1. What volume of a PFR is required to remove 90% of a substance that decays according to first-order kinetics with a rate constant of 0.05 d\(^{-1}\)? The flow rate is 395 m\(^3\)/d (~105,000 gal/d).

2. What is the effluent concentration of a substance that enters the first reactor in a series of three CMRs at a concentration of 560 mg/L? Each reactor has a volume of 80 m\(^3\), and the flow rate is 150 m\(^3\)/h. The substance decays according to second-order kinetics with a rate constant of 0.062 L/mg-h.

3. A system with three treatment units has an influent, \(Q\), of 3,800 m\(^3\)/d. The volumes of the First and second basins are 950 and 500 m\(^3\), respectively. Flow from the second basin is recycled at a rate of 0.50 \(Q\) to the first basin. Also, 20% of the flow coming into the second basin is sent to the third basin. Seventy percent of the flow coming into the second basin is returned to the first basin. What are the detention times in the first and second basins, based on the total flow entering them? What volume is required in the third basin to provide a detention time of 15 d based on the total flow entering it?

4. Using information from EPA web sites and any other sources that you choose, write a short (~2 page) summary of the regulatory situation with regard to the drinking water contaminant indicated below. Include some discussion of the typical sources of contamination, health effects, current regulatory status, and possible treatment options.

   HW Group 1: Atrazine
   HW Group 2: Perchlorate
   HW Group 3: Arsenic
   HW Group 4: Cryptosporidium