement Meters

This type of meter works by measuring and registering the number of times the meter chamber, whose volume is known, is filled and emptied.

ADVANTAGES:

- Measures wide variations of flow
- Needs no straight pipe upstream or downstream

DISADVANTAGES:

- Low flow rates are not detected on meters over (2) two inches in size
- High head loss at high flows
- Foreign matter or corrosion will stop or cause loss of accuracy

Types of Displacement Meters

- Nutating disc meters
- Piston meters
- Positive Displacement Meters

Velocity Meters

Operate on the principle that water passing through a known cross-sectional area with a measured velocity can be equated into a volume of flow. Velocity meters are good for high flow applications.

ADVANTAGES:

Used for large flows, low head loss

DISADVANTAGES:

Inaccurate at low flows

Types Of Velocity Meters

- Turbine
- Venture
- Multi-jet
- Propeller
- Magnetic
- Ultrasonic
- Orifice
- Single -Jet

TURBINE Meters

Have a rotating element that turns with the flow of water. Volume of water is measured by the number of revolutions by the rotor.

Venturi Meters

Have a section that has a smaller diameter than the pipe on the upstream side. Based on a principle of hydraulics, as water flows through the pipe, its velocity is increased as it flows through a reduced cross-section area. Difference in pressure before water enters the smaller diameter section and at the smaller diameter “throat” is measured. The change in pressure is proportional to the square of velocity. Flow rate can be determined by measuring the difference in pressure. Venturi meters are suitable for large pipelines and do not require much maintenance.

Propeller Meters

Have a fan-shaped rotor that spins with the flow of water. A recorder is attached to the rotor to register the readings.

Multi-jet Meters

Have tangential openings in a chamber to direct the water flow across a rotor with many vanes. Flow is measured proportional to the speed of the rotor.

Magnetic Meters

Have an insulated section through which water flows. The flow of water induces an electrical current that is proportional to the velocity and hence the flow rate.

Ultrasonic Meters

Send sound waves diagonally across the flow of water in the pipe. Changes in the velocity of water are converted electronically to change in flow rate.

Orifice Meters

Work on the same principle as venturi meters, except that, instead of the decreasing cross-sectional area, there is a circular disk with a concentric hole. Flow rate is calculated similarly to the venturi meter by measuring the difference in pressure.

Compound Meters

Used where the water demand varies widely

Two meters in one:

- Has a positive displacement meter for the low flows and a velocity meter for the high flow

Meter replacement

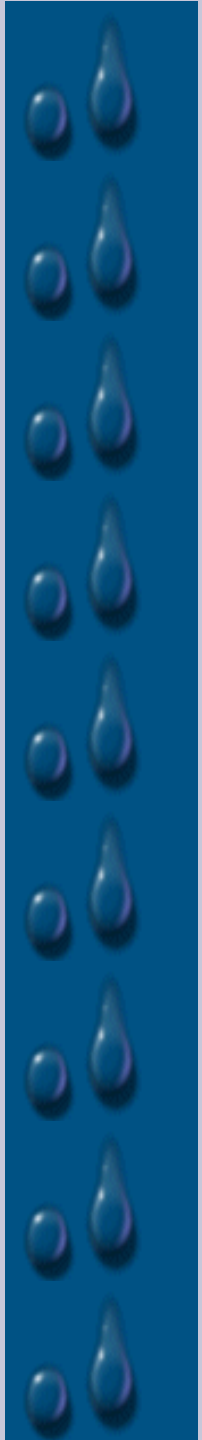
Never assume that the existing meter is the right meter.

Research what the demands are.

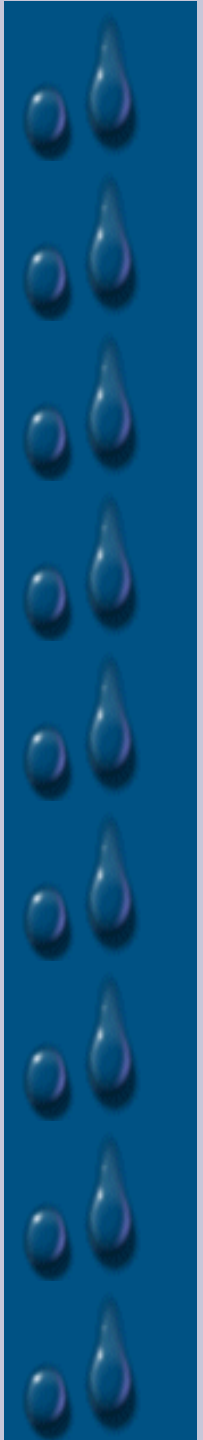
Use a data logger if you have one.

Meter	Minimum Flow Rate (*gpm*)	Low Normal Flow Rate (*gpm*)	High Normal Flow Rate (*gpm*)	Maximum Flow Rates (*gpm*)	Head Loss At Maximum Flow (*psi*)
Positive Displacement					
5/8 in.	0.25	1	10	20	15
3/4 in.	0.5	2	15	30	15
1 in.	0.75	3	25	50	15
1.5 in.	1.5	5	50	100	15
2 in.	2	8	80	160	15
Multijet					
5/8 in.	0.25	1	10	20	15
3/4 in.	0.5	2	15	30	15
1 in.	0.75	3	25	50	15
1.5 in.	1.5	5	50	100	15
2 in.	2	8	80	160	15
Electromagnetic					
2 in.	.25	.5	176	220	5

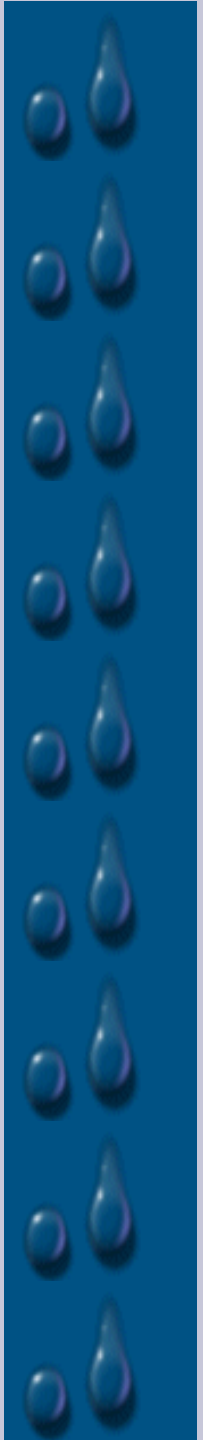
Meter	Minimum Flow Rate (*gpm*)	Low Normal Flow Rate (*gpm*)	High Normal Flow Rate (*gpm*)	Maximum Flow Rates (*gpm*)	Head Loss At Maximum Flow (*psi*)	Change Over Range
Turbine class 1						
3/4 in.	1.5	N/A	20	30	15	
1 in.	2		35	50	15	
1.5 in.	3		65	100	15	
2 in.	4		100	160	15	
3 in.	6		220	350	15	
4 in.	8		420	630	15	
6 in.	15		865	1300	15	
Compound						
2 in.	0.25	2	80	160	20	20
3 in.	0.5	4	160	320	20	23
4 in.	0.75	6	250	500	20	28
6 in.	1.5	10	500	1000	20	32
8 in.	2	16	800	1600	20	50



FOLLOW THE MANUFACTURES INSTALLATION REQUIREMENTS!



Test the new meter before you leave the job site



Meter Selection

Choose the right meter for the job

Know the flow demands: high and low

Displacement meters are not designed for continues high flow.

Velocity meters are not good at recording low flows.

Inch	mm
1/2	15
3/4	20
1	25

TABLE 6-4
Water Supply Fixture Units (WSFU) and Minimum Fixture Branch Pipe Sizes[3]

Appliances, Appurtenances or Fixtures[2]	Minimum Fixture Branch Pipe Size[1,4]	Private	Public	Assembly[6]
Bathtub or Combination Bath/Shower (fill)	1/2"	4.0	4.0	
3/4" Bathtub Fill Valve	3/4"	10.0	10.0	
Bidet	1/2"	1.0		
Clothes washer	1/2"	4.0	4.0	
Dental Unit, cuspidor	1/2"		1.0	
Dishwasher, domestic	1/2"	1.5	1.5	
Drinking Fountain or Watercooler	1/2"	0.5	0.5	0.75
Hose Bibb	1/2"	2.5	2.5	
Hose Bibb, each additional[8]	1/2"	1.0	1.0	
Lavatory	1/2"	1.0	1.0	1.0
Lawn Sprinkler, each head[5]		1.0	1.0	
Mobile Home, each (minimum)		12.0		
Sinks				
Bar	1/2"	1.0	2.0	
Clinic Faucet	1/2"		3.0	
Clinic Flushometer Valve				
with or without faucet	1"		8.0	
Kitchen, domestic	1/2"	1.5	1.5	
Laundry	1/2"	1.5	1.5	
Service or Mop Basin	1/2"	1.5	3.0	
Washup, each set of faucets	1/2"		2.0	
Shower, per head	1/2"	2.0	2.0	
Urinal, 1.0 GPF Flushometer Valve	3/4"	See Footnote [7]		
Urinal, greater than 1.0 GPF Flushometer Valve	3/4"	See Footnote [7]		
Urinal, flush tank	1/2"	2.0	2.0	3.0
Washfountain, circular spray	3/4"		4.0	
Water Closet, 1.6 GPF Gravity Tank	1/2"	2.5	2.5	3.5
Water Closet, 1.6 GPF Flushometer Tank	1/2"	2.5	2.5	3.5
Water Closet, 1.6 GPF Flushometer Valve	1"	See Footnote [7]		
Water Closet, greater than 1.6 GPF Gravity Tank	1/2"	3.0	5.5	7.0
Water Closet, greater than 1.6 GPF Flushometer Valve	1"	See Footnote [7]		

Notes:

1. Size of the cold branch pipe, or both the hot and cold branch pipes.
2. Appliances, Appurtenances or Fixtures not included in this Table may be sized by reference to fixtures having a similar flow rate and frequency of use.
3. The listed fixture unit values represent their load on their cold water service. The separate cold water and hot water fixture unit value for fixtures having both hot and cold water connections may each be taken as three-quarter (3/4) of the listed total value of the fixture.
4. The listed minimum supply branch pipe sizes for individual fixtures are the nominal (I.D.) pipe size.
5. For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in gallons per minute (GPM) and add it separately to the demand (in GPM) for the distribution system or portions thereof.
6. Assembly [Public Use (See Table 4-1)].
7. When sizing flushometer systems see Section 610.10.
8. Reduced fixture unit loading for additional hose bibbs as used is to be used only when sizing total building demand and for pipe sizing when more than one hose bibb is supplied by a segment of water distributing pipe. The fixture branch to each hose bibb shall be sized on the basis of 2.5 fixture units.

TABLE 6-5
Fixture Unit Table for Determining Water Pipe and Meter Sizes

Inch	mm
1/2	15
3/4	20
1	25
1-1/4	32
1-1/2	40
2	50
2-1/2	65

Pressure Range – 30 to 45 psi (207 to 310 kPa)**

Meter and Street Service, Inches	Building Supply and Branches, Inches	Maximum Allowable Length in Feet (meters)														
		40 (12)	60 (18)	80 (24)	100 (30)	150 (46)	200 (61)	250 (76)	300 (91)	400 (122)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)	1000 (305)
3/4	1/2***	6	5	4	3	2	1	1	1	0	0	0	0	0	0	0
3/4	3/4	16	16	14	12	9	6	5	5	4	4	3	2	2	2	1
3/4	1	29	25	23	21	17	15	13	12	10	8	6	6	6	6	6
1	1	36	31	27	25	20	17	15	13	12	10	8	6	6	6	6
3/4	1-1/4	36	33	31	28	24	23	21	19	17	16	13	12	12	11	11
1	1-1/4	54	47	42	38	32	28	25	23	19	17	14	12	12	11	11
1-1/2	1-1/4	78	68	57	48	38	32	28	25	21	18	15	12	12	11	11
1	1-1/2	85	84	79	65	56	48	43	38	32	28	26	22	21	20	20
1-1/2	1-1/2	150	124	105	91	70	57	49	45	36	31	26	23	21	20	20
2	1-1/2	151	129	129	110	80	64	53	46	38	32	27	23	21	20	20
1	2	85	85	85	85	85	85	82	80	66	61	57	52	49	46	43
1-1/2	2	220	205	190	176	155	138	127	120	104	85	70	61	57	54	51
2	2	370	327	292	265	217	185	164	147	124	96	70	61	57	54	51
2	2-1/2	445	418	390	370	330	300	280	265	240	220	198	175	158	143	133

Pressure Range – 46 to 60 psi (317 to 414 kPa)**

3/4	1/2***	7	7	6	5	4	3	2	2	1	1	1	0	0	0	0
3/4	3/4	20	20	19	17	14	11	9	8	6	5	4	4	3	3	3
3/4	1	39	39	36	33	28	23	21	19	17	14	12	10	9	8	8
1	1	39	39	39	36	30	25	23	20	18	15	12	10	9	8	8
3/4	1-1/4	39	39	39	39	39	39	34	32	27	25	22	19	19	17	16
1	1-1/4	78	78	76	67	52	44	39	36	30	27	24	20	19	17	16
1-1/2	1-1/4	78	78	78	78	66	52	44	39	33	29	24	20	19	17	16
1	1-1/2	85	85	85	85	85	85	80	67	55	49	41	37	34	32	30
1-1/2	1-1/2	151	151	151	151	128	105	90	78	62	52	42	38	35	32	30
2	1-1/2	151	151	151	151	150	117	98	84	67	55	42	38	35	32	30
1	2	85	85	85	85	85	85	85	85	85	85	85	85	85	83	80
1-1/2	2	370	370	340	318	272	240	220	198	170	150	135	123	110	102	94
2	2	370	370	370	370	368	318	280	250	205	165	142	123	110	102	94
2	2-1/2	654	640	610	580	535	500	470	440	400	365	335	315	285	267	250

Pressure Range – Over 60 psi (414 kPa)**

3/4	1/2***	7	7	7	6	5	4	3	3	2	1	1	1	1	1	0
3/4	3/4	20	20	20	20	17	13	11	10	8	7	6	6	5	4	4
3/4	1	39	39	39	39	35	30	27	24	21	17	14	13	12	12	11
1	1	39	39	39	39	38	32	29	26	22	18	14	13	12	12	11
3/4	1-1/4	39	39	39	39	39	39	39	39	34	28	26	25	23	22	21
1	1-1/4	78	78	78	78	74	62	53	47	39	31	26	25	23	22	21
1-1/2	1- 1/4	78	78	78	78	78	74	65	54	43	34	26	25	23	22	21
1	1-1/2	85	85	85	85	85	85	85	85	81	64	51	48	46	43	40
1-1/2	1-1/2	151	151	151	151	151	151	130	113	88	73	51	51	46	43	40
2	1-1/2	151	151	151	151	151	151	142	122	98	82	64	51	46	43	40
1	2	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1-1/2	2	370	370	370	370	360	335	305	282	244	212	187	172	153	141	129
2	2	370	370	370	370	370	370	370	340	288	245	204	172	153	141	129
2	2-1/2	654	654	654	654	654	650	610	570	510	460	430	404	380	356	329

**Available static pressure after head loss.

***Building supply, three-quarter (3/4) inch (20 mm) nominal size minimum.

METER TESTING

Test all new meters:

11/2” to 2” meters every 4 years

3” and above every 2 years

Residential meters every 10 to 15 years.

Think of a large meter as a car, the more miles the more frequent the oil changes.

Conclusion

Meters need to be properly sized, installed, maintained and tested in order to insure that water resources are measured properly.

Thank You

Lonnie Burke

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