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Laboratory Exercise — Safety on Roads

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Laboratory Exercise — Safety on Roads

Background

In transportation study area, safety is a great issue. GIS is appropriate to perform spatial analysis the accident history in define area. Specifically, GIS allow researchers to find an area or road segment that have high probability of any type of car accident such as Vehicle to Vehicle, Vehicle to Pedestrian, and Vehicle to Bicycle.

Problem Statement

There were 1,040 total pedestrian accidents in Utah. Those accidents are 0.7 percentage of the total number of car accidents-151,237. Although the number of crashes involving pedestrians is small, the severity of pedestrian accident is worse than other accidents. There were 49 (17.6%) people killed in pedestrian related crashes and 278 people were killed in car to car related crashes. There are over 150 public schools in Utah County. In the last year there have been 134 crashes involving pedestrians, 116 of which were injured and 7 were killed in the Utah County area. In addition, the largest percentage of pedestrians in crashes were pedestrians ages 10-29 years (41.5%). Teenager pedestrian accident account for a large proportion of pedestrian accidents. Since the severity of pedestrian crash with teenagers is severe, it is important to find out were there are high possibility of teenager pedestrian accident. The areas of higher crash potential can be located by combining population, school, crash, and traffic data.

Spatial Considerations

For the purposes of this exercise, the following limitations will be used:

- Main roads: Of the roads given in the (data source), only roads with more than 10,000 cars per day were considered.
- Proximity to main roads: Each of the roads considered for this exercise was buffered to 50 feet, or the approximate width of a four-lane road plus a median.
- Proximity to areas of known crashes: Areas with recorded crashes will be regarded as higher risk than areas without recorded crashes. (looking into aggregating crash data for faster run time)
- Proximity to public schools: Only areas within 1.5 miles of each school were considered, as those are the areas most likely to have children pedestrians.
- Areas of high population density: Areas with more people in Utah County reflect a higher population of vehicles and children.

Data

The following datasets will be needed for this project.

- http://gis.utah.gov/data/boundaries/citycountystate/ Utah Counties Shapefile: Scroll down the page until you see the "County Boundaries" section. Select the "County Boundaries: Shapefile" and download. It will dowload into a zip file.
- http://gis.utah.gov/data/demographic/2010-census-data/ Census District Map Shapefile: Follow the link to find the 2010 Utah census data. Scroll down until you see "2010 U.S. Census Bureau Data." Under downloads select "Shapefile: Census Blocks." This will download into a shapefile that will need all files to be extracted so you can use them in your model.
- https://docs.google.com/spreadsheets/d/1bLvS-g-30USzsh6c3pBHndLnx7BN4FKAzoL4IN5tkSU/edit?usp=sharing/ List of Utah County Public Schools. Download data as an excel spreadsheet. The excel spreadsheet will be imported into your map. Data originally found at http://www.publicschoolreview.com/utah/utah-county/
- http://udot.uplan.opendata.arcgis.com/datasets/9cf1cc07d564420faad779e6e7e991c3_0 AADT (Roads): Follow the link to the UDOT Open Data site. In the upper right hand corner select "Download Dataset" dropdown. Under "Full Dataset" select shapefile. It will download into a zip folder.
- http://udot.uplan.opendata.arcgis.com/datasets?q=crashes&sort_by=relevance Crash Data Shapefiles: Follow the link to the UDOT Open Data site. Download "Crash Rate Score" shape file

ModelBuilder Tools

In this exercise, the following tools will be used:

- Buffer takes a shapefile and adds additional area to the original shapefile. If the shapefile is a point for example the buffer tool will increase the radius around the point. The buffer tool will be used twice in this model. Once to increase the roads and another time to increase the public school radius.
- Intersect is an overlay operation. The intersect tool can take multiple inputs and overlay all of them to find the area where all the inputs or requirements overlay. In this model you will intersect population and Utah County so that you are only looking that the population in Utah County. You will also use the intersect tool to find all the areas that are moderate and high danger zones.
- Select is used to find features from your data layers based on attributes from the attribute table. In this lab you will select the amount of average annual daily traffic (AADT) that you determine is a high level of traffic. You will also need to select low, moderate, and high population counts in the Utah county area.
- Aggregate is used to draw polygons around clusters of points with a user-specified tolerance. In this lab you will aggregate clusters of crash points within a 500 ft tolerance. Points that are not within another point for 500 feet will not have any polygons drawn around them, helping to thin out outliers in favor of areas with regular crashes.

Example Model
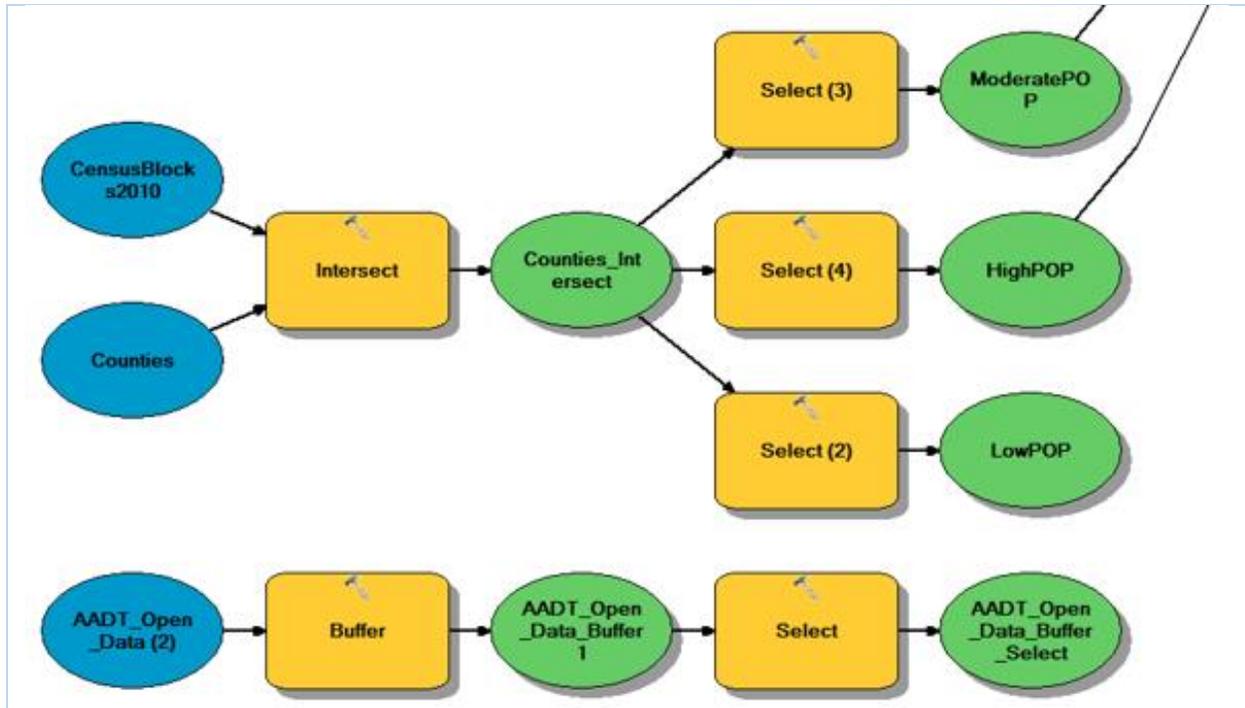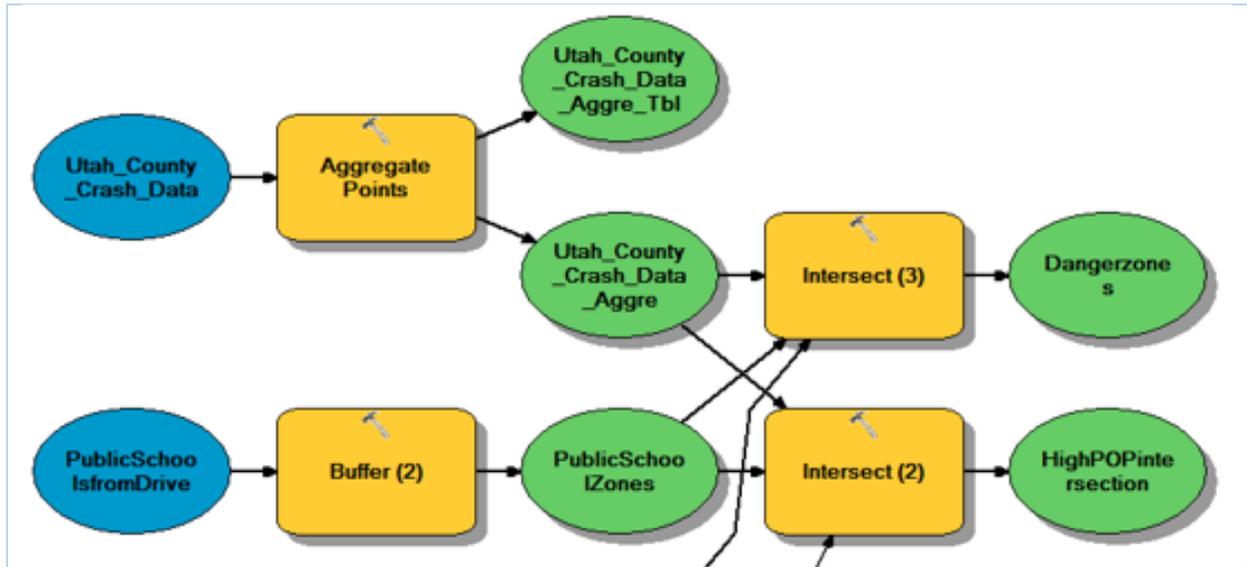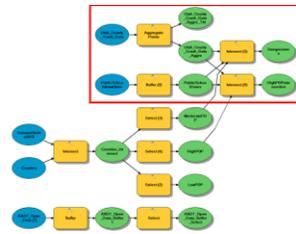
Step by Step Solution

AADT Data are buffered at a distance of 50 ft using the "Buffer" tool. The width of 40 ft with extra 10 ft for all road segment are regarded. After AADT Data are buffered, the Select tool is used to select road segment with AADT of 2014 greater than 10,000 veh/day using an SQL expression "AADT2014 ≥ 10000. This will filter out road segment with less amount of traffic volume which have less possibility with car accident.

Figure 1 – Buffer and Select tool in Modelbuilder

Step 2

The intersect tool is used to intersect CensusBlocks2010 with Counties (Utah County) to find areas that are inside both. Then, using select tool, select the census districts with a population density into three level such as low population ≤ 200, 200 < moderate population ≤ 900, 900 < high population ≤ 1,800. An example of expression SQR is '900 < "POP 100" AND "POP100" <=1800'.
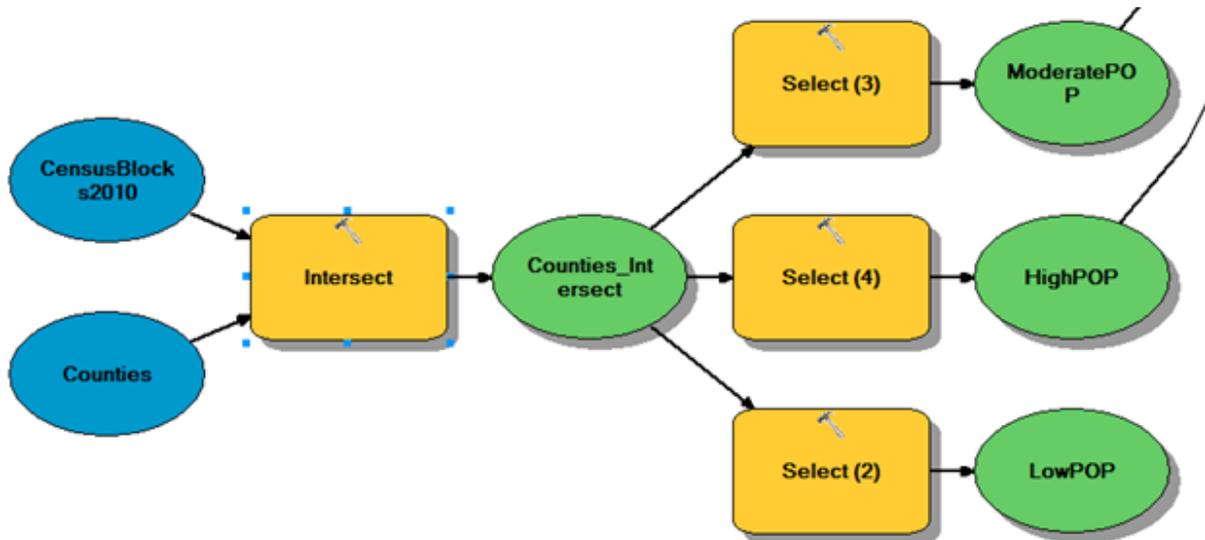

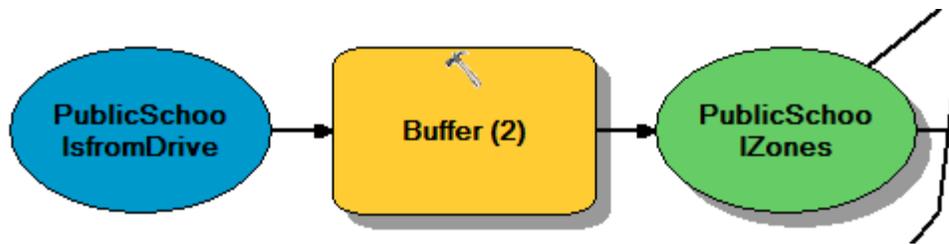*Figure 2 – Intersect and Select tool in Modelbuilder*

Step 3

Figure 3 – Buffer tool in Modelbuilder

Step 4

The public school data was pulled from an online site and manually entered into a spreadsheet. This spreadsheet will need to be added to the ArcGIS project in a number of steps before being used as a layer input in the model. To get the spreadsheet into layer form:

- Click 'Add Data' and select your spreadsheet and the appropriate sheet within the worksheet.
- Right-click on the sheet that has appeared in the Table of Contents window. Select 'Display XY Data'.
- Make sure your X and Y field have found the Longitude and Latitude columns, respectively, of your spreadsheet. There is no Z field. Then, Click the 'Edit...' button to assign a coordinate system. **DO NOT SKIP THIS.** If your points do not have a coordinate system you will not be able to use the points in your model. For Utah County, use NAD 1983 UTM Zone 12N. Make sure that the units being used are decimal degrees and not units of feet. Hit OK on the 'Table Does Not Have Object-ID Field' warning, we're going to fix that next.
- Right-click on the new Sheet Events that should have appeared just above the first sheet in the Table of Contents.
- Select 'Data | Export Data...' Change the output feature class to somewhere you will be able to find it later should you need it. This would also be a good time to rename it if you desire.
- Click yes when asked if you would like to add the data as a layer.
- Remove the Sheet Events and Sheet to clean up the Table of Contents.

After adding the data as a layer, the public school locations are ready to buffer with a distance of 0.75 miles, indicating that this model assumes most pedestrians heading to and from school will only be walking 0.75 miles either way.
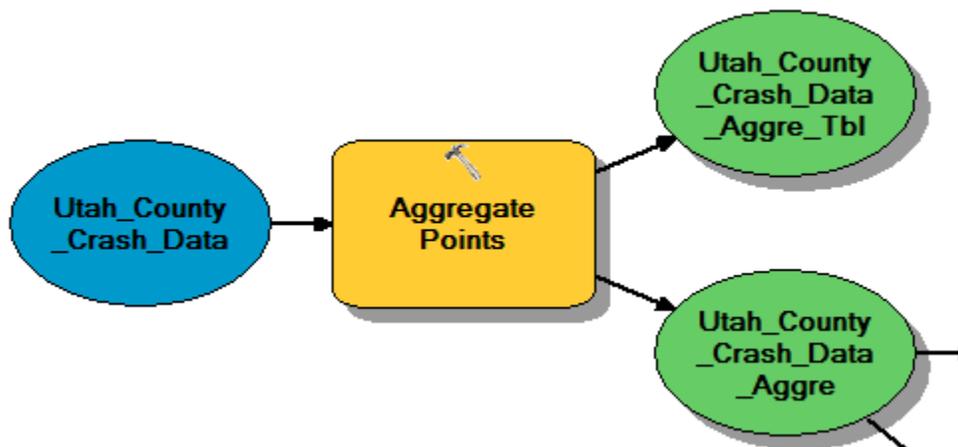

Figure 4 – Aggregate Points tool in Modelbuilder

The crash data point shapefile provides many points, and most of the points are in clusters. Rather than buffering the data and generating a polygon field around each point, the Aggregate Points tool is used to draw polygons around clusters of points. The higher the tolerance for distances between points considered to be in the same cluster, the larger the resulting polygons. The tolerance for crash sites was 500 ft.
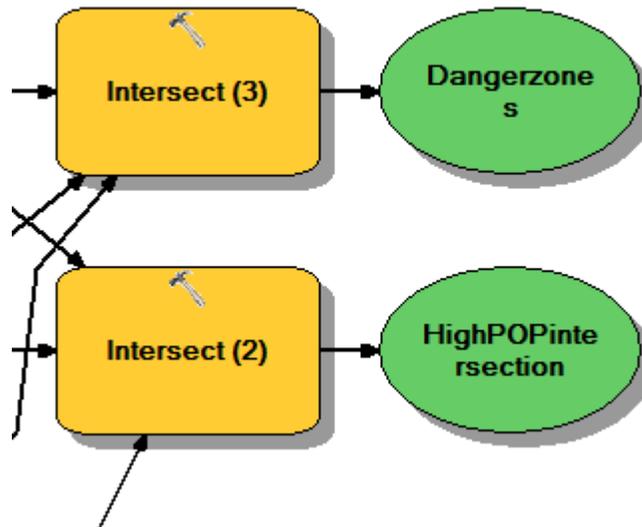

Figure 5 – Intersect tool in Modelbuilder

Step 6

The intersect tool is used to intersect the aggregated crash polygons, the public school buffered polygons, and a population polygon layer. The first intersect looks at the moderate population layer, and the second intersect looks at the high population layer. If desired, a third intersect with the low population can also be computed.
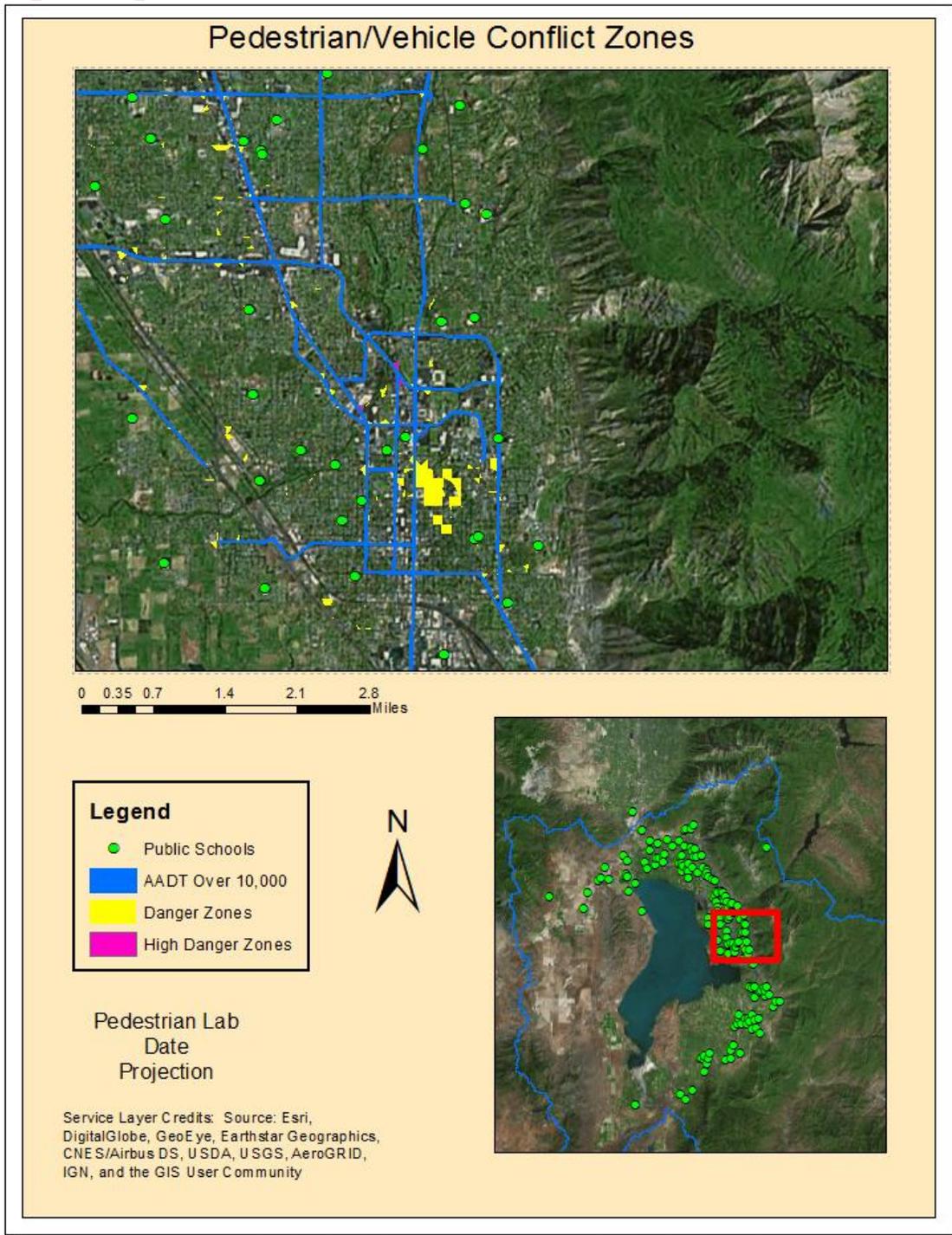
Deliverables

Prepare a professional map layout showing a background map of Utah County, the AADT buffered roads, the public school locations, and an interesting area the high and moderate danger zone results. Your map should include an inset map to show the selected area of interest with respect to Utah County. Write a report that describes the project requirements, your approach to solving it, the model you used to solve it, discuss the areas of interest you selected, and present the map and model. Make sure to review the rubric at the end of this chapter for the full requirements for the laboratory exercise.

References

Bolstad, P. (2008) GIS Fundamentals: A first Text on Geographic Information Systems. 3rd Edition. Esri Publishing.

National Highway Traffic Safety Administration (NHTSA). (2015) Traffic Safety Facts 2013 Data – Pedestrians. US Department of Transportation. <http://www-nrd-nhtsa.dot.gov/Pubs/812124.pdf>

Example Map

Pedestrian/Vehicle Conflict Zones

0   0.35 0.7   1.4   2.1   2.8
                                    Miles

Legend
● Public Schools
▬ AADT Over 10,000
▬ Danger Zones
▬ High Danger Zones

N

Pedestrian Lab
Date
Projection

Rubric for Road Safety

Item	Points
Assignment Title, Author Name, Date, Course Name	/5
Brief summary of the requirements of the project	/5
Describe your model • List each of the tools used: (2 pts) • List tool settings applied for the analysis: (2 pts) • List all input, intermediate, and output datasets: (2 pts) • Describe each input dataset including type (point, line, polygon, raster) and the source of the data: (2 pts) • Describe each output dataset (point, line, polygon, raster): (2 pts)	/10
• One or more full pages (**8.5x11**) showing your model (5 pts) • All text is readable (**10 point font minimum**) (3 pts) • All tools and data sets are shown (2 pts)	/10
• Where are the most dangerous areas/intersections in Utah County? (2 pts) • What are some possible reasons why these zones are particularly dangerous? How would you make them safer? (3 pts)	/5
Make a full page (**8.5x11**) map showing the identified location(s) of the danger zones. • Show public school locations (2 pts) • Show dangerous zones (3 pts) • Map Title (1 pt) • Neat Line (1 pt) • North Arrow (1 pt) • Scale Bar (1 pt) • All features (public schools and danger zones) are labeled (1 pt) • Text box with author name, date, map projection (1 pt) • Background map is visible (1 pt) • Zoomed to an appropriate scale for viewing all features (1 pt) • All text is legible on printed map (1 pt)	/15
Bonus Task: Repeat the lab exercise with a different set of data. Include in your report what data you used, how you acquired it, what, if anything, you changed to complete the exercise work. Also include an additional full page map showing your results.	Instructor's Discretion