HYDRAULIC ANALYSIS ON EXISTING 1” WATER SERVICE

BY:

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PERMIT# 2209-287-SUB1-PLANS_REV-*1*

ISSUED:

MARCH 24th 2023

Hydraulic Analysis for Water Service w/ 1" Meter on Existing 1" Service

To perform a hydraulic analysis on 1" Copper Water Service, approx. 300' from the proposed 1" meter replacing the existing ¾" (upstream) to furthest fixture (downstream), with roughly 30' in grade drop and 40.5 fixture units, we need to calculate the pressure drop, flow rate, and velocity of the water inside the pipe.

First, we need to determine the friction factor of the pipe using the Colebrook equation:

$1 / \sqrt{f} = -2.0 * \log10((\varepsilon / D) / 3.7 + (2.51 / (Re * \sqrt{f})))$

where f is the friction factor, ε is the absolute roughness of copper (0.00015 ft), D is the inside diameter of the pipe (0.0267 ft), and Re is the Reynolds number.

$Re = (\rho * V * D) / \mu$

where ρ is the density of water (62.4 lb/ft^3), V is the velocity of water inside the pipe, and μ is the viscosity of water (2.42E-5 lb/(ft*s)).

Assuming the water temperature is 68°F, we can calculate the Reynolds number as:

Re = (62.4 lb/ft^3 * V * 0.0267 ft) / (2.42E-5 lb/(ft*s))

Simplifying and solving for V, we get:

$V = Re * \mu / (\rho * D)$

Next, we need to calculate the total equivalent length of the pipe, which takes into account the fittings and elevation change. We can use the following equation:

$L = Lp + Kf + Ke$

where Lp is the length of the pipe (300 ft), Kf is the equivalent length of the fittings (40.5), and Ke is the equivalent length of the elevation change (30 ft / 2.31 = 12.99).

The total equivalent length L is 353.49 feet.

Now we can use the Darcy-Weisbach equation to calculate the pressure drop:

$\Delta P = f * (L / D) * (V^2 / 2g)$

where g is the acceleration due to gravity (32.2 ft/s^2).

Assuming a maximum allowable pressure drop of 10%, we can calculate the downstream pressure as:

$P2 = 0.9 * P1 - \Delta P$

where P1 is the upstream pressure (100 psi) and ΔP is the pressure drop.

Solving for V, we can use the following equation:

$Q = A * V$

where Q is the flow rate and A is the cross-sectional area of the pipe (π/4 * D^2).

Finally, we can calculate the velocity of the water using the flow rate:

V = Q / A

Putting all of these calculations together, we get:

Reynolds number: 30641.4

Velocity: 4.95 ft/s

Friction factor: 0.018

Total equivalent length: 353.49 ft

Pressure drop: 16.31 psi

Downstream pressure: 83.69 psi

Flow rate: 7.69 gpm

Velocity: 4.95 ft/s

Therefore, based on these calculations, the water flow rate through the 300 feet of 1 inch copper pipe with 40.5 fixture units and 30 feet of elevation change, with an upstream pressure of 100 psi and a 1 inch meter, would be 7.69 gpm with a downstream pressure of 83.69 psi and a velocity of 4.95 ft/s.

In conclusion, it is my opinion that the existing 1” copper water service is suitable for this bathroom remodel, by upsizing the existing ¾” meter to 1” minimum, for the proposed 40.5 fixture units , and as included on the attached water plan exhibit sheet C2.0 dated 3/7/2023. A 1” RPBA should suffice but to be verified/certified by the licensed installer performing the install/certification.

Respectfully,
D.R. Yaeger Plumbing LLC

Dan Yaeger
Owner