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GIS in Water Resources Midterm Exam **Fall 2017**

There are five questions on this exam. Please do all five. They are of equal credit.

Question 1

(a) The National Water Model is built using a foundational geospatial dataset called NHDPlus, formed from the National Elevation Dataset and National Hydrography Dataset.

Briefly describe the National Elevation Dataset.

4 A raster dataset whose cell values record the elevation above geodetic datum of the land surface of the US

Briefly describe the National Hydrography Dataset.

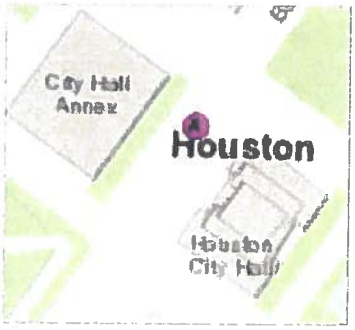
4 A vector dataset that stores the "blue lines" from USGS topographic maps in scanners digital form - flowlines, water bodies, water features

How are the land and water systems of the nation connected in the NHDPlus dataset?

4 By segmenting the National Hydrography Dataset flowlines into reaches and drawing a local catchment around each reach using the National Elevation Dataset. The reach & reach catchment have the same ComID identifier.

(b) Houston is located at the following location in geographic coordinates (95°22'11"W, 29°45'38"N)

Determine the location of Houston in Decimal Degrees



Longitude = 95° 22' 11" W

$= -(95 + 22/60 + 11/3600)$

$= -(95 + 0.36667 + 0.003056)$

4 $= -95.3697$

Latitude = 29° 45' 38" N

$= 29 + 45/60 + 38/3600$

4 $= 29 + 0.75 + 0.010556$

$= 29.7606$

∴ Latitude, Longitude = (29.7606, −95.3697)

Question 2

For flood inundation mapping during Hurricane Harvey, FEMA used the following coordinate system:

Projected Coordinate System	NAD 1983 UTM Zone 15N
Projection	Transverse Mercator
WKID	26915
Authority	EPSG
Linear Unit	Meter (1.0)
False Easting	500000.0
False Northing	0.0
Central Meridian	-93.0
Scale Factor	0.9996
Latitude Of Origin	0.0

Geographic coordinate system	GCS North American 1983
WKID	4269
Authority	EPSG
Angular Unit	Degree (0.0174532925199433)
Prime Meridian	Greenwich (0.0)
Datum	D North American 1983
Spheroid	GRS 1980
Semimajor Axis	6378137.0
Semiminor Axis	6356752.314140356
Inverse Flattening	298.257222101

(a) What Earth Datum is used?

2 NAD83 – North American Datum of 1983

(b) What spheroid is used?

2 GRS 1980 – Geodetic Reference System of 1980

(c) What is the difference in length between the earth's equatorial radius and polar radius on this spheroid (km)?

3 Difference = 6378.137 – 6356.752 = 21.385 km

(d) What map projection is used?

2 Universal Transverse Mercator

(e) Is this a conical, cylindrical or azimuthal projection?

2 Cylindrical

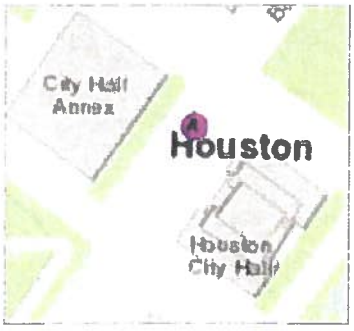
93°W = Central Meridian

2 Draw on this map the location of the Central Meridian of the projection.

Where is the Latitude of Origin of this projection?

2 0°N = Equator

The coordinates of Houston in this projection are (X,Y) = (270870, 3294609).



2 How far is Houston from the Latitude of Origin (m)? 3,294,609m, or 3294 km North of Equator

How far is Houston from the Central Meridian (m)?

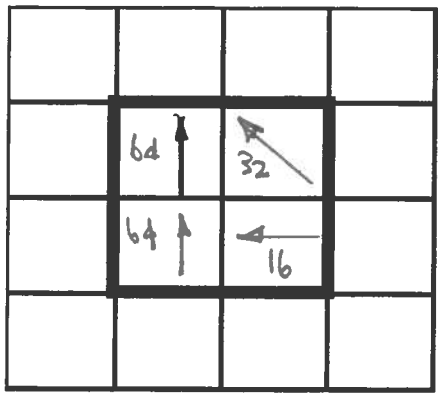
3 False Easting = 500,000m ∴ Houston is 500000 − 270870 = 229,130m or 229 km west of Central Meridian

Question 3

Following is a grid of elevation values in meters in a digital elevation model with 25 m cell size

9	8	10	10
11	9	11	12
14	10	13	15
10	12	13	12

10



a) For the four inner grid cells determine their D8 flow direction. Indicate D8 flow directions in the diagram above to the right. Also indicate the numerical values of the flow direction encoding as used by ArcGIS.

(1) 9 → 8 by inspection

(2) 10 → 9 by inspection

(3) 11 → 9

Slope = $\frac{11-9}{25}$ = 0.08

11 → 8

Slope = $\frac{11-8}{25\sqrt{2}}$ = 0.085

(4) 13 → 10

Slope = $\frac{13-10}{25}$ = 0.12

13 → 9

Slope = $\frac{13-9}{25\sqrt{2}}$ = 0.113

b) For the four inner grid cells determine their D8 flow accumulation. Indicate flow accumulation values in the diagram below. In evaluating these flow accumulation values you may disregard any flow from outside the bold box of four inner grid cells.

	2	0	
	1	0	

4

c) Calculate the Hydrologic (D8) slope of the grid cell with the steepest slope among the four inner grid cells.

For the path 10 → 9 → 8, the slope is $\frac{1}{25}$ = 0.04 for each cell

For path 11 → 8, slope is 0.085

For path 13 → 10, slope is 0.12 this is the maximum

4

d) Following is a grid of elevations in meters in a digital elevation model identify any pits and indicate the elevation they would need to be raised to, for them to be filled.

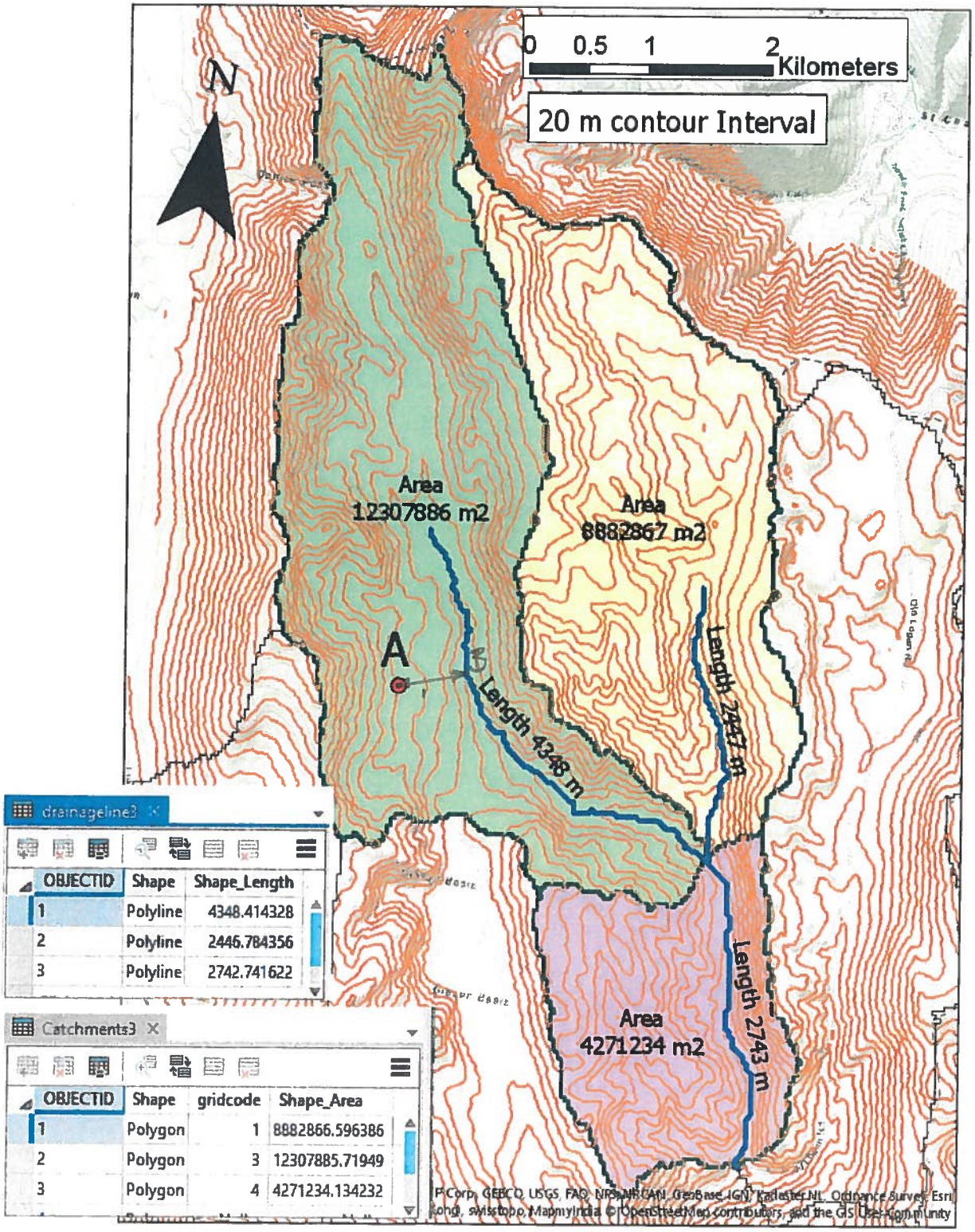
16	17	15	15	15	16
14	15	14	13	12	13
11	15	12	10 → 11	11	12
15	18	12	12	13	9
14	17	15	11	10	8
15	16	15	15	8	7

Raise cell 10 to 11

2

Question 4.

Consider the map of streams derived from a digital elevation model with attribute tables for the drainage lines and catchments shown.



Units on Shape_Length attributes are meters and units on Shape_Area attributes are square meters.

a) Determine the drainage area of this watershed (km²)

4

ObjectID	Area (km²)
1	8.883
2	12.307
3	4.271
	25.461

Drainage area = 25.461 km²

b) Determine the length of channels in this watershed (km)

4

ObjectID	Length (km)
1	4.348
2	2.446
3	2.742
	9.536

Length of channels = 9.536 km

c) Determine the drainage density of this watershed (km/km²)

4

Drainage density = 9.536 / 25.461 = 0.375 km^{-1}

d) For location A in the watershed determine the distance to the nearest stream (km). Approximate this using the scale information given.

4

A → B on stream = 11mm on map

Scale is 20mm on map = 1km on earth

∴ distance AB = 1 x 11/20 = 0.55 km ≈ 550m

e) For location A in the watershed determine the height above the nearest drainage (m). Note contour interval is 20 m.

4

The line AB crosses 4 contour intervals, so

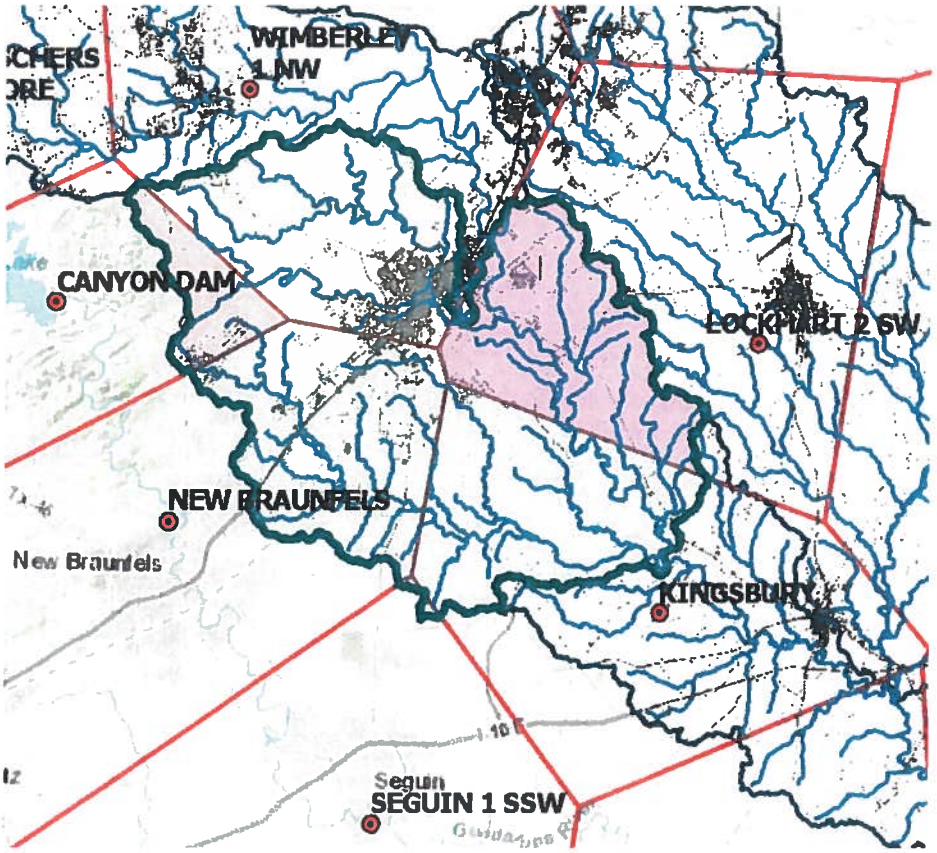
height above nearest drainage = 4 x 20

= 80m

slope = 80/550 = 0.145 = 14.5% — steep!

Question 5

The map below shows the Upper San Marcos River HUC 10 subwatershed (1210020303) and nearby precipitation stations from data used in exercises 2 and 3. Also shown are selected columns from the table obtained from intersecting the Thiessen polygons with the HUC 10 Subwatersheds.



Thiessen Polygon HUC 10 intersection table. The units of attribute AnnPrecip_in are inches, and of attribute Shape_area are square meters.

ArcGIS Pro - Ex3_Project

ThiessenHuc10Intersect

Field: Selection:

OBJECTID	HUC 10 ID	stname	Nyr	AnnPrecip_in	Shape_Area
13	1210020303	NEW BRAUNFELS	17	34.270588	265993677.175304
14	1210020303	WIMBERLEY 1 NW	21	40.47619	274065178.063422
15	1210020303	SEGUIN 1 SSW	14	35.712857	2660776.341296
16	1210020303	CANYON DAM	17	39.082353	68575157.687755
17	1210020303	LOCKHART 2 SW	10	36.125	233722906.59475
18	1210020303	KINGSBURY	7	38.788571	260572886.090427

6 of 31 selected Filters: 100 %

(a) Which station influencing this HUC 10 subwatershed has the highest mean annual precipitation?

4 Wimberley 1 NW (40.48"/yr)

(b) Calculate the Area and Annual Precipitation in Inches for the Upper San Marcos River HUC 10 subwatershed and enter them in the table below. A blank table is also provided to help you organize your computations.

4

HUC 10	Area (Km^2)	Annual Precipitation (in)
1210020303 (Upper San Marcos)	1105.59	37.57

12

ObjectID	Precip(inches)	Area (km^2)	Area x Precip
13	34.27	265.99	9115.6
14	40.47	274.07	11091.4
15	35.71	2.66	95.0
16	39.08	68.58	2679.9
17	36.13	233.72	8444.4
18	38.79	260.57	10107.6
	Sum	1105.59	41534.0

Average Precip = $\frac{41534.0}{1105.59}$

= 37.57 inches