CE 326 Principles of Environmental Engineering
Wastewater Treatment Plant Design - Team Project
Due April 30, 2008

A large metropolitan city in Iowa has requested that you, the consulting engineers, provide them with a design for a new wastewater treatment plant since the city will be converting to a sewered system (i.e., they will be eliminating all septic tanks in the city). The population in twenty years (design population) is expected to grow to 80,000 people. The influent BOD_5 and SS solids concentrations are each expected to be 250 mg/L, respectively. Average per capita water consumption is 350 L/d, 95% of which is expected to be recovered by the sewerage system (i.e., plant influent flow is expected to be 95% of the per capita water production). The peaking factor is expected to be 3.0 (i.e., the peak hourly flow during a heavy rainfall is estimated to be 3.0 times the average hourly dry weather flow – use this flow for clarifier design).

The city has already selected the bar screens, but needs a design for the grit tank, primary clarifiers and activated sludge process. Assume no SS or BOD removal in the screens and grit tanks. Use the attached "10 State Standards" criteria for overflow rates, weir loading rates, side water depths, detention times, etc. The city has asked that two or more tanks for each unit process should be provided, but that no spare tanks are specified. They have also requested that circular tanks be used for the primary and secondary clarifiers and that these tanks have standard diameter dimensions of 25 ft (7.62 m), 50 ft (15.24 m), 75 ft (22.86 m), 100 ft (30.47 m) 150 ft (45.7 m) etc. so that the clarifier equipment won't have to be special ordered.

1. Based on the above design criteria, design a grit removal system (horizontal flow grit tanks) to remove sand as small as 0.15 mm with a specific gravity 0f 2.65. Specify tank dimensions to comply with "10 State Standards" and assume a temperature of 20°C.

2. Design primary clarifier tanks for the city. Due to concerns about odors, flow equalization should not be used. Specify the number of tanks required, dimensions, and design criteria (surface and weir loading rates, detention time, and influent and effluent concentrations of SS and BOD_5) for average and peak flow conditions. Estimate the daily primary solids production, kg/d. Assume 60% SS removal and 35% BOD_5 removal in the primaries.

3. Using the effluent from the primary clarifiers, design an activated sludge process to meet an effluent SS and BOD_5 limit of 25 mg/L each. Assume that the BOD_5 concentration of the SS in the effluent is 0.60 mg BOD_5 per mg SS. The city has asked that the MLSS concentration used for the design is no more than 3000 mg/L and that the aeration detention time is at least 4 hours. Assume that MLSS = 1.18·MLVSS. Use an average water temperature of 20°C. Specify the aeration tank dimensions and volume, m^3, recycle pumping capacity, m^3/d, solids retention time, d, hydraulic retention time (at peak and average flow conditions), h, sludge production, kg/d, waste sludge pumping capacity, m^3/d, and oxygen requirements, kg/d, for this design. **Base the design of the aeration basins on average flow conditions.** Use the typical values of growth constants given in Table 6-11 on page 467 of your text.

4. Design the secondary clarifiers. Specify the number of tanks required, dimensions, and design criteria (surface and weir loading rates and detention time) for average and peak flow conditions.

5. The city anticipates that in the not too distant future the State will amend their discharge permit to include ammonia removal. If their influent ammonia concentration is 25 mg/L as N and they expect to meet a discharge limit of 2 mg/L as N, how would nitrification affect the required blower capacity (for example, would nitrification require a blower 1.1 times as big, 1.5 times, 2 times...?)? How much alkalinity would be consumed?

6. Include a layout of the proposed treatment processes and a schematic of what the hydraulic profile might look like. i.e., plan and profile (use attached sheet as a guide) and specify what scale you use.