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OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS 2005

FOURTH SCIENCE EXAMINATION (4EV, 4ER) - HYDROLOGY [EH403]

Examiners: Professor K.J. Beven
Professor C. Cunnane
Mr. T. Henry

Time allowed is *three* hours.

Attempt Question 1 (Section A), and any four questions from Section B.
All questions carry equal marks.

SECTION A

1. Answer *any eight* of the following:

   (a) How is the *potential evapotranspiration* rate modified when moisture is limiting?
   (b) Define *Permanent Wilting Point*?
   (c) What is the difference between *imbibition* and *drainage*?
   (d) Three factors are required for continuous evaporation from a free water surface. What are they?
   (e) What is the difference between *dry weather flow* and *95 percentile flow*?
   (f) What is the difference between *available soil moisture* and *available water capacity*?
   (g) What is tortuosity? Explain why its value in porous media is always greater than one.
   (h) What is the difference between a *wetting* and a *non-wetting* fluid?
   (i) Three broad aquifer classes are used in Ireland. What are they?
   (j) *List* two advantages and two disadvantages of bioremediation.

   (2.5 marks each)

SECTION B

2. Discuss the importance of weather, vegetation and soils as controls of evaporation.
   (20 marks)

3. Write an essay on a water resource issue of national or international significance.
   (20 marks)

Section B continues overleaf

4. The NUIG River runs through the university campus. The Annual Maximum and Minimum Flows have been recorded over a period of greater than 30 years. The flows are graphed on the attached charts as a function of the reduced y-variable.

(a) Determine the 50-year and 100-year flow for the NUIG River from Graph No 1.

(2 marks)

(b) The river channel is rectangular with the following dimensions: width 24m; depth 2m; slope of bed 1/1000m/m. The river is a natural channel with some grass and weeds. Use Manning's Equation to determine the bankful discharge of the river. (Use a roughness coefficient of 0.03.)

$$Q = \frac{1}{n} A R^{0.67} S_0^{0.5}$$

(6 marks)

(c) Will the Q_{50} and Q_{100} discharges determined above overtop the banks of the river?

(2 marks)

(d) The university is building a new accommodation block comprising 500 apartments. Each apartment will have four occupants. The waste water from the apartments will be given secondary treatment and the effluent will be discharged to the river. How will this discharge impact on flood flows in the river?

(4 marks)

(e) Graph No. 2 shows the annual minimum flows recorded at the river over a number of years. Determine the value of the *50-year* low flow. Will this flow provide sufficient dilution of the effluent from the new accommodation blocks if the County Council require an 8:1 dilution?

(6 marks)

5. Answer both (a) and (b).

(a) Explain how karstification of limestone would affect the concentration distribution of a finite volume of L-NAPL in groundwater (refer to advection and dispersion in your answer).

(10 marks)

(b) A spill of D-NAPL occurs at the surface. Explain what happens to all phases of the contaminant as it percolates below the ground surface.

(10 marks)

Section B continues overleaf

6. Pump & treat is a widely used remediation option. Explain the process, outlining the options for use (including wells or trenches) and explain the advantages and disadvantages of using the methodology as a remediation strategy.

(20 marks)

7. Permission is being sought for development of housing on a site formerly used for heavy industrial use. Before construction and development can begin you are hired to ascertain the quality status of groundwater below the site. Assuming that there is contamination present outline the sequence of work you would undertake to address the contamination issue.

(20 marks)

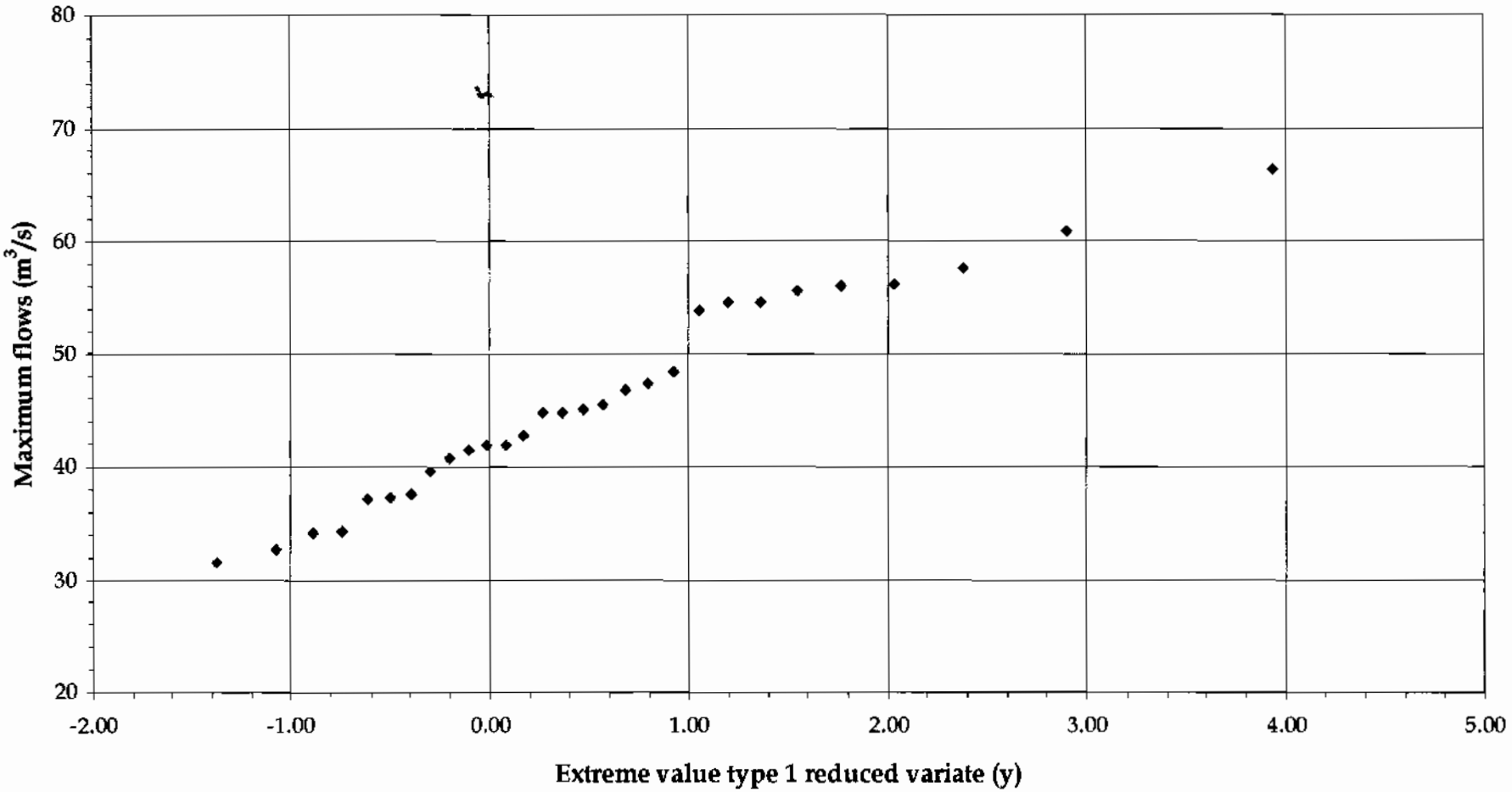
8. Sources of groundwater contamination can be broadly categorised into six groups. List the groups, and explain *two* in detail.

(20 marks)

Question 4 (a)

T	2	5	10	20	25	50	100
Extreme Value Type I	0.37	1.50	2.25	2.97	3.20	3.90	4.60

Graph No. 1: Probability Plot of Annual Maximum Flows at NUIG River



Question 4 (e)

T	2	5	10	20	25	50	100
Extreme Value Type I	0.37	1.50	2.25	2.97	3.20	3.90	4.60

Graph No. 2: Probability Plot of Annual Minimum Flows NUIG River