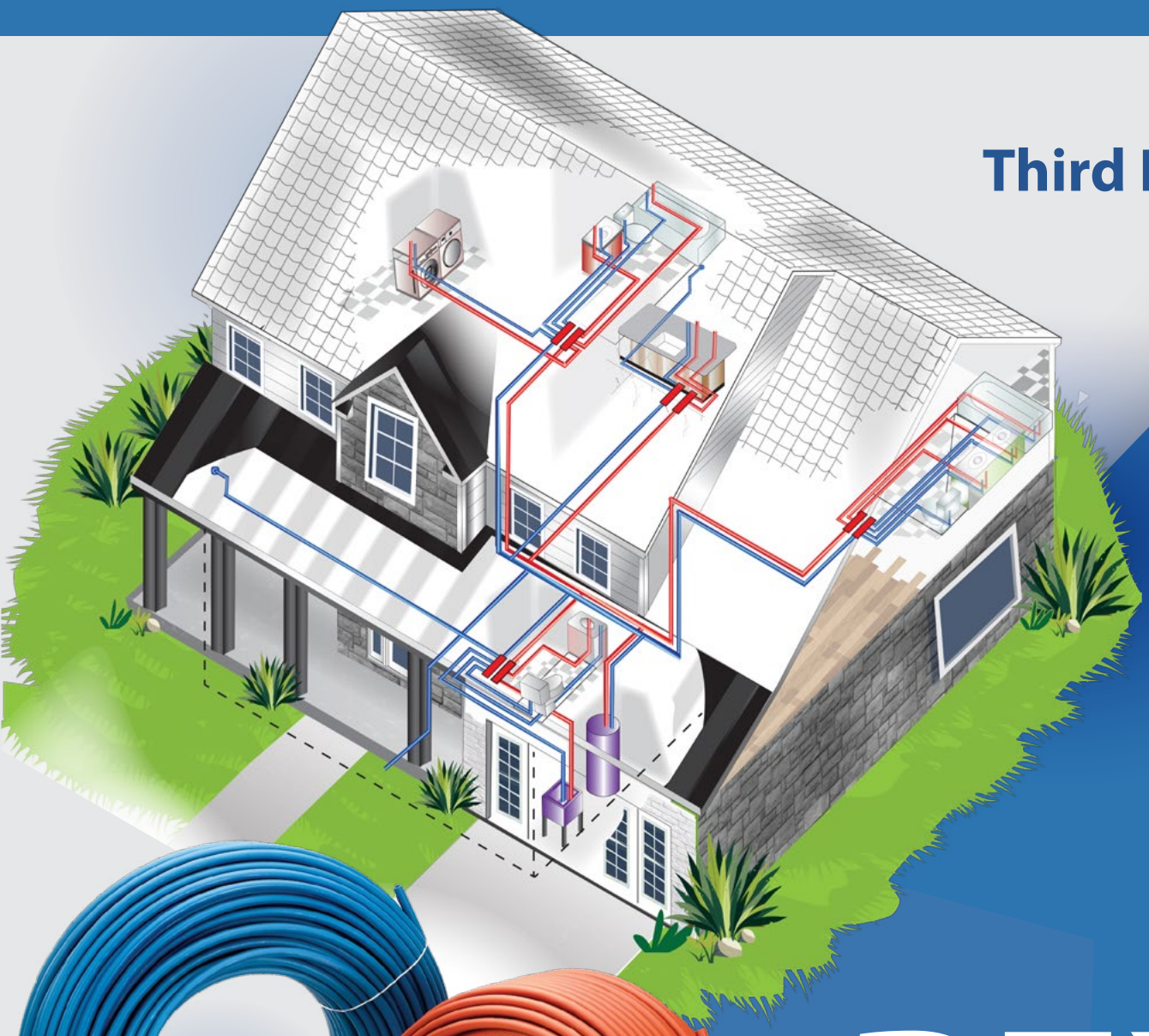
Third Edition



PEX

Plumbing Distribution Systems Design and Installation Guide

Advantages | Material Properties | Codes & Standards

Joining Methods | PEX Plumbing Layouts | Optimizing Design

Installation Guidelines | Water Service Line | Other Applications

IAPMO

PPI Plastics Pipe Institute The Voice of an Industry.

Home Innovation RESEARCH LABS™

PPFA Plastic Pipe and Fittings Association

ES ICC EVALUATION SERVICE®

PEX

Plumbing Distribution Systems Design and Installation Guide

Third Edition

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Optimizing PEX Plumbing Designs

7

This chapter focuses on optimizing plumbing system designs for the use of PEX systems. It provides example plumbing system designs utilizing the three main layout options described in **Chapter 6 *Layouts & Design*** (trunk & branch, parallel, zoned) for four common types of residential and multi-family structures:

- **The Colonial:** 2,000 square feet house, unfinished basement plus two levels, 4 bedrooms, 2 full baths, 1 half bath (see **Figure 7.1**)
- **The Ranch:** 1,300 square feet, one story, 3 bedrooms, 2 full baths
- **The Townhouse:** 1,000 square, three levels, 2 bedrooms, 1 full bath, 1 half bath
- **The Condo:** 1,200 square feet, one level, 2 bedrooms, 2 full baths

While many commercial buildings are unique structures and require a specific hot- and cold-water plumbing design based on fixtures, flows, locations, distance to water heaters, customer expectations, and the applicable plumbing codes, certain commercial plumbing designs (e.g., apartments, hotels) may be modeled based on the guidance provided in these four design examples. For such structures, plumbing engineers can follow the principles provided in **Chapter 6** and this chapter.

Chapter 8 *Performance Data* provides performance measurements for each type of system, with regards to the flow and residual pressure, as well as the time-to-wait for hot water in each of the plumbing layouts.

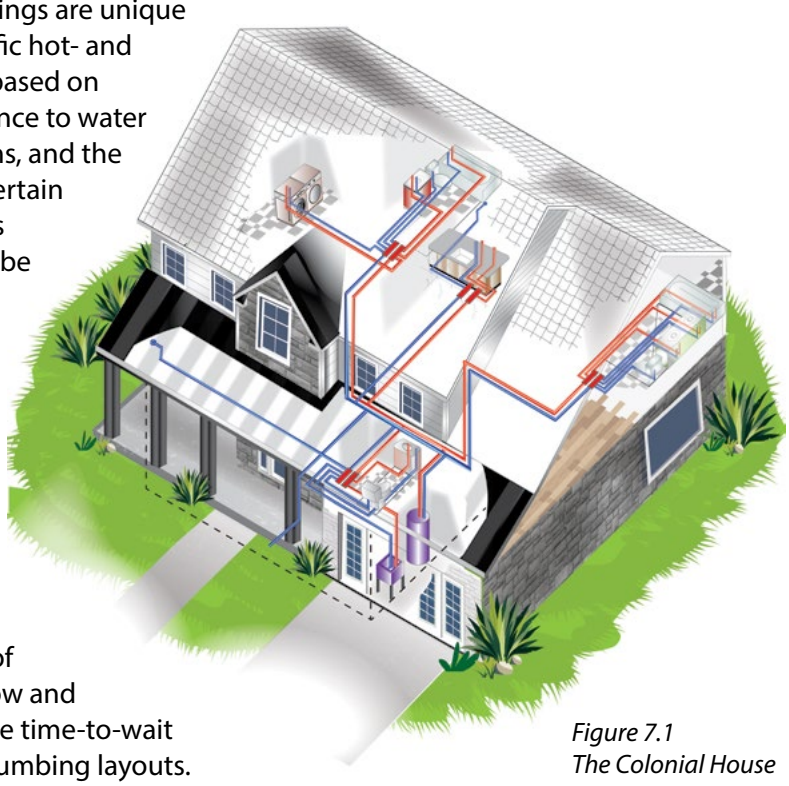

Figure 7.1
The Colonial House

Example Layouts

The following plumbing system layouts were based on simulated Computer-Aided Design (CAD) designs matching the architectural scale of each of the four housing types. These CAD designs provide hot- and cold-water distribution piping designs. The length of tubing for both hot- and cold-water supply and quantities of fittings and joints are shown for each design to provide a comparison of material use and labor required. You can choose the residential design that most closely resembles your project to help select the PEX plumbing system that is optimal for each project. In these designs, only a few common structural obstructions are accounted for; therefore, these piping layouts represent idealized pipe runs with minimal fittings. Actual construction with more structural obstructions may require additional tubing and changes of direction to bypass them.

Table 7.1 outlines the number and type of fixtures for each residence type.

Table 7.1 Fixture Count for Each Residence Type

Fixture	Colonial	Ranch	Townhouse	Condominium
Kitchen Sink	1	1	1	1
Dishwasher	1	1	1	1
Lavatory	4	3	2	3
Water Closet	3	2	2	2
Shower/Tub	3	3	1	3
Clothes Washer	1	1	1	1
Utility Sink	1	0	0	0
Hose Bibbs	2	2	2	0
Total	**16**	**13**	**10**	**11**

Colonial Layout

The Colonial house layout has approximately **2,000** square feet of floor area and an unfinished basement. The water service line enters the house under the basement slab. The water heater is located near the service line in the basement. The first floor has a living room, dining room, kitchen, family room, and a powder room. The second floor has four bedrooms, two full baths, and clothes washer.

Table 7.2 provides the Fixture Summary for the Colonial house.

Table 7.2 Fixture Summary for the Colonial House

Level	Kitchen Sink	Dish-washer	Lava-tory	Water Closet	Shower / Tub	Clothes Washer	Utility Sink	Hose Bibs	Total
Basement	0	0	0	0	0	0	1	0	**1**
First Floor	1	1	1	1	0	0	0	2	**6**
Second Floor	0	0	3	2	3	1	0	0	**9**
Total	**1**	**1**	**4**	**3**	**3**	**1**	**1**	**2**	**16**

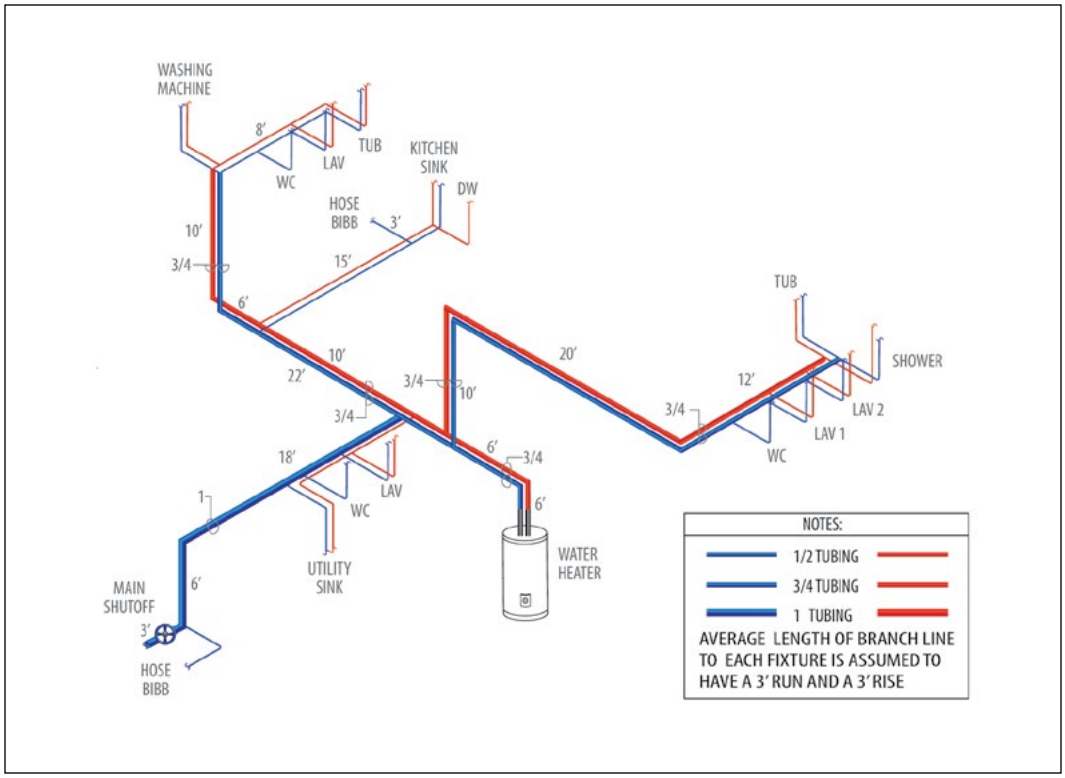

Figure 7.2 Trunk and Branch Isometric Riser for the Colonial House

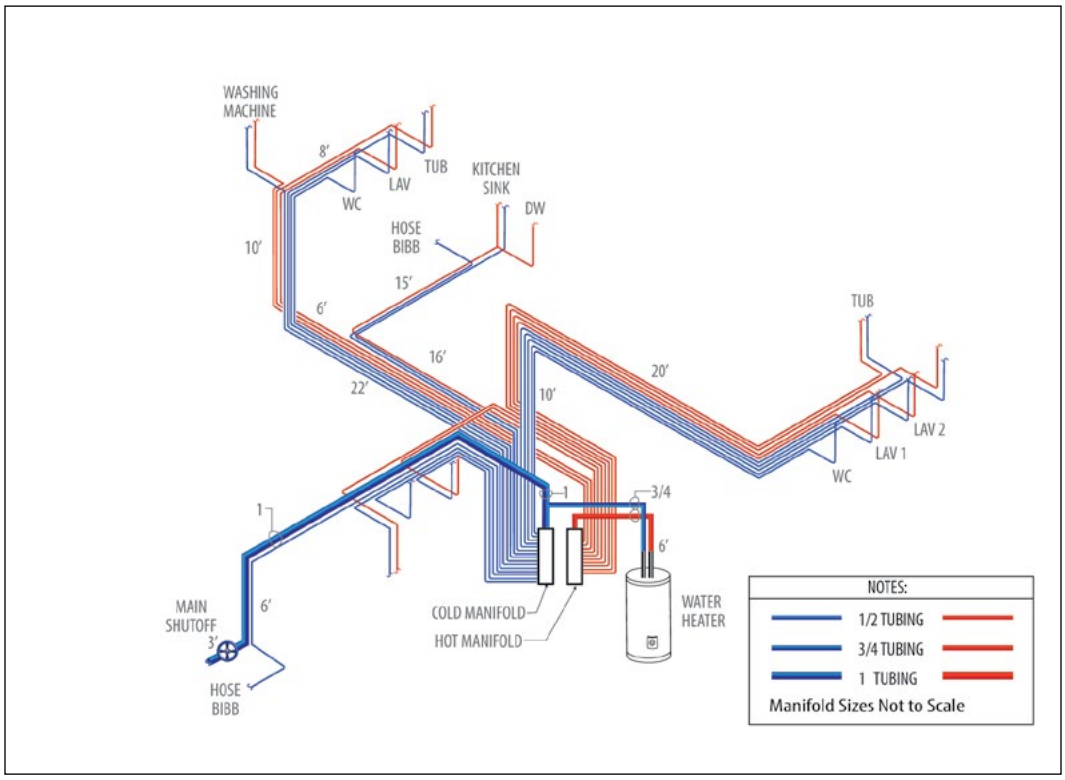

Figure 7.3 Parallel Isometric Riser for the Colonial House

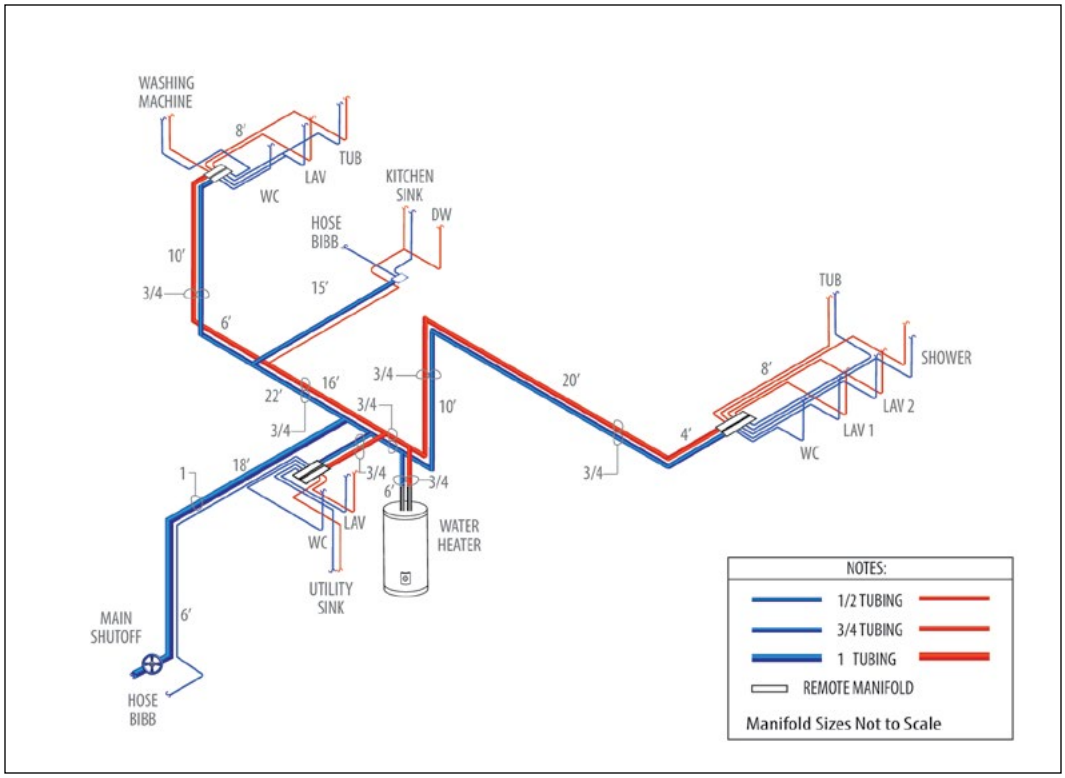

Figure 7.4 Zone Isometric Riser for the Colonial House

Table 7.3 provides the Material Summary for PEX tubing, fittings, and joints for each of the three plumbing layouts for the Colonial house.

Table 7.3 Material Summary for the Colonial House

	Length of Cold Pipe			Length of Hot Pipe			Fittings		Manifolds/ Multi-port Tees		Joints	
	1	3/4	1/2	1	3/4	1/2	Tees	Elbows	Main	Remote	Fixtures	Piping
Trunk and Branch	27'	80′	110′	0′	80′	98′	25	10	0	0	26	97
Parallel	33′	12′	602′	0′	12′	428′	2	7	2	0	26	49
Zone	27′	93′	152′	0′	93′	107′	8	13	0	7	26	83

In homes and buildings with a large separation between fixture groups (e.g., bathrooms), the trunk and branch design uses the least amount of total tubing but the most fittings and joints. In this example, the T&B design uses **395** feet of tubing, **35** fittings and **123** joints. The parallel system uses the most tubing (**1,087** feet or 2.75 times more than T&B) and the least amount of fittings (**11**) and joints (**75**). While the parallel system uses more tubing, it is all smaller diameter, which is easier to handle and install, particularly around obstructions and bends. The zoned system strikes a balance with **472** feet of tubing, **28** fittings, and **109** joints.

An appropriate balance between labor and material costs as well as the relative performance of the systems is important when deciding on a system layout for a particular house or building.

Ranch Layout

The Ranch house has approximately **1,300** square feet of one-story floor area slab-on-grade. The water service line enters the house under the slab. The one-story floor plan includes a great room, a kitchen, a dining room, three bedrooms, and two full baths. The water heater and clothes washer are located in the utility room.

Table 7.4 provides the Fixture Summary for the Ranch house.

Table 7.4 Fixture Summary for the Ranch House

Level	Kitchen Sink	Dish-washer	Lava-tory	Water Closet	Shower / Tub	Clothes Washer	Utility Sink	Hose Bibs	Total
Main Floor	1	1	3	2	3	1	0	2	**13**

See **Figure 7.5** for the trunk and branch, **Figure 7.6** for parallel, and **Figure 7.7** for zoned plumbing layouts for the Ranch house.

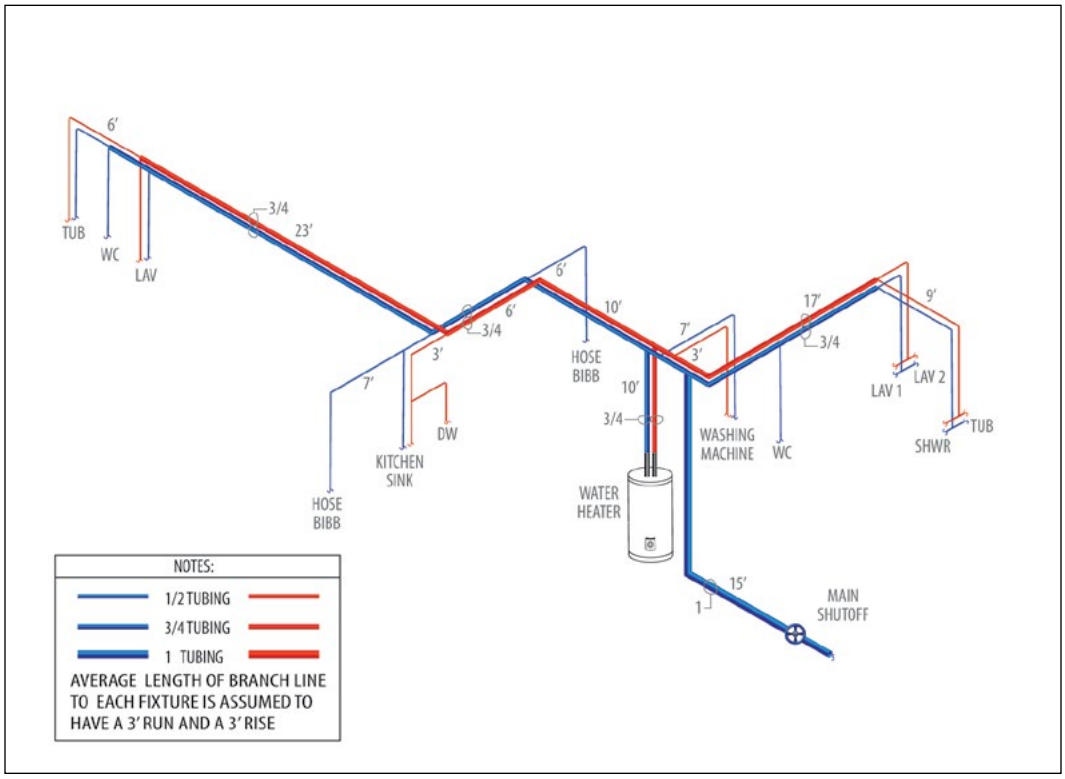

Figure 7.5 Trunk and Branch Isometric Riser for the Ranch House

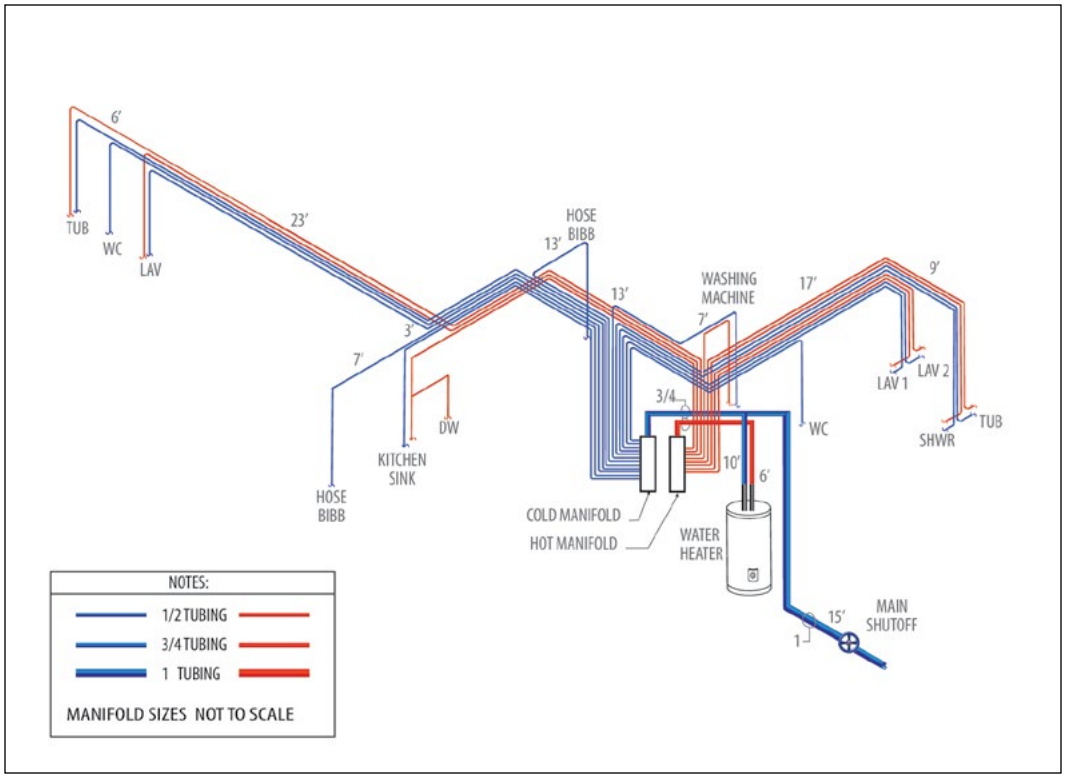

Figure 7.6 Parallel Isometric Riser for the Ranch House

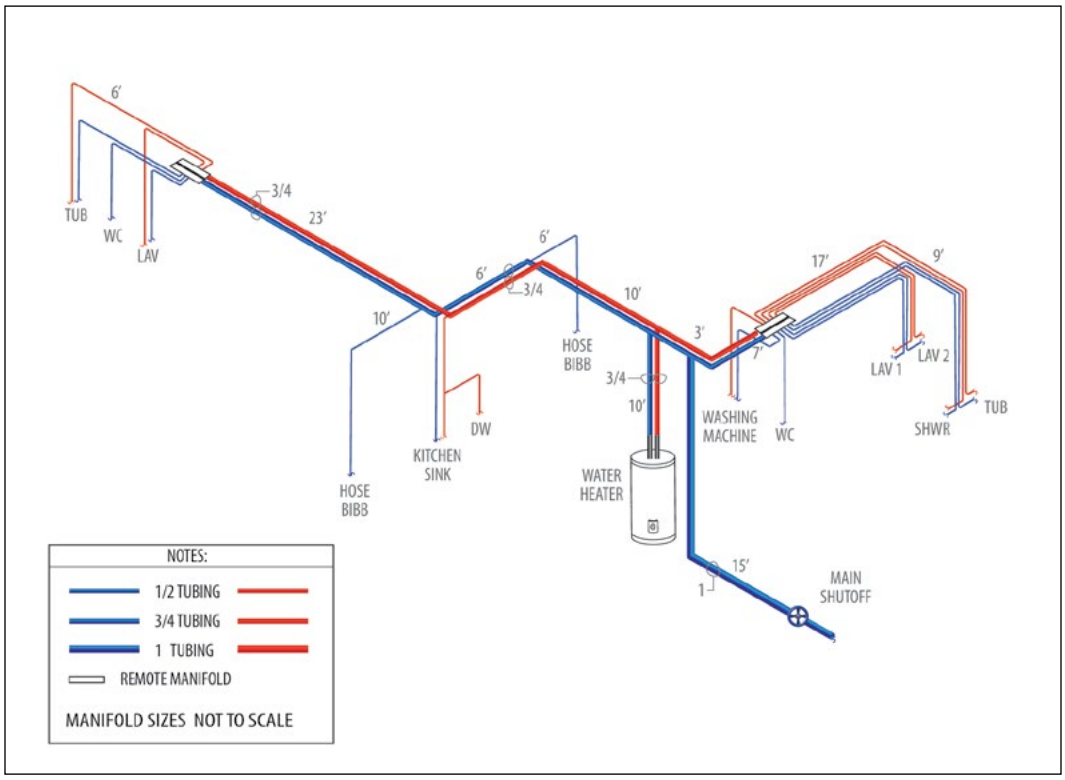

Figure 7.7 Zone Isometric Riser for the Ranch House

Table 7.5 provides the Material Summary for PEX tubing, fittings, and joints for each of the three plumbing layouts for the Ranch house.

Table 7.5 Material Summary for the Ranch House

	Length of Cold Pipe			Length of Hot Pipe			Fittings		Manifolds/ Multi-port Tees		Joints	
	1	3/4	1/2	1	3/4	1/2	Tees	Elbows	Main	Remote	Fixtures	Piping
Trunk and Branch	25′	75′	112′	0′	72′	81′	20	5	0	0	21	71
Parallel	25′	10′	413′	0′	10′	294′	2	5	2	0	21	39
Zone	25′	59′	196′	0′	59′	159′	8	4	0	4	21	53

In homes and buildings with a large separation between fixture groups (e.g., bathrooms, kitchens), the trunk and branch design uses the least amount of total tubing, but the most fittings and joints. In this example, the T&B design uses **365** feet of tubing, **25** fittings and **92** joints. The parallel system uses the most total tubing (**752** feet or 2 times more than T&B) and the least amount of fittings (**7**) and joints (**60**). While the parallel system uses the most tubing, it is all smaller diameters, which is easier to handle and install, particularly around obstructions and bends. The zoned system strikes a balance with **498** feet of tubing, **12** fittings, and **74** joints.

An appropriate balance between labor and material costs as well as the relative performance of the systems is important when deciding on a system layout for a particular house or building.

Townhouse Layout

The Townhouse has two stories and is approximately **1,000** square feet of floor area. The water service line enters the house under the first floor's slab. The first floor has a living room, kitchen, dining room, and a powder room. The second floor has two bedrooms and one full bath. The water heater and clothes washer are located on the first floor.

Table 7.6 provides the Fixture Summary for the Townhouse.

Table 7.6 Fixture Summary for the Townhouse

Level	Kitchen Sink	Dish-washer	Lava-tory	Water Closet	Shower / Tub	Clothes Washer	Utility Sink	Hose Bibs	Total
First Floor	1	1	1	1	0	1	0	2	**7**
Second Floor	0	0	1	1	1	0	0	0	**3**
Total	**1**	**1**	**2**	**2**	**1**	**1**	**0**	**2**	**10**

See **Figure 7.8** for the trunk and branch, **Figure 7.9** for parallel, and **Figure 7.10** for zoned plumbing layouts for the Townhouse.

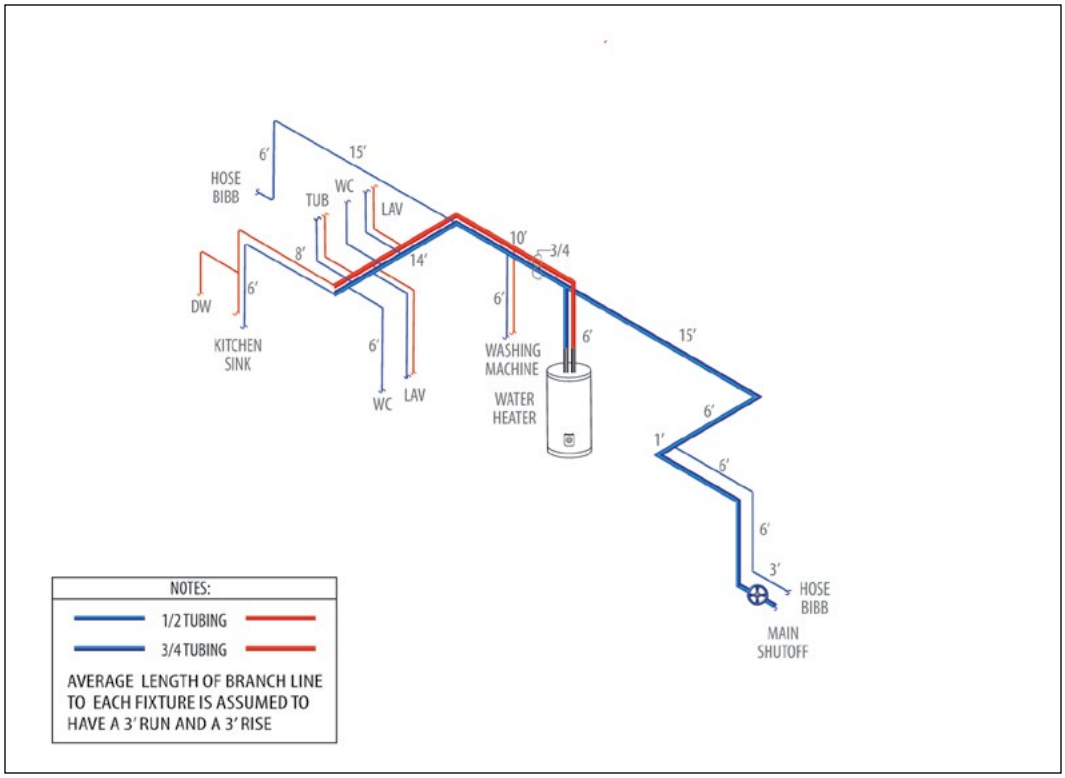

Figure 7.8 Trunk and Branch Isometric Riser for the Townhouse

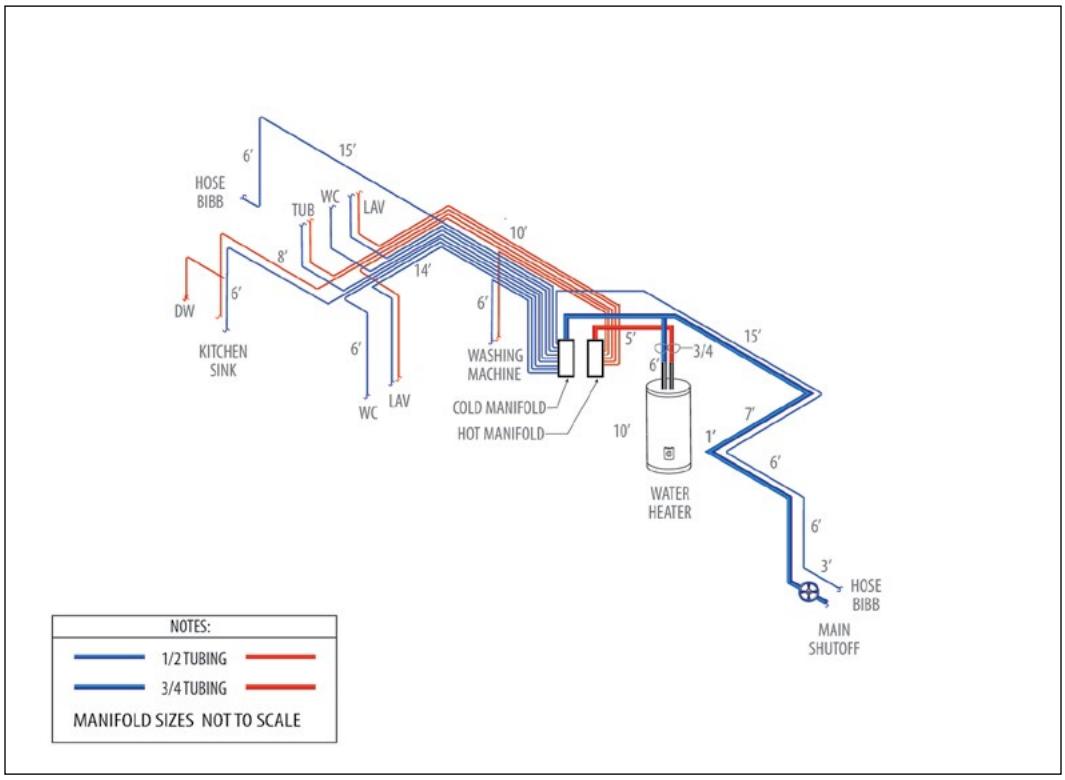

Figure 7.9 Parallel Isometric Riser for the Townhouse

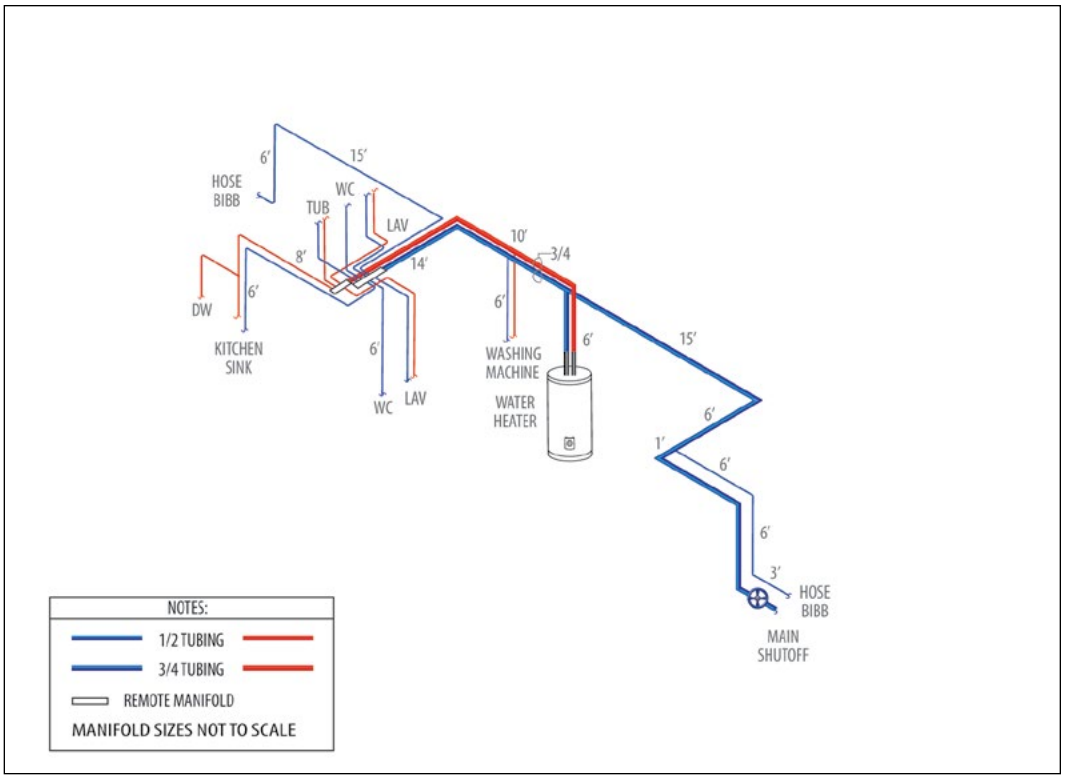

Figure 7.10 Zone Isometric Riser for the Townhouse

Table 7.7 provides the Material Summary for PEX tubing, fittings, and joints for each of the three plumbing layouts for the Townhouse.

Table 7.7 Material Summary for the Townhouse

	Length of Cold Pipe			Length of Hot Pipe			Fittings		Manifolds/ Multi-port Tees		Joints	
	1	3/4	1/2	1	3/4	1/2	Tees	Elbows	Main	Remote	Fixtures	Piping
Trunk and Branch	0′	66′	86′	0′	30′	44′	14	8	0	0	15	59
Parallel	0′	42′	247′	0′	11′	138′	2	8	2	0	15	39
Zone	0′	67′	100′	0′	30′	44′	5	7	0	2	15	42

In compact house designs such as townhomes, the differences between the trunk and branch and zone systems are primarily in reduced fittings and joints for the zone system. In this example, the T&B design uses **226** feet of tubing, **22** fittings and **74** joints. The parallel system uses considerably more tubing, **438** feet or 1.9 times more than T&B, with **10** fittings and **54** joints. While the parallel system uses more tubing, all of it is smaller diameter, which is easier to handle and install, particularly around obstructions and bends. The zoned system strikes a balance with **241** feet of tubing, **12** fittings, and **57** joints.

An appropriate balance between labor and material costs as well as the relative performance of the systems is important when deciding on a system layout for a particular house or building.

Condominium Layout

The Condominium has approximately **1,200** square feet of floor area on one level. This layout is also applicable to large apartments and hotel rooms. It has a living room, kitchen, dining room, two bedrooms, and two full baths. The clothes washer is located in the unit. The condominium building has a central plant for water heating; therefore, there is no water heater located in the unit.

Table 7.8 provides the Fixture Summary for the Condominium.

Table 7.8 Fixture Summary for the Condominium

Level	Kitchen Sink	Dish-washer	Lava-tory	Water Closet	Shower / Tub	Clothes Washer	Utility Sink	Hose Bibs	Total
Main Floor	1	1	3	2	3	1	0	0	**11**

See **Figure 7.11** for the trunk and branch, **Figure 7.12** for parallel, and **Figure 7.13** for zoned plumbing layouts for the Condominium.

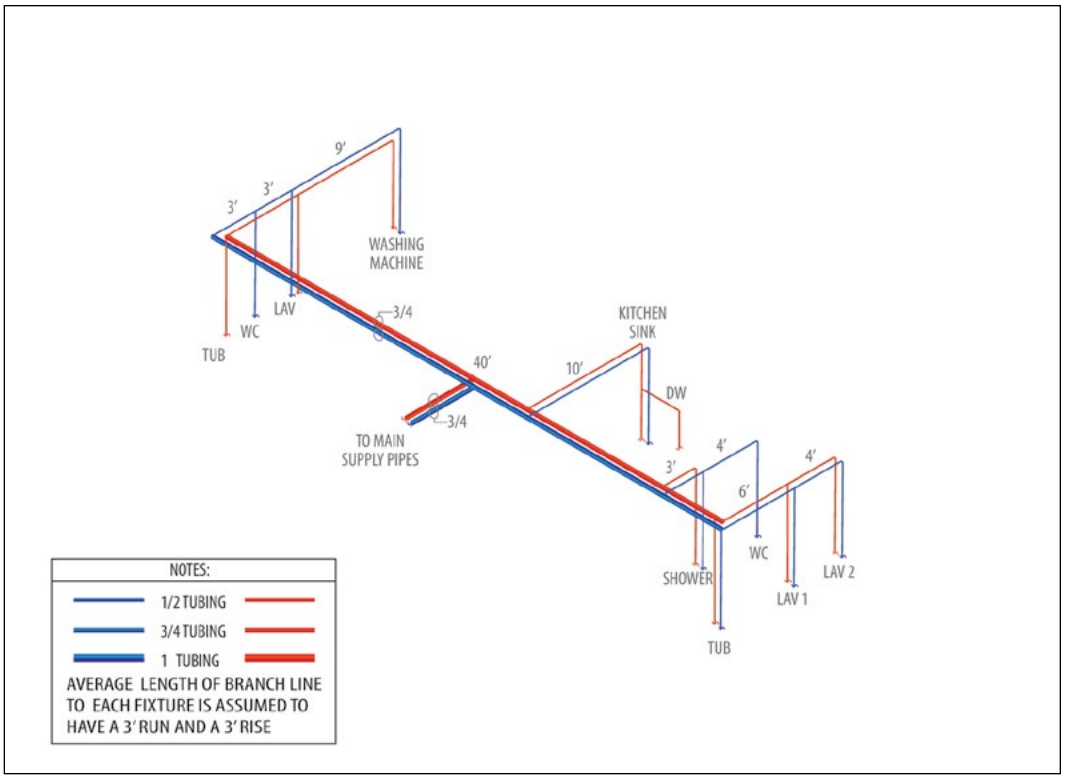

Figure 7.11 Trunk and Branch Isometric Riser for the Condominium

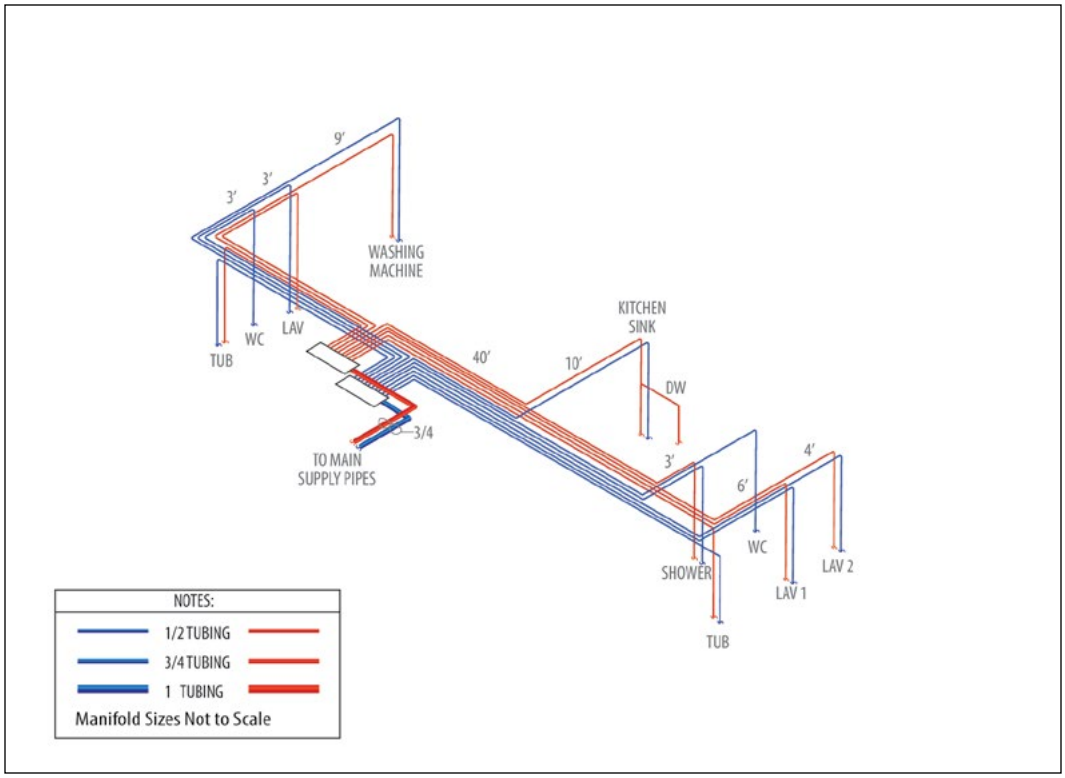

Figure 7.12 Parallel Isometric Riser for the Condominium

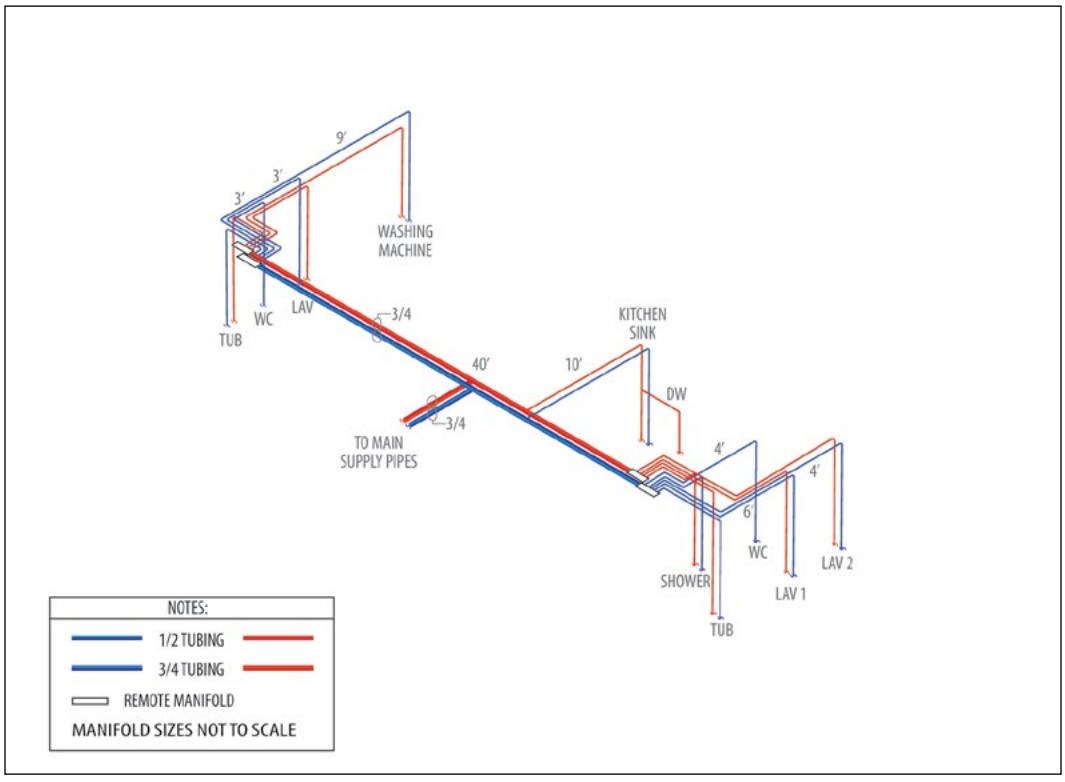

Figure 7.13 Zone Isometric Riser for the Condominium

Table 7.9 provides the Material Summary for PEX tubing, fittings, and joints for each of the three plumbing layouts for the Condominium.

Table 7.9 Material Summary for the Condominium

	Length of Cold Pipe			Length of Hot Pipe			Fittings		Manifolds/ Multi-port Tees		Joints	
	1	3/4	1/2	1	3/4	1/2	Tees	Elbows	Main	Remote	Fixtures	Piping
Trunk and Branch	0′	45′	120′	0′	45′	104′	17	0	0	0	19	53
Parallel	0′	10′	295′	0′	10′	242′	1	2	2	0	19	29
Zone	0′	35′	132′	0′	35′	115′	5	0	0	4	19	37

In this type of structure, a trunk and branch system uses the most tees, which increases the number of joints, whereas the zone system uses fewer fittings, resulting in fewer joints. In this example, the T&B system uses **314** feet, **17** fittings and **72** joints. The parallel system uses **557** feet of tubing (1.8 times more than T&B), **3** fittings and **48** joints. While the parallel system uses more tubing, it is all smaller diameter, which is easier to handle and install, particularly around obstructions and bends. The zoned system strikes a balance with **317** feet of tubing, **5** fittings, and **56** joints.

An appropriate balance between labor and material costs as well as the relative performance of the systems is important when deciding on a system layout for a particular house or building.

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