



AZRED v2.0 Tutorial

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Technical Contents:

- Exercise 1-Single junction: Mixing at Cross junction
- Exercise 2-Single junction: Mixing at double-Tee and Wye junctions
- Exercise 3-Multiple junctions: A 4x5 grid network

Exercise 1-Single junction: Mixing at Cross junction

Scenario:

The water distribution pipe network shown below is a single-junction network. The center node is a cross junction with two inlets and two outlets. The two inlets are being supplied by two pumps connected to separate reservoirs. One reservoir contains pure water (west) while the other has contaminated water (south). One pump provides pure water ($C = 0$ mg/L) while the other injects a constant amount (each hour) of water mixed with salt in a concentration of 1 mg/L. The two pumps are of the same type with the same specifications: a 1-point curve with a flow of 200 GPM (757.1 L/min) and a head of 40 ft. (12.2 m). The entire network lies flat at ground level. Both outlet nodes are demand points, each with a demand of 100 GPM (378.5 L/min). Every section of pipe has a diameter of 12 in. (30.48 cm), a roughness of 100 (HW), and a length of 1000 ft. (304.8 m). The map shown is not to scale.

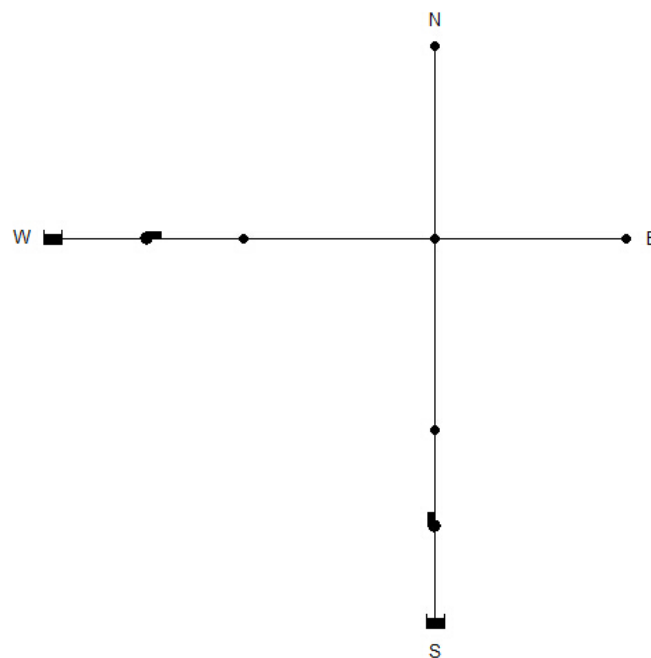


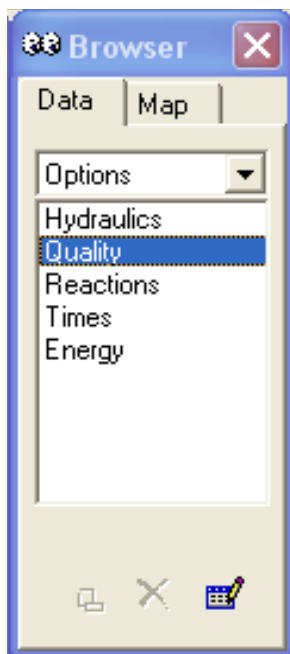
Fig. 1. Cross network map

Objectives:

- Use AZRED v.2.0 to predict the concentration of the contaminant at each outlet, assuming incomplete mixing.
- Compare the results to those obtained using the perfect mixing model (EPANET).

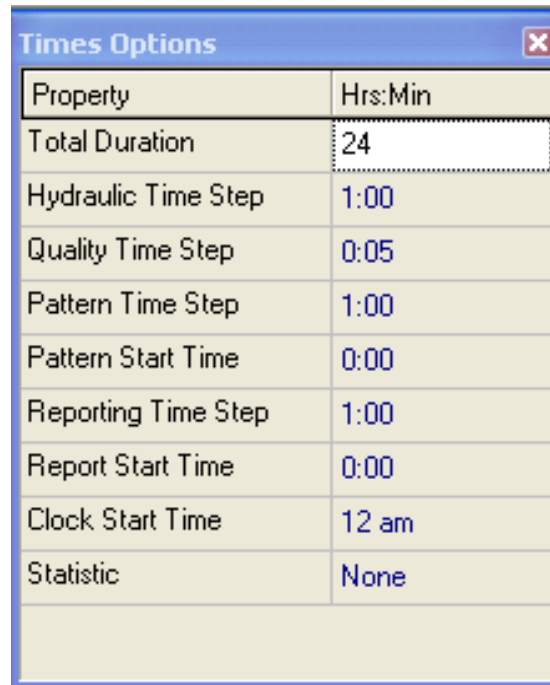
Steps:

1. Run the AZRED version of EPANET (epanet2w.exe). Create your own single-junction network. Use the information supplied in the Scenario to recreate the network.
2. Set the Quality Options by going to the Browser window on the right hand side. Inside the Data tab, choose Options, and then double click Quality (on the dropdown menu). Inside the Quality Options, change the Parameter option to Chemical.



Quality Options	
Property	Value
Parameter	Chemical
Mass Units	mg/L
Relative Diffusivity	1
Trace Node	
Quality Tolerance	0.01

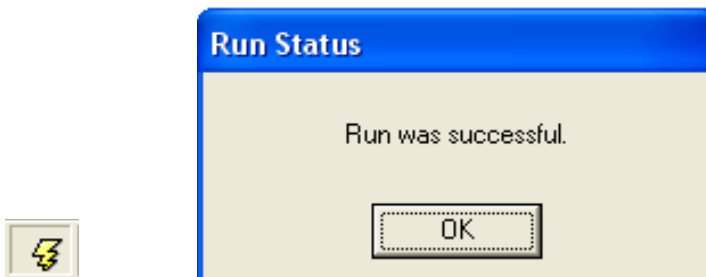
3. Set the Times Options by going to the Browser window again. Inside the Data tab, choose Options, and then double click Times (on the dropdown menu). Inside the Times Options, change the Total Duration to 24 (to set up a 24-hour simulation period).



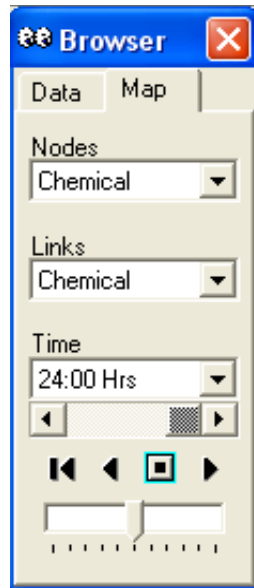
The 'Times Options' dialog box contains a table with the following data:

Property	Hrs:Min
Total Duration	24
Hydraulic Time Step	1:00
Quality Time Step	0:05
Pattern Time Step	1:00
Pattern Start Time	0:00
Reporting Time Step	1:00
Report Start Time	0:00
Clock Start Time	12 am
Statistic	None

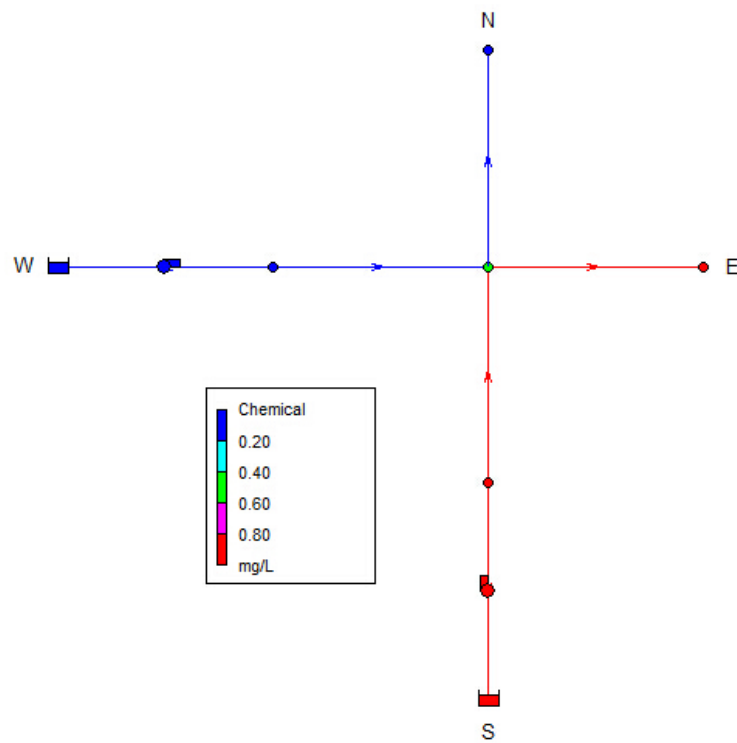
- The project is now ready for analysis. Run the analysis by clicking the run button (the button with the picture of a lightning bolt). A window should appear with the message Run was Successful. Press OK to continue.



- To view the water quality results, go to the Browser window. This time pick the Map tab. Select Chemical for both Nodes and Links. Then press the play button to start the simulation.



6. The results of the incomplete mixing should be as follows:



7. The results of the perfect mixing can be obtained by using the same network file used above, but use it in conjunction with the original EPANET program. The perfect mixing results should be as follows:

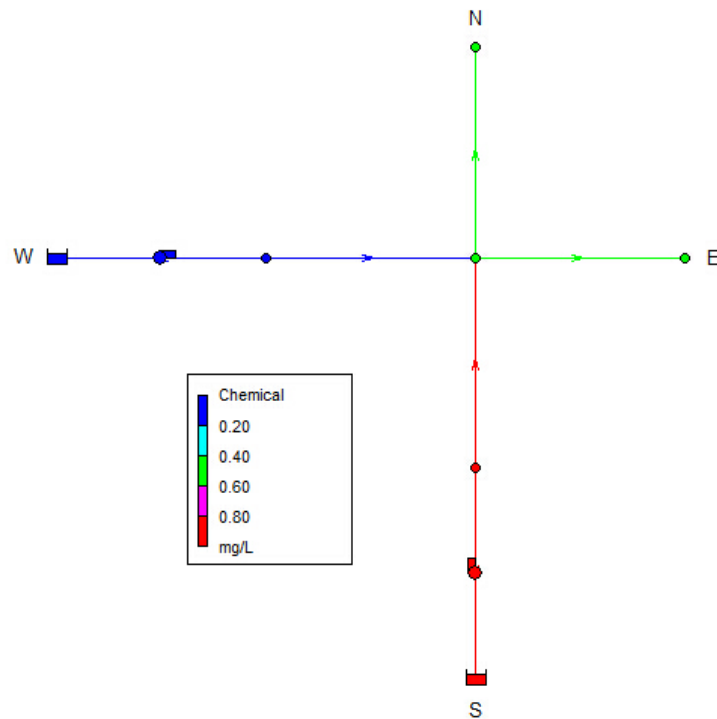


Table 1. Cross junction network results

Junction Type	EPANET (complete mixing)		AZRED v2.0 (incomplete mixing)	
	Outlet Conc. (mg/L)			
	N	E	N	E
Cross	0.50	0.50	0.09	0.91

where L^* is the dimensionless distance between the two fittings, L is the distance between fittings, and D is the inner pipe diameter.

Scenario:

The water distribution pipe network shown below is a double-Tee junction network. A double-Tee junction is two nodes connected by a single pipe (mid-pipe) of a length no longer than 10 diameters. Each Tee-junction node joins together three pipes. Two pipes bring flows to the incoming node and one pipe carries a flow away from the node. The outgoing node is of an opposite configuration, having one pipe that brings a flow to the node and two pipes carrying flows away from the node. There are several types of double-Tee junction, including N, U, or Wye (or Y) junctions. The Wye-junction can also be split into YN- or YU-junctions. The angles of the outgoing pipes relative to the incoming pipes determine whether the double Tee-junction is an N-, U-, or Wye-Junction. The two inlets are supplied by two pumps connected to separate reservoirs. One reservoir (west) contains pure water while the other (south) contains contaminated water. One pump provides pure water ($C = 0$ mg/L) while the other injects a constant amount (each hour) of water contaminated (1 mg/L of salt). Both pumps are of the same type with the same specifications: a 1-point curve with a flow of 200 GPM (757.1 L/min) and a head of 40ft (12.2 m). The entire network lies flat at ground level. Both outlet nodes are demand points, each with a demand of 100 GPM (378.5 L/min). Every section of the pipe has a diameter of 12 in (30.48 cm), a roughness of 100 (HW), and a length of 1000ft (304.8 m). The distance between the two Tee-junction nodes is set to 2.5 ft. and the diameter to 1 ft. This gives a dimensionless L^* value of 2.5.

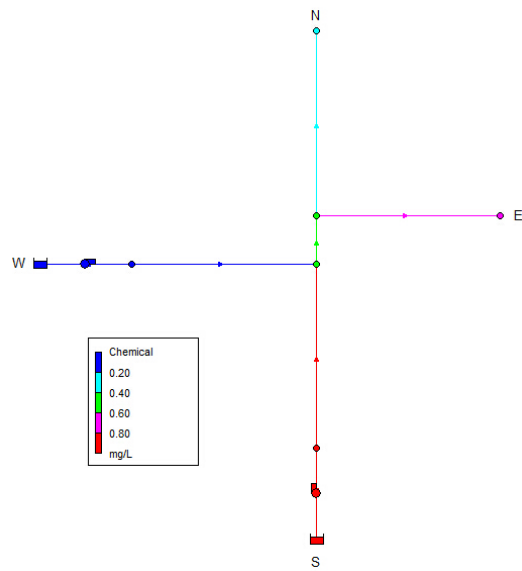
Objectives:

- Use AZRED v2.0 to predict the concentration at the double-Tee junctions.
- Compare the results to those obtained using the perfect mixing model (EPANET).

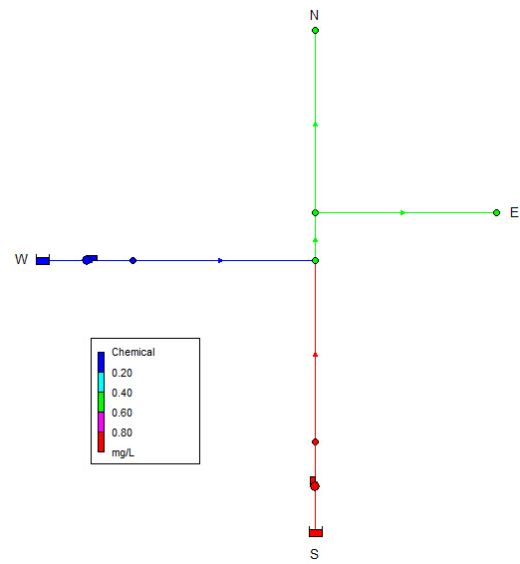
Steps:

1. Run the AZRED version of EPANET (epanet2w.exe). Use the information supplied in the scenario to recreate the networks above.
- 2 – 5. Repeat the same steps as those in Exercise 1.
6. The differences between perfect mixing and incomplete mixing should be as follows: (YN-junction was not included because the experimental data showed that its results were very similar to the N-junction, so any YN-junction could be treated as an N-junction)

N junction:

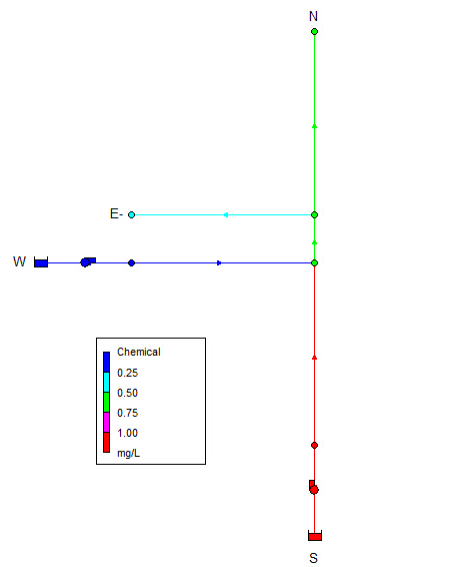


AZRED v2.0

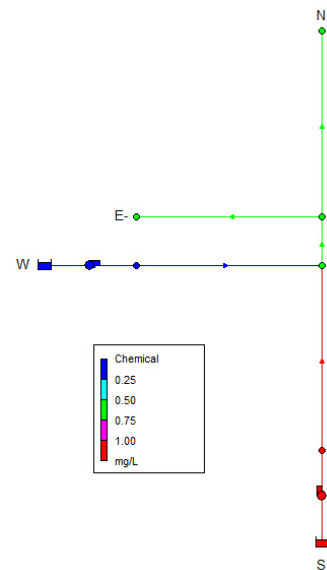


EPANET

U junction:

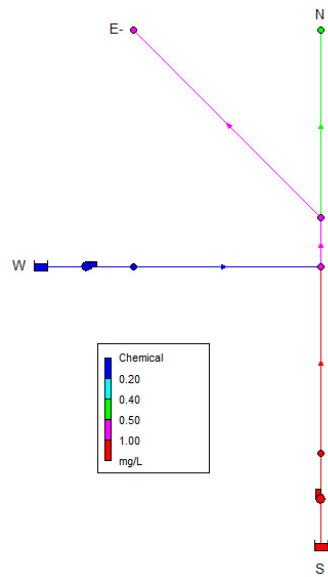


AZRED v2.0

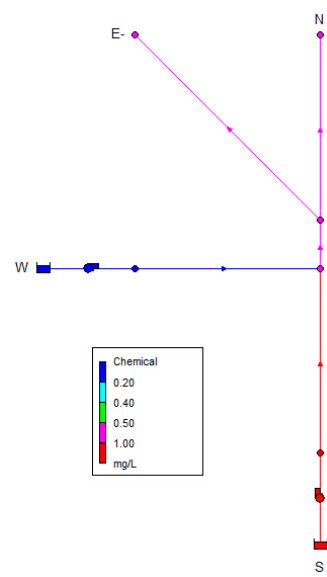


EPANET

YU junction:



AZRED v2.0



EPANET

Table 2. double-Tee junction network results

Junction Type	EPANET (complete mixing)		AZRED v2.0 (incomplete mixing)	
	Outlet Conc. (mg/L)			
	N	E/E-	N	E/E-
double-Tee (N)	0.50	0.50	0.33	0.67
double-Tee (U)	0.50	0.50	0.60	0.40

Table 3. Wye junction network results

Junction Type	EPANET (complete mixing)		AZRED v2.0 (incomplete mixing)	
	Outlet Conc. (mg/L)			
	N	E-	N	E-
Wye (YU)	0.50	0.50	0.49	0.51

Exercise 3-Multiple junctions: A 4x5 grid network

Scenario:

The water distribution pipe network shown below is a 4 x 5 network with 6 incomplete mixing junctions (4 Cross junctions and 2 double-Tee (N) junctions). A pump provides clean water ($C = 0$ mg/L), drawn from a reservoir, to the entire network, and has a 1-point curve with a flow of 300 GPM (1135.6 L/min) and a head of 40 ft. (12.2 m). A pollutant is injected into the network at a concentration of 100mg/L and a flow of 1 GPM through a 10 ft. pipe, and this pipe is oriented perpendicular to the mid-point of the section pipe connected. The concentration of the contaminant when it enters the main system is 1.62 mg/L. The entire network is set up at ground level and lies flat. There are 3 demand points in the system, each representing a subdivision in a neighborhood, and these are labeled A, B, and C, respectively. Each of these nodes has a demand of 100 GPM (378.5 L/min). Also, every section of the pipe has a diameter of 12 in. (30.48 cm), a roughness of 100 (HW), and a length of 1000 ft. (304.8 m). For the double-Tee (N) junctions, set the distance of L to 2.5 ft. and the diameter to 1ft. This gives a dimensionless L^* value of 2.5. The network shown is not to scale.

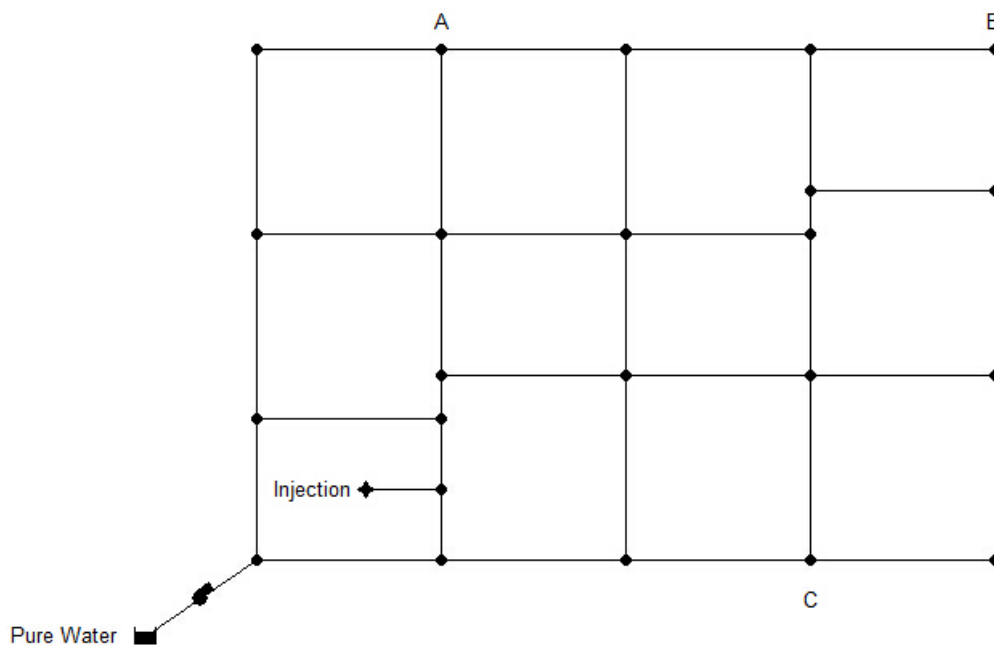


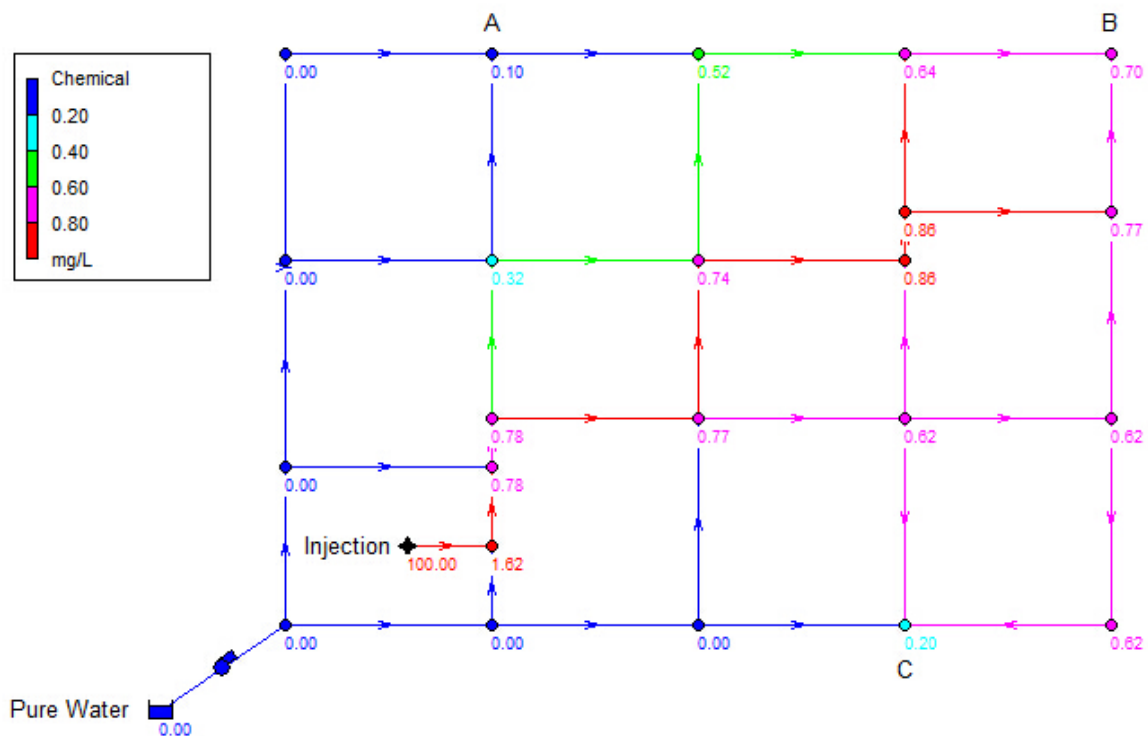
Fig. 2. 4x5 network map

Objectives:

- Use AZRED v2.0 to predict the concentration of the contaminant at the node corresponding to each subdivision (A, B, and C), assuming incomplete mixing.
- Compare the results to those obtained using the complete mixing model (EPANET).

Steps:

1. Run the AZRED version of EPANET (epanet2w.exe). Create your own 4x5 junction network. Use the information supplied in the Scenario and in Fig.1 to recreate the network.
- 2-5. Repeat the same steps as those in Exercise 1, except for time. Set the time at 48 hours.
6. The results obtained when assuming incomplete mixing should be as follows:



7. The results when assuming complete mixing can be obtained by using the same network file as above except along with the original EPANET program. The complete mixing results should be as follows:

