**Surface Water Hydrology**
**Homework #2**
**Due on Wednesday, Feb. 15, 2012**

**Problem 1.** Two tipping bucket rain gages are used to collect the following rainfall data:

| Time | Cumulative precipitation (mm) Gage #1 | Cumulative precipitation (mm) Gage #2 |
|---|---|---|
| 12:00 a.m. | 0.0 | 0.0 |
| 1:00 a.m. | 0.0 | 0.0 |
| 2:00 a.m. | 1.0 | 1.0 |
| 3:00 a.m. | 3.0 | 2.0 |
| 4:00 a.m. | 4.0 | 3.0 |
| 5:00 a.m. | 10.0 | 8.0 |
| 6:00 a.m. | 12.0 | 9.0 |
| 7:00 a.m. | 13.0 | 10.0 |
| 8:00 a.m. | 14.0 | 11.0 |
| 9:00 a.m. | 14.0 | 12.0 |
| 10:00 a.m. | 14.0 | 12.0 |
| 11:00 a.m. | 14.0 | 12.0 |
| 12:00 p.m. | 14.0 | 12.0 |
| 1:00 p.m. | 14.0 | 12.0 |
| 2:00 p.m. | 14.0 | 12.0 |
| 3:00 p.m. | 14.0 | 12.0 |
| 4:00 p.m. | 14.0 | 12.0 |
| 5:00 p.m. | 14.0 | 12.0 |
| 6:00 p.m. | 14.0 | 12.0 |
| 7:00 p.m. | 14.0 | 12.0 |
| 8:00 p.m. | 14.0 | 12.0 |
| 9:00 p.m. | 14.0 | 12.0 |
| 10:00 p.m. | 14.0 | 12.0 |
| 11:00 p.m. | 14.0 | 12.0 |
| 12:00 a.m. | 14.0 | 12.0 |

A. Calculate the mean daily rainfall intensity for each station (mm/hr)
B. Calculate the maximum 2-hour rainfall intensity for each station (mm/hr)
C. Calculate the maximum 5-hour rainfall intensity for each station (mm/hr)
D. Using the arithmetic average method and knowing that the drainage basin area is 200 $mile^2$, calculate the total volume of rainfall ($m^3$) delivered to the basin during the event.

**Problem 2.** Measurement of changes in volume of water in an evaporation pan is a standard technique for estimating potential evapotranspiration. United States Class A evaporation pans are cylindrical with following dimensions: depth =10.0 inches and diameter = 47.5 inches. An evaporation pan can be considered a hydrological system with an inflow flow, outflow, and storage volume.

A. Calculate the cross-sectional area ($m^2$) of a United States Class A evaporation pan through which inflows and outflows of water can pass. Also, calculate the total storage volume of the pan ($m^3$).
B. Initially, the pan contains 12.00 gallons of water. Calculate the depth of water in the pan (mm).
C. Assuming a water density of 997.07 $kgm^{-3}$ (25°C), calculate the mass (kg) of water in the pan.
D. After 24 hours in an open field (no precipitation), the pan is checked and the volume of water left in the pan is determined to be 11.0 gallons. Calculate the average evaporation rate (mm/hr) from the pan.
E. The pan is emptied and refilled with 12.0 gallons of water and left in an open field for another 24 hours. During this period, rain fell for a 4-hour period at a constant intensity of 2.0 mm/hr; after 24 hours, the volume of water in the pan was 12.8 gallons. Calculate the average evaporation rate (mm/hr) from the pan during this period.
F. If the evaporation rate calculated in E remains constant and no additional precipitation occurs, estimate the time (days) for the pan to empty as a result of evaporation.

**Problem 3.** For Problem 2 part D, calculate the flux of latent heat from the water in the pan to the atmosphere ($W/m^2$). Use a water density, $\rho_w$=1000.0 $kg/m^3$.

**Problem 4.** A small (area =50 $mile^2$) catchment in Texas absorbs a mean net radiation $R_n$=400 W/ $m^2$ during the month of June. In this problem, you will apply the energy balance approach to estimate evapotranspiration from the catchment during the month of June.

A. Write a complete energy balance equation (i.e., including all terms) for the catchment for the month of June.
B. Neglecting conduction to the ground (G) and the change in energy stored (dQ/dt=0), simplify your energy balance equation for the catchment so that it can be solved for the latent heat flux (LE). Also, replace the term H (the sensible heat flux) with B×LE (where B is the Bowen ratio).
C. Using a mean Bowen ratio of 0.80 for the catchment, calculate the mean daily flux of latent heat to the atmosphere ($W/m^2$) and the mean evapotranspiration rate (mm/day) from the catchment. Use a water density, $\rho_w$=1000.0 $kg/m^3$.
D. Calculate the total evapotranspiration from the catchment during the month of June (mm).