CE 412 A: Water Supply & Wastewater Disposal Systems
Tutorial – 2022-23 (2nd sem) ● Part II: Wastewater Management
### TUTORIAL 1 ● Tuesday, February 28, 2023

Problem 1: Check the design of sanitary sewers given in the table for the given area shown in the Figure with the following details and fill in the values of Total Full and Invert Levels.

1	Population Density	300 Persons/hect.
2	Water Supply	250 lpd/head (ultimate)
3	Maximum rate of infiltration	20,000 lpd/hect.
4	Minimum depth of cover to be provided over the crown of the sewer	1 m
5	Minimum velocity in sewer at peak flow	0.6 m/sec
6	Maximum velocity in sewer	2.0 m/sec
7	Minimum size of the sewer	150 mm
8	Waste water reaching sewers	90% of Water Supply
9	Peak flow	3.5 x Ave. flow

➤ Take slopes as per following recommendation:

Dia (mm)	150	200-350	400 and above
Slope	0.008	0.005	0.033
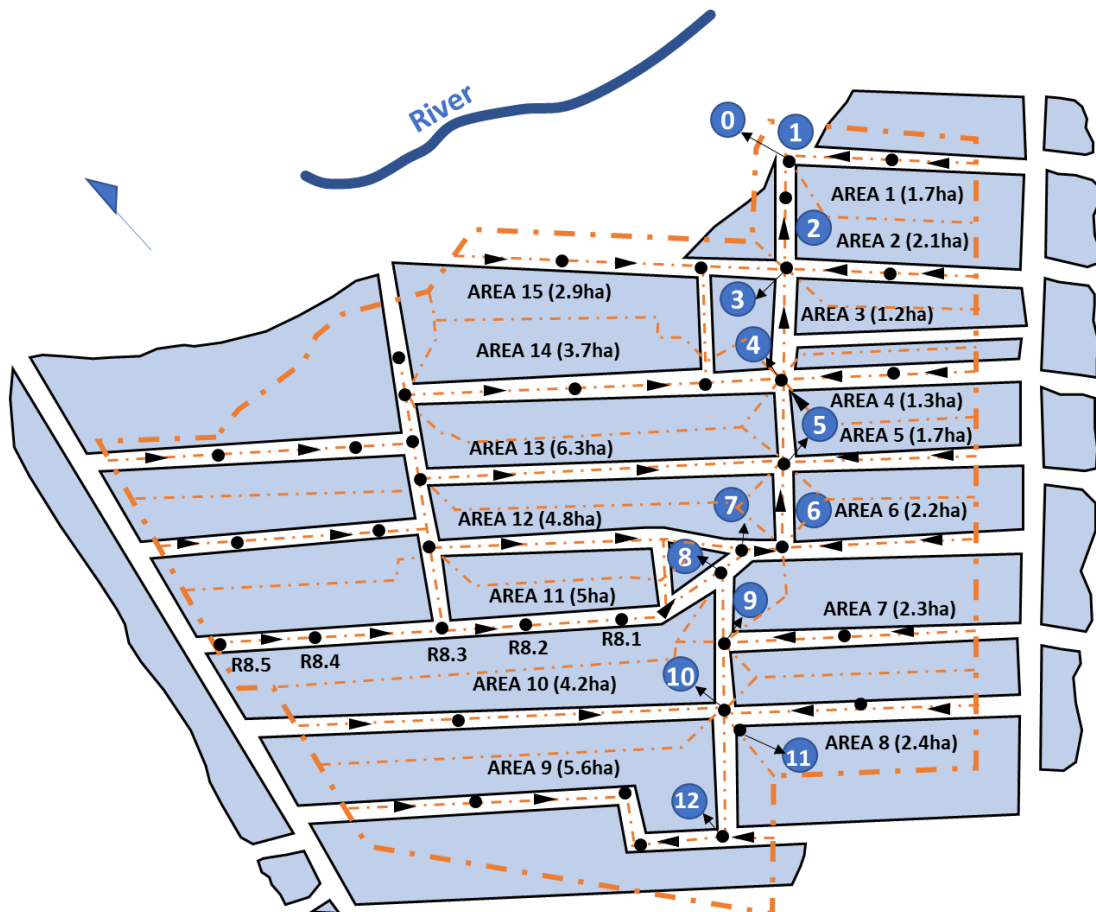
Notes:

1. **A minimum level difference of 30 mm has to be provided between the incoming and outgoing sewers**
2. **v/V and q/Q as a function of d/D**

d/D	v/V	q/Q
1.0	1.000	1.000
0.9	1.124	1.066
0.8	1.140	0.968
0.7	1.120	0.838
0.6	1.072	0.671
0.5	1.000	0.500
0.4	0.902	0.337
0.3	0.776	0.196
0.2	0.615	0.088
0.1	0.401	0.021

Solution:

1. Draw a line to represent the proposed sewer in each street or valley to be served. Near the line indicate by an arrow the direction in which sewage is to flow → Marked in given figure.

2. Locate the manhole, giving each an identification number → Marked in given figure.

3. Sketch the limits of the service areas for each lateral → Marked in given figure.

4. Measure the areas (ha) of the several service areas → Values given in the table.

5. Prepare a table with the columns for the different steps in computation and a line for each section of sewer between manholes.

Columns 1-6 for the line manhole, location of the manhole, manhole numbers, ground level at starting manhole and length of line between the manholes.

Columns 7-8 the corresponding area for the next street of sewer and in Col.8 the sum of the areas are entered.

Column 9 the population served by each corresponding line is to be entered.

Column 10 enter the sewage flow (mld) through each line. The sewage flow is assumed as 90% of the per capita water supply.

Column 11 enter the ground water infiltration for each area = $20{,}000 \times 10^{-6} \times$ Col.8.

Column 12 enter the peak flow i.e. Col.10 × 3.5 + Col.11.

Column 13 enter the peak flow in lps.

Column 14-15 indicate the diameter and slope of the pipes determined from the Manning's chart.

Columns 16-17 indicate the discharge through pipe flowing full and enter the actual discharge through the pipes i.e. as Col. 13.

Column 18 also determined from the Manning's chart when pipe following full.

Column 19 calculate from the hydraulic elements for the circular pipes.

Column 20 gives Col.6 × Col.15.

Columns 21-22 Enter invert levels of the lines.

Table: Design of a sewer system

Line	Location	Manhole from	Manhole to	Ground level at start manhole	Length m	Area Served (ha) increment	Area Served (ha) total	Population	Sewage Flow mld	Groundwater Infiltration mld	Peak Flow mld	Peak Flow lps	Diameter Mm	Slope	Q Full	Q Actual	V Full	V Actual	Total fall M	Upper end	Lower end
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Street	R8.5	R8.4	38.275	120	0.80	0.80						150	0.008	14		0.75	0.57			
2	Street	R8.4	R8.3	37.960	116	1.20	2.00						150	0.008	14		0.75	0.72			
3	Street	R8.3	R8.2	36.873	114	1.40	3.40						150	0.008	14		0.75	0.82			
4	Street	R8.2	R8.1	36.895	116	0.90	4.30						150	0.008	14		0.75	0.86			
5	Street	R8.1	8	36.420	75	0.70	5.0						200	0.005	24		0.70	0.74			
6	Street	8	7	36.117	41	14.5	19.5						300	0.005	70		1.0	1.13			
7	Street	7	6	35.830	26	4.8	24.3						350	0.005	100		1.2	1.32			
8	Main St.	6	5	35.105	88	2.2	26.5						350	0.005	100		1.2	1.32			
9	-do-	5	4	34.412	86	7.8	34.3						400	0.0033	125		1.0	1.12			
10	-do-	4	3	34.181	36	5.0	39.3						400	0.0033	125		1.0	1.14			
11	-do-	3	2	34.105	77	1.2	40.5						400	0.0033	125		1.0	1.14			
12	-do-	2	1	34.905	117	5.0	45.5						450	0.0033	160		1.0	1.12			
13	-do-	1	0	33.250	41	1.7	47.2						450	0.0033	160		1.0	1.12			