



UNIVERSITY OF ESWATINI  
Faculty of Health Sciences  
Department of Environmental Health Science

BSc DEGREE IN ENVIRONMENTAL MANAGEMENT AND  
WATER RESOURCES

**MAIN EXAMINATION PAPER FEBRUARY 2021**

TITLE OF PAPER : WATER DISTRIBUTION AND SEWERAGE SYSTEMS

COURSE CODE : EHS 451

DURATION : 2 HOURS

MARKS : 100

INSTRUCTIONS :

- : READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
- : ANSWER **ANY FOUR** QUESTIONS
- : EACH QUESTION **CARRIES 25** MARKS.
- : WRITE NEATLY & CLEARLY
- : NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.
- : BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY  
THE INVIGILATOR.

**QUESTION ONE ( 5 marks each )**

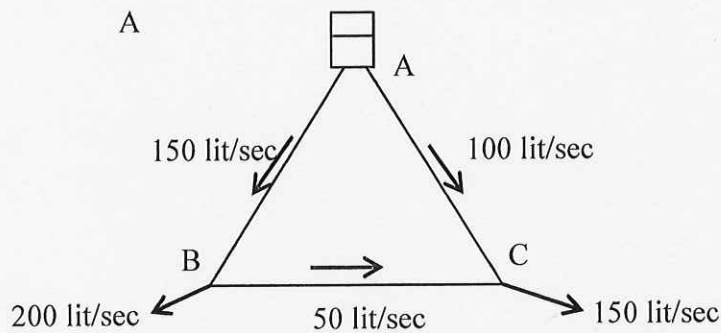
- 1A.** Describe four methods used for the development of a well.
- 1B.** Evaluate the benefits of providing i) ductile iron pipes and ii) PVC pipes for distribution systems.
- 1C.** List the long term measures for the elimination of microbial growths in distribution systems.
- 1D.** For a given well whose diameter is 20 cm and the well is driven to 80 meters while the water table is at 30 meters, determine the amount of chlorine that has to be added into the well to maintain a disinfection concentration of 30 mg/L for 24 hours assuming that the hypochlorite powder has 70% free available chlorine in it.
- 1E.** Determine the production capacity of a treatment installation for a city with a population of 1,250,000. Assume a specific consumption per capita of 150 l/d, non-domestic water use of 30,000,000 m<sup>3</sup>/y and UFW of 12%.

**QUESTION TWO** (5 marks each)

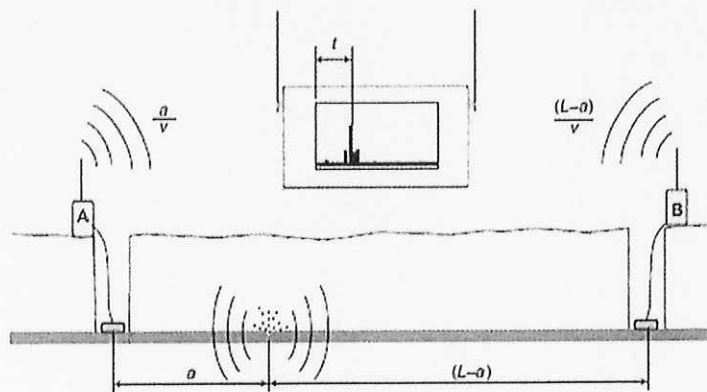
**2A.** State the advantage and disadvantage of installing a two tank storage system at household level compared to a single elevated storage tank.

**2B.** The pipe system shown below has the source water from A (Reservoir) supplying water to demand nodes B and C. Assume that the probability that two or more pipes fail at the same time is low.

- a. Calculate the nodal reliabilities at B and C .....[ 3 Marks ]
- b. Calculate also the overall system reliability. ....[ 2 Marks ]

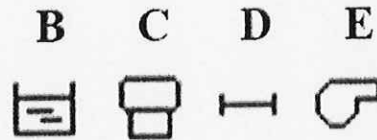


**2C.** A leak noise correlator (shown in the figure below) was used for locating leak along a 350 meter length pipe. If the leak noise signals from the ends of the pipes were received with a time interval difference of 0.25 sec, determine the location of the leak measured from the left end A.



$L$  = Section length       $v$  = Sound propagation 1240 m/s  
 $a$  = Leak location       $t$  = Time delay in signals from sensors A & B

- 2D. The diagram below shows some of the symbols used for the commands in EPANET pipe network analysis program. State what each of the symbol is used for in the EPANET modeling.



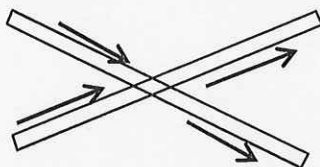
- 2E. State the procedure for carrying out extended period simulation in the EPANET pipe network analysis program.

**QUESTION THREE ( 5 marks each )**

**3A.** How is it possible to create a pressure zone (without using pressure reducing valves) in gravity supply systems?

**3B.** Explain the leak noise correlation method for the detection of leaks in water distribution systems.

**3C.** For the pipe crossing shown in the figure indicate the position (s) of anchorage support (s).



**3D.** Describe with the help of a diagram the well point method of trench dewatering.

**3E.** The table below shows operational data of water consumption for Manzini Town water supply.

Determine:

- i. The unaccounted for water (UFW) in %
- ii. The Revenue Water in % and
- iii. The non-revenue water in %

Billed consumption	55%	Illegal connection	10%
Leakage	20%	Meter inaccuracies	5%
Unbilled authorized consumption	10%		

**QUESTION FOUR ( 5 marks each )**

**4A.** Describe methods that can be employed to remove and control odors in sewer systems.

**4B.** Describe the following sewer systems:

- i. Vacuum sewerage .....[1.5 Marks]
- ii. Pressurized sewerage .....[1.5 Marks]
- iii. Small bore sewerage. ....[2 Marks]

**4C.** Compare separate sewer systems with that of combined sewer systems in terms of their suitability for collection of waste water from cities. .

**4D.** List five methods of inspection of sewer pipes.

**4E.** Describe briefly what aspects you would look in the preliminary reconnaissance survey for the design of sewer system for a given city.

**QUESTION FIVE** (5 marks each)

The minimum slope required to achieve self-cleansing velocity has been suggested as 2.2% for a sewer pipe diameter of 250 mm. Manning's roughness coefficient  $n$  can be taken as  $n = 0.013$ . In an area with a ground slope of 2.2% a sanitary sewer is required to carry a flow of  $0.5 \text{ m}^3/\text{min}$ . Using the discharge equation given in Eq. Q5-1 and the partial flow graph provided in Figure Q5-1 below:

**5A.** Determine if the suggested slope for the given diameter will achieve self-cleansing velocity of greater than or equal to  $0.6 \text{ m/sec}$  at the specified flow.  
 .....[20 Marks]

**5B.** Suggest what should be done in the event this self-cleansing velocity were not achieved. ....[5 Marks]

$$Q = \left( \frac{0.312}{n} \right) * D^{\frac{8}{3}} * S^{1/2}$$

.....(Eq. Q5-1)

- Where  $Q$  = sewer flow in  $\text{m}^3/\text{sec}$   
 $D$  = Sewer pipe diameter in meters  
 $n$  = Manning's coefficient =  $0.013$   
 $S$  = Slope of sewer pipe (m/m).

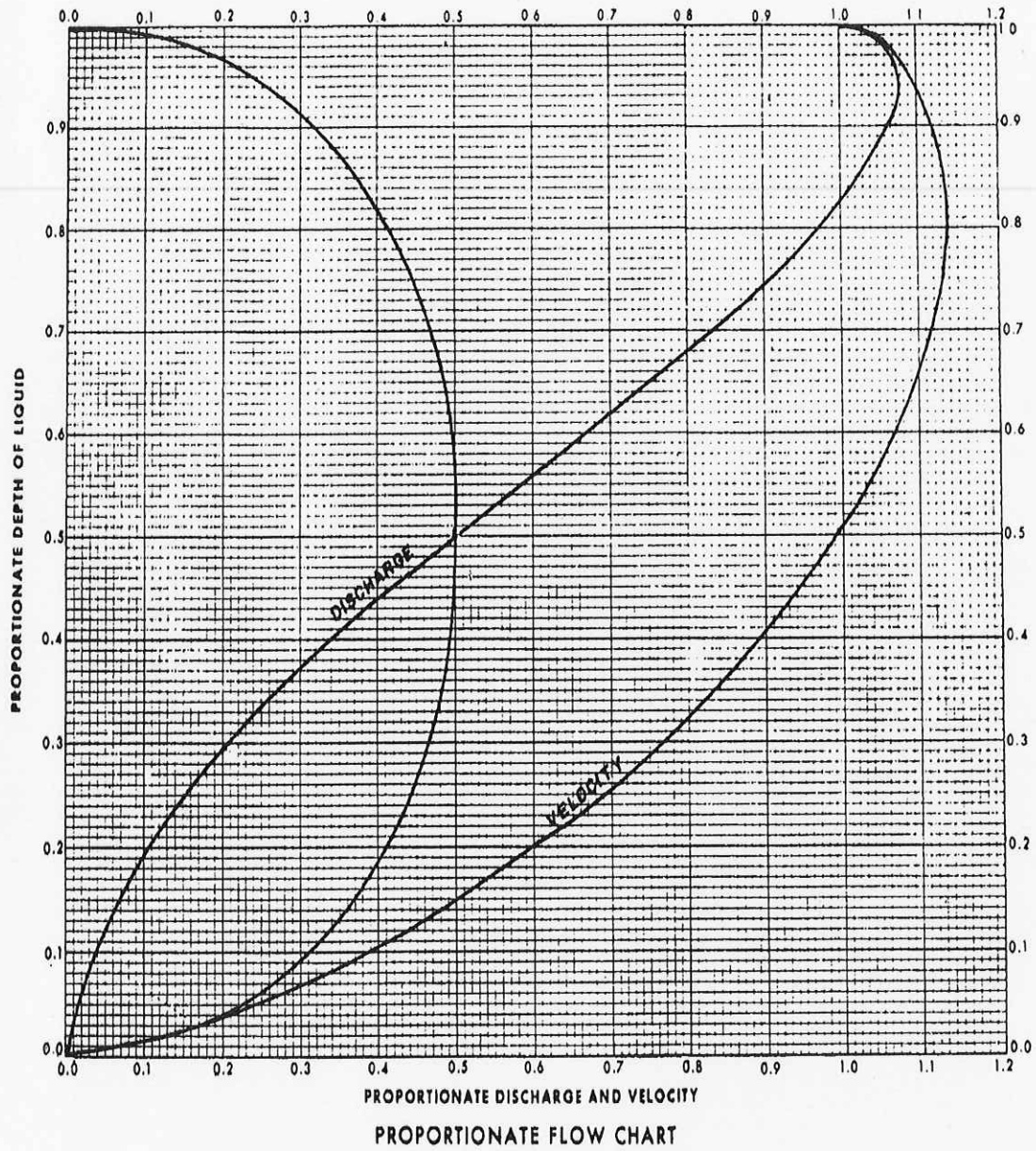


Figure Q5-1: Partial flow graph for Sewer flow calculation