Name:__Tarboton____________

GIS in Water Resources Midterm Exam **Fall 2016**

There are four questions on this exam. Please do all four. They are not all of equal weight.

Question 1. (20%)

(a) Three key functions of GIS are Visualization, Data Storage, and Analysis. For ArcGIS Pro, briefly describe the components that achieve these functions:

Visualization

Maps, Charts, Legends, Layouts, and Tables are all used to visualize GIS information. Symbology controls how information is presented. [3]

Data Storage

Geodatabases hold feature classes, feature datasets, rasters and tabular data on disk. [3]

Analysis

Geoprocessing tools act on datasets to produce new datasets. [2]

(b) Two key datasets that we have used in this class are NHDPlus and the National Elevation Dataset. Briefly outline what each of these datasets describes and what data type (vector or raster) is used to represent it.

NHDPlus

Stream and water body data over the US in vector format. There are associated raster format datasets for catchments, flow directions, flow accumulation etc used in the terrain analysis. [3]

National Elevation Dataset

Elevation data in meters on a 10 m or 30 m grid in raster format. If obtained from USGS it is on a 1/3 or 1 arc second geographic coordinate grid. [3]

(c) We can show location on earth using geographic and projected coordinate systems. Briefly describe these coordinate systems and specify the map units that would be used in each case.

Geographic coordinates

Latitude and longitude in angular units, usually degrees, measuring spheroid angles relative to the equator and central meridian. [3]

Projected coordinates

Distortions of the spheroid onto a flat plane following the rules of a projection. X and Y coordinates in m on the flat plane relative to a specified origin. [3]

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Visualization

3 Maps, charts, legends, layouts, tables are all used to visualize GIS information. Symbology controls how information is presented.

Data Storage

3 Geodatabases, hold feature classes, feature datasets, rasters and tabular data.

Analysis

2 Geoprocessing tools act on datasets to produce new datasets.

(b) Two key datasets that we have used in this class are NHDPlus and the National Elevation Dataset. Briefly outline what each of these datasets describes and what data type (vector or raster) is used to represent it.

NHDPlus

3 Stream and water body data over the US in vector format.

National Elevation Dataset

3 Elevation data in meters on a 10 m or 30 m grid in raster format.

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Geographic coordinates

3 Latitude and Longitude in angular units, usually degrees measuring spheroid angles relative to the equator and central meridian.

Projected coordinates

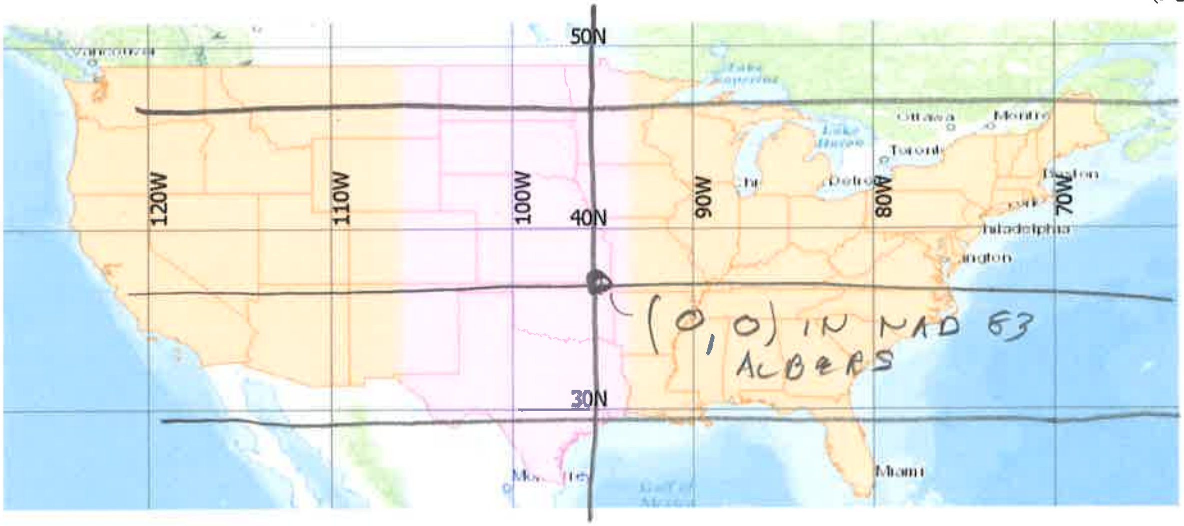
3 Distortion of the spheroid onto a flat plane following a projection. X and Y coordinates in m on the flat plane relative to a specified origin.

Question 2. (20%)

The map below shows the continental United States in geographic coordinates overlaid by a grid which has 10° x 10° cells.

CENTRAL MERIDIAN $-96°$

3



STD PARALLEL 2 45.5°

2

REF LATITUDE 37.5°

3

STD PARALLEL 1 29.5°

2

The parameters are given below of a map projection you have used in this class. Draw on the map above the Central Meridian, Reference Latitude, and Standard Parallels used in this projection.

Projected Coordinate System	NAD 1983 Albers
Projection	Albers
WKID	0
Authority	
Linear Unit	Meter (1.0)
False Easting	0.0
False Northing	0.0
Central Meridian	-96.0
Standard Parallel 1	29.5
Standard Parallel 2	45.5
Latitude Of Origin	37.5

Put a large dot at the intersection of the Central Meridan and Reference Latitude on the map and label this with the (X,Y) coordinates that this location has in the NAD83 Albers projected coordinate system.

4

What earth surface property does the NAD 1983 Albers projection preserve regardless of the projection parameters? AREA

3

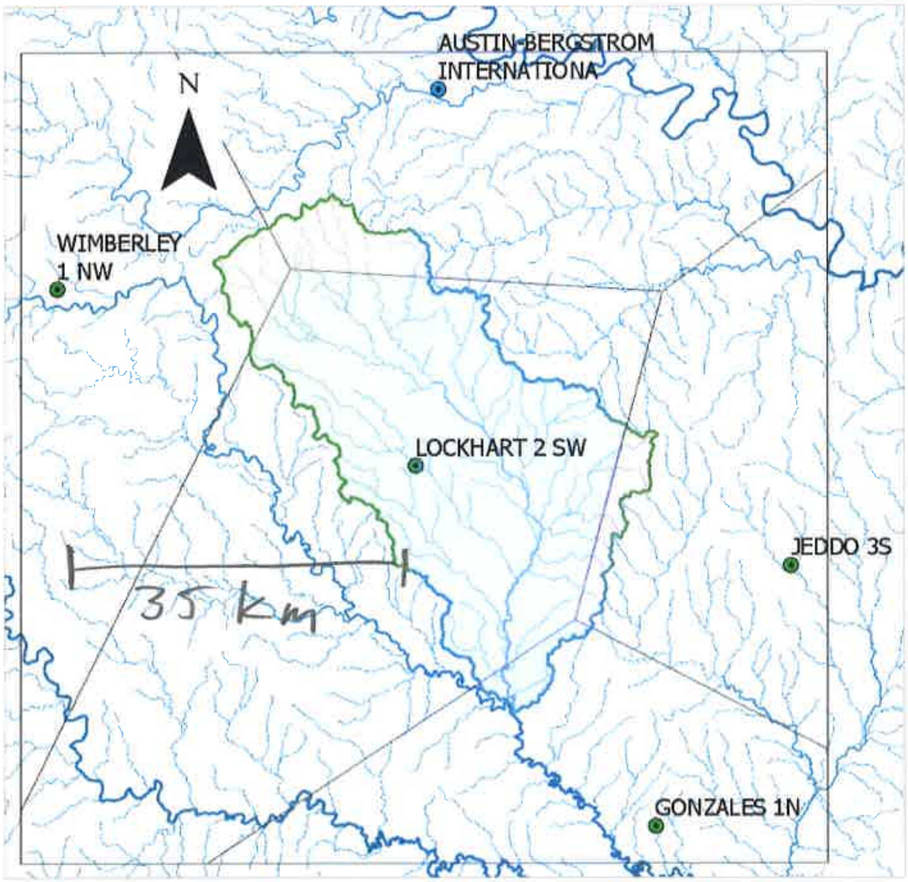
What earth datum is used with this projection?

North American datum of 1983

3

Question 3. (25%)

The map below shows the Plum Creek HUC 10 subwatershed 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 Plum Creek HUC 10 Subwatershed.



The units of attribute AnnPrecip_in are inches, and of attribute Shape_Area are square meters.

ThiessenIntersect

Field: New Delete Calculate Selection: Switch

HUC_10	stname	latdd	longdd	AnnPrecip_in	Shape_Area
1210020304	AUSTIN-BERGSTRO...	30.183333	-97.683333	34.515	77213877.643232
1210020304	GONZALES 1N	29.533333	-97.45	35.1448	32599135.578323
1210020304	JEDDO 3S	29.766667	-97.316667	38.240952	44063228.780483
1210020304	LOCKHART 2 SW	29.85	-97.7	36.125	808854143.735947
1210020304	WIMBERLEY 1 NW	30	-98.066667	40.47619	44743644.434836

a) The map on the previous page is missing a scale. Use the geographic coordinate information to calculate the East-West distance along a 30°N parallel between Wimberley 1 NW and Lockhart 2 SW precipitation stations in Km. Assume a spherical earth with Radius R= 6371 Km. Based on the distance you calculate, draw a scale bar on the map.

4

Distance E-W = $R \Delta\lambda \cos\phi \times \frac{\pi}{180}$

$\Delta\lambda = -97.7 + 98.066667 = 0.366667°$

$\phi = 30°$

$R = 6371$

∴ Distance $= \frac{\pi}{180} \times 6371 \times 0.366667 \cos 30$

$= 35.309$ km

5

b) Calculate the Area and Annual Precipitation in Inches for the Plum Creek HUC10 subwatershed and enter them in the table below. A blank table is also provided to help you organize your computations.

8 8

HUC 10	Area (Km^2)	Annual Precipitation (in)
1210020304 (Plum Creek)	1007	36.24

STN	P	A (km^2)	PRODUCT
Au - B	34.515	77.2	2664.56
GON	35.145	32.5	1142.21
JUDDG	38.241	44.06	1684.90
LOCK	36.125	808.85	29219.71
WIM	40.476	44.74	1810.90
SUM		1007	36502.28

$\bar{P} = \frac{36502.28}{1007} = 36.24$ in

Question 4. (35%)

a) The following diagram gives elevation values (in meters) on a **10 m** DEM grid that is part of a larger DEM being analyzed. Identify any pits by shading them and indicate the elevation to which they need to be raised to fill them so that the DEM is hydrologically conditioned and they can drain.

3

13.9	14.9	17.3	20.4	22.3	21.4
13.7	12.5	12.2	14.8	17.4	16.8
17.6	14.8	13.4	12.4	11.0	13.0
18.9	16.5	14.3	13.3	12.4	10.7
19.8	18.8	18.4	19.7	20.2	18.4

RAISE TO 12.4 m

b) D8 flow directions have been evaluated for all but two of these grid cells, and are shown below. Determine the D8 **flow direction** for the grid cells where flow directions are missing and draw them as arrows on the diagram below.

6

13.9 ↘	14.9 ↓	17.3 ↓	20.4 ↗	22.3 ↗	21.4 ↘
13.7 →	12.5 →	12.2 ↘ 4	14.8 ↘	17.4 ↓	16.8 →
17.6 ↑	14.8 ↑	13.4 →	12.4 →	11.0 ↘	13.0 →
18.9 ↗	16.5 → A	14.3 ↗	13.3 →	12.4 →	10.7 ↗
19.8 ↗	18.8 ↗	18.4 ↑	19.7 ↑	20.2 ↑	18.4 ↗

A: $\frac{16.5-14.3}{10} = 0.22$

$\frac{16.5-13.4}{10\sqrt{2}} = 0.219$

SO A IS TO E →

$\frac{14.3-12.4}{10\sqrt{2}} = 0.134$

TO NE

$\frac{14.3-13.3}{10} = 0.1$

c) Calculate the **hydrologic slope** along its flow direction for grid cell A in (b) above.

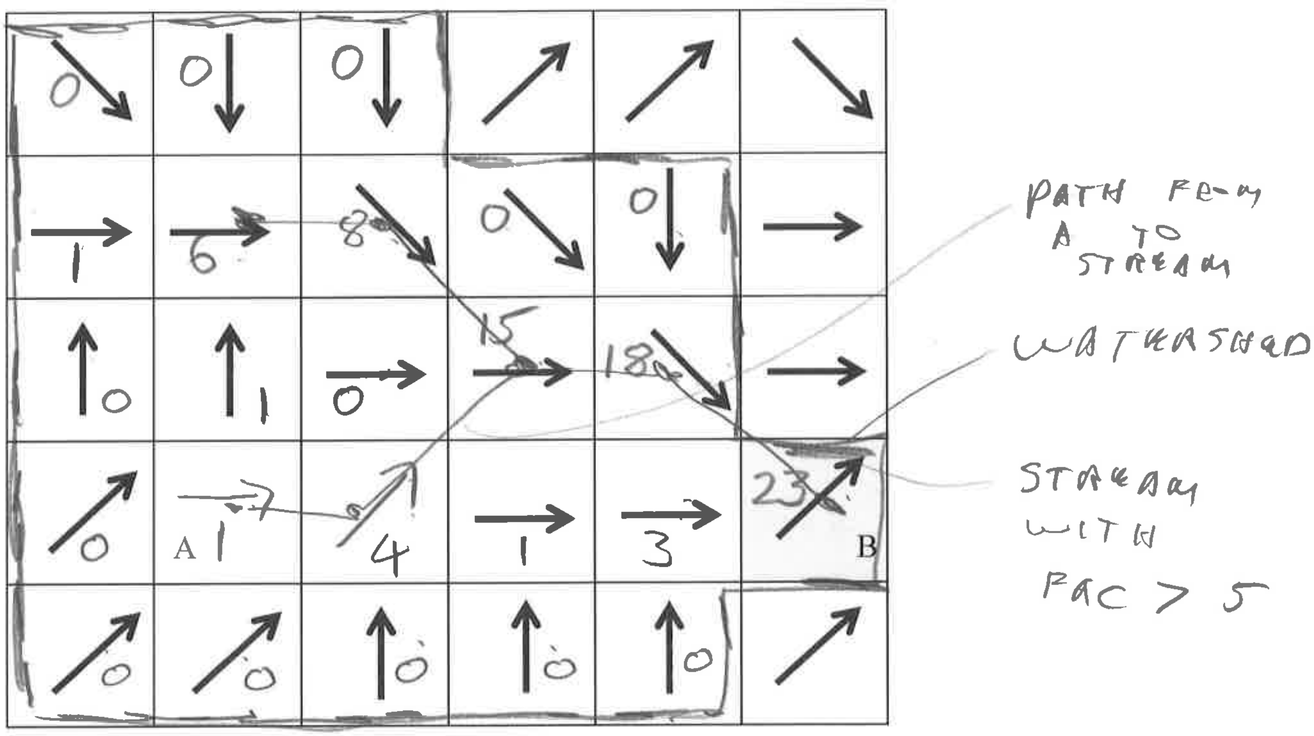
$$\frac{16.5 - 14.3}{10} = 0.22$$

3

Hydrologic Slope: 0.22

d) Copy into the diagram below the missing flow directions you worked out above. Then outline the watershed draining to and including the shaded cell B.

3



e) Write on the diagram above the values of flow accumulation for each grid cell in the watershed draining to grid cell B by counting how many grid cells drain into each grid cell (as ArcGIS does it).

6

f) Determine the area (in square meters) of the watershed draining to and including the shaded cell B above.

3

23 CELLS IN + 1 CELL
$= 24 \times 10 \times 10 = 2400\ m^2$

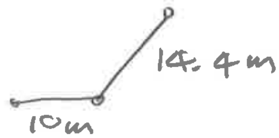
Area: 2400 m^2

g) Draw on the diagram above the stream that would be defined with a flow accumulation threshold of 5 grid cells.

3

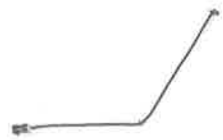
3 h) Based on the flow directions you have determined trace the path from grid cell A to the stream you mapped and draw it on the diagram above.

5 i) Based on the DEM elevations in (a) and the path that you just traced determine the flow distance from grid cell A to the stream (in meters) and the height of grid cell A above the stream (in meters).



$(10\sqrt{2})$

$z = 12.4$ m



Distance to stream: 24.4 m

Height above stream: 4.1 m

$z = 16.5$ m

$16.5 - 12.4 = 4.1$ m