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CE 365K Hydraulic Engineering Design **Second Exam** **Spring 2014**

There are five questions on this exam. Please do all five questions.

1. (a) Capital Improvement Planning

The City of Austin has an 8-step plan for developing watershed protection projects as part of its Capital Improvement Program. Name and briefly describe these 8 steps:

(i) Identify – locate the problem – reduce flood hazard for a specific area of Austin

(ii) Verify – make field visits, surveys, inspections, modeling

(iii) Prioritize – rank on basis of feasibility, value, cost, access to site

14 (iv) Analyze – define solution – change to system to make improvements use models to look at effects of alternatives.

(v) Design – develop construction plans

(vi) Permit – Ensure compliance with City Code

(vii) Project Manual – describes the project to enable bidding on it

(viii) Construction Oversight – ensure project is built as planned

1 (b) Define and give an example of the following:

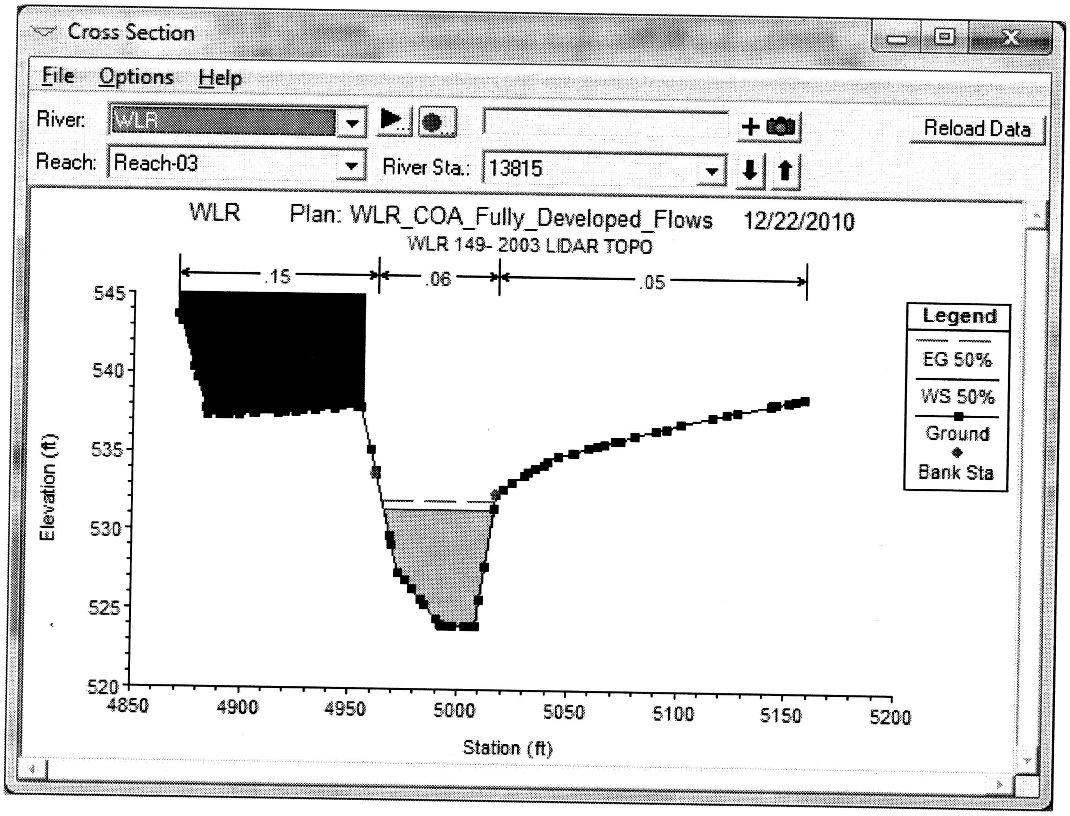
Geographic Information System – a system designed to capture, store, manipulate,
6 analyze, manage and present all types of geographic information eg ArcGIS

Vector data – geographic features define by points, lines and areas eg river stream maps, building footprints

Raster data – surfaces defined by continuous coverage eg orthophotos, digital elevation models

2. Hydraulic Modeling

The following information is drawn from the HEC-RAS model used by the City of Austin for hydraulic design for Waller Creek. This is River Station 13815 on Reach 3, which is upstream of our campus. This profile is for a flood with annual probability of occurrence of 50%.



River: WLR | Profile: 50%

Reach: Reach-03 | RS: 13815 | Plan: WLR_COA_FD

Plan: WLR_COA_FD WLR Reach-03 RS: 13815 Profile: 50%

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	531.91	Wt. n-Val.		0.060	
Vel Head (ft)	0.48	Reach Len. (ft)	100.00	131.00	134.00
W.S. Elev (ft)	531.43	Flow Area (sq ft)		272.38	
Crit W.S. (ft)		Area (sq ft)		272.38	
E.G. Slope (ft/ft)	0.005914	Flow (cfs)		1510.00	
Q Total (cfs)	1510.00	Top Width (ft)		50.70	
Top Width (ft)	50.70	Avg. Vel. (ft/s)		5.54	
Vel Total (ft/s)	5.54	Hydr. Depth (ft)		5.37	
Max Chl Dpth (ft)	7.39	Conv. (cfs)		19634.5	
Conv. Total (cfs)	19634.5	Wetted Per. (ft)		54.85	
Length Wtd. (ft)	131.00	Shear (lb/sq ft)		1.83	
Min Ch El (ft)	524.04	Stream Power (lb/ft s)		10.16	
Alpha	1.00	Cum Volume (acre-ft)	0.01	2.88	0.49
Frctn Loss (ft)	0.51	Cum SA (acres)	0.97	11.82	1.50
C & E Loss (ft)	0.08				

(5.)

2 (a) Flow Parameters Specify the following values at cross-section 13815:

Discharge = 1510 cfs (Q)

Cross-sectional area = 272.38 ft² (A)

Wetted perimeter = 54.85 ft (P)

Manning's "n" = 0.060 (for the Channel only)

Slope of the Energy Grade Line = 0.005914 (S_f)

2(b) Flow computations

Use this information to verify the value of stream velocity (ft/sec) given by the model

(7)

$$V = \frac{1.486}{n} R^{2/3} S_f^{1/2}$$

$$R = A/P = 272.38/54.85 = 4.9659 \text{ ft}$$

$$V = \frac{1.486}{0.060} (4.9659)^{2/3} (0.005914)^{1/2}$$

$$= 5.54 \text{ ft/sec}$$ as shown in table on previous page

as check $V = Q/A = 1510/272.38 = 5.54$ ft/sec as before

2 (c) Flow Interpretation Specify the following:

(8)

Minimum Channel Elevation (ft) = 524.04 ft

Water Surface Elevation (ft) = 531.43 ft

Maximum Water Depth (ft) = 531.43 − 524.04 = 7.39 ft

Top Width of Flow (ft) = 50.70 ft

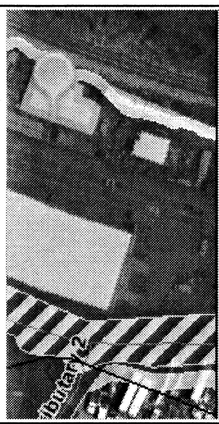
Distance to the downstream end of Waller Creek (ft) = 13815 ft (the river station number)

Return period of the flood event (yrs) = 2 yrs (50% annual probability of occurrence)

$$T = 1/p = 1/0.5 = 2 \text{ yrs}$$

3. Economic Analysis of Flood Damage

The data below show the expected flood losses and potential mitigation strategies for a property in Asheville, NC. Determine the **expected annual flood loss ($)** and **select the mitigation strategies** that are worth employing to reduce this loss.



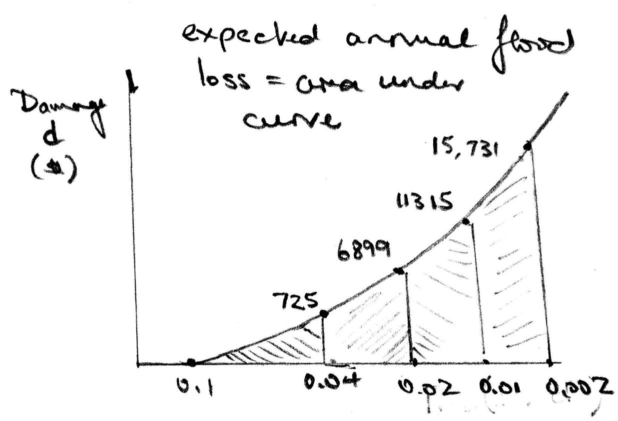
77 Westview Ave, Asheville, NC

Google Street View

Property	
Building Value ($):	109853
Stories:	1
Square Feet (ft):	1724
Foundation:	Slab on Grade
Occupancy Type:	Retail Trade

Risk Reduction Option	Cost	Cost Effectiveness
Elevation	$49,996	0.65
Relocation	$115,508	0.98
Dry Floodproofing	N/A	N/A
Wet Floodproofing	$5,000	4.76
Levees & Floodwalls	N/A	N/A
Mitigation Reconstruction	$205,156	0.16
Utility Elevation	$12,000	1.35

Annual Chance of Flood	Depth Above Finished Floor (in feet)	Damage	Building Losses
10 %	N/A	0%	N/A
4 %	-0.3	1%	$725
2 %	0.7	6%	$6,899
1 %	1.3	10%	$11,315
.2 %	2.2	14%	$15,731



Percent	Probability	Damage $	Δ Prob	Average Dam.	Product
10	0.1	0	0.1	0	0
4	0.04	725	0.06	362.5	21.75
2	0.02	6899	0.02	3812	76.24
1	0.01	11315	0.01	9107	91.07
0.2	0.002	15731	0.008	13523	108.18

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297.24

expected annual flood loss = $297.24

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Mitigation strategies worth employing

- Wet flood proofing B/c ratio = 4.76
- Utility elevation B/c ratio = 1.35

4. Flood Planning on Waller Creek

This semester, we have used the Waller Creek watershed as a case study area for studying flood problems.

(i) Name and briefly describe **four types of flood problems** existing in this watershed. For each problem, describe what measures might be employed to mitigate it.

(a) Channel Stabilization – stream bank protection with an engineered wall employing both vegetation and solid materials

(b) Flooded Structures & Roadways – remove or raise structures, flood proofing, increase channel capacity, off-channel conveyance

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(c) Inadequate Storm Drains – replace with larger pipes, build upstream detention storage to reduce flow

(d) Poor Water Quality – grassed buffer strips, LID development to capture and store storm water, especially first flush

(ii) GIS data are used to represent the Waller Creek watershed and its flow systems. **Specify two GIS feature classes** used for this purpose. Give the feature type (point, line, area) and briefly describe what the features represent

(a) Watershed polygons – used to define subbasins in HEC-HMS model

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(b) Stream Cross-sections – lines – used to define location of cross-sections in HEC-RAS model

(iii) Hydrologic and hydraulic models are used to describe how the Waller Creek and its watershed operate as a flow system. Name and briefly describe the function of **two of these models**.

(a) HEC-HMS – used to convert storm rainfall on watershed into runoff discharge in stream

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(b) HEC-RAS – use to convert discharge in stream to corresponding water surface elevation.

5. Future of Flood Engineering

In this class, we have talked a lot about how flood engineering is done now, and how it might be done in the future. Assuming current trends continue, describe how you think hydraulic engineering design might be done in 5 or 10 years time. What things will remain the same? What things will be done differently? What are the critical trends that are changing the way hydraulic engineering design is carried out?

Problems remain largely as they are now and so will basic flow equations for hydraulics

Solution strategies will evolve

- better conveyance
- more storage
- water quality detention
- low impact development (more emphasis on this rather than large concentrated projects)

Technology will improve

- LIDAR - airborne & land-based
- more use of 3D buildings in GIS
- detailed imagery
- better modeling, especially for newer technologies like LID.
- more use of site-specific information as for flood damage estimates for homes in North Carolina

More assessment of climate change

- Impact of sea level rise.