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Final Laboratory Project – Emergency Landing Site Map

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Group Project “Lab Assignment”
Emergency Landing Site Map

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CE En 414 – Dr. Ames

Final Laboratory Project – Emergency Landing Site Map

Background

Utah county is constantly developing and expanding. New developments require new roads, new power lines, and changes to existing topography. GIS data is maintained and made available for the state of Utah by Utah AGRC (Automated Geographic Reference Center). GIS can be used to make an easy to update map that will display the current situation of roads, power lines, population density, and terrain. In this exercise a model will be created that will execute to create a map that will display safe emergency landing sites for recreational aircraft in Utah County.

Problem Statement

Emergency landings are constantly considered by pilots during their flights. Recreational pilots operating small personal aircraft have trained to safely land an aircraft in an emergency on whatever “landing strip” they can find. When airports are not within reach during an emergency, a straight segment of road or an open flat field can act as a runway. Pilots need to be aware of power lines, vegetation or terrain features that could interrupt their landing. Once an aircraft has descended for an emergency landing it is committed to that landing since in most emergency situations the aircraft has lost power. It is important for the pilot to be able to quickly make a decision on where to attempt a landing. With a landscape that changes from year to year with new housing developments, new roads, or new power lines, an area that may have been safe for landing may not be safe currently and vice versa.

In this exercise you are tasked with making a map that will highlight the safest areas of Utah County for an emergency landing. Recreational aircraft generally require about 600 feet of effective runway for a safe rolling landing. A landing in a field or a belly landing may require a shorter landing distance. In order to safely land on a street an aircraft must avoid overhead power lines and have a straight segment of street that is long enough for a rolling landing. The slope of the road should also be relatively flat. Additionally, it is much safer to land an aircraft in an area that is not densely populated so potential landing sites should be in an area with a suitable population density. Interstate highways are purposefully designed to accommodate emergency landings and are landing site that pilots are trained to look for. Highways are not always close enough to be used as a safe landing zone and during peak traffic hours they may not be safe to land on at all. This exercise will explore all the suitable landing areas within Utah County according to the parameters mentioned.

A model can be created in ArcGIS ModelBuilder that analyzes and combines the parameters of this exercise. A pre-generated python script can also be downloaded to identify suitable roads for emergency landings. The resulting product will be a raster heat-map showing 5 different degrees of safety for emergency landing sites.

Spatial Considerations

The scope of this project is limited to Utah County and the spatial factors for each data feature are as follows:

- Street sinuosity: Find streets with a sinuosity of .99 or Greater.
- Street length: Find streets that are at least 535 feet long.
- Population density: Locate areas in Utah County with a population density less than
- Terrain slope: Landing sites are preferred to be as flat as possible, locate areas with a terrain slope less than 25 %.
- Power lines: Locate landing sites no closer than 500 feet to an above ground utility line.

Data

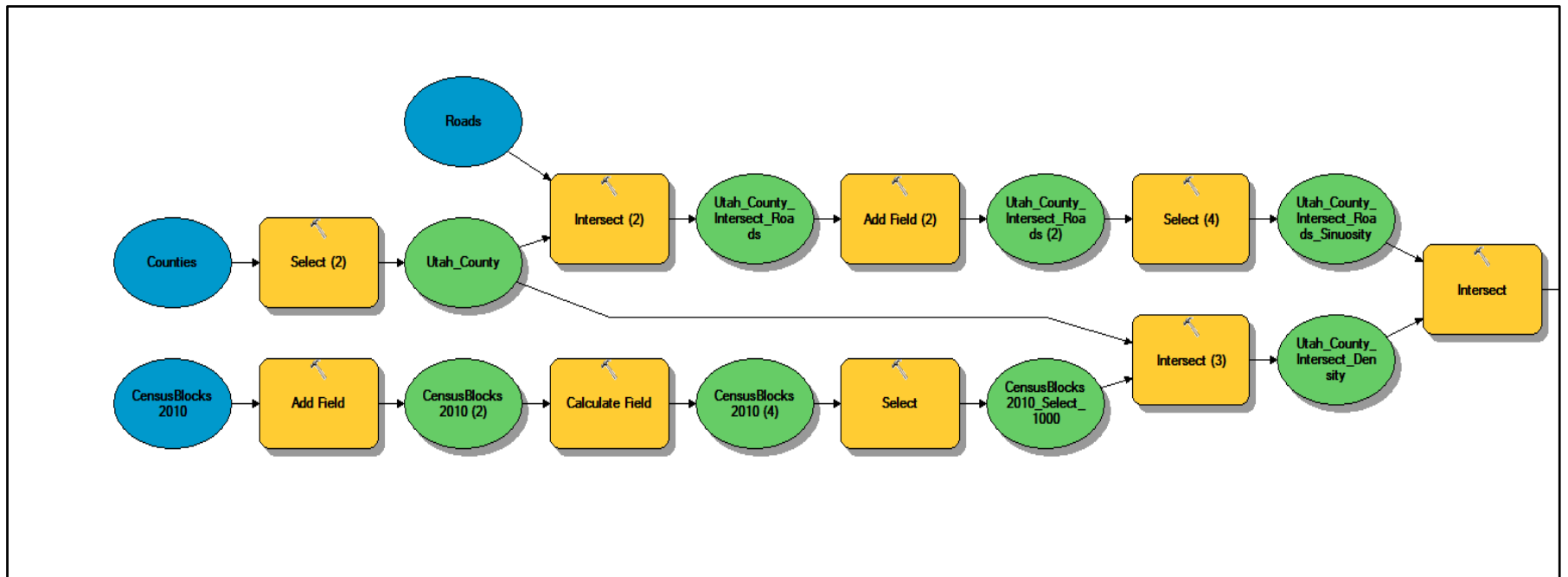
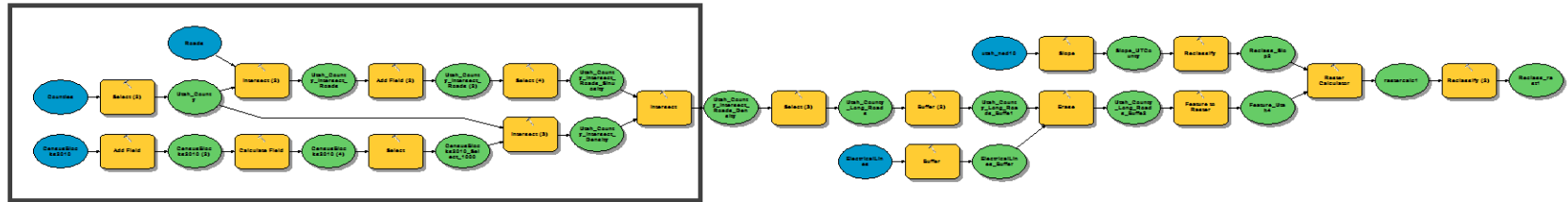
- <https://gis.utah.gov/data/elevation-terrain-data/10-30-meter-elevation-models-usgs-ned/> NED (National Elevation Dataset): You will need to download this meter elevation dataset for Utah provided by the USGS. You should download the 10m NED for Utah County using any method on this page.
- ftp://ftp.agrc.utah.gov/UtahSGID_Vector/UTM12_NAD83/UTILITIES/UnpackagedData/ElectricalLines/ Electrical Transmission Lines: You will need to download the Electrical transmission “_Statewide/” data from this ftp site.
- <https://gis.utah.gov/data/boundaries/citycountystate/> Utah Counties Shapefile: You can find a shapefile that represents all the counties from Utah (you will select the specific county during the exercise). For the county boundaries section, select “County Boundaries: Shapefile” under the downloads section in the County Boundaries section. This will download in a zip file.
- <https://gis.utah.gov/data/demographic/2010-census-data/> 2010 U.S. Census Bureau Data: You can find a shapefile that represents the 2010 Census data for Utah. For the Census data section, select “Shapefile: Census Blocks” under the downloads section in the 2010 U.S. Census Bureau Data section.

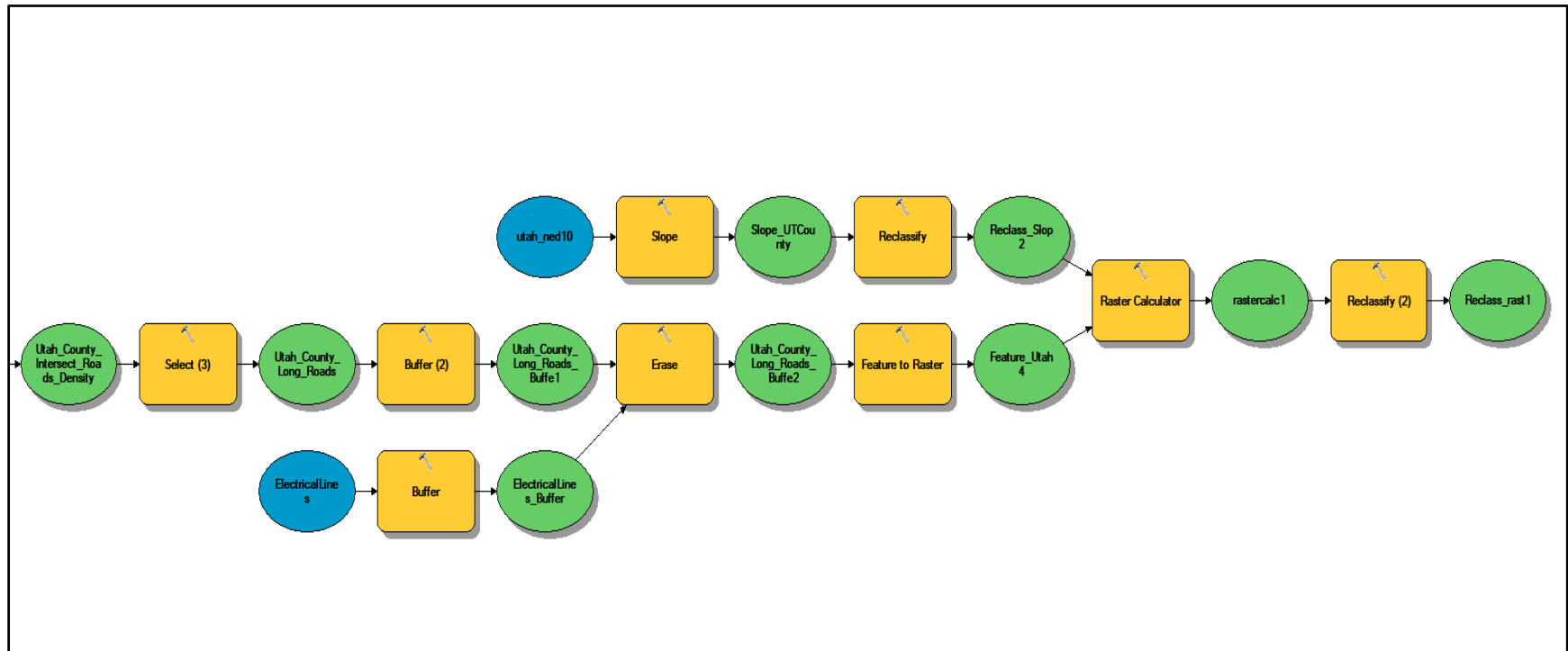
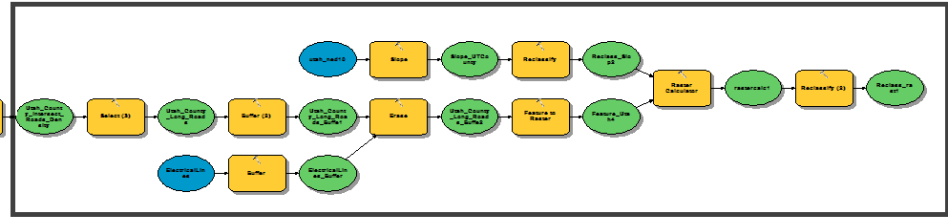
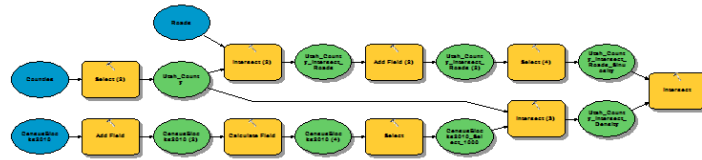
ModelBuilder Tools

In this exercise you may use some previous tools and you will use the following new tools.

- Sinuosity is defined as the deviation from the shortest distance between two points. The custom tool, Calculate Sinuosity, returns a value for a polyline between 0 and 1. A value of 1 would indicate that the analyzed line was perfectly straight. Values less than one indicate increasing deviance from the shortest distance between the start point and the end point. The sinuosity tool is not a normal tool found in ArcMap. You will need to download the python script for the sinuosity tool here:
<https://www.arcgis.com/home/item.html?id=00e708a448b74810a0e805c4a97f9d46#!>

Example Model





Step by Step Solution

For an advanced GIS student, the information up to this point is all you need to complete the assignment and create an output map from the results. Feel free to try conducting the analysis using only the information provided above. If you need specific steps, follow the instructions.

Step 1

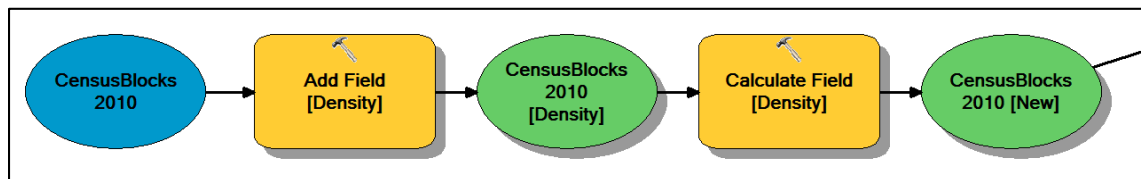


Figure 1 – Using the Add Field and Calculate Field tools.

A field title “Density” can be added to the CensusBlocks2010 shapefile using the Add Field tool. Under Field Name, type “Density.” Under Field Type, type “DOUBLE.” After adding this field, it can be calculated. This is done with the Calculate Field tool. Select “Density” under the Field Name. In the Expression field, type **[POP100]/ [SqMiles]**.

Step 2

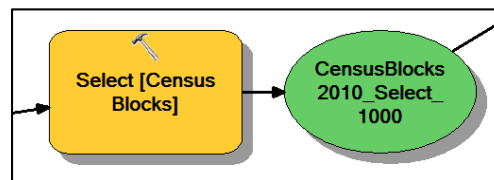


Figure 2 – Using the Select tool with the CensusBlocks2010 shapefile.

With the Density field added, simply select the new shapefile as the Output Feature Class.

Step 3

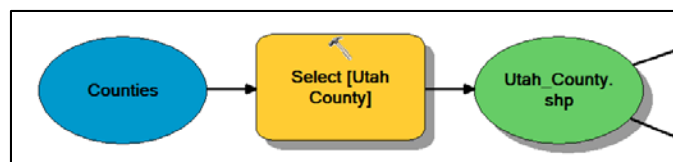


Figure 3 – Using the Select tool with the Counties shapefile.

Using the Counties shapefile, select the Utah County shapefile. Under the Expression field, type **"NAME" = 'UTAH'**.

Step 4

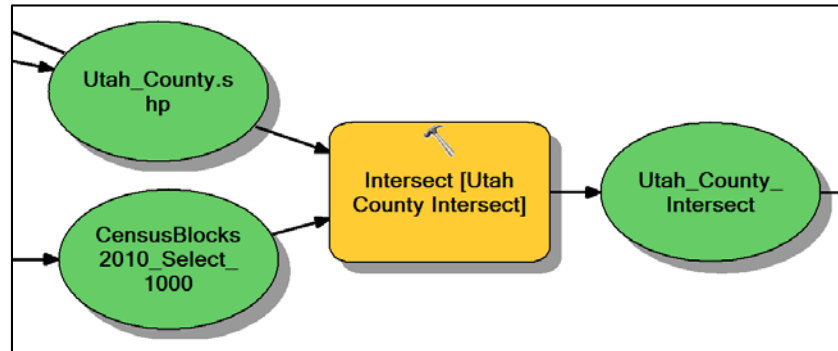


Figure 4 – Using the Intersect tool.

With Utah County selected, use the Intersect tool to intersect the Utah County shapefile with the Census Blocks shapefile created in Step 2. The intermediate dataset created in this step will be used in Step 8.

Step 5

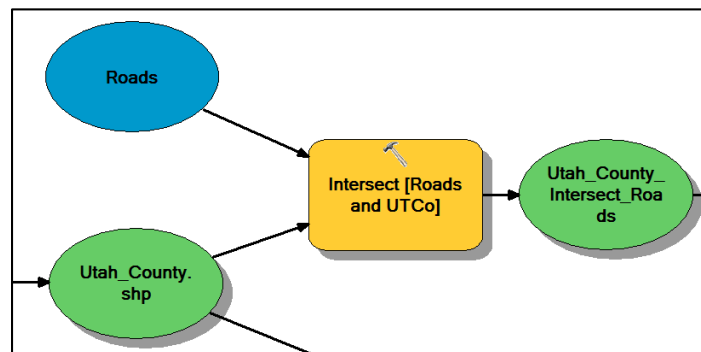


Figure 5 – Using the Intersect tool.

Now that Utah County is the only county selected, you can intersect it with the UDOT Roads. Select them in the order shown in Figure 6 below.

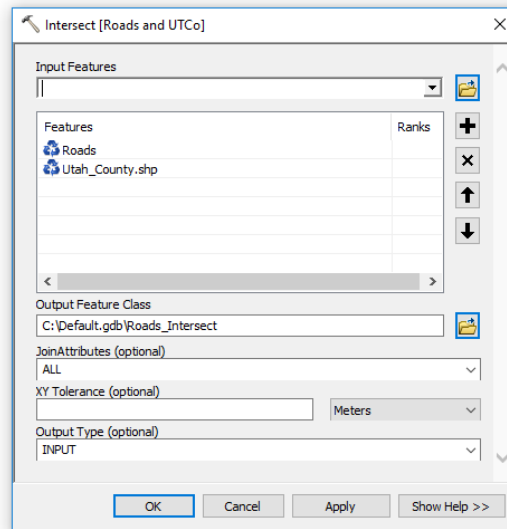


Figure 6 – The Intersect tool interface.

Step 6

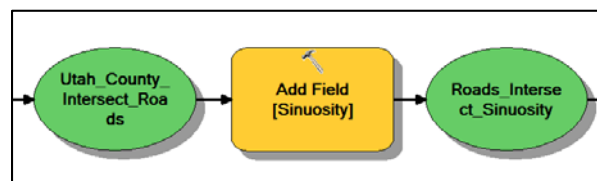


Figure 7 – Using the Add Field tool.

With the UDOT roads intersected with Utah County, you are ready to run the Sinuosity script (run outside the model). Then use the Add Field tool to add a field titled “Sinuosity” to the shapefile. Enter “DOUBLE” under field type.

Step 7

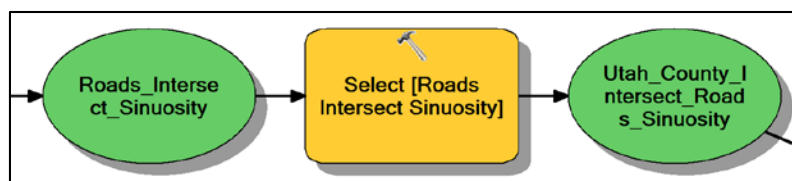


Figure 8 – Using the Select tool.

Now use the Select tool to select the shapefile created in the previous step.

Step 8

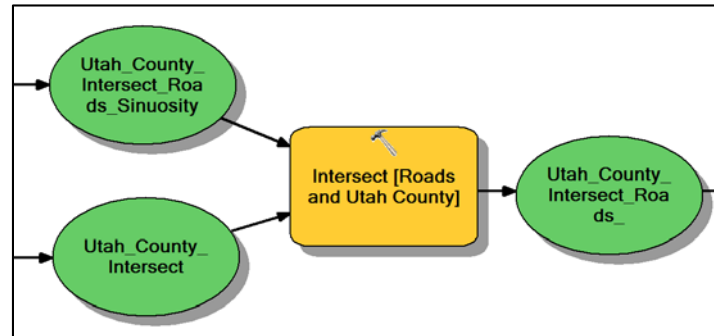


Figure 9 – Using the Intersect tool.

Use the Intersect tool to intersect the Utah_County_Intersect shapefile (created in Step 4) with the Utah_County_Intersect_Roads_Sinuosity shapefile (created in Step 7).

Step 9

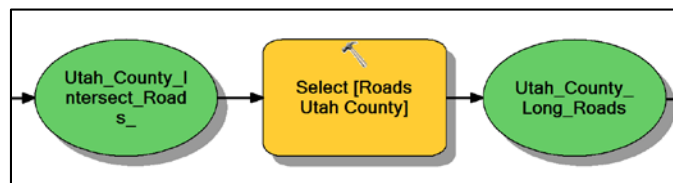


Figure 10 – Using the Select tool.

Use the Select tool again to select the Utah County roads shapefile created in the last step.

Step 10

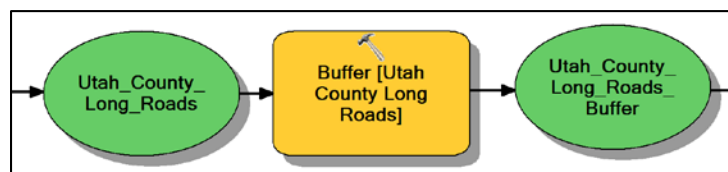


Figure 11 – Using the Buffer tool.

Create a 1-mile buffer around the roads.

Step 11

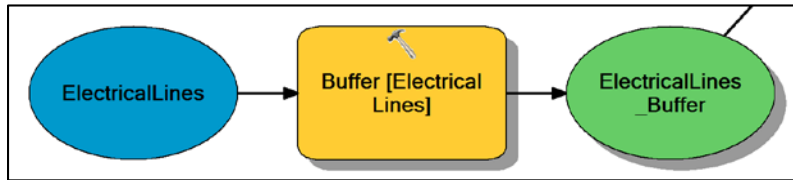


Figure 12 – Using the Buffer tool on the electrical lines.

Use the Buffer tool to create a 500-foot buffer around the ElectricalLines shapefile.

Step 12

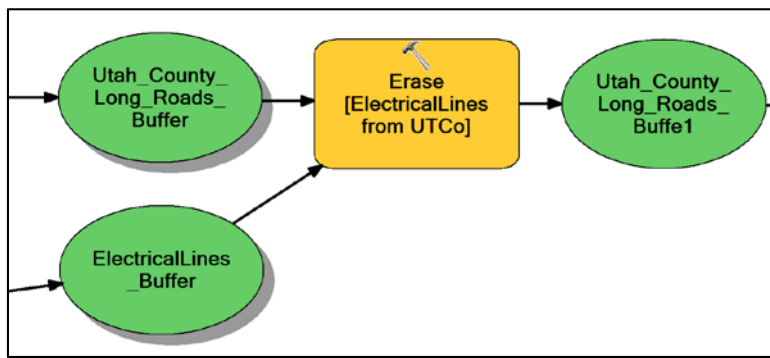


Figure 13 – Using the Erase tool.

Use the Erase tool to erase the buffered electrical lines from the Utah County roads shapefile. Under the Input Features field, enter the Utah County buffer name. Under the Erase Features field, enter the Electrical Lines buffer.

Step 13

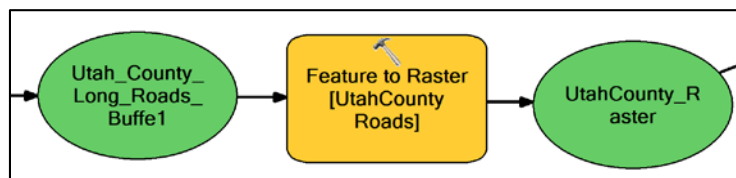


Figure 14 – Using the Feature to Raster tool.

Use the Feature to Raster tool to select the Shape_Length field. This creates a raster dataset.

Step 14

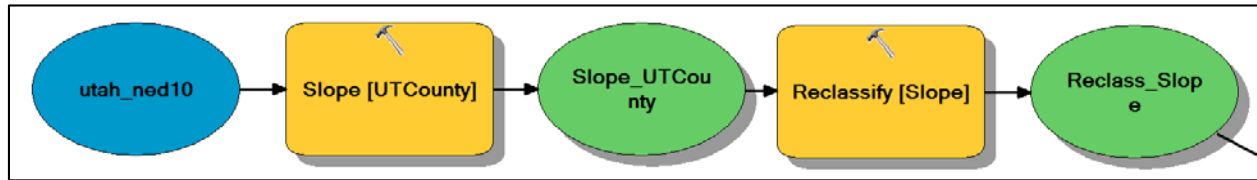


Figure 15 – Using the Slope and Reclassify tools.

With the Utah DEM shapefile, calculate the slope. Write “DEGREE” in the Output Measurement field. Then reclassify the slope using the Reclassify tool. Use the values shown in Figure 16 below.

Reclassify [Slope]

Input raster: Slope_UTCounty

Reclass field: Value

Reclassification

Old values	New values
0 - 3	1
3 - 6	2
6 - 10	3
10 - 15	4
15 - 25	5
25 - 90	6
NoData	NoData

Buttons: Load..., Save..., Reverse New Values, Precision..., Classify..., Unique, Add Entry, Delete Entries

Output raster: C:\Default.gdb\Reclass_Slop1

☐ Change missing values to NoData (optional)

Buttons: OK, Cancel, Apply, Show Help >>

Figure 16 – The Reclassify tool inputs.

Step 15

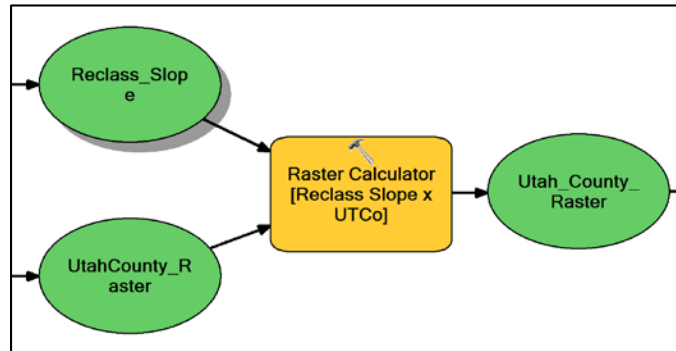


Figure 17 – Using the Raster Calculator tool.

Input the following into the Raster Calculator tool:

"%Reclass_Slope%" * "%UtahCounty_Raster%"

This creates a new raster.

Step 16

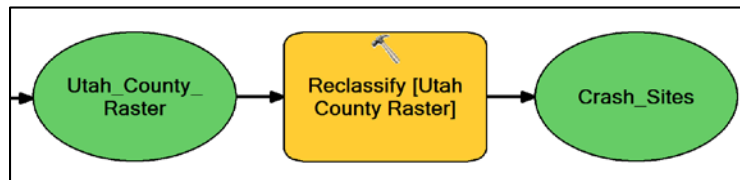


Figure 18 – Using the Reclassify tool.

Use the Reclassify tool for the raster created in Step 15. Input the values shown in Figure 19.

The screenshot shows the 'Reclassify [Utah County Raster]' dialog box. The 'Input raster' is 'Utah_County_Raster'. The 'Reclass field' is 'Value'. The 'Reclassification' table is as follows:

Old values	New values
0 - 992975	1
992975 - 1985940	2
1985940 - 2978910	3
2978910 - 3971880	4
3971880 - 4964850	5
4964850 - 5957825	6
NoData	NoData

Buttons on the right include 'Classify...', 'Unique', 'Add Entry', and 'Delete Entries'. At the bottom, there are 'Load...', 'Save...', 'Reverse New Values', and 'Precision...' buttons. The 'Output raster' is 'C:\Default.gdb\Reclass_rast1'. The 'Change missing values to NoData (optional)' checkbox is unchecked. The 'OK' button is highlighted.

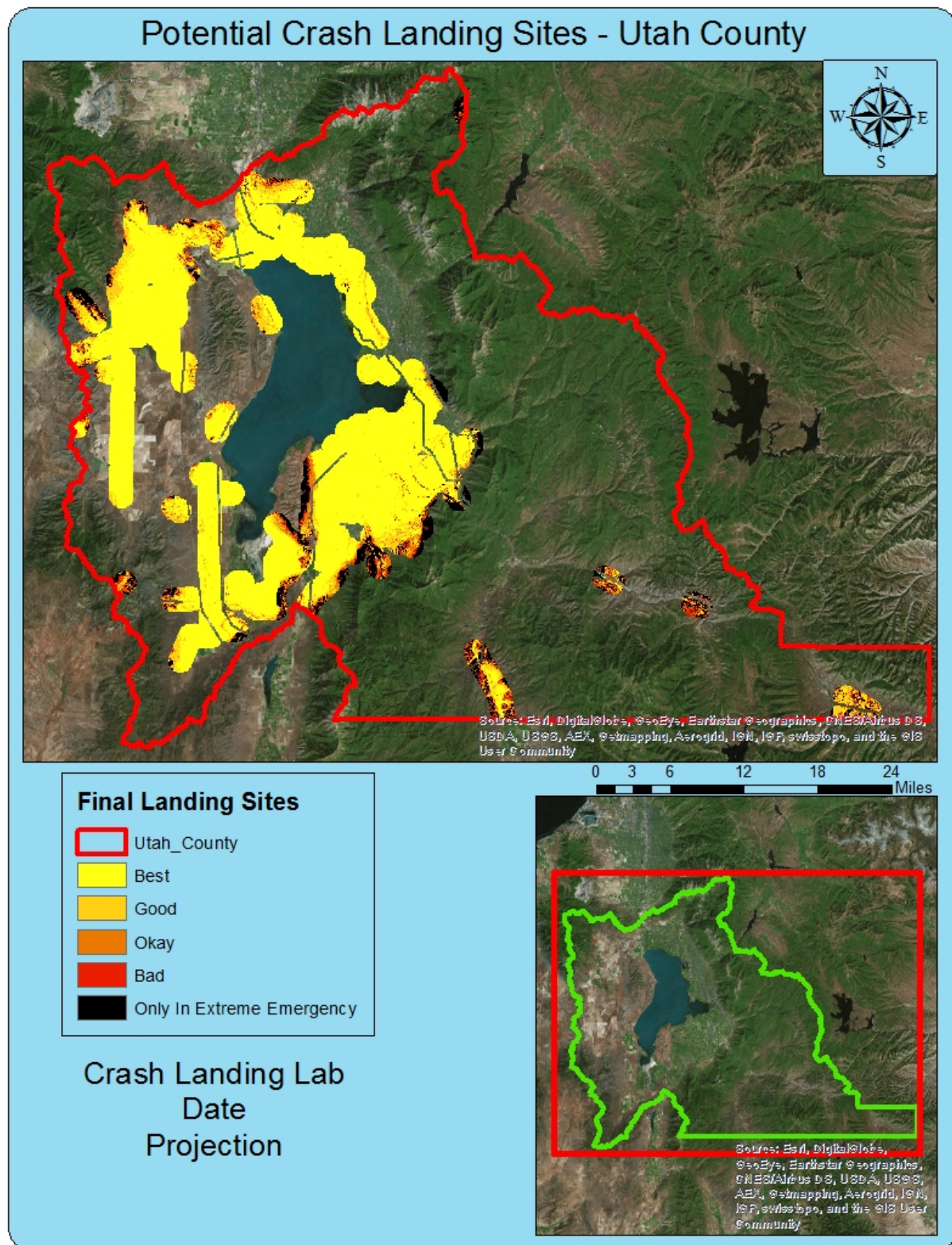
Figure 19 – Inputs for the Reclassify tool

Deliverables

Using the data described above, construct a single ModelBuilder model that will prepare all of your input data for the potential crash landing analysis; and then conduct the analysis. As noted above, you are to find the locations in Utah County that are suitable for a crash landing for a personal aircraft.

Prepare a report in the form of a word document that contains a screen shot of your model that clearly shows all elements of the model, a list of the steps that were taken in the model building process, and a final map of your results. Make sure to review the rubric at the end of this chapter for the full requirements for the laboratory exercise.

Example Map



Rubric for Emergency Landing Site Map

Item	Points
Assignment Title, Author name, Date, Course Name	/5
Provide a brief summary of the purpose and requirements of the project.	/5
Describe your model <ul style="list-style-type: none"> List the tools used: (2pts) List important tool settings applied for the analysis (could someone repeat the assignment using your lab report?): (2pts) List all input, intermediate, and output datasets: (2pts) Describe each input dataset including type (point, line, polygon, raster) and the source of the data: (2pts) Describe each output dataset (point, line, polygon, raster): (2pts) 	/10
<ul style="list-style-type: none"> One or more full pages (8.5x11) showing your model (5pts) All text is readable (10-point font minimum) (3pts) All tools and data sets are shown (2pts) 	/10
<ul style="list-style-type: none"> Describe the heat map generated for crash landing sites, does this seem realistic? (3 pts) What parameters or classifications could be changed to make the map more useful or realistic? (2pts) 	/5
Make a full page (8.5x11) map showing the result of your emergency landing site analysis <ul style="list-style-type: none"> Map Title: (1pt) Neat Line: (1pt) North Arrow: (1pt) Scale Bar: (1pt) Text box with author name, date, map projection: (1pt) Heat map showing potential emergency landing sites clearly shown: (6pts) Heat map clearly classified in legend: (1pt) Visual basemap showing cities and terrain: (1pt) Zoomed to an appropriate scale for viewing analysis results: (1pt) All text is legible on printed map: (1pt) 	/15
Bonus Task: Expand this lab exercise to create an emergency landing site map for the entire state of Utah. Located more data for the other 28 counties in Utah or locate statewide data. Add at least one more feasible dataset to the analysis that will improve the accuracy of the emergency landing site map.	Instructor's Discretion