CE 3372 – Water Systems Design
Exercise Set 6

Purpose:	Application of Manning's equation and flow geometry in open channels;
ABET Criteria 3:	(a) . . . apply knowledge of mathematics, science, and engineering (e) . . . solve engineering problems (k) . . . an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Exercises

1. Water flows at $8m^3/s$ through a rectangular channel 4 m wide and 3 m deep. If the velocity is $1m/s$, calculate the flow depth in the channel. If this channel expands (downstream) to a width of 5 m and the depth decreases by 0.5 m from the upstream depth, what is the mean section velocity in the expanded section?

   a) Sketch the two cross sections and label the width, depth, and channel wall height.

   b) Write the relationships between velocity, depth, and discharge for each section.

   c) Compute the depth in the narrow section.

   d) Compute the depth in the wider section.

   e) Compute the velocity in the wider section.

2. Water flows at a depth of 2.20 m in a trapezoidal, concrete-lined section with a bottom width of 3.6 m and side slopes of 2:1 (H:V). The longitudinal slope of the channel is 0.0006 and the water temperature is 293°K. Assuming uniform-flow conditions, estimate the mean section velocity (in meters per second) and the discharge (in cubic meters per second) in the channel.

   a) Sketch the cross section and label the width, depth, and side slope.

   b) Write the relationships between velocity, depth, and discharge for the section.

   c) Compute the velocity in the section.

   d) Compute the discharge in the section.

3. A circular sewer is laid on a slope of 0.5%. What diameter is required if the concrete pipe is to carry 25 cubic-feet per second? If the desired design mean section velocity is between 3 and 7 feet per second, is the design acceptable?

   a) Sketch the cross section and label the diameter and flow depth.

   b) Write the appropriate relationships between velocity, depth, and discharge for the section.

   c) Size the pipe; assume pipe is flowing full, but not pressurized.

   d) Compute the actual fill depth (the pipe will flow less than full) using either the hydraulic element chart or by computation.

   e) Compute the velocity in the section (using the actual fill depth).

   f) Is the computed velocity within the stated criteria?

4. A grass-lined roadside swale (ditch) is to be built as a trapezoidal channel to carry 20 cubic-feet per second, with a 1 foot freeboard. If the desired flow depth is 1 foot, and the right of way available to fit the ditch is 12 feet, what is the required side slope and bottom width. The longitudinal slope is 1%.

   i Sketch the cross section and label the width, depth, and side slope.

   ii Write the appropriate relationships between velocity, depth, and discharge for the section.

   iii Compute the required side-slope in the section.

   iv Compute the mean section velocity in the section.