

Unit Operations/Water & Wastewater

ESR 410/510 - CE 474/574

Midterm Examination (Practice Version/Not All Topics represented)

Closed book, closed notes. Time: 90 min. The calculations required are all very simple but if you are having trouble with a calculation, be sure to show an **exact set-up** of the calculation and give an approximate answer.

1. Sketch a graph on the diagram below the typical municipal water demand over the course of a day (from midnight to midnight). Draw **two** plots: 1) for a city with a population of 5000, and 2) for a city with a population of 2 million. Label each plot clearly. (I am looking for the general shapes and magnitudes of the curves, not exact numbers.)
2. A municipal wastewater treatment plant serves a population of 1 million customers.
 - a. What is a typical daily mean wastewater inflow to the plant in units of MGD?
 - b. Approximately how many pounds of BOD enter the plant each day (on average)?
3. If the plant above (serving 1 million people) meets the typical maximum permissible discharge of TSS in effluent, how many pounds of suspended solids are discharged from the plant each day?
4. A water sample has the following chemical composition:

$$[\text{Ca}^{2+}] = 60 \text{ mg-Ca/L}$$

$$[\text{Mg}^{2+}] = 24 \text{ mg-Mg/L}$$

What is the total hardness of this water in units of mg/L as CaCO_3 ? The relevant molecular weights are $\text{Ca} = 40$, and $\text{Mg} = 24$.

5. A water has a Ca-hardness of 150 mg/L as CaCO_3 . Lime treatment reduces that to 50 mg/L as CaCO_3 . If the plant treats 1 million liters/day, how many kg of CaCO_3 sludge (dry weight) are produced per day?
6. An activated sludge system has a sludge age of 10 days. What is the *net doubling time* (t_d) of the bacterial population in the system (in units of days)?
7. An activated sludge system has a secondary clarifier that produces a sludge with $\text{RVSS} = 6000 \text{ mg/L}$. If $R = 0.5$ for this system, what is the approximate MLVSS in the aeration basin?
8. What is the precise definition of the F/M ratio ($= U$)? Please give typical units that are consistent with this definition.
9. How does the climate in which a wastewater treatment plant affect the key design parameters of an activated sludge process. Name as many design or operating parameters as you can that are affected by climate and state the general effect you would expect to see.