CE 365 Project

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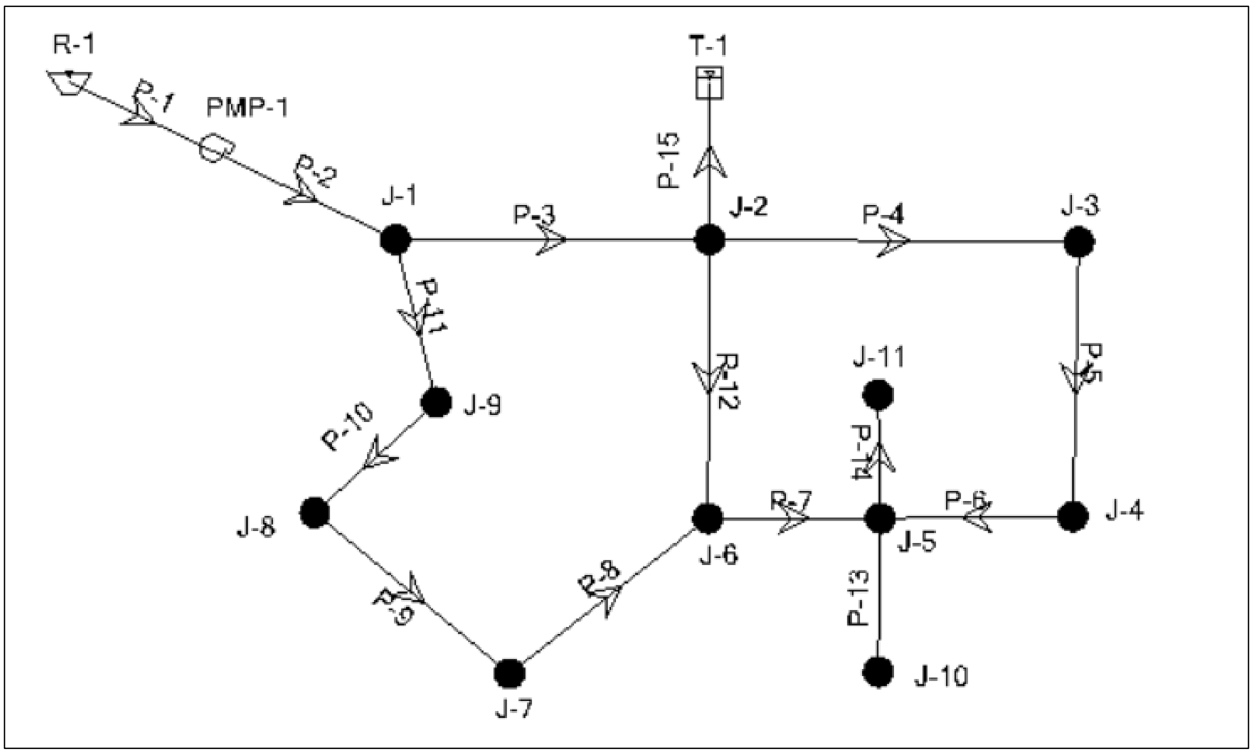
Instructor: Michael Piasecki

Specific Project Problems

Problem 3

A distribution system is needed to supply water to a resort development for normal usage and emergency purposes (such as fighting a fire). The proposed system layout is shown in the following figure:



The source of water for the system is a pumped well. The water is treated and placed in a ground-level tank (shown above as a reservoir because of its plentiful supply), which is maintained at a water surface elevation of 210 ft. The water is then pumped from this tank into the rest of the system.

The well system alone cannot efficiently provide the amount of water needed for fire protection, so an elevated storage tank is also needed. The bottom of the tank is at 376 ft (high enough to produce 35 psi at the highest node), and the top is approximately 20 ft higher. To avoid the cost of an elevated tank, this 80-ft diameter tank is located on a hillside, 2,000 ft away from the main system. Assume that the tank starts with a water surface elevation of 380 ft.

The pump was originally sized to deliver 300 gpm with enough head to pump against the tank when it is full. Three defining points on the pump curve are as follows:

Discharge Q [gpm]	Head [ft]
0	200
300	180
600	150

The pump elevation is assumed to be the same as the elevation at J-1, although the precise pump elevation is not crucial to the analysis.

The system is to be analyzed under several demand conditions with minimum and maximum pressure constraints. During normal operations, the junction pressures should be between 35 psi and 80 psi. Under fire flow conditions, however, the minimum pressure can drop to 20 psi. Fire protection is being considered both with and without a sprinkler system.

Demand Alternatives: WaterGEMS enables you to store multiple demand alternatives corresponding to various conditions (such as average day, peak hour, etc). This feature allows you to run different scenarios that incorporate various demand conditions within a single project file without losing any input data. For an introduction and more information about scenarios and alternatives, see WaterGEMS's online help system.

Table: Junction Information

Junction	Elevation	Average Day (gmp)	Peak Hour (gpm)	Min. Hour (gpm)	Fire w/ sprinkler (gpm)	Fire w/o sprinkler (gpm)
1	250	0	0	0	0	0
2	260	0	0	0	0	0
3	262	20	50	2	520	800
4	262	20	50	2	520	800
5	270	0	0	0	0	800
6	280	0	0	0	0	800
7	295	40	100	2	40	40
8	290	40	100	2	40	40
9	285	0	0	0	0	0
10	280	0	0	0	30	160
11	270	160	400	30	160	160

Pipe Network: The pipe network consists of the pipes listed in the following table. The diameters shown are based on the preliminary design, and may not be adequate for the final design. For all pipes, use ductile iron as the material and a Hazen-Williams coefficient of 130.

<u>Table:</u> Pipe Information

Pipe	Diameter (in)	Length (ft)
1	8	20
2	8	300
3	8	600
4	6	450
5	6	500
6	6	300
7	5	250
8	6	400
9	6	400
10	6	200
11	6	500
12	8	500
13	6	400
14	6	200
15	10	2000

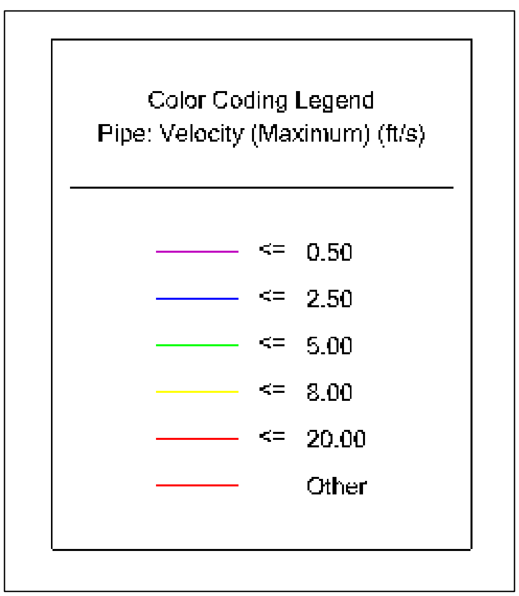
To help keep track of important system characteristics (like maximum velocity, lowest pressure, etc.), you may find it helpful to keep a table such as the following:

Table: Results Summary

Variable	Average Day	Peak Hour	Min. Hour	Fire w/ Sprinkler	Fire w/o Sprinkler
Node w/ low pressure					
Low Pressure (psi)					
Node w/ high pressure					
High pressure (psi)					
Pipe w/ max velocity					
Max velocity (ft/s)					
Tank in/out flow (gpm)					
Pump discharge (gpm)					

Another way to quickly determine the performance of the system is to color-code the pipes according to some indicator. In hydraulics design, a good performance indicator is often the velocity in the pipes. Pipes consistently flowing below 0.5 ft/s may be oversized. Pipes with velocities above 5 ft/s are fairly heavily stressed, and those with velocities above 8 ft/s are usually bottlenecks in the system under that flow pattern. Color-code the system using ranges in the tale below. After you define the color-coding, place a legend in the drawing.

Color-Coding Range



Questions:

a) Fill in or reproduce the Results Summary table after each run to get a feel for some for the key indicators during various scenarios.

b) For the average day run, what is the pump discharge?

c) If the pump has a best efficiency point at 300gpm, what you can say about its performance on an average day?

d) For the peak hour run, the velocities are fairly low. Does this mean you have oversized the pipes? Explain.

e) For the minimum, what was the highest pressure in the system? Why would you expect the highest to occur during the minimum hour demand?

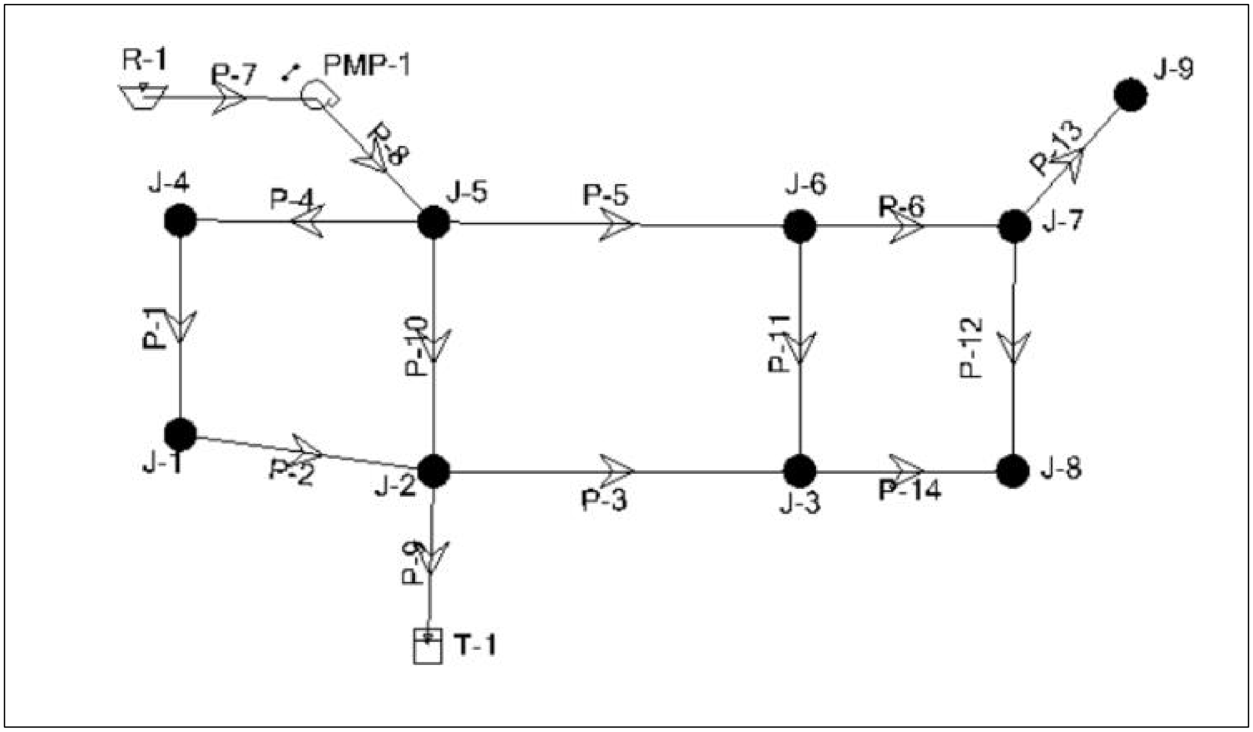
f) Was the system (as currently designed) acceptable for the fire flow case with the sprinkled building? On what did you base this decision?

g) Was the system (as currently designed) acceptable for the fire flow case with all the flow provided by hose streams (no sprinkler)? If not, how would you modify the system so that it will work?

Problem 9

A planning commission has indicated a new industry may be connected to the water system shown below. The water surface elevation at the reservoir is 70 m. The cylindrical tank (T-1) has a diameter of 15 m. The base and minimum elevations are 99 m. The maximum elevation is 104 m, and the initial elevation is 103.4

System Layout (same as Tutorial 2)



You are to determine the pipe diameters in the network to minimize the installation cost assuming all the pipes are ductile iron. Use the Darwin Designer to determine the total cost and size each pipe for each of the following conditions. Use the pipe cost information from Tutorial 4 the ductile iron pipe.

The **pump information** is as follows:

Head [m]	Discharge [l/min]	Controls
40	0	Off if node T-1 is above 103.5 m On if node T-1 below 100.5 m
35	3000	
24	6000	

Table: Junction Data

Junction	Elevation [m]	Demand [l/min]
J-1	73	151
J-2	67	227
J-3	81	229
J-4	56	219
J-5	67	215
J-6	73	219
J-7	55	215
J-8	84	180
J-9	88	151

Table: Pipe Data

Pipe	Length [m]	Diameter [mm]	Roughness
P-1	300	200	130
P-2	305	200	130
P-3	300	200	130
P-4	200	200	130
P-5	300	300	130
P-6	200	200	130
P-7	1	300	130
P-8	5,000	300	130
P-9	300	300	130
P-10	500	200	130
P-11	500	200	130
P-12	500	200	130
P-13	150	150	130
P-14	200	200	130

Questions:

1) Size the pipes using a demand multiplier (peaking factor) of 3.2. The pressure must remain between 170 and 550 kPa during peak demand. Exclude pipes P-7 and P-8 in your analysis when determining the pipe sizes, Hint: you will need to specify an additional demand of zero (o l/min) with the default pressure constraints at the junctions or a fatal error will occur.

2) It is expected that a new industry with an expected additional demand of 2,000 l/min with a required minimum pressure f 260 kPa will be added to the system. It could be tapped into the network at either junction 6, 7, or 8. Size the pipes for the conditions in part 1) above, along with the industry added to all proposed junctions. You will need to analyze the network three times, once the industry at J06, again with the industry at J-7, then finally with the industry at J-8.

   i) Indicate which option(s) would work.

   ii) Which junction should the industry be tapped into to be the least costly and what is the expected cost?

   iii) What is the size of each pipe for the best solution for the least costly option with the industry added?

   iv) What is the calculated minimum pressure at the industry for the best solution?