



# Prediction of Contaminants in Water Distribution Systems

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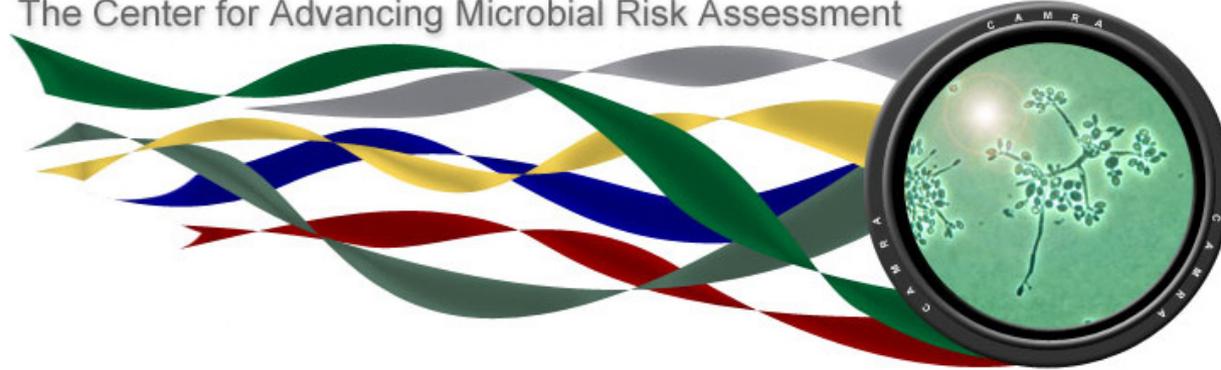
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The University of Arizona



# CAMRA – National Homeland Security Center

The Center for Advancing Microbial Risk Assessment



Michigan State University

The University of Michigan

The University of  
California, Berkeley

Drexel University

Northern Arizona University

Carnegie Mellon University



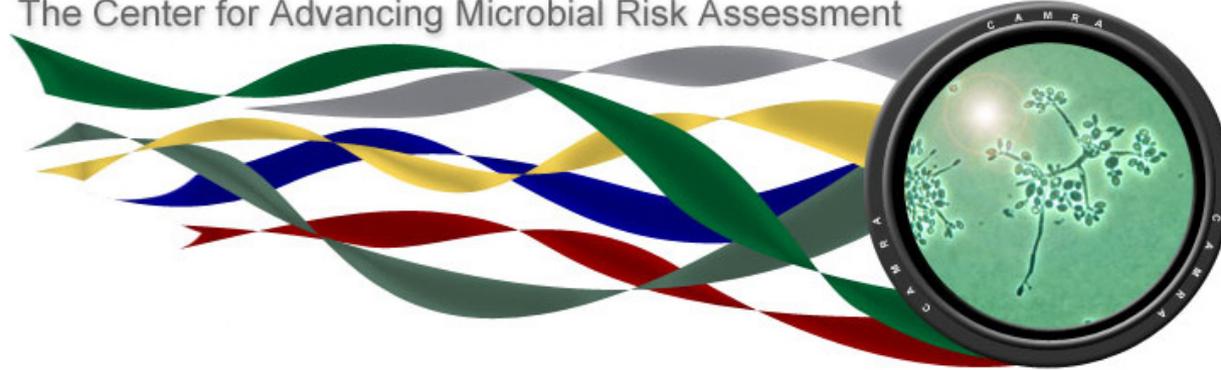
The University of Arizona

Main Research Focus of Choi's Group:  
Water Distribution Systems



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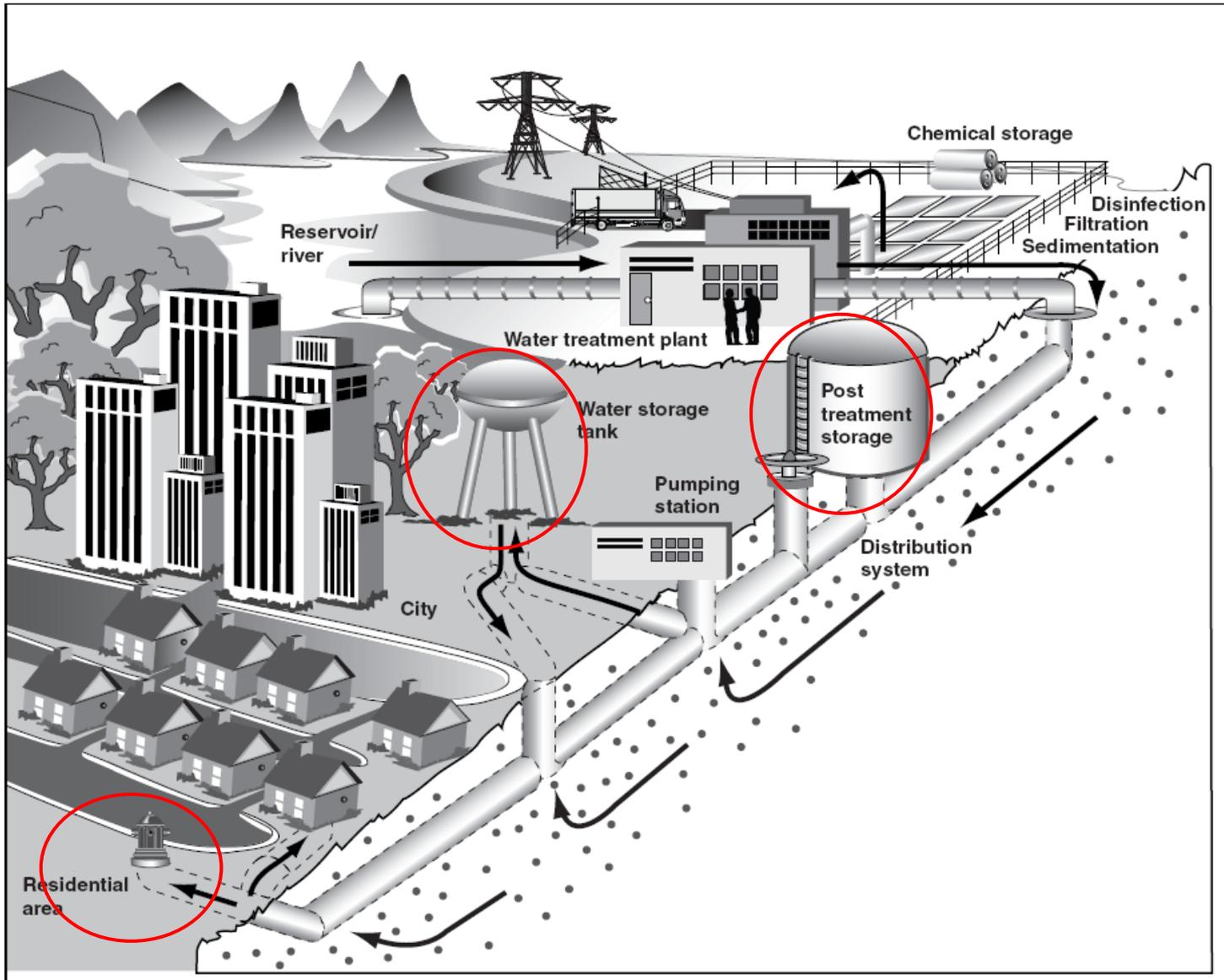
## **UA's Research Responsibilities**

### **Exposure, Detection, Fate and Transport of**

**Agents** - The goal is to improve our ability to quantify exposure to biological agents of concern (Category A and B agents) in **drinking water systems** and indoor air environments.

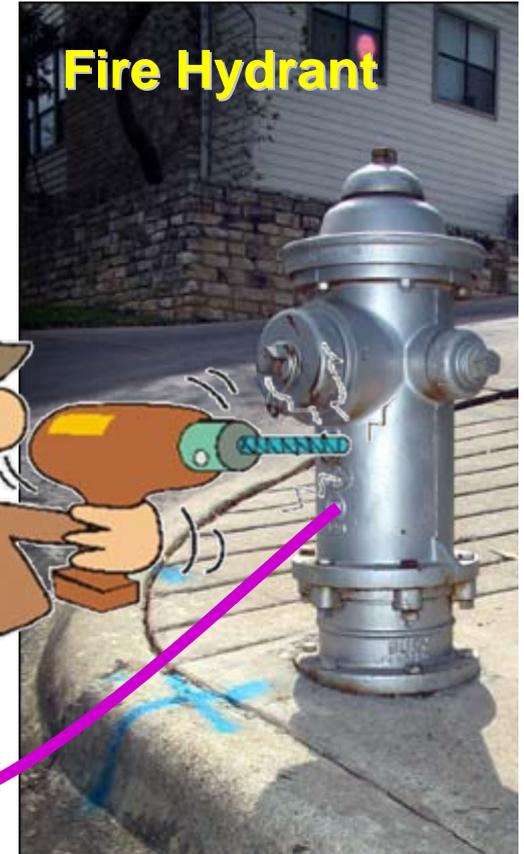
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# Key Components of a Typical Drinking Water System

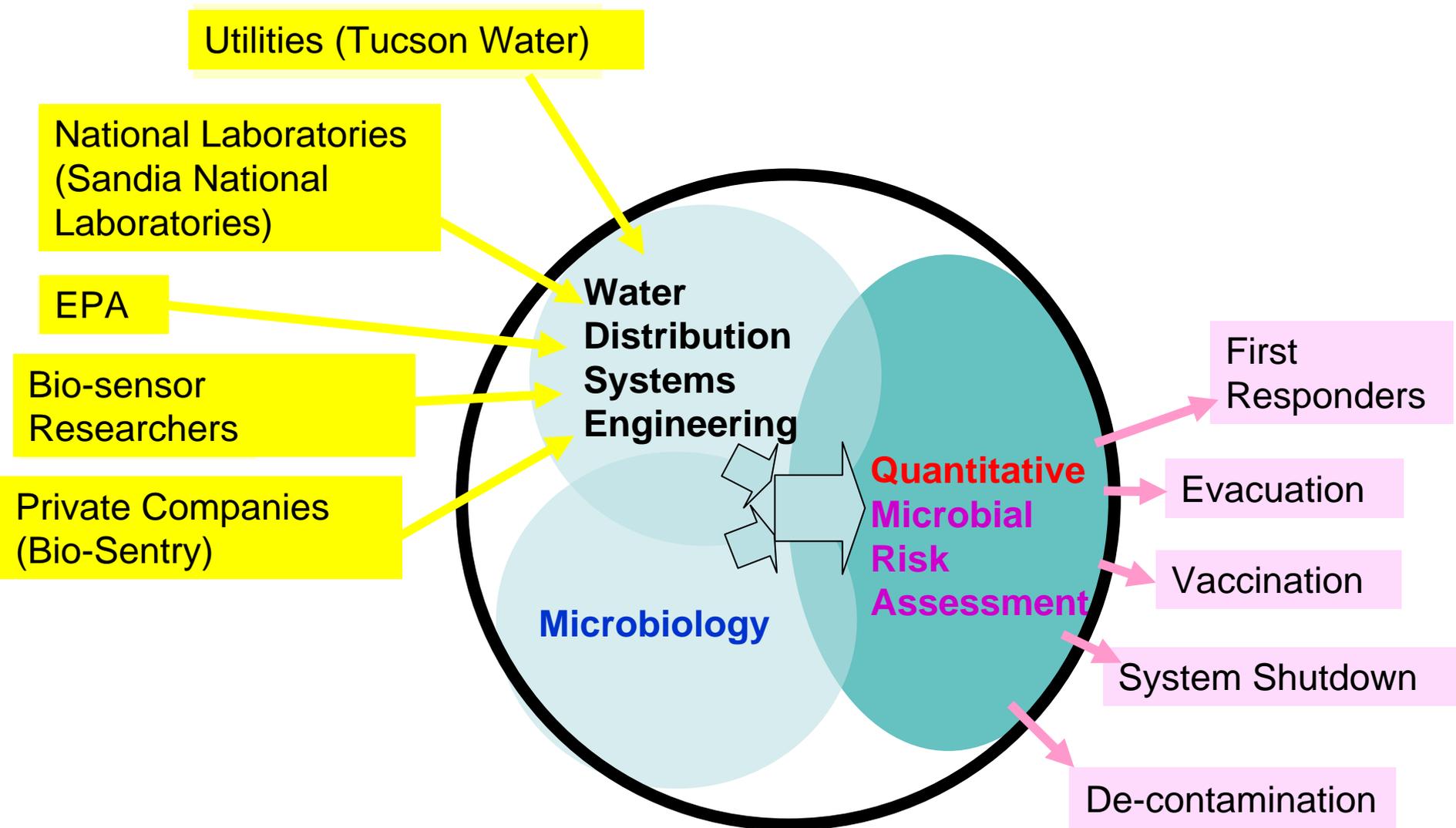


## What if...

contaminants



without backflow prevention devices



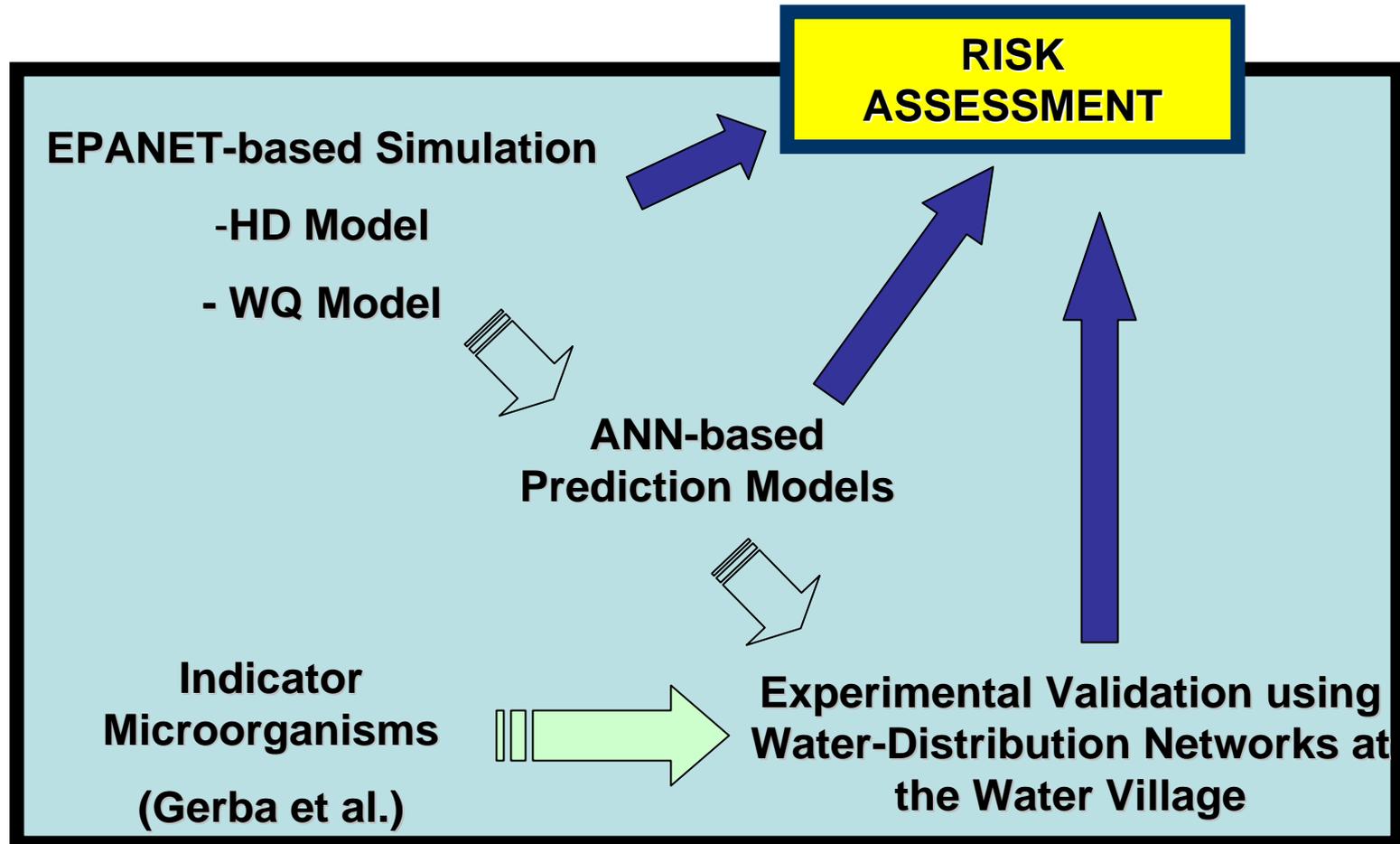
# Water Village



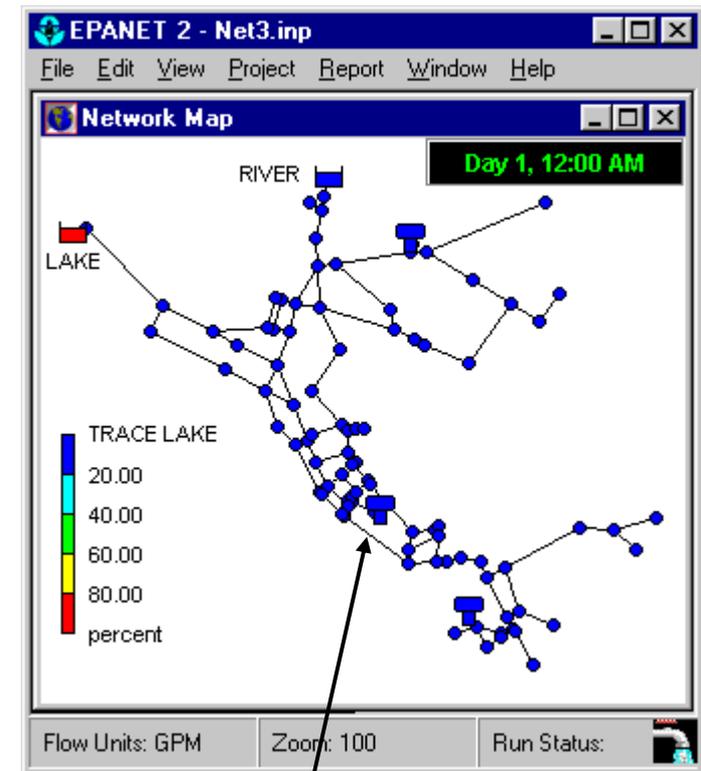
**Tucson International Airport**



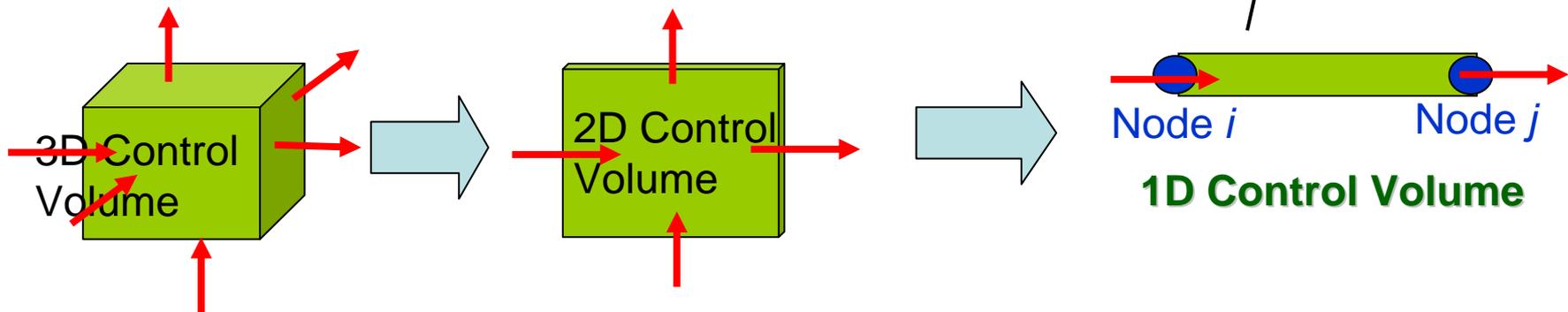




EPANET models the hydraulic and water quality behavior of water distribution piping systems. EPANET is a 'free & open source' Windows program written in C & Delphi programming languages that performs extended period simulation of hydraulic and water-quality behavior within pressurized pipe networks. A network can consist of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs.

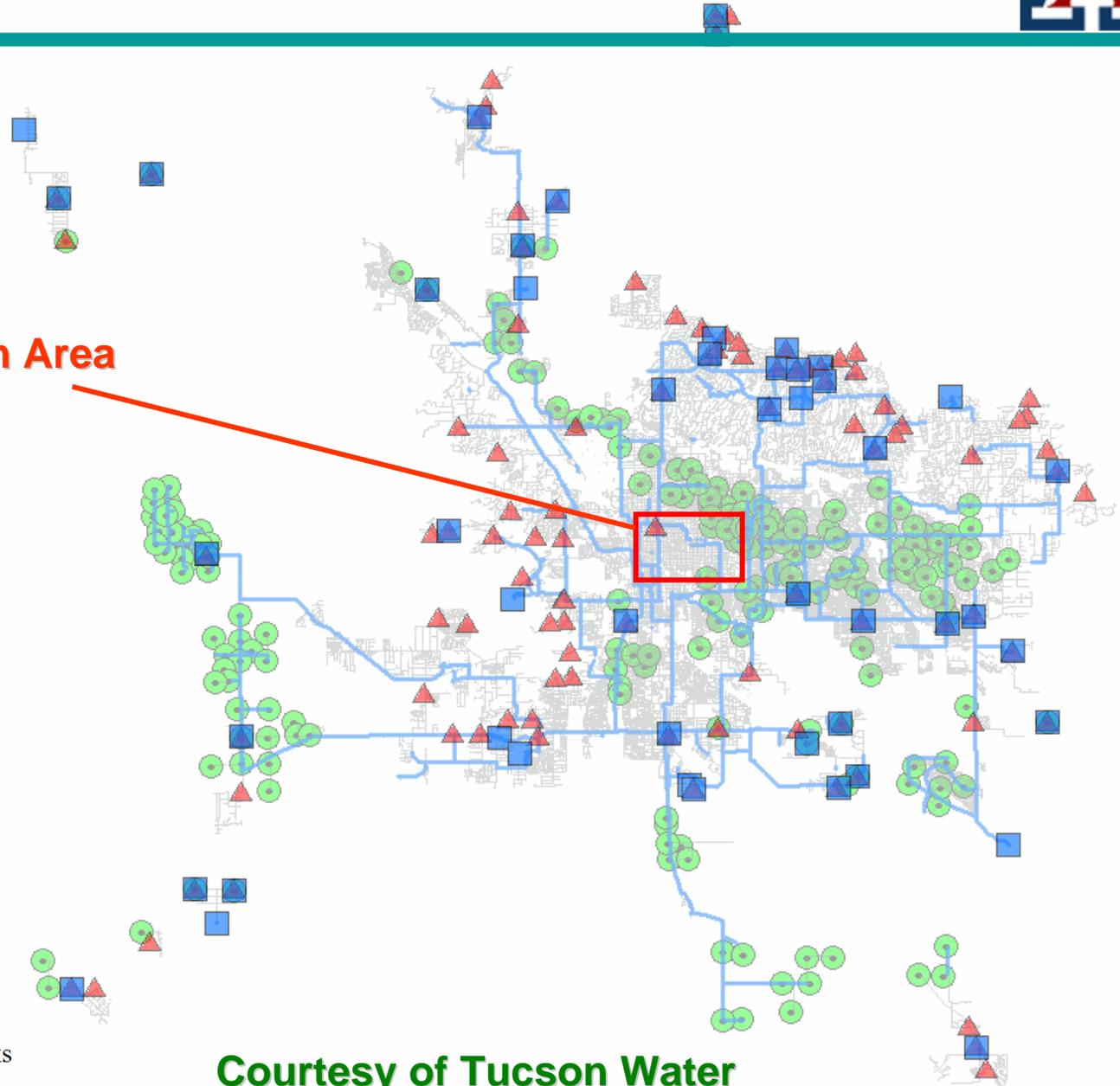


A “Node-to-Node” macroscopic  
Approach.

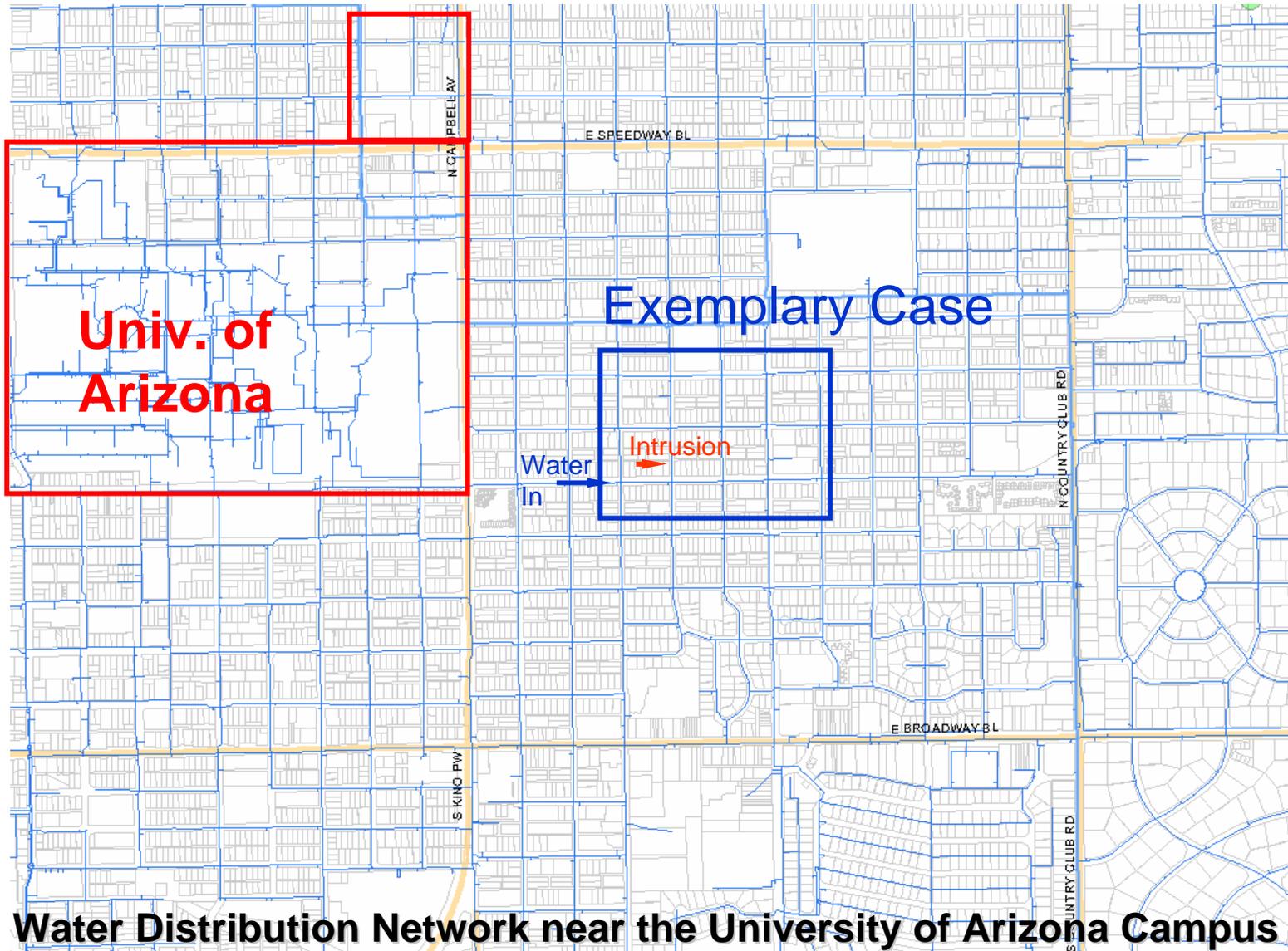


**UA & Downtown Area**

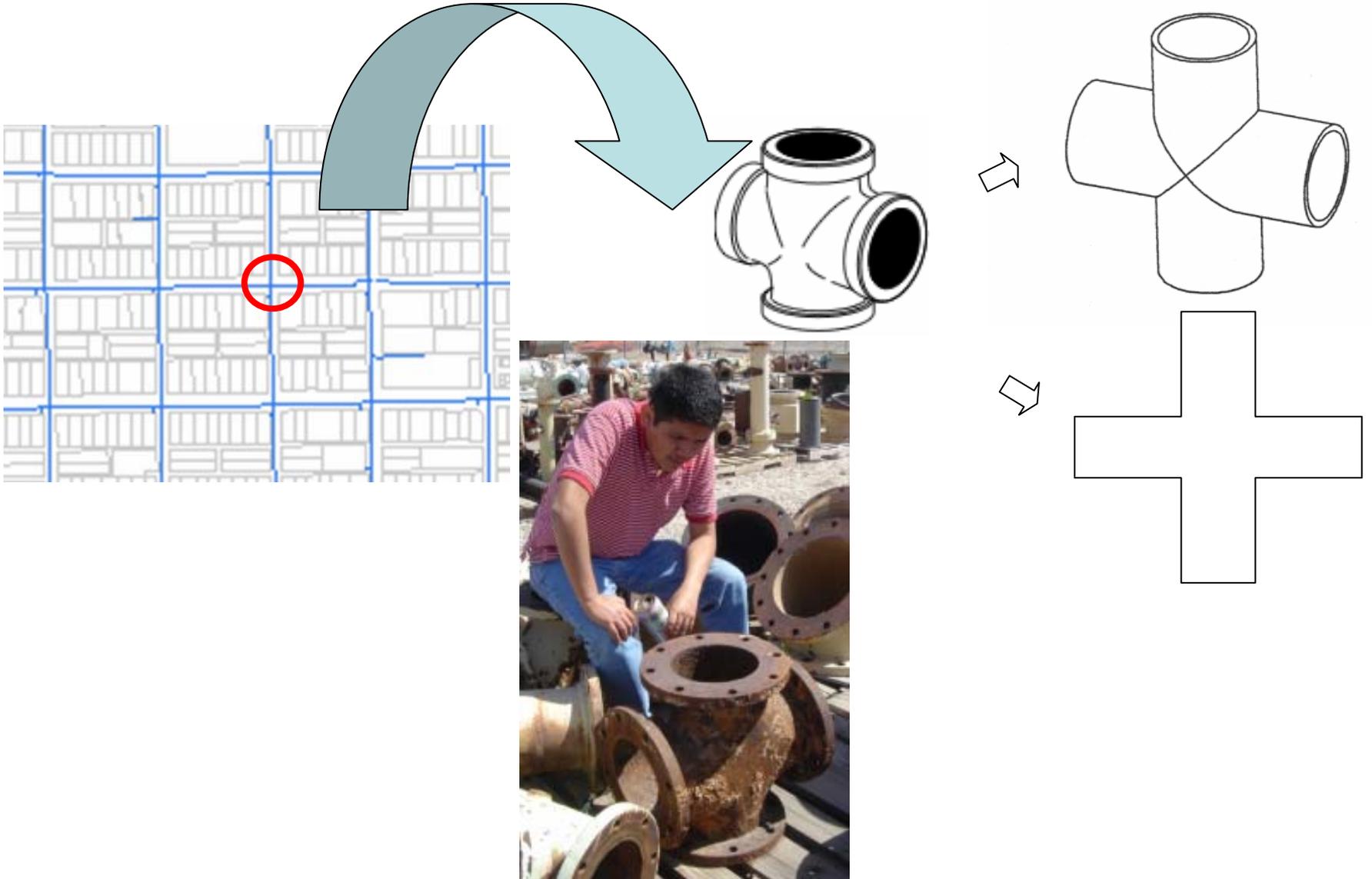
-  Wells
-  Pressure Booster Stations
-  Storage Reservoirs and Tanks



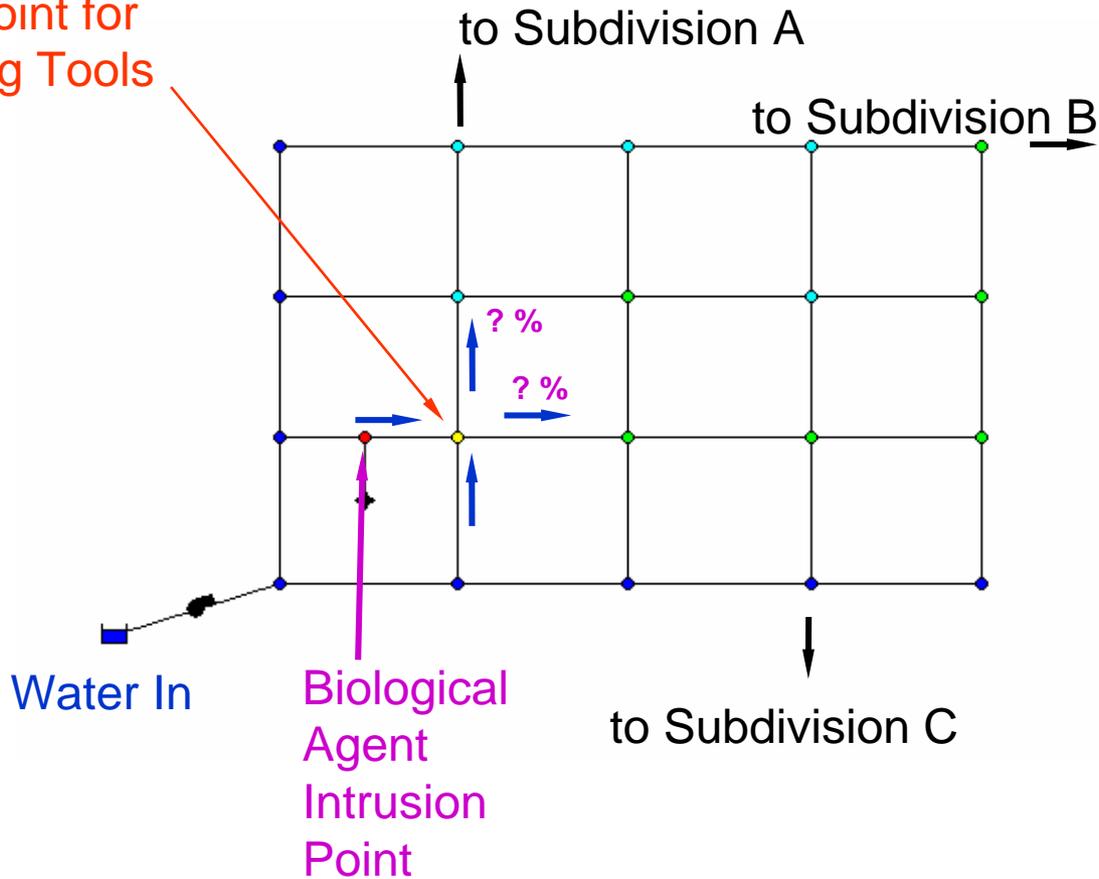
**Courtesy of Tucson Water**



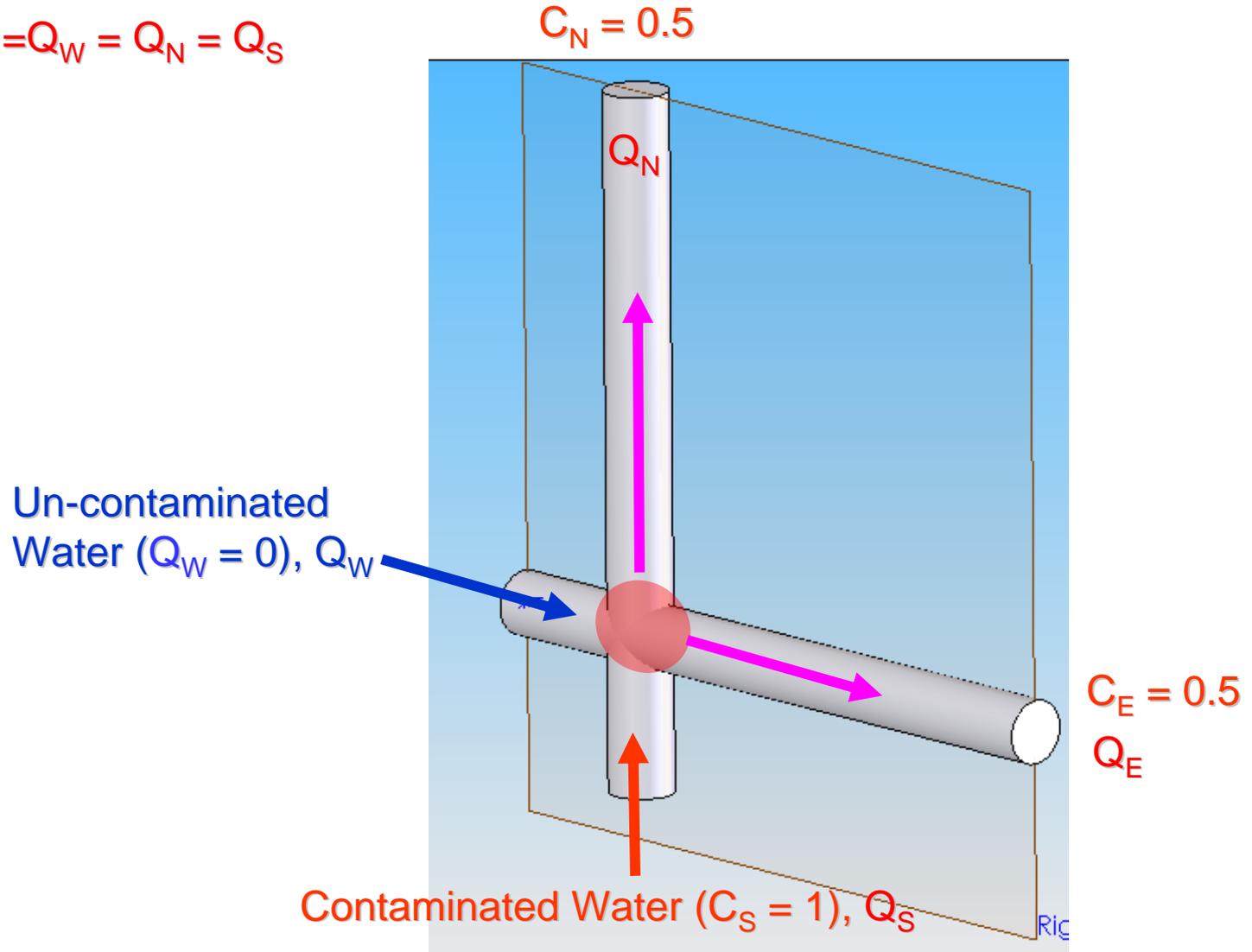
**Water Distribution Network near the University of Arizona Campus**

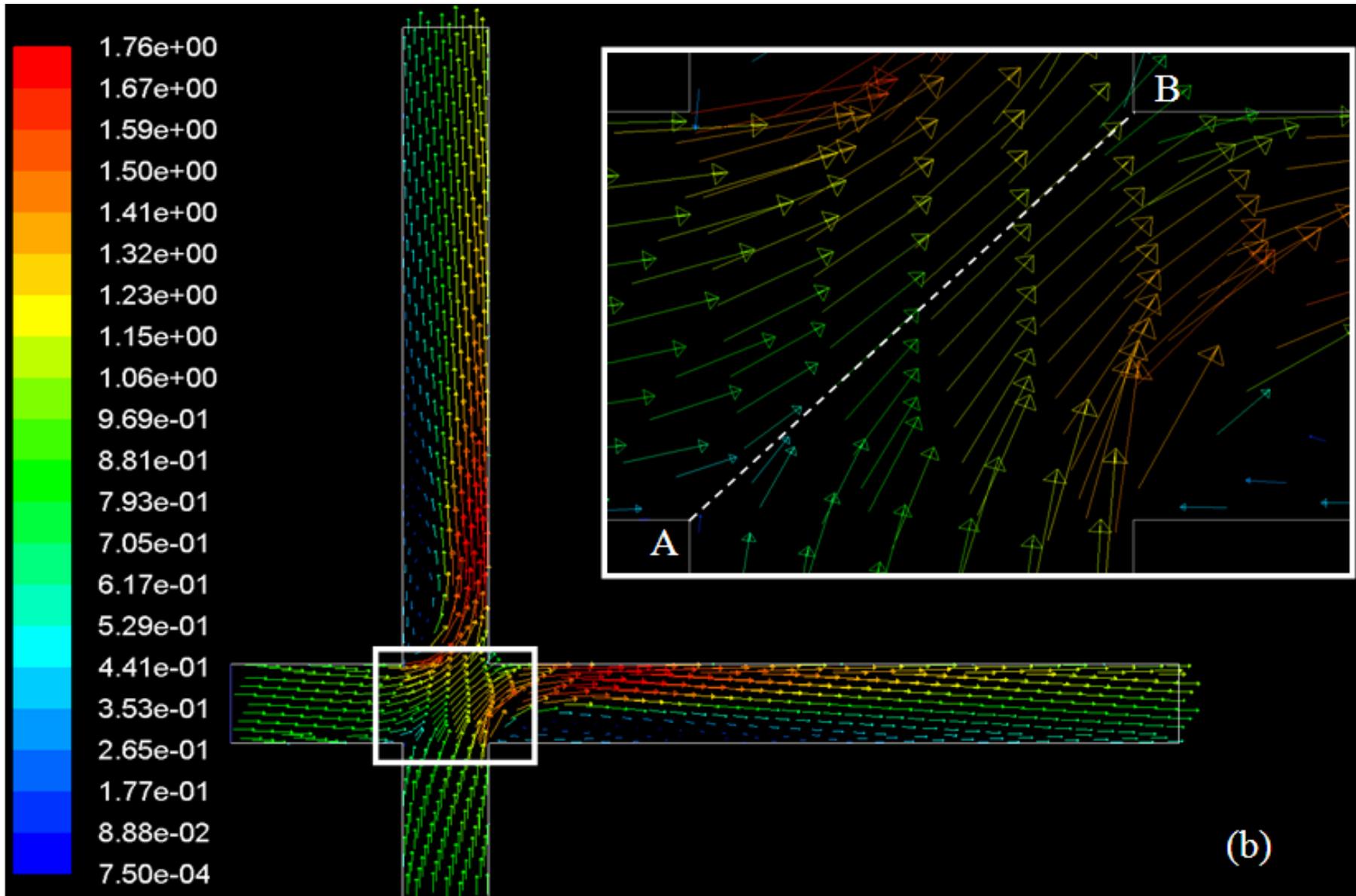


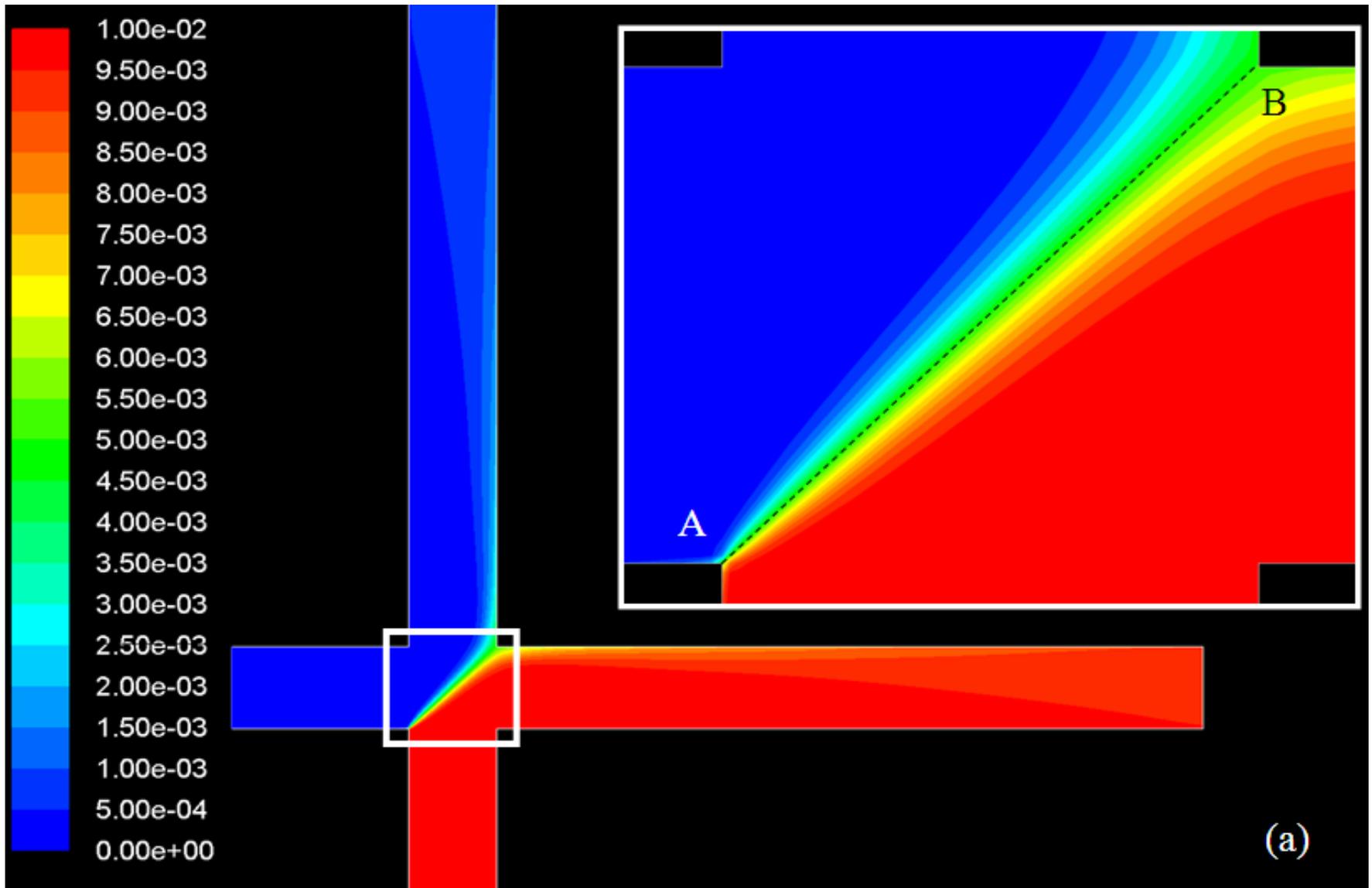
Perfect Mixing  
Assumed at the  
Cross Joint for  
Modeling Tools



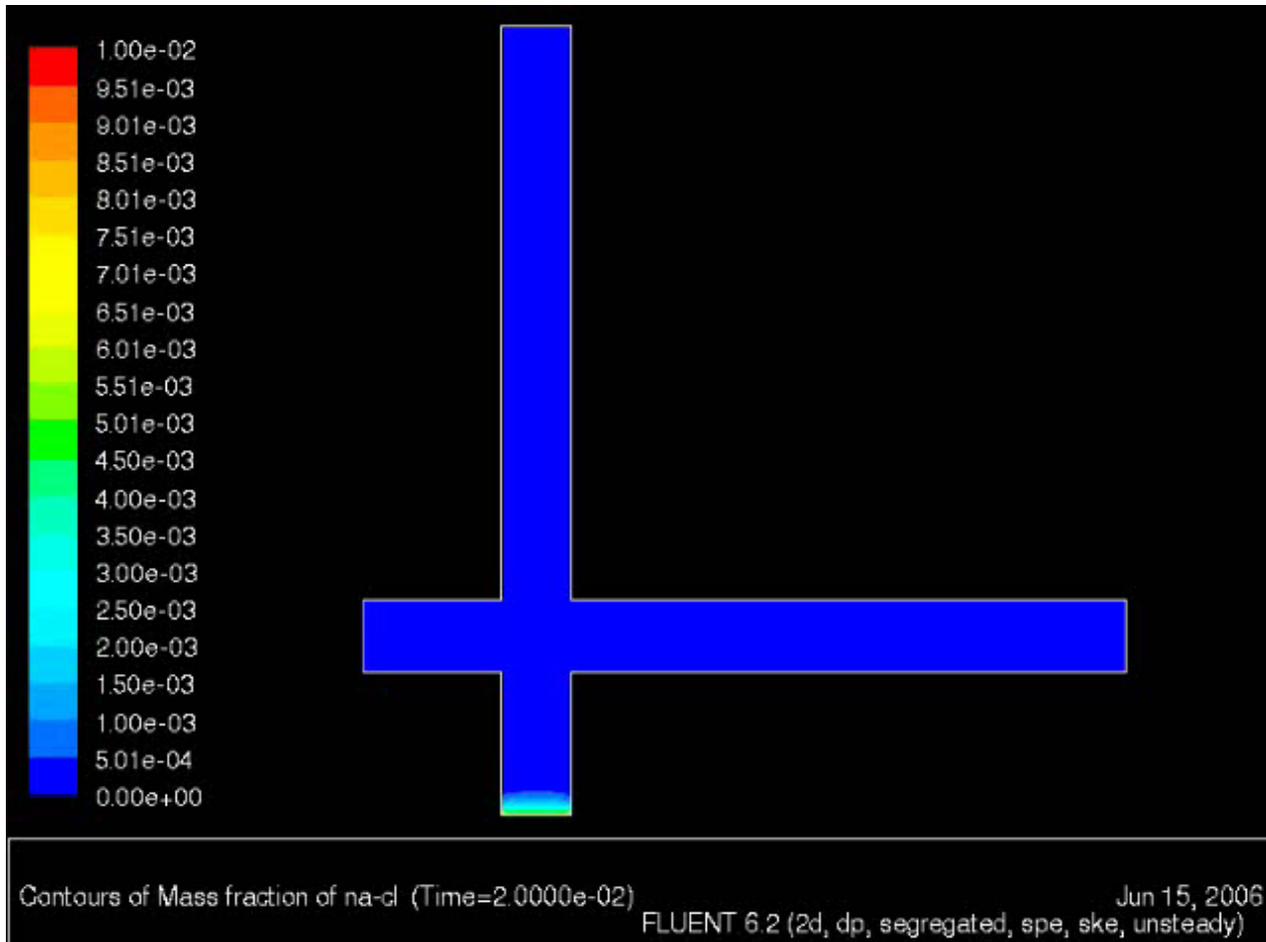
Scenario 1:  $Q_E = Q_W = Q_N = Q_S$





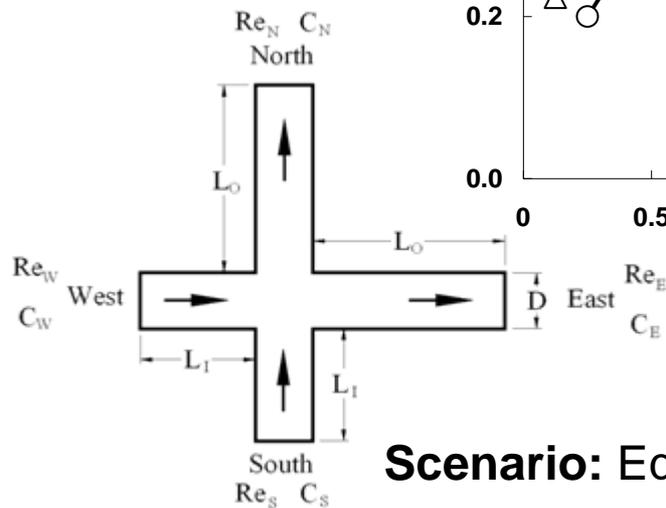
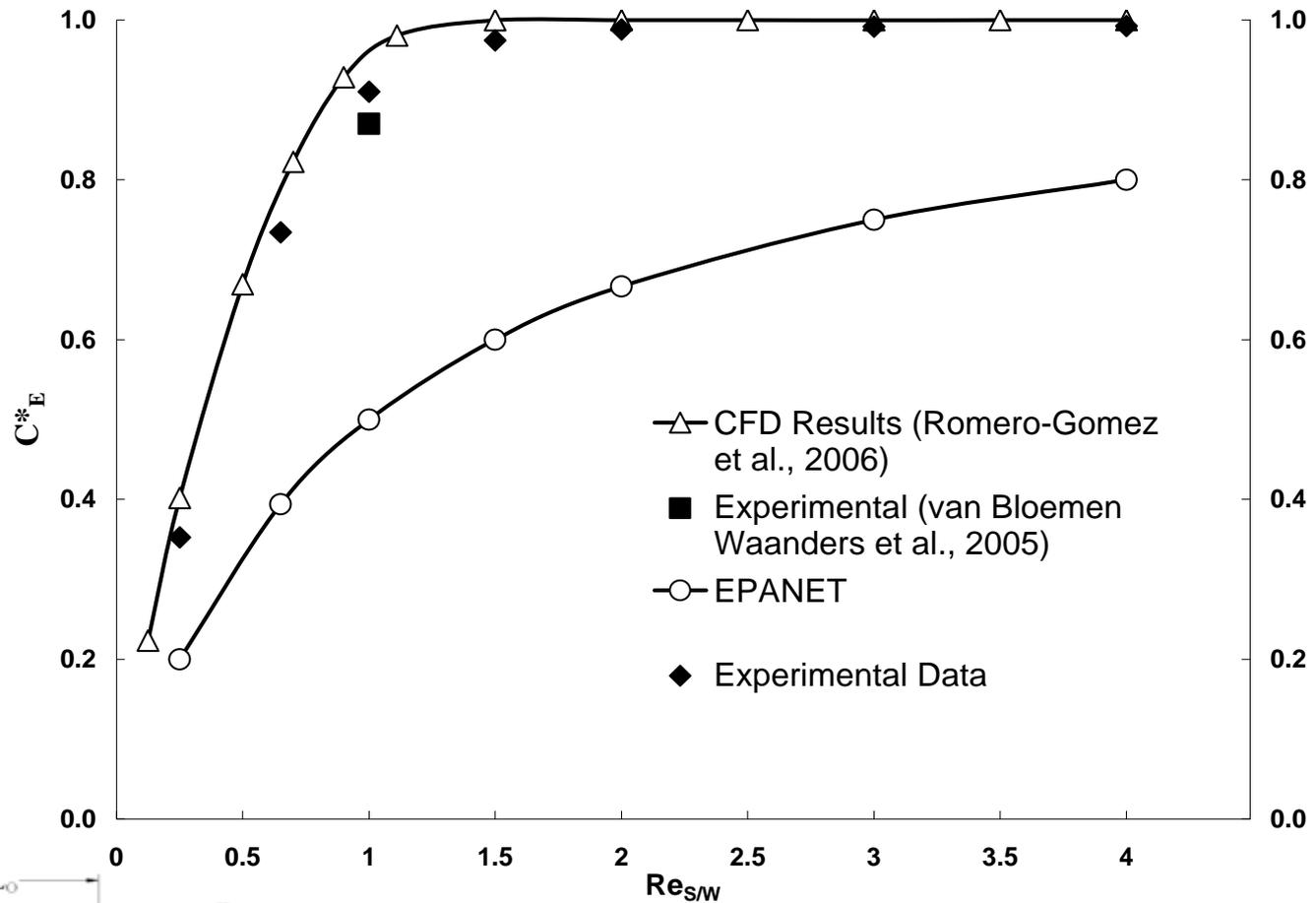


# Mixing patterns along the interface



# New Water Distribution Network Laboratory



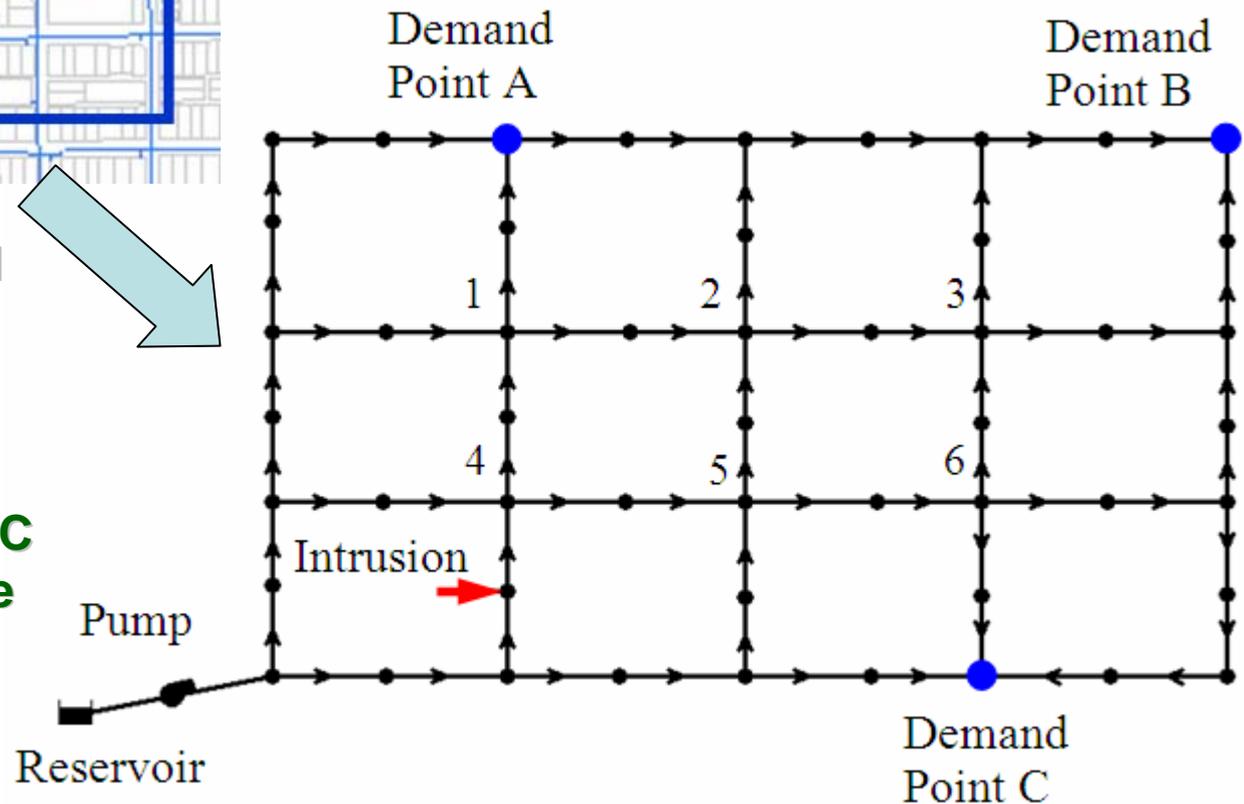


**Scenario:** Equal outflows, varying inflows ( $Re_S \neq Re_W, Re_N = Re_E$ )

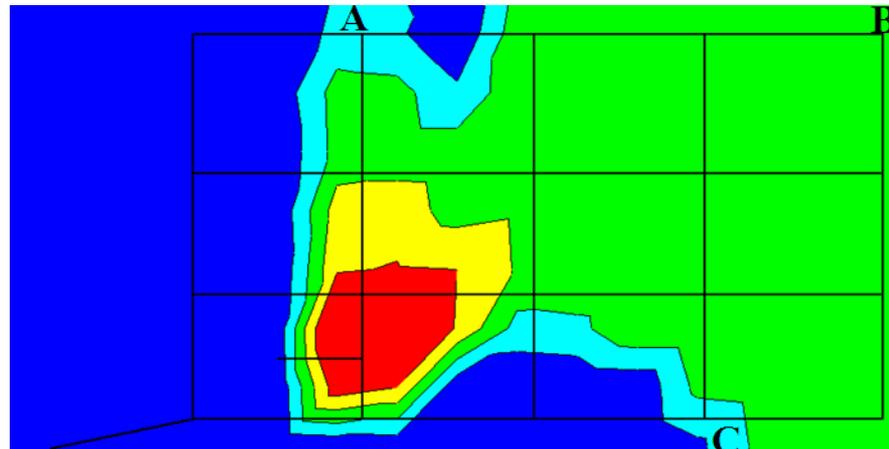


CFD simulations based on four Reynolds numbers at each node with  $Sc_t = 0.135$

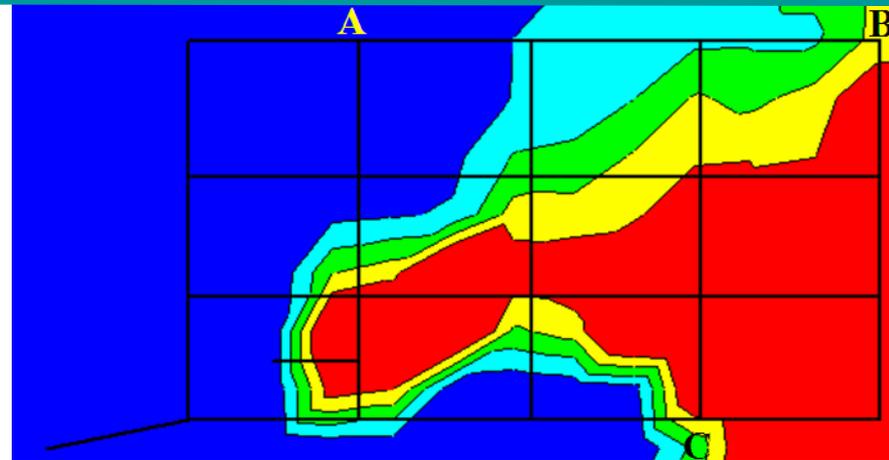
Revise EPANET using C programming language based on CFD results



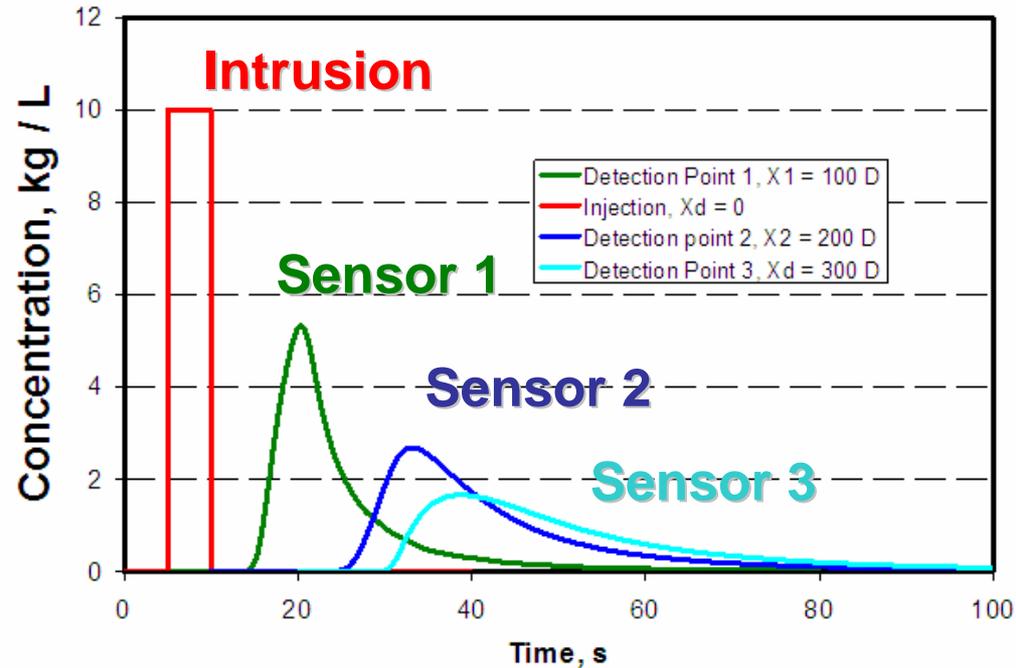
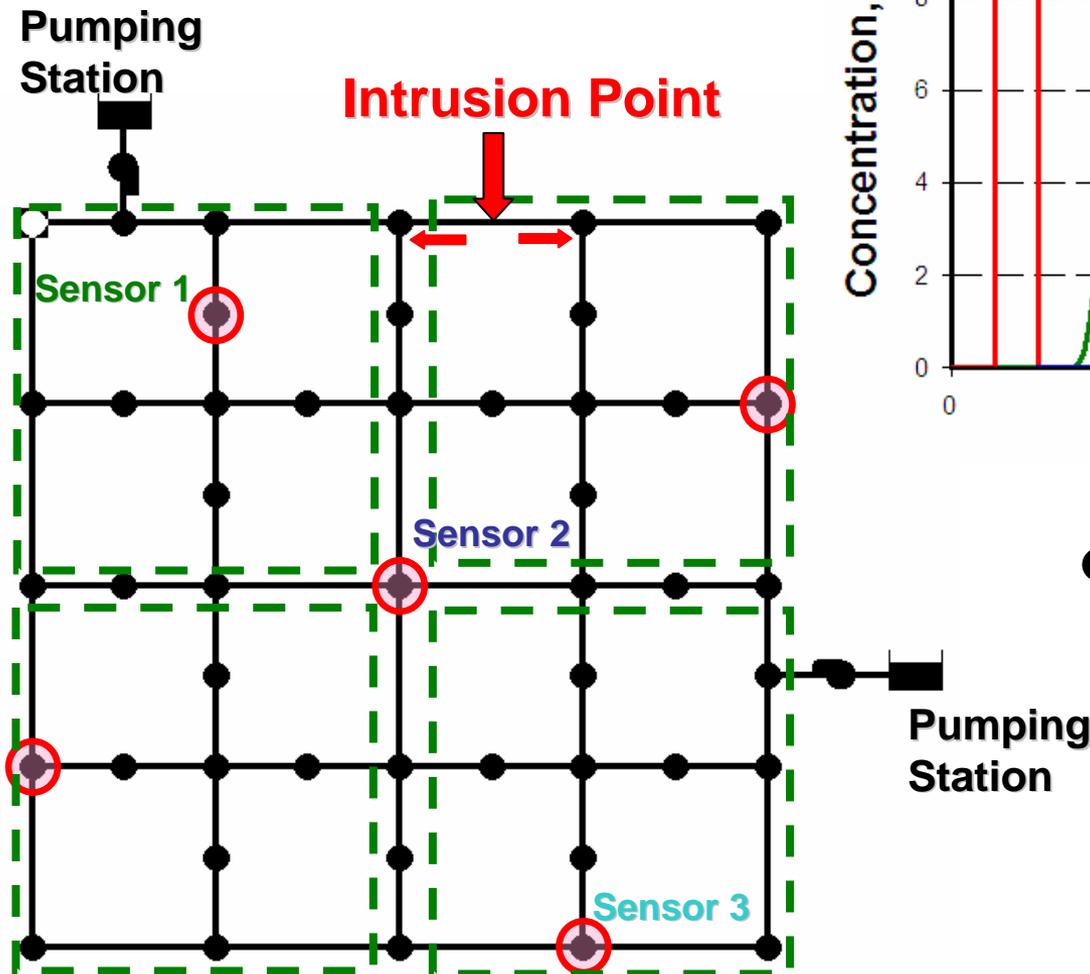
Current  
EPANET



Modified  
EPANET using  
C/C++



		A	B	C
NaCl concentration (mg/L)	Current	0.2699	0.5283	0.1489
	Modified	0.0303	0.6593	0.3598
NaCl mass rate (mg/min)	Current	102.02	199.70	56.28
	Modified	11.45	249.22	136.00



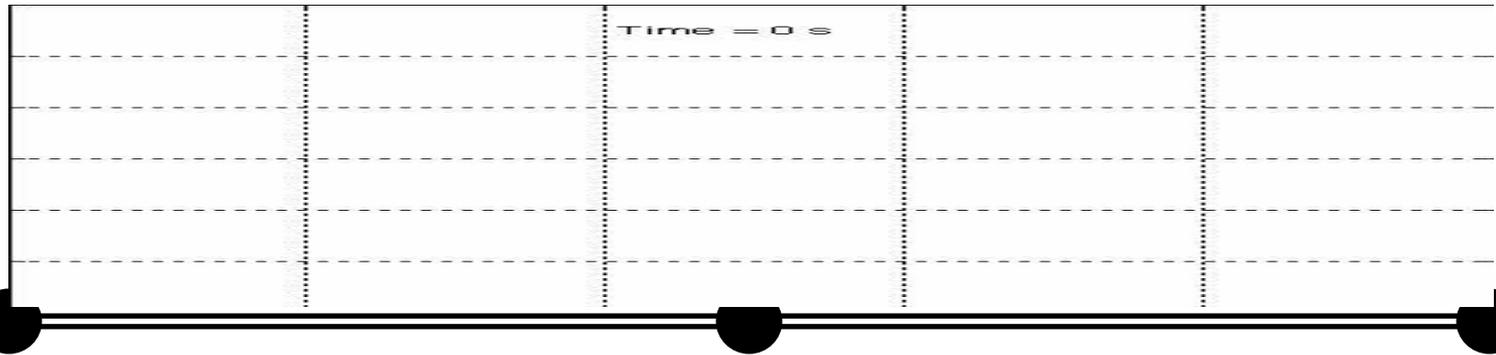
● Point of Use



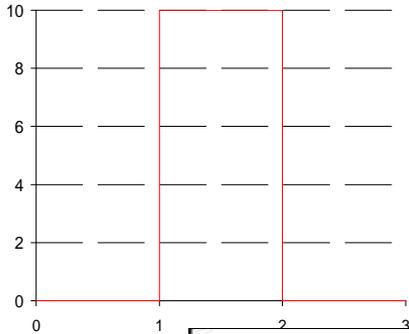
$U = 0.635 \text{ m/s}$

$Re = 8,000$

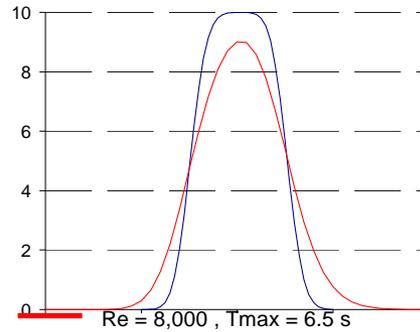
Pipe length = 6.35 m,  $D = \frac{1}{2}$  "



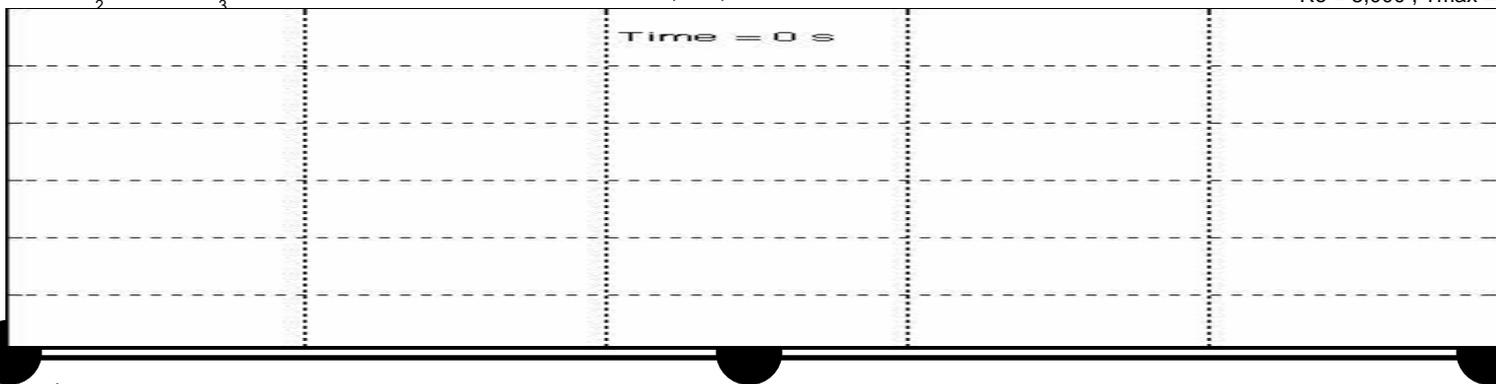
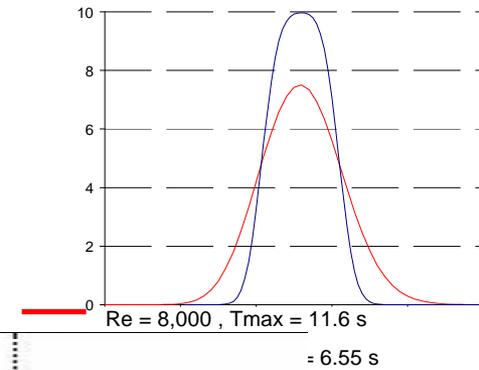
$X = 0$



$X = 250 D$



$X = 500 D$

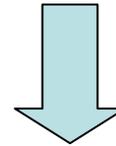
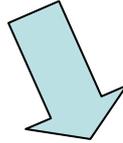
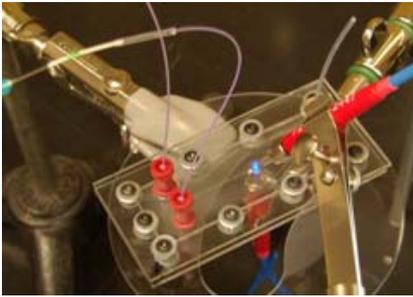


$U = 1.27 \text{ m/s}$

$Re = 16,000$

Pipe length = 6.35 m,  $D = \frac{1}{2}$  "

# A Test bed or Bio-Sensors and Event Monitors





# The End – Thank You!

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## Research Sponsors and Collaborators



Grant # R83236201