

Test Format and Instructions

- 3 problems on 2 pages
- 30 - 40 points per problem, 100 points total
- closed book, w/ 3 pages of hand-written notes, and homeworks allowed
- initial all pages, staple solutions to test and hand in package
- start at 9:30, end at 10:50, Thursday, April 27, 2000

1. Pumps in Parallel and Series (40 points)

The following table gives the performance curve for a single kinetic pump, and the head required to deliver water through a main to a storage tank

<u>Q (cfs)</u>	<u>Head Added (ft.)</u>	<u>Head Required (ft)</u>
0	90	70
50	80	75
100	60	90
150	30	115
200	0	150

- a) Estimate the head added for a pump station having two of these pumps connected in **series**, for a range of Q's varying from 0 to 200 cfs.

<u>Q (cfs)</u>	<u>Head Added (ft.)</u>
0	_____
50	_____
100	_____
150	_____
200	_____

- b) Estimate the head added for a pump station having two of these pumps connected in **parallel**, for a range of Q's varying from 0 to 400 cfs.

<u>Q (cfs)</u>	<u>Head Added (ft.)</u>
0	_____
100	_____
200	_____
300	_____
400	_____

- c) Estimate the flow that could be delivered to the water tower (the operating point) for the **two pumps in series** pump station described in a).

- d) Describe how you might decide on which type of kinetic pump would be best suited to delivering a flow of 100 cfs through the pipeline?

2. Rational Method (30 points)

- a) Give two circumstances where you might recommend against using the rational method to estimate runoff from a watershed.

- b) Estimate the concentration time for 3000-acre residential development, assuming a surface slope of 0.5%. Assume the watershed length and width to be equal.

- c) Assuming a rainfall intensity of 3 in./hr. for this watershed, estimate the runoff flow in cfs.

3. Open channel flow (30 points)

- a) A rectangular channel, 30 ft. wide has a water depth of 2.0 ft. and a Froude number of 0.5. Calculate the discharge (Q) in the channel.

- b) What is the critical depth for a discharge of 100 cfs in a rectangular channel 20-ft. wide?

- c) If the flow described in a) above is the result of a hydraulic jump, what is the conjugate depth just upstream of the jump?

TABLE 7.3 Runoff Curve Numbers for Hydrologic Soil-Cover Complexes

Land Use and Treatment or Practice	Hydrologic Condition	Hydrologic Soil Group			
		A	B	C	D
Fallow	—	77	86	91	94
Straight row Row crops	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 and terraced	Poor	66	74	80	82
Contoured and terraced	Good	62	71	78	81
Small grain	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 and terraced	Poor	61	72	79	82
Contoured and terraced	Good	59	70	78	81
Close-seeded legumes or rotation meadow	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 and terraced	Poor	63	73	80	83
Contoured and terraced	Good	51	67	76	80
Pasture or range	Poor	68	79	86	89
No mechanical treatment	Fair	49	69	79	84
No mechanical treatment	Good	39	61	74	80
No mechanical treatment	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
Roads*	—	72	82	87	89
Dirt	—	74	84	90	92
Hard surface	—				

Source: Soil Conservation Service Technical Paper No. 149.

*Including rights of way.

the 24 hr rainfall distribution (Type I storm) is significantly different from that in the Northwestern coastal regions (Type IA storm), and again from the distribution in the rest of the country (Type II storm). Thus, different standards for runoff discharge determination have been developed for different geographic locations.

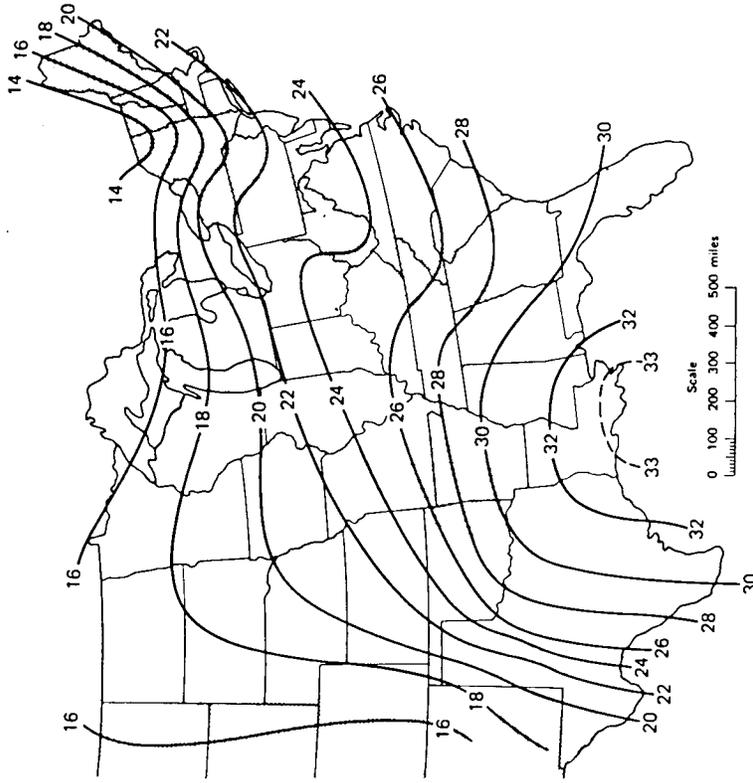


FIGURE 7.2 Maximum possible precipitation in inches over a 200 mi² area in one day.

TABLE 7.2 Coefficients for Use with the Rational Formula (Equation 7.7)

Description of Area	Runoff Coefficients
Business	
Downtown	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single-family	0.30 to 0.50
Multifamily, detached	0.40 to 0.60
Multifamily, attached	0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartments	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yard	0.20 to 0.35
Unimproved	0.10 to 0.30

*One acre-inch per hour nearly equals 1 ft³/sec.