Greenco Headquarters Siting Project

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In this assignment, you will use information about physical geography and soils in Austin, Texas to plan a future development. As you will notice on the attached map, three major biophysical environments meet at Austin (you might notice the city is located on the border of the Inland South and Great Plains regions):

1. hard limestone of the Edwards Plateau
2. deep clays of the Black Prairies
3. floodplain of the Colorado River (a different one!)

The Edwards Plateau is known to Texans as "Hill Country," a rocky area of hills and ravines covered by scrubby vegetation. Many prestigious, but money-losing, cattle ranches are located here (e.g. LBJ Ranch). The value of the land is low for agriculture, but many Texans have fallen in love with the scenery of the region. It is also home to the nation's highest concentration of goats.

The Black Prairies are a rich farming region – Texas' "Corn Belt." The soils are vertisols (consisting of a water-loving clay), and livestock production is profitable. When the soil is dry, however, deep cracks occur (similar to the freeze-thaw action in Minnesota that causes potholes and sidewalk cracks).

The Colorado River Floodplain is known for heavy rainfall, and is extremely prone to occasional flooding. After a particularly severe flood in 1935, dams were built upstream, providing flood control and recreational lakes. Even with the dams, flooding remains a problem. But the land is built up because the land is flat and easy to build on, and the soil is fertile.

As Austin has grown, development has occurred in each of these three environments, with different results. Downtown Austin is located on the floodplain, while most of the rest of the city is on the Black Prairies. Recent development (within the last twenty years or so) has been on the hills of the Edwards Plateau near reservoirs on the Colorado River.

Your Task!

Assume that the Greenco environmental consulting firm has hired you to help locate their new regional headquarters in Austin. Greenco is an image-conscious company, and they would like to build in the area of Austin with the least environmental impact.

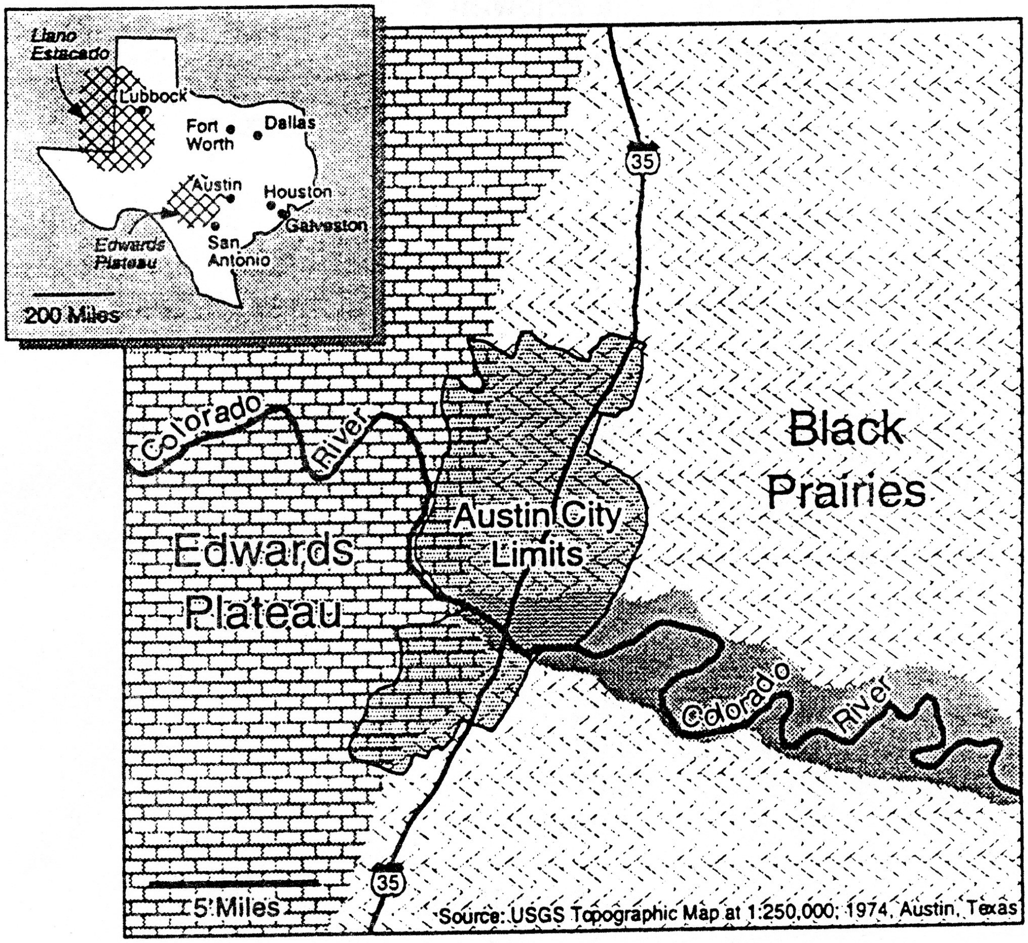
Their South Central Division has 325 employees, who might like to live near work, buy lunch across the street, do some shopping on their way home, etc. Greenco predicts that multiplier factors will lead to rapid development around the new headquarters.

All three potential sites in Austin have distinct advantages and serious problems. Austin is expanding in all three environments, and experiencing problems in each. You will use information about soils and runoff to make a recommendation to President Bluegrass and the board of directors about the location of their new headquarters. (You will work through erosion and runoff calculations on the attached pages.)

Write a 1-2 page report to the President and the board of Greenco, outlining your opinion of the best site for development, and your reasoning in making that choice. In your report include details of soil erosion and runoff characteristics of each site, but remember that the members of the board are probably not soil scientists (i.e. be clear and concise). Also include an assessment of risks at your recommended site vs. the other two sites. Address both physical and human geographic factors in you recommendation. Why did you choose this particular site?

Turn in:

- ✓ Report to the President and board
- ✓ Calculation worksheet


Llano Estacado
Lubbock
Fort Worth
Dallas
Austin
Houston
Galveston
Edwards Plateau
San Antonio
200 Miles
35
Colorado River
Black Prairies
Austin City Limits
Edwards Plateau
Colorado River
35
5 Miles
Source: USGS Topographic Map at 1:250,000; 1974, Austin, Texas

Universal Soil Loss Equation

Several factors contribute to soil erosion, such as:

1. Climate – Water and wind are the major agents. Both amount and intensity of rainfall affect erosion. Large amounts of fine mist may have little impact; once-a-year gully washers may remove lots of dirt.

2. Slope – Water can't remove soil without the help of gravity.

3. Soil Texture - Porous soil might not erode because water passes right through it. Clayey soils force water to stay on the surface.

4. Land Use – Row crops allow water to pick up more speed than pastures, which slow the water and absorb more. Thirsty plants can also absorb lots of water that might otherwise run off.

Soil scientists have assigned numbers to each of these factors so they can estimate soil erosion through a simple formula known as the "Universal Soil Loss Equation":

$$E = K * R * S * C$$

E – estimate of soil loss, in tons per acre (only an estimate, but good for comparing effects of different conditions)

K – measure of importance of soil texture

R – measure of rainfall intensity; varies widely around the country
Austin has a long-term R factor of about 270 (highest values up to 500 in Florida and the Gulf Coast (frequent thunderstorms and sometimes hurricanes); lowest values of less than 50 in parts of the west; southern MN around 125)

S – measure of importance of slope length and steepness

C – varies with land use

Once you know all these numbers for a given place, you can calculate soil loss for that place.

Hint: for Question #1, the Balcones Escarpment (cliff) is the boundary between the Plateau and Prairies (see p. 195 (3rd ed.) or p. 200 (4th ed.) of your textbook).

R is a measure of rainfall intensity, which varies widely around the country. Florida and the Gulf Coast, with their frequent thunderstorms and occasional hurricanes, have the highest R values in the country, up to 500. The R for parts of the western United States is less than 50. Southern Minnesota and northern Iowa average around 125. Austin, Texas, has a long-term R factor of about 270.

S is a measure of the importance of slope length and steepness. For a slope length of 1,000 feet, the following S factors apply (interpolate to find intermediate values):

Slope Angle	S factor
4%	1.3
8%	3.1
12%	5.7
16%	9.1
20%	13.2

C varies with land use. The following table provides some representative C factors:

Land Use	C factor
Bare soil	1.00
Row crops	0.30
Goat pasture	0.25
Grazed forest	0.02
Grass sod	0.01
Dense forest	0.0005

To calculate the E number for soil loss in a given place, plug in the numbers. For example, erosion on a soybean field on 1% sloping Lake Charles clay (K = .32) in Brazoria County, Texas (R = 400), would be:

K x R x S x C = E
0.32 x 400 x 0.4 x 0.30 = about 15 tons per acre per year

2. Greenco's resident soil engineer is on vacation, but she has provided you with information from the *Soil Survey of Travis County, Texas* for three major soils series (types) in the Austin region (box below). Read each description, think about the soil traits, and then on the blanks on Answer Sheet 3, write the region that you think the soil is in (Edwards Plateau, Black Prairies, or Colorado River Floodplain).

Tarrant Series

The Tarrant series consists of shallow to very shallow, well-drained, stony, clayey soils overlying limestone. Large limestone rocks cover 25 to 85 percent of the surface. These soils occupy nearly level to gently sloping ridges, rolling side slopes, and steep, hilly breaks. Slopes are complex and range from 0.5 percent on ridges to 40 percent on breaks. Most areas are broad and irregular in shape. Tarrant soils developed under tall grass and an open canopy of trees.

In a representative profile, a layer of about eight inches of dark grayish-brown stony clay is underlain by limestone. About 50 percent of the surface is covered with limestone rocks one to three feet in diameter, and the lower part of the solum is about 60 percent smaller limestone fragments mixed with soil material. The soil is calcareous and mildly alkaline throughout. Tarrant soils are moderately slowly permeable, and the available water capacity is low.

Tarrant soils impose severe limitations on building foundations. Bedrock lies only four to fourteen inches below the surface, and the soil has a high shrink-swell potential.

K factor: 0.10 Slope in proposed area: 8%
Land use before building: Goat pasture

Yahola Series

The Yahola series consists of well-drained soils on bottom lands. These soils occupy long, narrow areas paralleling the river. Some areas are smooth; other areas, in the river bends, are channeled by numerous shallow drainageways. These soils developed under a cover of tall grasses and an overstory of trees.

In a representative profile, the surface layer is pale-brown, friable (crumbly), very fine sandy loam fourteen inches thick. The next layer is brown silt loam about six inches thick. The next lower layer is light-brown very fine sand about fourteen inches thick. Below this is brown silty clay loam about six inches thick, which is underlain to a depth of fifty-two inches by light-brown very fine sand. Below this very fine sand, to a depth of sixty inches, is brown silt loam.

The Yahola soils are easily worked. They are moderately rapidly permeable, and the available water capacity is high. Yahola soils impose only moderate limitations on building foundations.

K factor: 0.32 Slope in proposed area: 1%
Land use before building: Soybean field

Houston Black Series

The Houston Black series consists of deep, moderately well-drained clay soils. These soils have developed in calcareous marls, alluvial clays, and chalk, under a prairie of tall grasses. Slopes are gentle but often irregular; the range is from 0 to 8 percent.

In a representative profile, the surface layer is very dark gray clay about twenty-four inches thick. The next layer is dark-gray clay that reaches to a depth of about thirty-eight inches. The next lower layer, to a depth of about eighty inches, is grayish-brown clay. The underlying material, to a depth of 104 inches, is mottled clay.

These soils crack when dry and are very slowly permeable when wet. The available water capacity is high.

Houston Black soils impose severe limitations on building foundations because of the high shrink-swell potential.

K factor: 0.32 Slope in proposed area: 4%
Land use before building: Cornfield

3. On the answer sheet, fill in the Universal Soil Loss Equation section, based on the numbers provided in the descriptions above. Which soil has the least erosion?

5. If Greenco builds on a site, the amount of soil erosion will be changed. Using a C factor of .55 for construction sites, recalculate soil erosion on the three Austin-area soils and fill in the blanks on Answer Sheet 3.

6. Will construction of Greenco headquarters increase or decrease soil erosion at the three sites?

7. Which soil will have the least erosion as a Greenco building site?

8. What aspects of an office park are likely to change the flow of water on the land? Answer in the space provided on the answer sheet.

9. Flooding is a major concern in the Austin area, and Greenco doesn't want to increase flooding potential if at all possible. With the information on land use and soil texture given in the box below, you can make a rough prediction of future flooding.

Cover Index

A cover index is a standard way to predict flood size by analyzing the combined effect of surface cover and soil type. Using the table below, find the cover index for the three Austin soils for before and after Greenco's construction, and fill in the numbers on your answer sheet.

Land Use	Cover Index Number				
	Fine clay	Silty clay	Loam	Sandy loam	Coarse sand
Forest	76	70	59	43	21
Row crops	80	75	66	53	35
Scattered houses	84	80	73	63	49
Suburban houses	86	83	77	68	56
Grass	88	85	80	73	63
Plowed land	90	88	84	78	70
Urban residential	92	90	87	83	77
Business district	96	95	94	93	91
Pavement	98	98	98	98	98

Runoff

After you have cover index numbers, you can calculate the amount of runoff for a given amount of rainfall. Using the table below, calculate the amount of runoff from a three-inch thunderstorm at each of the three Greenco sites. Write the answers on the answer sheet.

Rain (inches)	Runoff (inches)							
	Cover Index 30	40	50	60	70	80	90	98
12	1.8	3.4	5.0	6.6	8.0	9.5	10.8	11.8
10	1.0	2.2	3.6	4.7	6.2	7.5	8.7	9.8
8	0.4	1.3	2.3	3.3	4.5	5.6	6.8	7.8
6	0.1	0.5	1.1	1.9	2.8	3.8	4.9	5.8
5	0.0	0.2	0.7	1.3	2.0	2.9	3.9	4.8
4	0.0	0.1	0.3	0.8	1.3	2.0	2.9	3.8
3	0.0	0.0	0.1	0.3	0.7	1.3	2.0	2.8
2	0.0	0.0	0.0	0.1	0.2	0.6	1.1	1.8
1	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.8

Exercise: Analyzing Physical Landscapes

1. What major highway parallels the Balcones Escarpment? __________
   What other major Texas cities lie along this cliff?

   ____

2. Where does Tarrant soil occur? ______________________

   Where does Yahola soil occur? ______________________

   Where does Houston Black soil occur? ______________________

3. Calculate the soil erosion for each soil, using the C factor of its most recent land use:

Soil Type	K	x	R	x	S	x	C	=	E (result)
Tarrant	_____		_____		_____		_____		_____
Yahola	_____		_____		_____		_____		_____
Houston Black	_____		_____		_____		_____		_____

Soil with least erosion ______________________

5. Calculate soil erosion with Greenco headquarters as land use:

Soil Type	K	x	R	x	S	x	C	=	E (result)
Tarrant	_____		_____		_____		_____		_____
Yahola	_____		_____		_____		_____		_____
Houston Black	_____		_____		_____		_____		_____

6. Will construction of Greenco headquarters increase or decrease soil erosion at the three sites?

7. Which soil will have the least erosion as a Greenco building site?

   ____

8. What aspects of an office park are likely to change the flow of water on the land?

9. Runoff on site with current land use (before construction):

Soil Type	Cover Index	Runoff
Tarrant	______	______
Yahola	______	______
Houston Black	______	______

Runoff on site after construction:

Soil Type	Cover Index	Runoff
Tarrant	______	______
Yahola	______	______
Houston Black	______	______