# HYDROLOGY – CVG-3120
# MIDTERM EXAMINATION
# November 2st, 2006

**Duration: 80 minutes**
**Room: STEC0136**

**Question 1 – 25 points**
An open area has a surface of 8.6 $km^2$. The area is to be developed as an urban neighborhood and pre- and post-development characteristics of the area are as follows:

$C_{initial} = 0.25$ $C_{developed} = 0.70$
$t_{concentration}^{initial} = 45$ minutes $t_{concentration}^{developed} = 22$ minutes

Using the provided IDF curves for the city of Ottawa Using the Rational Method, find the peak flows for pre-development and post-development. Explain the results.

**Question 2 - 15 points**

(a) What is the probability that a 100- year storm will occur at least once in a 50 –year interval?

(b) If the design life of a dam spillway is 200 years and the acceptable risk of failure is 2%, what would be the required return period for the design of the spillway?

**Question no. 3 - 25 points**
A land-use change is proposed for a wooded area in hydrologic soil group class A (good condition). The area is 19.4 ha in size. A developer has plans to pave and build over 10 ha of the area (residential district type, class A soil, ½ acres type). These 10 ha will be directly connected to a sewer system. The municipal authority requires that runoff from a 75 mm rainfall should be stored in a nearby pond reservoir adjacent to the site. Size the storage reservoir using: a composite curve number for the entire 19.4 ha area and (b) separating the newly developed residential area and storing only the water collected from its surface. As an engineer, which solution would you choose? Explain why.
Note: Assume Antecedent Moisture Condition III for both areas (Soil Conservation Method) and use the tables in the appendix of the exam sheet.

**Question no. 4 - 25 points**
The following values are available for the Horton infiltration method: $f_o$=17.78 mm/h, $f_c$=5.08 mm/h and k=0.5 $h^{-1}$. Compute the depth of losses and the excessive rainfall depth for a 3-hour rainfall with constant intensity i=25.4 mm/h.

**Question no. 6 – 10 points**
True or false? Circle the correct answer:

**T** **F** Relative humidity is a measure of the amount of water vapor in an air sample relative to its value if the air were saturated.

**T** **F** Stage-discharge relationship is independent of the geometry of the river cross section.

**T** **F** Size of the water body affects the evaporation

**T** **F** The storm hydrograph at the exit of an elongated watershed has a smaller peak as opposed to a circular watershed of the same surface.

**T** **F** In the Soil Conservation Service (SCS) CN method, the initial abstractions have a precise proportion to the precipitation.

**T** **F** The rational method uses the linear Φ –index method.

**T** **F** Salt water evaporation is stronger then freshwater water evaporation.

**T** **F** The antecedent moisture condition depends on the time between the rainfall events.

**T** **F** The return period of a hydrograph is approximately the same as the return period of the hyetograph which generated the hydrograph.

**T** **F** The albedo is the ratio of total solar energy to the reflected energy.

**APPENDIX**

**TABLE 14.3** RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL-COVER COMPLEXES (AFTER SOIL CONVERSATION SERVICE, 1969)[a]

| Cover | | | Hydrologic soil group | | | |
|---|---|---|---|---|---|---|
| Land Use | Treatment or Practice | Hydrologic condition | A | B | C | D |
| Fallow | Straight row | — | 77 | 86 | 91 | 94 |
| Row crops | Straight row | Poor | 72 | 81 | 88 | 91 |
| | Straight row | Good | 67 | 78 | 85 | 89 |
| | Contoured | Poor | 70 | 79 | 84 | 88 |
| | Contoured | Good | 65 | 75 | 82 | 86 |
| | Contoured & terraced | Poor | 66 | 74 | 80 | 82 |
| | Contoured & terraced | Good | 62 | 71 | 78 | 81 |
| Small grain | Straight row | Poor | 65 | 76 | 84 | 88 |
| | Straight row | Good | 63 | 75 | 83 | 87 |
| | Contoured | Poor | 63 | 74 | 82 | 85 |
| | Contoured | Good | 61 | 73 | 81 | 84 |
| | Contoured & terraced | Poor | 61 | 72 | 79 | 82 |
| | Contoured & terraced | Good | 59 | 70 | 78 | 81 |
| Closed-seeded Legumes[b] or rotation meadow | Straight row | Poor | 66 | 77 | 85 | 89 |
| | Straight row | Good | 58 | 72 | 81 | 85 |
| | Contoured | Poor | 64 | 75 | 83 | 85 |
| | Contoured | Good | 55 | 69 | 78 | 83 |
| | Contoured & terraced | Poor | 63 | 73 | 80 | 83 |
| | Contoured & terraced | Good | 51 | 67 | 76 | 80 |
| Pasture or range | | Poor | 68 | 79 | 86 | 89 |
| | | Fair | 49 | 69 | 79 | 84 |
| | | Good | 39 | 61 | 74 | 80 |
| | Contoured | Poor | 47 | 67 | 81 | 88 |
| | Contoured | Fair | 25 | 59 | 75 | 83 |
| | Contoured | Good | 6 | 35 | 70 | 79 |
| Meadow | | Good | 30 | 58 | 71 | 78 |
| Woods | | Poor | 45 | 66 | 77 | 83 |
| | | Fair | 36 | 60 | 73 | 79 |
| | | Good | 25 | 55 | 70 | 77 |
| Farmsteads | | — | 59 | 74 | 82 | 86 |
| Road (dirt)[c] | | — | 72 | 82 | 87 | 89 |
| (hard surface)[c] | | — | 74 | 84 | 90 | 92 |

[a] Antecedent moisture condition II, and $I_a = 0.2S$.

[b] Close drilled or broadcast.

[c] Including the right of way.

***Table 2-6: Runoff Curve Numbers for Urban Areas (SCS, 1986)[1]***

| Cover Type and Hydrologic Condition | Avgerage Percent Impervious Area[2] | Curve Numbers for Hydrologic Soil Group | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| *Fully developed urban areas (vegetation established)* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.)[3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious area only)[4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1 to 2 inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| *Developing urban areas* | | | | | |
| Newly graded area (pervious areas only no vegetation)[5] | | 77 | 86 | 91 | 94 |
| Idle lands (CNs are determined using cover types similar to those in 2-2(c) (SCS, 1986) | | | | | |

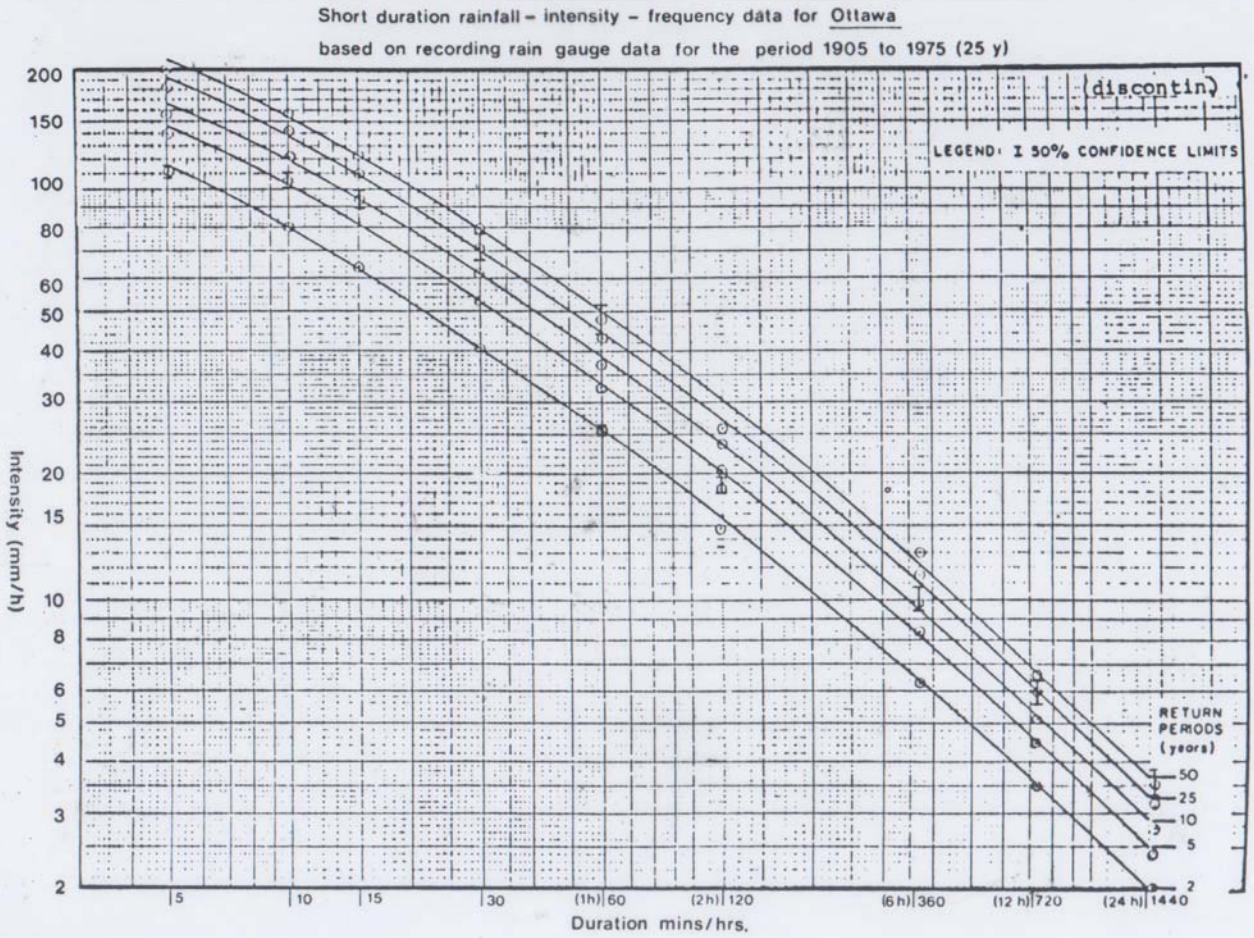


Figure 2.3.1 — Typical intensity-duration-frequency curves (20)