National Exams December 2018

18-Env-B2, Water Resources

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Question 1 (20 marks):

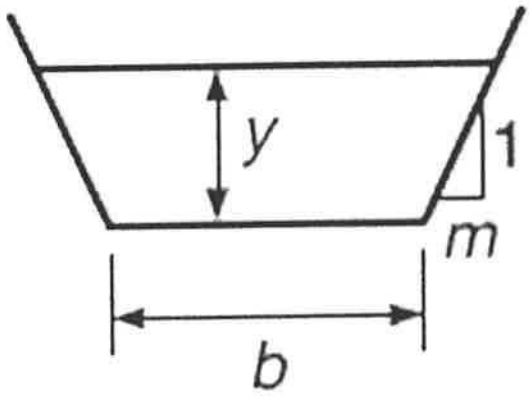
1. Explain the importance of protecting aquatic life in streams located in urbanized watersheds and the role of water resources engineers should take? Should fish and wildlife management be an entirely local, provincial, or federal obligation? Why? **(10 marks)**; and
2. Soil is often used as a wastewater treatment medium. Compare the land application of municipal treated sewage in "sewage farms" with the use of septic tanks. Is there a marked difference between these two wastewater treatment methods? Can either of these practices contribute to Eutrophication in rivers and lakes? Why? **(10 marks).**

Question 2 (20 marks):

Water flows at 15 m^3/s in a concrete-lined trapezoidal channel with a bottom width of 4.5 m and side slopes of 1.5:1 (H:V).

a) Determine the value of the normal depth for the above conditions. **(10 marks)**; and

b) Determine the value of the critical depth for the above conditions. **(10 marks).**

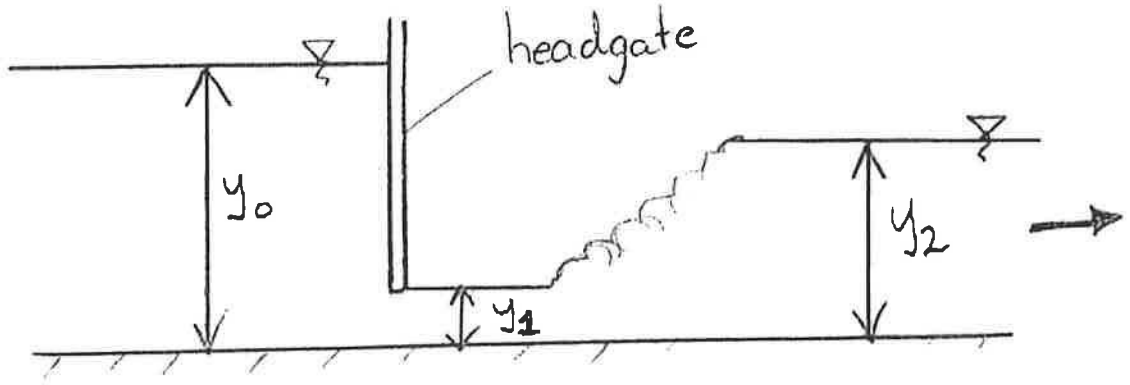


Question 3 (20 marks):

The channel shown in the figure below has a rectangular cross-section. For the flow conditions illustrated in the figure, $y_0 = 0.90$ m and $y_2 = 0.388$ m. The hydraulic jump occurs sufficiently near the head gate so that y_1 can be assumed to be equal to the head gate opening. Assume no head loss through the head gate.

a) Using a combination of energy and momentum principles, determine y_1. **(10 marks)**; and

b) Determine the energy loss per unit time through the jump. **(10 marks)**.

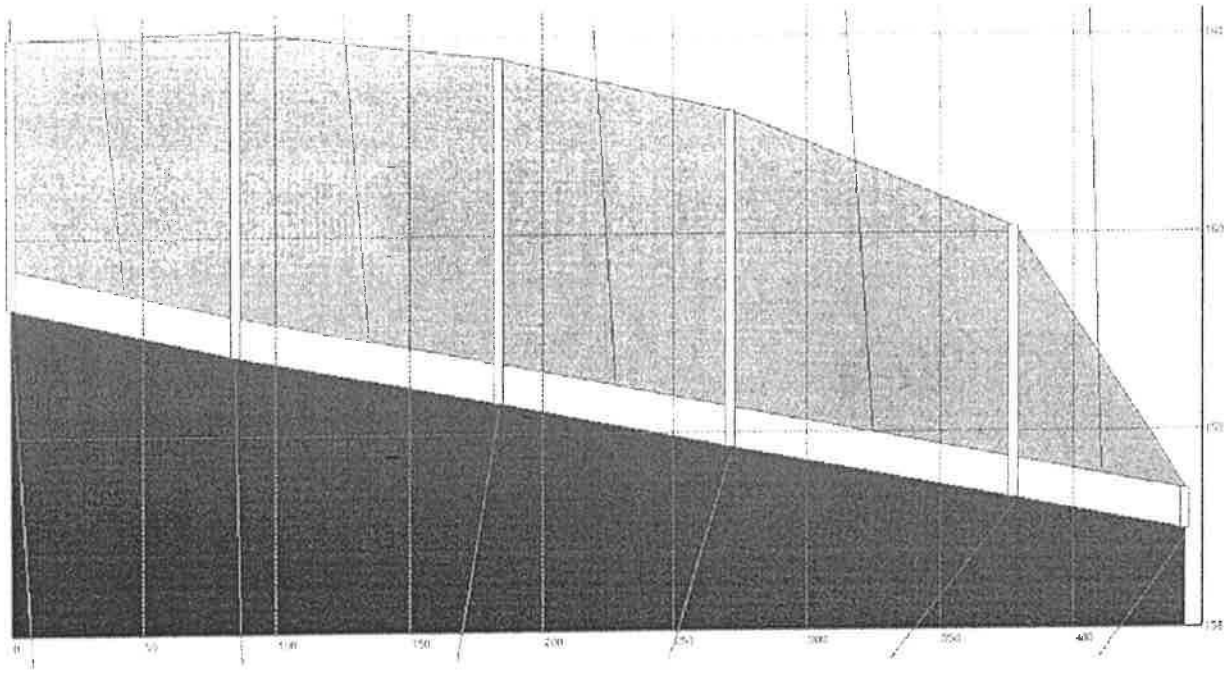


Question 4 (20 marks):

A 450 m long straight section of a sanitary sewer main has a longitudinal slope of 0.001. The infiltration and inflow contribution is 0.25 m^3/s at the upstream end with no additional "local" inflow infiltration and inflow. The peak wastewater flow is 90 m^3/min. The minimum design flow is 15 m^3/min. Manholes are located every 90 m with a 0.03 m drop in invert elevation across the manhole.

a) Calculate the size of the sewer main based on flow depth being less than half of the pipe diameter **(10 marks)**; and

b) Verify that the flow velocity under minimum-flow conditions exceeds the minimum permissible velocity and that the depth of flow under maximum flow conditions does not exceed the acceptable limit **(10 marks).**



Sanitary Sewer Pipe

Question 5 (20 marks):

The Shelter Valley Brook watershed, in Northumberland County, has a drainage area of 125 km^2, largely forested or covered with rough pasture. The soils are sandy with a high hydraulic conductivity. The large portion of the streamflow comes from ground water seepage. The flow rate data for the watershed is available for eleven years is given in Table 1. Data for the precipitation for the watershed are available from the Meteorological Service of Canada for the thirty-year period are given in Table 2.

a) What percentage of annual precipitation, streamflow, evapotranspiration (watershed evaporation), occur during late winter and spring (February, March, April and May), Summer and early fall (June, July, August and September) and fall and early winter (October, November, December and January)? **(10 marks)**; and

b) If management of fish in the Shelter Valley Brook requires that stream flow rate be maintained at no lower than 30% of the mean annual monthly (A. M.) flow rate, which month will need flow augmentation? What minimum total volume of water in m^3 would have to be stored in an upstream reservoir and then released to augment streamflow for the months which will need flow augmentation? **(10 marks).**

Table 1. Measured and estimated monthly precipitation, stream flow and evaporation for the Shelter valley Brook watershed.

Month	Flow rate			Mean Precipitation		Mean Evaporation	
	Mean	Max	Min.	Snow	Rain	Free Water	Watershed
	$m^3 s^{-1}$			cm	mm	mm	mm
Jan.	1.15	3.7	0.008	27	31	10	10
Feb.	1.35	5.9	0.13	23	28	15	15
March	3.46	5.8	1.6	17	49	25	25
April	2.16	4.8	0.48	4	75	43	40
May	0.63	1.3	0.25	0	79	104	90
June	0.56	0.8	0.06	0	82	122	100
July	0.36	0.8	0.03	0	82	120	95
Aug	0.27	0.7	0.01	0	75	96	65
Sep.	0.29	3.8	0.01	0	58	66	50
Oct.	0.18	1.1	0.04	0	61	46	40
Nov.	0.43	2.2	0.05	10	52	22	20
Dec.	1.4	4.4	0.03	23	41	10	10

Table 2. Estimated mean monthly snow storage, storm flow and ground water inputs for the Shelter valley Brook watershed.

Month	Month-end Snow Storage	Mean Storm Flow	Mean groundwater input
	mm liquid water	mm liquid water	mm liquid water
Jan.	15	20	11
Feb.	11	21	14
March	0	66	11
April	0	20	24
May	0	3	1
June	0	3	0
July	0	2	0
Aug	0	2	1
Sep.	0	4	1
Oct.	0	2	3
Nov	0	5	6
Dec.	0	25	12

Question 6 (20 marks):

1. Discuss common sources of waste inputs to water systems in Canada, including three examples for point sources and three examples for non-point sources **(5 marks).**
2. Explain the key factors influencing the longitudinal diffusion, dispersion and contaminant transport mechanisms in urban streams **(5 marks).**
3. Discuss the main limitations of common urban watershed models used by professional engineers for hydraulic design, environmental assessment and flood water level calculation in Canada **(5 marks).**
4. Discuss the main Federal/Provincial/Municipal laws and legislation that deal with sustainable water resources management, water conservation practices, and policies on source water protection **(5 marks).**