CE 3372 Water Systems Design
Exam 2
Spring 2025

1. (10 points) In a sewer system if design criteira require a minimum velocity of 2 ft/sec, and your design cannot produce that velocity at the design flow, what are some changes can you make in your design?

2. (10 points) Why is population forecasting imp[ortant for water distribution and wastewater collection system designs?

3. (10 points) What is a lift station, and when are they necessary?

4. (10 points) Define the time of concentration for a drainage area.

5. (10 points) Define the inlet time for an urbanized drainage area.

6. (10 points) Define inflow and infiltraton in the context of a sanitary sewer system.

7. (10 points) Figure 1 shows ten (10) sources of non-permitted drainage into a sanitary sewer system. For each listed source classify the source type as infiltration or inflow and complete Table 1

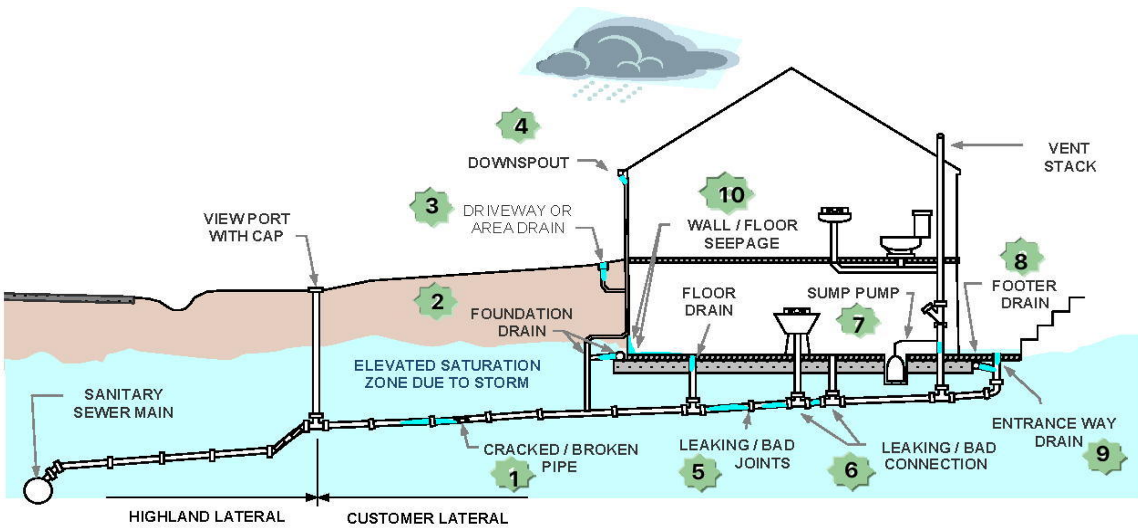

Figure 1. Schematic of Inflow and Infiltration Sources.

Table 1. Inflow and Infiltration Source Classification.

Source ID	Source Name	Source Type (Inflow or Infiltration?)
1	Cracked/Broken Pipe	
2	Foundation Drain	
3	Driveway or Area Drain	
4	Downspout	
5	Leaking/Bad Joints	
6	Leaking/Bad Connection	
7	Sump Pump	
8	Footer Drain	
9	Entrance Way Drain	
10	Wall/Floor Seepage	

8. (30 points) Figure 2 is a grain size distribution curve for a soil sample in a receiving stream. Figure 3 is a Hjulstrom diagram;

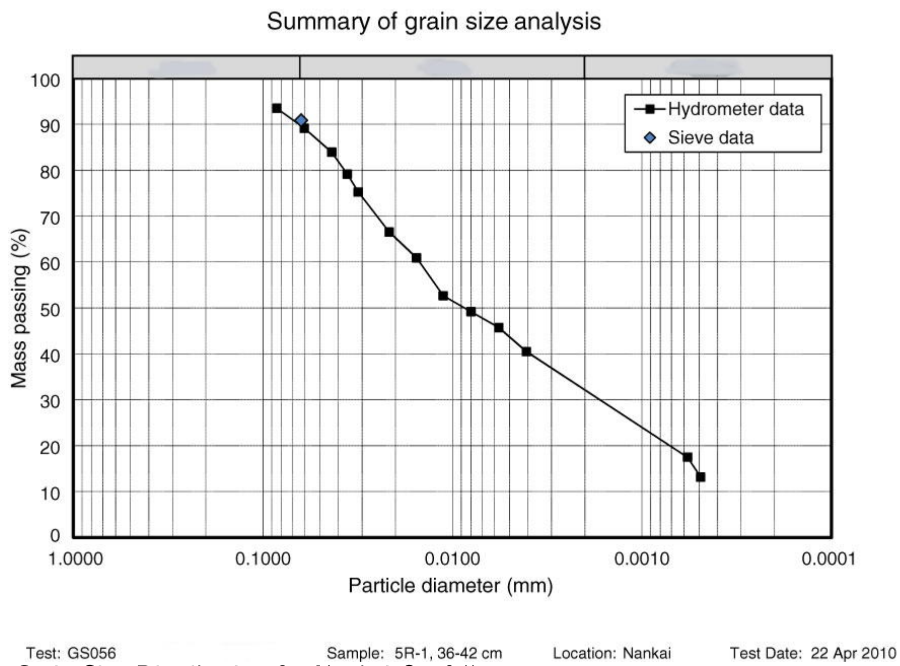

Figure 2. Grain Size Distribution for Nankai Outfall.

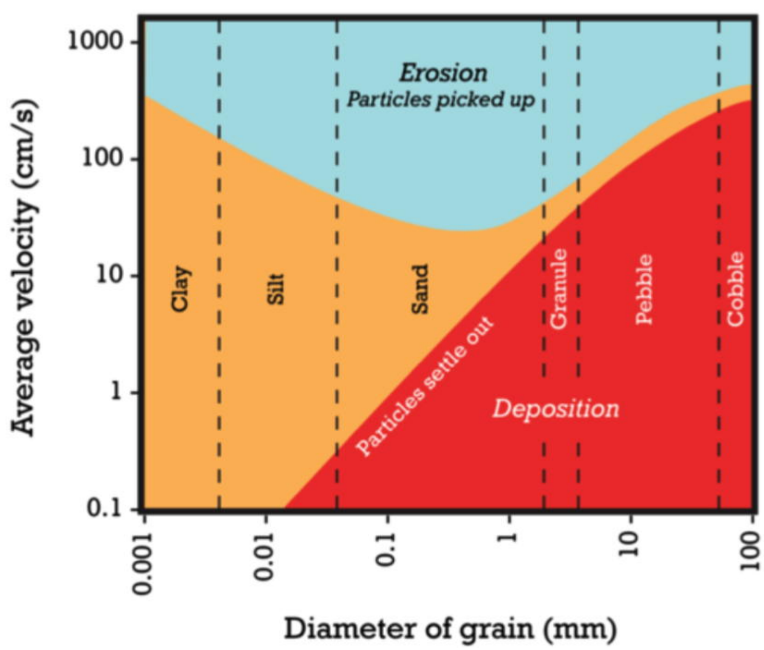

Figure 3. Hjulstrom Diagram for Sediment Transport.

Using the grain size distribution and the Hjulstrom diagram;

A) Estimate the median grain diameter, in millimeters. Draw directly on the diagram to show where the mean grain size is plotted.

B) Estimate the **largest** particle diameter represented in the soil sample. Draw directly on the diagram to show where the largest grain size is plotted.

C) Estimate the **smallest** particle diameter represented in the soil sample. Draw directly on the diagram to show where the smallest grain size is plotted.

D) Draw directly on the diagram the three sizes determined above (smallest, median, and largest).

E) Determine the maximum stream velocity, in feet per second, at the outfall to prevent erosion if the smallest size is considered.

F) Determine the maximum stream velocity, in feet per second, at the outfall to prevent erosion if the median size is considered.

G) Determine the maximum stream velocity, in feet per second, at the outfall to prevent erosion if the largest size is considered.

H) Determine the maximum stream velocity, in feet per second, at the outfall to prevent erosion if no material in the sample is to be mobilized.

9. (100 points) Consider the drainage area depicted in Figure 4.

Figure 4. Drainage System Layout.

Table 2 lists the hydrologic features of the four drainage areas.

Table 2. Hydrologic data for each drainage area in Figure 4
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Area ID	Area (*acres*)	Width (*feet*)	Avg. Slope (%)	NRCS CN
DA_1	25	1073	0.2	85
DA_2	25	1073	0.2	85
DA_3	17	719	0.8	85
DA_4	8	688	0.9	85

Table 3. Elevation data for each junction in Figure 4
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Junction ID	Invert Elevation (*feet*)	Land Elevation (*feet*)
J-DA_1	65	70
J-DA_2	60	66
J-DA_3	56	66
J-DA_4	48	62
OUTFALL	35	N/A

The red dots on Figure 4 are inlets to the storm sewer system (indicated by the blue pipes). The red rectangle (on the East side of the figure) is a stormwater outfall. Table 3 lists the invert elevations, and land surface elevations of these points.

The system is to be sized using the design storm shown in Table 4[1]

Table 4. Design Storm for Drainage System in Figure 4
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Elapsed Time	Rainfall Intensity ($\frac{in}{hr}$)
00:00	0.11
01:00	0.11
02:00	0.13
03:00	0.13
04:00	0.15
05:00	0.17
06:00	0.19
07:00	0.21
08:00	0.27
09:00	0.34
10:00	0.54
11:00	4.28
12:00	1.09
13:00	0.48
14:00	0.34
15:00	0.26
16:00	0.22
17:00	0.19
18:00	0.17
19:00	0.14
20:00	0.13
21:00	0.12
22:00	0.12
23:00	0.11

The blue line segments on Figure 4 are pipes that comprise the storm sewer system. Table 5 lists the proposed design (i.e. pipe lengths, diameters, connection(s), and offsets) for the storm sewer.

[1] A 10-inch, 24 hour, SCS Type-2 - with the first and last hour trimmed

Table 5. Hydraulic data for each pipe in Figure 4

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Pipe ID	Connection (Start:End)	Diameter ($feet$)	Length ($feet$)	Offset (inlet:outlet)
P_1	DA_1 : DA_2	3.0	1000	0:0
P_2	DA_2 : DA_4	3.0	1000	0:2
P_3	DA_3 : DA_4	3.0	1000	0:2
P_4	DA_4 : OUTFALL	5.0	1000	0:0

Using these data build a SWMM model of the system. Assume the outfall is a fixed pool with depth 5 feet (water elevation 40 feet). Use DYNWAVE routing, and the SCS CN infiltration method in SWMM.

Use the model to inform answers to:

A) Make a screen capture of your working model.

B) How many subcatchments are in your model?

C) Are all the pipes below grade?

D) Does the system surcharge during the design storm?

E) If yes, when does the surcharge occur (what time)?

F) What is the maximum flow velocity in the sewer system?

G) Where does this maximum occur (which pipe)?

H) When does this maximum occur?

I) Use SWMM to sketch a profile of the sewer system and the water surface elevation at hour 12:00 of the simulation, starting at J-DA_1 and ending at the OUTFALL

J) Use SWMM to generate a time series (a plot) of the precipitation input

K) Use SWMM to generate a time series (a plot) of runoff in subcatchment DA_2

L) Modify your model to make pipes P_1 and P_2, into 5.0 foot diameter pipes, keeping them at least 2 feet below grade.

M) List the required changes (there are several, invert elevations must be changed, and offsets need changing)

N) Does the system surcharge during the design storm?

O) Use SWMM to sketch a profile of the sewer system and the water surface elevation at hour 12:00 of the simulation, starting at J-DA_1 and ending at the OUTFALL

P) Use SWMM to generate a time series (a plot) of runoff in subcatchment DA_2