Providence Water Supply Board
Wholesale Cost of Service Study
Transmission and Distribution Piping Evaluation

RI Public Utilities Commission – Docket 4994

May 4, 2021

Introductions

The hydraulic analysis presented herein was performed by Pare Corporation. Pare is a civil and environmental engineering firm with over 50 years of experience based out of Lincoln, RI.

The analysis was led by Mr. Timothy P. Thies, P.E. - Senior Vice President of Pare's Environmental Division. Mr. Thies has 19 years of industry experience performing hydraulic modeling studies for water systems across Rhode Island.

Study Purpose

The purpose of the study was to identify how wholesale customers utilize Providence Water's transmission and distribution system during three demand scenarios – average day demand (ADD), maximum day demand (MDD), and peak hour (or max hour) demand (PH).

The wholesale customers are:

- BCWA
- East Providence
- Greenville Water District
- KCWA
- Lincoln
- Smithfield
- Warwick

Methodology

- Pare utilized Providence Water's computerized hydraulic model to perform this study.
- The model was originally constructed by Pare in 2011 and updated by Pare in 2020.
- The model was built in Bentley's WaterGems software.
- The model was utilized to assist Pare in the *back-tracing analysis* and the *inch-mile analysis*.
- A key input parameter in the model was the *draw rate*, which Pare analyzed outside the model.

Methodology (Back-Tracing)

- The process of back-tracing is an iterative process where the engineer works backwards through the system
- Tracing starts at the wholesale customer connection and moves through the system toward the source.
- The engineer tracks and logs the total flow and wholesale customer flow in each pipe segment.
- The engineer calculates the split at each node where the pipe network splits.
- The engineer follows one leg of the split to the source (or to the next split in the pipes).

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Methodology (Back-Tracing)

- After one leg is traced back to the source, the engineer returns to the original split and works through the other pipes in the same manner until each pipe split has been traced back to the source.
- As the flow is traced, each pipe segment is flagged in the model and assigned to the individual wholesale customer.
- The flagging is used to extract data from the model relative to each customer's flow path.
- The type of data tracked includes total flow in each pipe section, portion of flow that can be attributed to each wholesale customer, pipe segment length, and pipe segment diameter.

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Methodology (Back-Tracing)

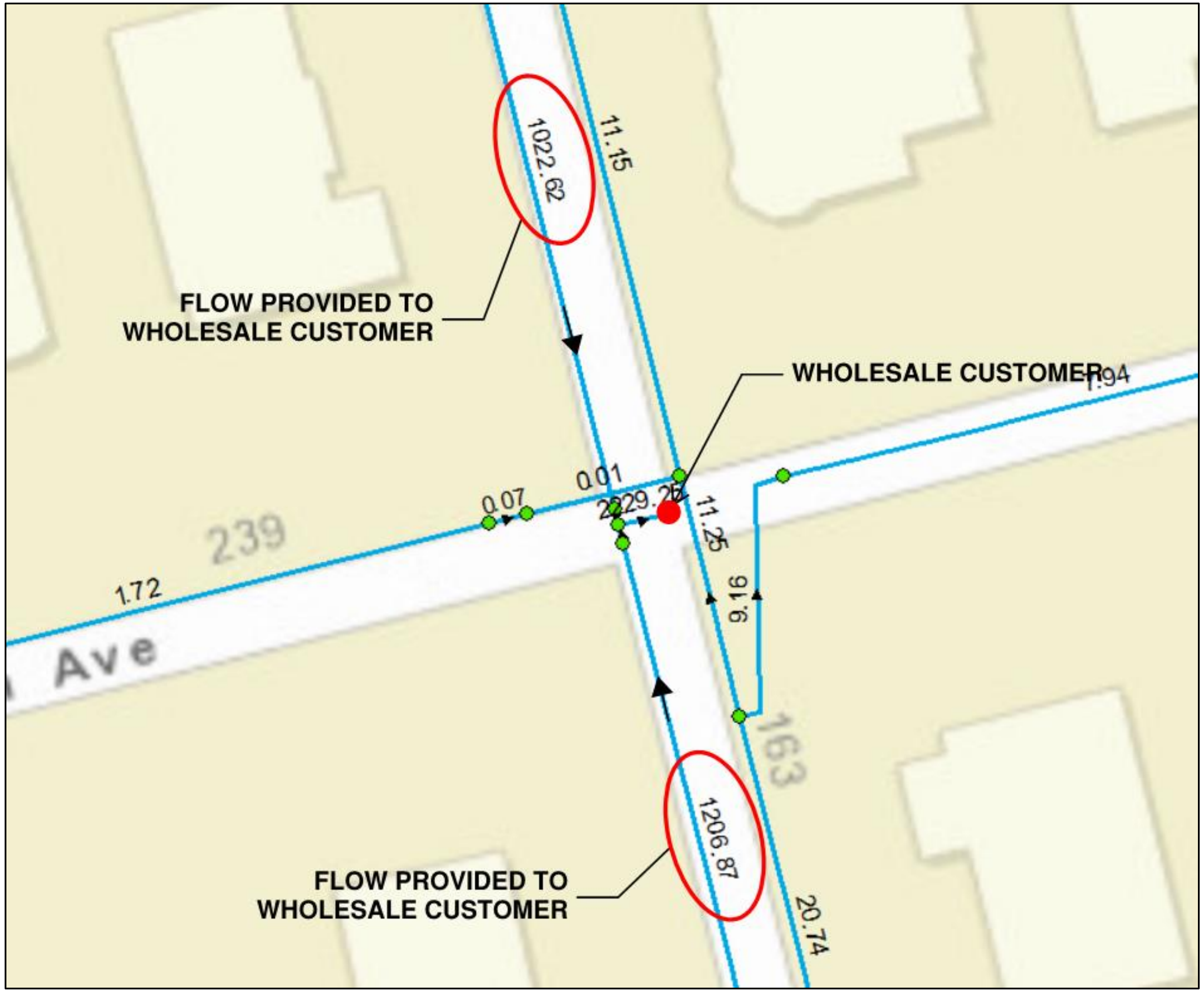

Figure 1 – Back-Tracing at Connection

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Methodology (Back-Tracing)

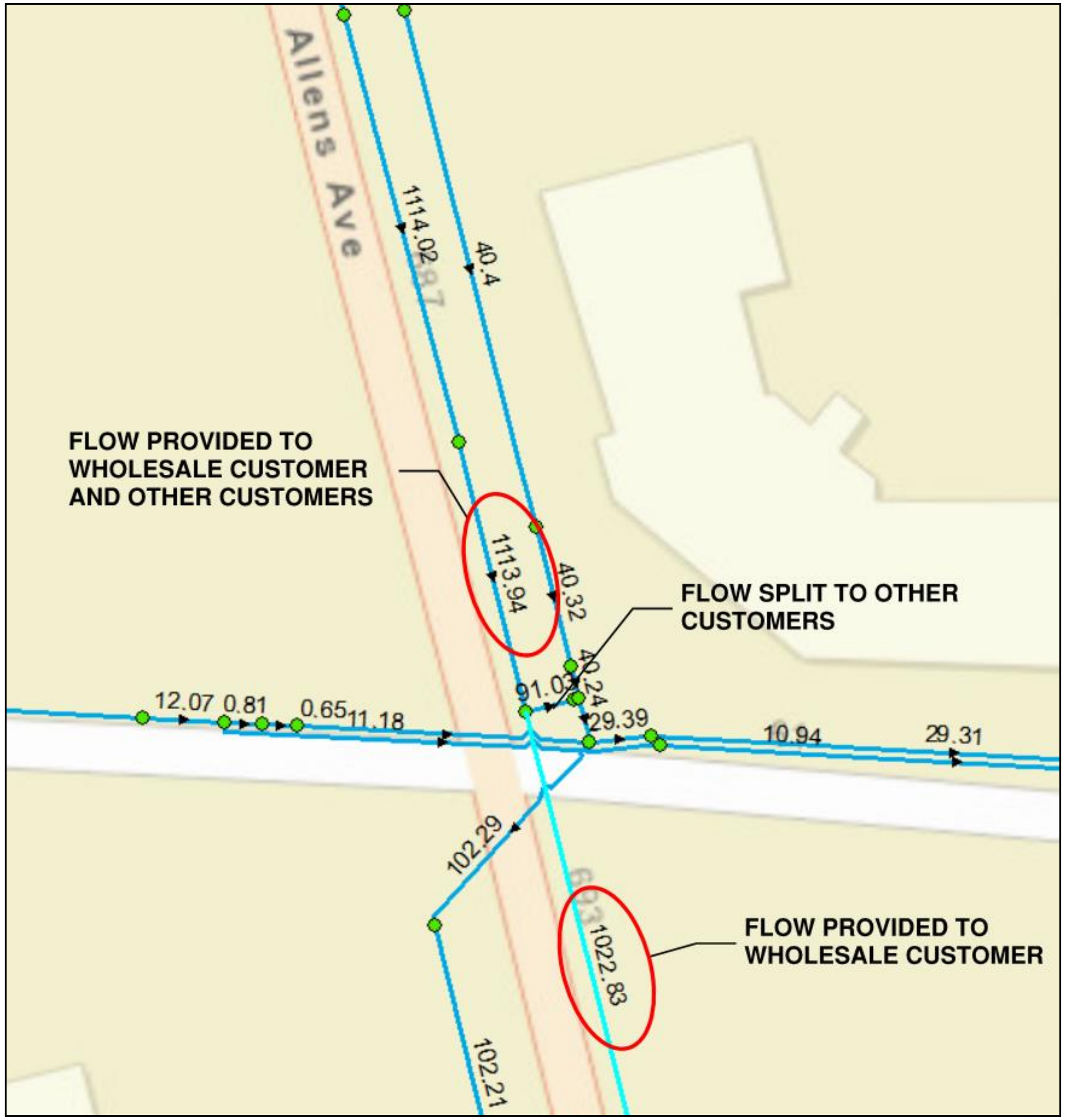

Figure 2 – Back-Tracing at Pipe Split

Methodology (Draw Rate Analysis)

- When performing the back-tracing, Pare needed to assess how much water, in terms of flow rate, each wholesale customer draws through Providence Water’s pipe network.
- Initially, Pare analyzed meter records to establish average day, maximum day, and peak hour demands for each wholesale customer.
- When Pare analyzed real-time data (referred to SCADA data) to evaluate how wholesale customers draw water, we identified that certain customers, particularly customers that pump, draw water through Providence’s system differently than the way those customers consume water.

Methodology (Draw Rate Analysis)

- For all wholesale customers, consumption varies day to day and hour by hour.
- Some wholesale customers draw water through Providence’s system at a rate and pattern that generally matches their consumption.
- Other customers, particularly customers that pump, draw their water through Providence’s system at a rate and pattern that doesn’t match their consumption.
- The figures on the next two pages illustrate how customers that pump draw water through Providence’s system.

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Methodology (Draw Rate Analysis)

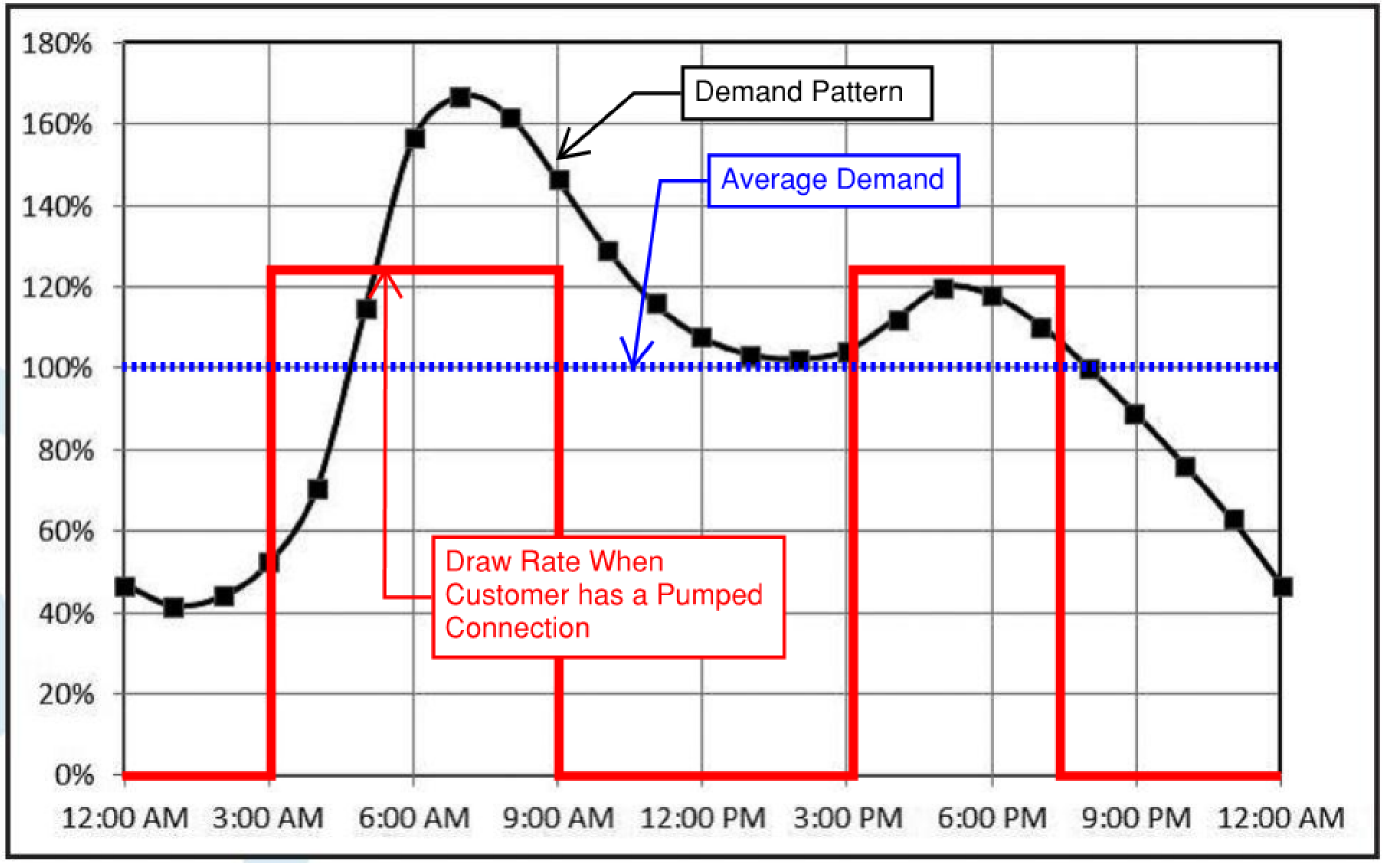

Figure 3 – Draw Rate with Single Pump

Methodology (Draw Rate Analysis)

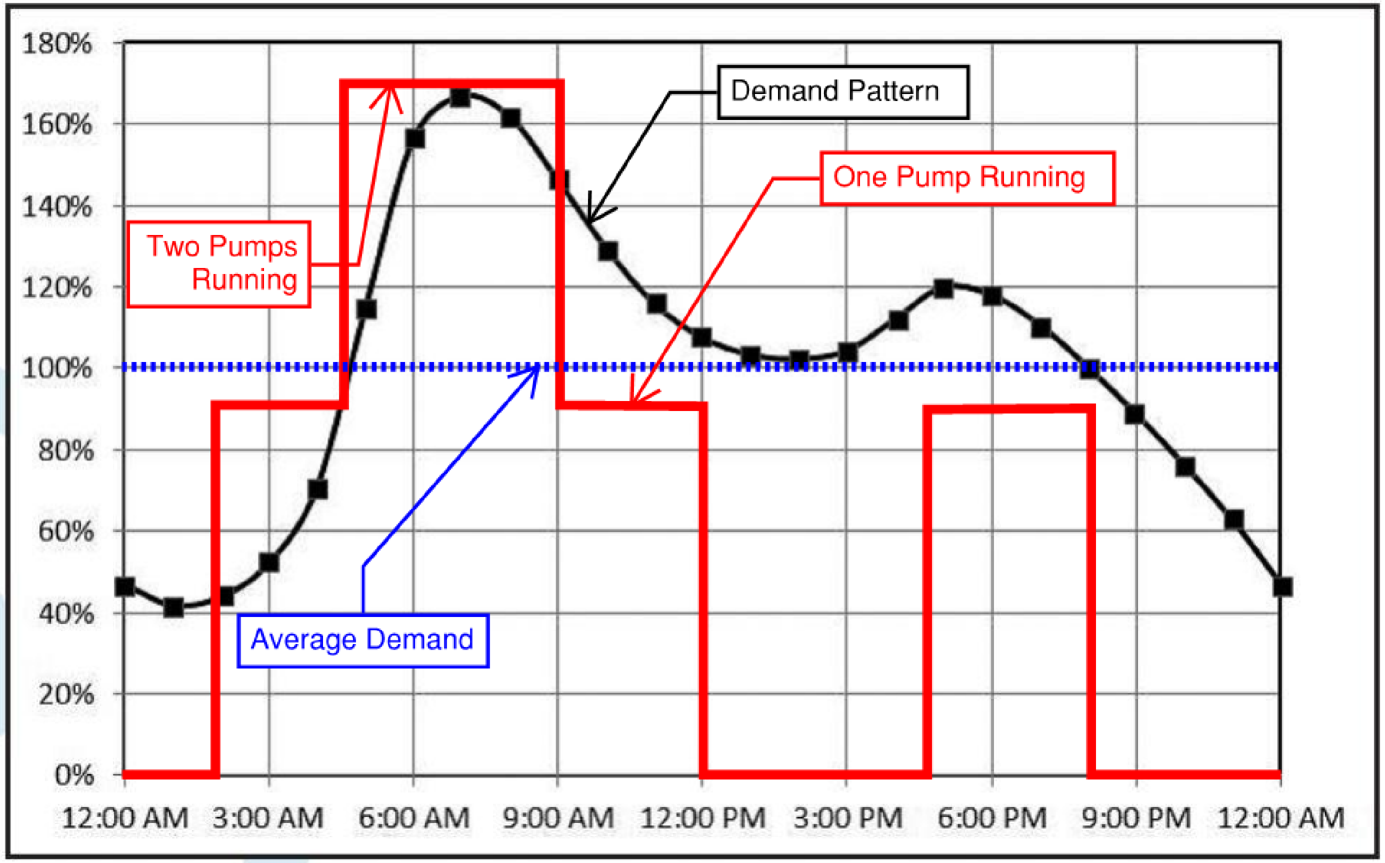

Figure 4 – Draw Rate with Dual Pump

Methodology (Draw Rate Analysis)

- Understanding how each customer draws its water through Providence Water's pipe network allows us to be more precise in our analysis of the pipe infrastructure that each customer utilizes.
- For this analysis, Pare utilized "draw rate" in lieu of demand. Draw rate provides a more accurate assessment how each wholesale customer utilizes Providence Water's infrastructure.
- Each customer's draw rate on an average day and on a maximum day, as well as during a peak hour, was applied to the node in the model that represents their connection point to Providence.

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Methodology (Inch-Mile Analysis)

- Once the flow path for each customer was mapped, it was necessary to quantify how much pipe each customer relies on to transport their water from the treatment plant to their connection.
- Because each system utilizes a different set of pipes with varying lengths and diameters, it was necessary to quantify the "amount of pipe" each wholesale customer uses in consistent way.
- For example, one customer might use all large diameter pipe but very few miles of pipe, while another customer might use many miles of small diameter pipe. Which customer uses more pipe?

Methodology (Inch-Mile Analysis)

- To compare one wholesale customer to another, Pare converted all the pipe each customer uses into a consistent unit of "inch-miles".
- To calculate the inch-miles for each wholesale customer, Pare multiplied each pipe segment's length (in miles) by its diameter (in inches).
- Pare then added together the results of all the pipe segments for that wholesale customer. The result is a summation of all the transmission and distribution pipes that each wholesale customer's flow touches on its way to the wholesale connection point.

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Methodology (Inch-Mile Analysis)

- Understanding that the amount of flow in each pipe segment attributed to any one wholesale customer varies, anywhere from <1% to 100 percent, the inch-mile value for each pipe segment was pro-rated by the percentage of flow that can be attributed to each wholesale customer.
- The resulting summation is a representation of the total pipe infrastructure that each wholesale customer utilizes when it draws water through Providence Water's system.
- The abbreviated table on the next slide shows an example of how inch-miles is calculated.

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	A	B	C	D	G	K	L	M	N	O	P
1	ID	Label	Start Node	Stop Node	Flow (gpm)	Length (ft)	Length (miles)	Diameter (in)	Inch Miles	% Wholesale Customer	Wholesale Customer Inch Miles
7	71174	1284	J-33641	J-33660	21,623.69	1,650	0.3125	78	24.375	4%	0.948178476
8	70372	1347	J-15409	J-5199	2,230.74	650	0.123106	30	3.693182	43%	1.601827939
9	3273	1379	J-1972	J-1973	7,442.30	2	0.000379	42	0.015909	2%	0.000265328
10	70957	1488	J-22001	J-10238	2,724.38	979	0.185417	30	5.5625	22%	1.237723209
11	71221	1672	J-32528	J-20994	1,830.62	2,474	0.468561	30	14.05682	65%	9.072426732
12	59125	1808	J-30100	J-16447	1,284.77	204	0.038636	36	1.390909	10%	0.134374885
13	71176	2071	J-33661	J-33662	12,764.00	1,617	0.30625	102	31.2375	7%	2.058565777
14	71160	2072	J-33658	J-33653	12,763.43	1,593	0.301705	102	30.77386	7%	2.028102493
15	70477	2223	J-24559	J-32935	1,437.86	683	0.129356	36	4.656818	10%	0.463765593
16	59884	2269	J-12554	J-13477	172.25	213	0.040341	16	0.645455	18%	0.119192409
17	48777	2309	J-15421	J-27889	2,369.81	99	0.01875	30	0.5625	41%	0.229653532
18	67847	2328	J-5154	J-6003	7,698.39	397	0.075189	42	3.157955	2%	0.050915582
19	20856	2353	J-12871	J-12872	50.38	14	0.002652	8	0.021212	57%	0.012180627
20	4877	2375	J-2990	J-2903	35.13	3	0.000568	12	0.006818	91%	0.006207678
21	16079	2379	J-9970	J-2990	1,089.75	11	0.002083	30	0.0625	92%	0.057324716
22	62398	2471	J-12886	J-19270	132.57	248	0.04697	16	0.751515	24%	0.18031616
23	5431	2643	J-3344	J-3345	57.59	3	0.000568	6	0.003409	38%	0.001293785
24	71186	2848	J-19376	J-6268	14,282.88	1,686	0.319318	66	21.075	7%	1.548482967
25	71125	3005	J-33771	J-2526	1,830.00	1,717	0.325189	30	9.755682	65%	6.29855872
26	70760	3050	J-7522	J-8071	7,863.37	802	0.151894	42	6.379545	2%	0.098483762
27	17731	3309	J-10955	J-10956	2,459.23	12	0.002273	36	0.081818	41%	0.033163742
28	68000	3402	J-32936	J-32242	1,439.03	405	0.076705	36	2.761364	10%	0.274776507
29	70324	3515	J-6278	J-16728	7,556.06	636	0.120455	42	5.059091	2%	0.083103982
30	34719	3564	J-5200	J-5928	2,303.16	32	0.006061	30	0.181818	42%	0.076379592
31	55357	3567	J-22320	J-6249	75.95	163	0.030871	12	0.370455	48%	0.176305818
32	64242	3568	J-11712	J-15801	973.87	273	0.051705	20	1.034091	3%	0.033201172

Results

- The result of the hydraulic modeling and inch-mile analysis are presented in the table on the next slide.
- The table provides the total amount of pipe (in inch-miles) that each wholesale customer touches and the amount of that pipe that each wholesale customer utilizes (in inch-miles).

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PROVIDENCE WATER WHOLESALE COST OF SERVICE STUDY - TABLE 1

SUMMARY OF INCH-MILE ANALYSIS															
WHOLESALER	ADD (gpm)	ADD (MGD)	Total Inch Miles	Wholesale Inch Miles	% Total Inch Miles	MDD (gpm)	MDD (MGD)	Total Inch Miles	Wholesale Inch Miles	% Total Inch Miles	PH DEMAND (gpm)	PH (MGD)	Total Inch Miles	Wholesale Inch Miles	% Total Inch Miles
BCWA	2,229	3.21	1998.96	284.01	14%	3,844	5.53	1966.07	341.53	17%	4,444	6.40	1994.12	327.32	16%
EP	6,458	9.30	1410.01	357.58	25%	6,458	9.30	871.96	251.42	29%	6,458	9.30	1410.01	241.73	17%
GREENVILLE	1,167	1.68	833.22	114.54	14%	1,875	2.70	873.11	111.66	13%	1,875	2.70	822.80	55.09	7%
KCWA	4,722	6.80	134.18	29.10	22%	5,903	8.5	134.18	24.67	18%	8,194	11.80	134.18	30.38	23%
LWC	2,167	3.12	2206.48	304.87	14%	3,167	4.56	1099.91	239.36	22%	3,167	4.56	2178.07	138.09	6%
SMITHFIELD	938	1.35	2147.02	134.65	6%	1,389	2.00	3135.85	187.91	6%	1,389	2.00	2068.97	199.48	10%
WARWICK NATICK	4,134	5.95	1033.33	184.90	18%	6,858	9.88	1002.87	208.03	21%	9,167	13.20	1033.33	252.97	24%
WARWICK PETTACONSETT	1,917	2.76				2,978	4.29				4,861	7.00			

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Issues addressed in the new COSS

a) Allocation of T&D costs including T&D Labor

b) Allocation of responsibility for Non-Revenue Water

c) Allocation of Unidirectional Flushing

d) Allocation of the Central Operations Facility

e) Allocation Pumping Costs

How was the hydraulic model data used?

1. **Used to Address**
   a) T&D costs including T&D Labor
   b) Non-Revenue Water
   c) Unidirectional Flushing

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What is driving the impacts?

1. **Settlement**
   a) Assumption: the more volume you use, the more infrastructure you use
   b) Common assumption used throughout the industry
2. **Hydraulic Model/New COSS**
   a) Identify which mains are actually used under normal operating conditions. Not necessarily aligned with volumes.
   b) Less common, more labor intensive, but more accurate in determining use of the system, especially for PW
3. **Impacts driven by amount of T&D infrastructure used relative to amount of water delivered.**

Differences between new COSS and Settlement COSS

1. **T&D Costs**
    1. Settlement – split between T&D (inch-miles), then allocated based on volumes
    2. New COSS – allocated based on Inch-Miles
2. **Unidirectional Flushing**
    1. Settlement – same approach as T&D Costs
    2. New COSS – allocated based on inch-miles <=12” (by individual wholesale customer and retail)

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Differences between new COSS and Settlement COSS

1. **Allocation of Non-Revenue Water (Real Losses)**
    1. Settlement - Split between T&D (length) then allocated based on volumes
    2. New COSS – allocated based on length of pipe (by individual wholesale customer and retail)
2. **Allocation of Non-Revenue Water (Flushing)**
    1. Settlement – Split between T&D (length)
    2. Flushing volumes based on length of pipe <=12” (by individual wholesale customer and retail)

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	Settlement		New COSS	
	Net Revenue Requirements		Net Revenue Requirements	
Functional Costs	Transmission 40% >12”	Distribution 60% <=12”	Transmission and Distribution (Excluding Flushing)	Unidirectional Flushing
Cost Components	Common to All	Retail Only	CTA – Transmission and Distribution	
	Base, Max Day, Max Hour	Base, Max Day, Max Hour	Inch-Miles	Inch-Miles <=12
Units of Service	HCF (Base), HCF/d (Max Day/Hour)	HCF (Base), HCF/d (Max Day/Hour)	Inch-Miles	Inch-Miles <=12”
Cost Distribution to Customer Classes	Retail Customers		Retail Customers	
	Wholesale Customers		Wholesale Customers	