MODULE 5
PLANNING FOR PUBLIC SAFETY AND WELFARE

SUMMARY:	Students will evaluate the locations of areas prone to natural hazards and learn the importance of limiting urban development on these lands.
ACTIVITIES:	Evaluate the locations of lands susceptible to natural hazards. Identify locations where urban development is located near these lands. Use geospatial tools to delineate areas of safety and protection.
SCIENCE STANDARDS:	Utah Science Core 9-12 - Earth Science: Standard 5, Objectives 3a and 3c Utah Social Studies Core 9-12: Utah Studies Strand 5, Standard 5.2 Utah Social Studies Core 9-12: World Geography Strand 1, Standards 1.1 and 1.4
MODULE LINK:	https://arcg.is/9i80f

GLOSSARY

Density: The number of occurrences per unit of area or length.

Density Surface Map: A surface that shows where point or line features are concentrated.

Earthquake: The sudden shaking of the ground due to movement within the crust of the Earth.

Epicenter: The location on the surface of the Earth directly above the focus of an earthquake.

Fault Zone: A location where sections of the crust of the Earth move relative to each other.

Flooding: The rising and overflowing of a body of water onto normally dry land.

Floodplain: A area of land adjacent to a stream or river which experiences flooding during periods of high discharge.

Heat Map: A type of symbology that displays the geographic density of features on a map.

Landslide: The movement downslope of a mass of rock, debris, earth, or soil.

Liquefaction: A phenomenon in which the strength and stiffness of the soil is reduced by earthquake shaking.

Public safety and welfare: The protection of the general public from adverse events.

Wildland Fire: A fire that occurs in a rural area or countryside.

Wildland-Urban Interface: The zone of transition between unoccupied land and urban development.

INTRODUCTION

Public safety and welfare refers to the protection of the general public from adverse events, such as natural disasters and hazards. State, county, and local governments are generally responsible for ensuring that the public remains protected from natural disasters and hazards. Reducing the risk to life and property requires careful planning, laws, and regulations, particularly in areas where humans may have little control. Areas prone to flooding, earthquake damage, landslides, and wildfire, should be assessed in detail when it comes to urban development. The construction of residences and buildings should be limited in these area to reduce the overall risk to life and property and to protect the safety and welfare of the public.

Residents of Utah communities are at risk to a wide array of natural hazard events, including floods, earthquakes, slope failures, landslides, wildfires, dam failures, and snow avalanches. While these events may not be avoidable, it is important to plan for them. Flood-related damage can be minimized by limiting development on floodplains. **Floodplains** are low-lying areas adjacent to streams or waterbodies that may be inundated during periods of high discharge. Earthquake-related damage can be minimized by limiting development on fault zones and areas susceptible to liquefaction. **Fault zones** are locations where sections of the crust of the Earth move relative to each other. **Liquefaction** refers to the phenomenon in which the strength and stiffness of the soil are reduced by earthquake shaking. Buildings that are located within liquefaction zones may be destroyed or may sink during earthquake events.

Landslides, slope failures, and snow avalanches are natural hazard events that may occur on areas with steep slopes. Many counties and cities have zoning regulations that limit the development of residences on excessively steep slopes. However, these regulations may not be enough to fully maintain public safety and welfare. It is important that building restrictions be placed on all steep slopes, especially in areas where there is geologic evidence of historic landslides.

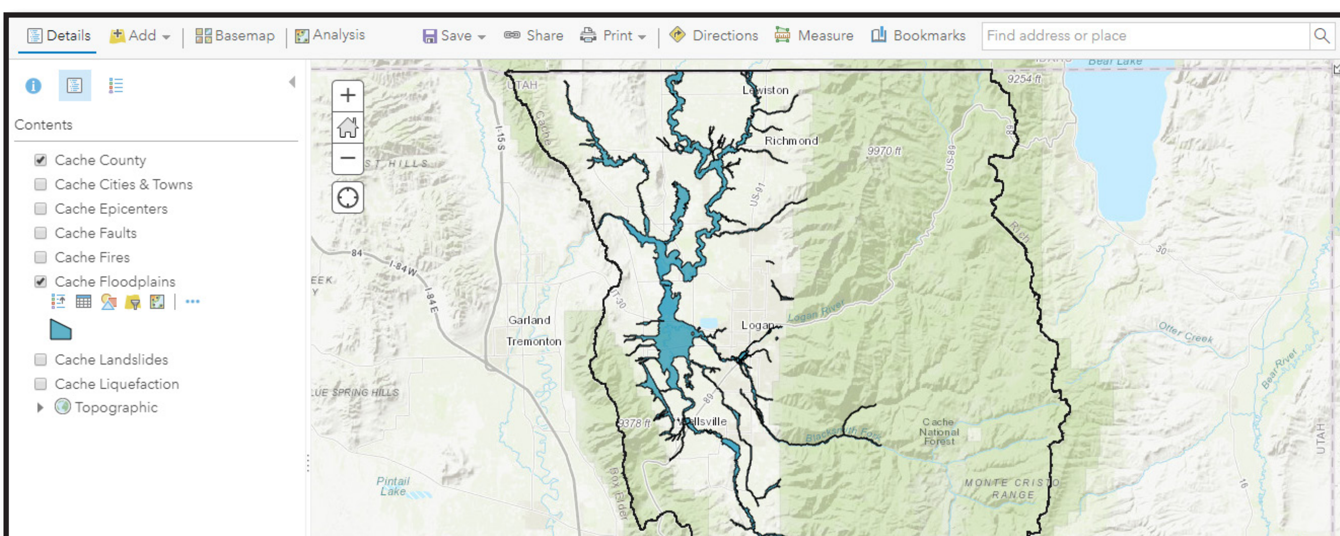
Wildland fires are other natural hazard events that are common in Utah due to climatic and seasonal patterns. **Wildland fires** are fires that generally occur in rural, or less populated, areas during the dry summer and fall months. However, wildland fires are becoming more common near urban development due to the expansion and spread of cities and towns. If a wildland fire occurs within a close proximity to a population center or municipality, the risk to life and property increases substantially. Therefore, it is important for planners and administrators to limit or restrict urban development in the wildland-urban interface. The **wildland-urban interface** refers to the zone of transition between unoccupied land and urban development.

INTERACTION

Open the map titled *Module 5 - Planning for Public Safety and Welfare* (https://arcg.is/9i80f). This ArcGIS Online map contains eight data layers: *Cache County*, *Cache Cities & Towns*, *Cache Epicenters*, *Cache Faults*, *Cache Fires*, *Cache Floodplains*, *Cache Landslides*, and *Cache Liquefaction*.

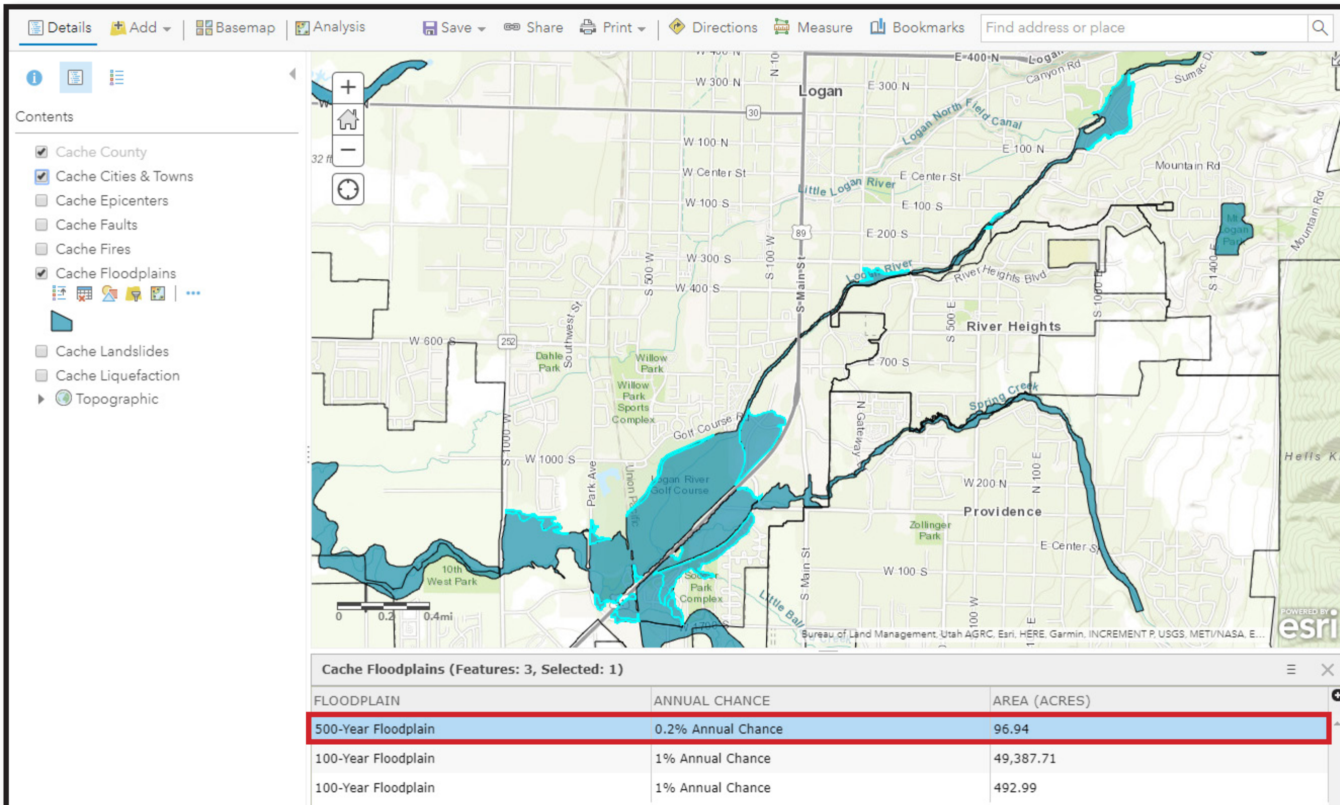
The *Cache County* data layer depicts the Cache County boundary. The *Cache Cities & Towns* data layer depicts the city and town boundaries. The *Cache Epicenters* data layer represents a modern recorded history of earthquakes in Cache County. The *Cache Faults* data layer represents known major fault lines. The *Cache Fires* data layer represents recorded wildland fires. The *Cache Floodplains* data layer represents the 100-year and 500-year floodplains. The *Cache Landslides* data layer represents some of the recent and historic landside areas. The *Cache Liquefaction* data layer represents liquefaction zones.

When you open the map, the *Cache County* and *Cache Cities & Towns* data layers should be the only data layers that are turned on. To familiarize yourself with the map and the spatial data, turn the other data layers on and off to identify any general patterns or relationships. Consider how the locations of these features affect urban planning and development. Identify where there may be conflicting areas. For example, what cities or towns have large areas of floodplains within their boundaries or what cities or towns are affected by liquefaction? After you have introduced yourself to the data, turn all of the data layers off with the exception of the *Cache County* data layer and *Cache Floodplains* data layer.

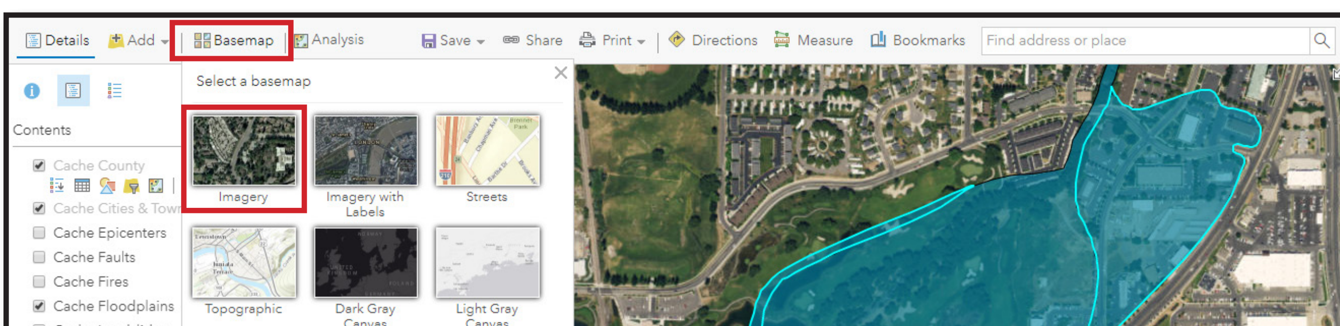


Open the attribute table associated with the *Cache Floodplains* data layer by clicking on the *Show Table* button. The attribute table indicates the yearly probability, or percent chance, that a flood will occur in a given year. In the 100-year floodplain, there is a 1 in 100 chance, or 1 percent chance, that the area will flood in any given year. In the 500-year floodplain, there is a 1 in 500 chance, or 0.2 percent chance, that the area will flood in any given year. While these probabilities do not sound significant, changes in climate, unexpected storms, and heavy winter snowfalls may cause flooding to occur more than once every one hundred or five hundred years.

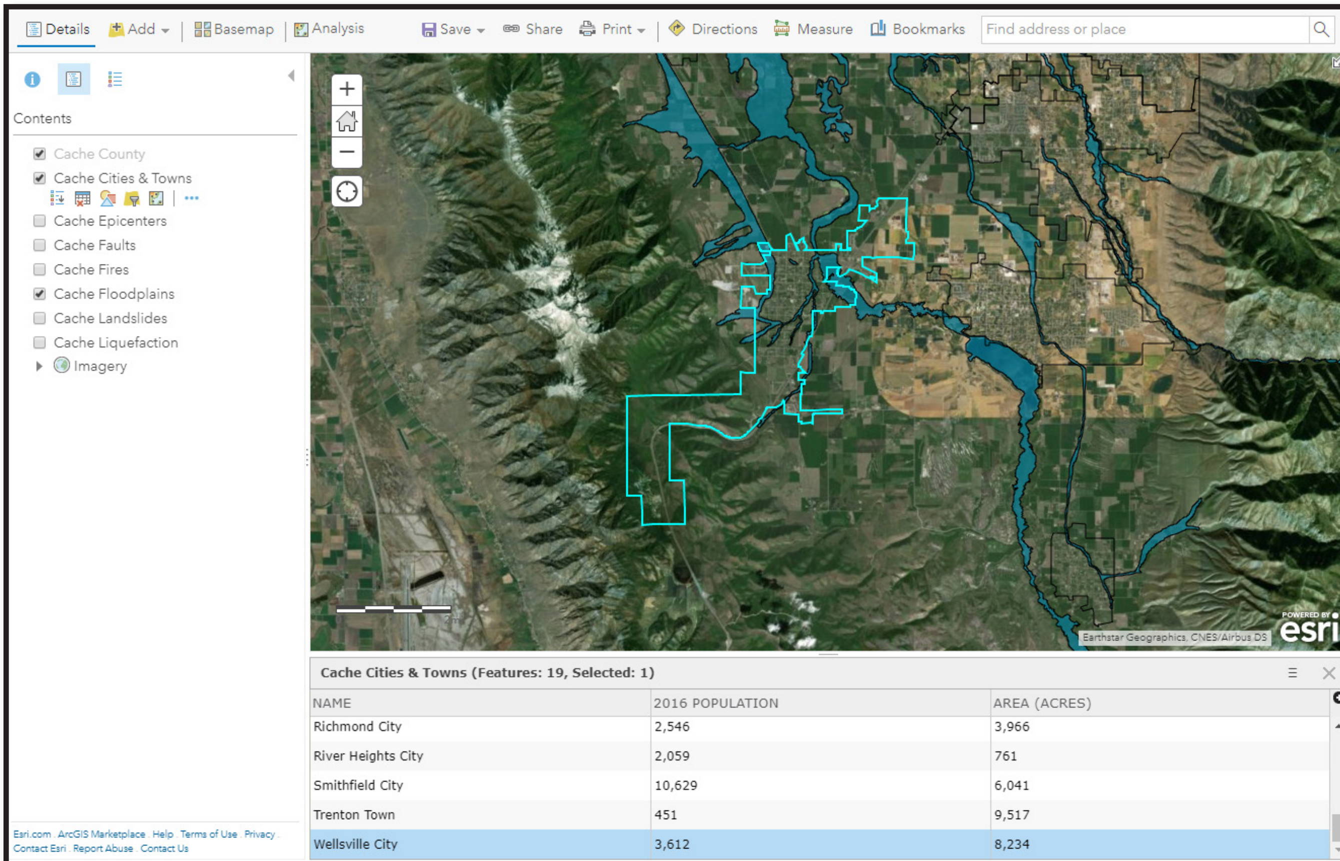
Floods that occur within the 500-year floodplain are often more significant, and potentially more destructive, than floods that occur with the 100-year floodplain. To identify where a 500-year flood may occur within Cache County, click on the *500-Year Floodplain* entry in the attribute table. A few polygons should be highlighted with a blue line. Turn on the *Cache Cities & Towns* data layer to identify what cities or towns may be affected. These polygons are located near the Logan City and Providence City border. Using the *Navigation* panel, zoom into the highlighted floodplain polygons.



To determine if there are any buildings within the 500-year floodplain that would be potentially at risk for flooding in the future, you can change the *Topographic Basemap* to the *Imagery Basemap*. To do this, click on the *Basemap* button. You will see 12 different basemap options. Select the *Imagery Basemap*. Once the *Imagery Basemap* has loaded, you can inspect the data in more detail. It appears that the majority of the 500-year floodplain is open space, including a golf course. However, it also appears that there are a few buildings within portions of the 500-year floodplain. What do you think this means for the owners of the buildings and houses? It likely means that they have been required to purchase floodplain insurance.



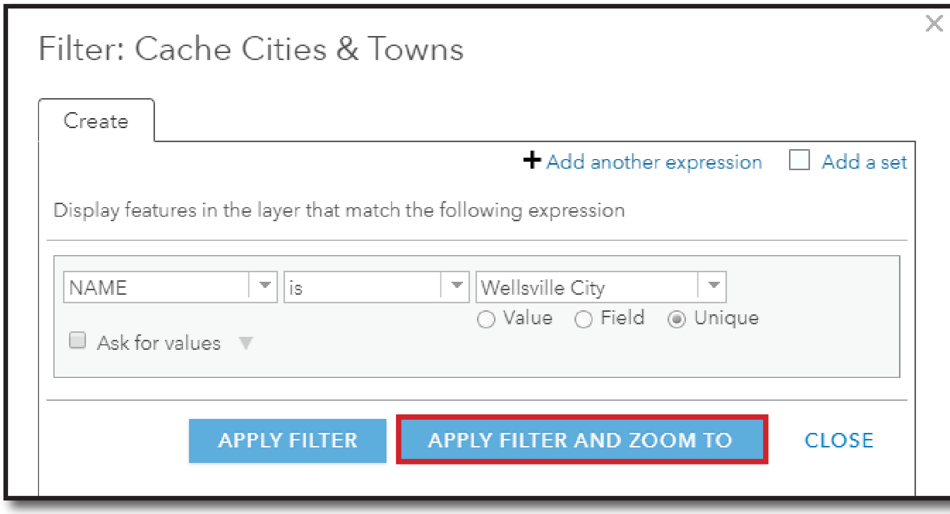
Zoom to the full extent of the *Cache Floodplains* data layer by clicking on the *More Options* button and then by clicking on *Zoom to*. Open the attribute table associated with the *Cache Cities & Towns* data layer. Scroll down to the last entry in the attribute table and select *Wellsville City*. Wellsville City will be highlighted. Zoom to the city using the *Navigation Panel*.



Wellsville City is considered the primary gateway into Cache County. The city boundary encompasses a large portion of Highway 89/91, one of the major highways in Cache County. Highway 89/91 also serves as the principal highway to the highly urbanized Wasatch Front (Salt Lake City and Ogden City). Wellsville City has sought to grow in size by adding residential and commercial buildings to accommodate the commuting population. However, there are several areas within the city that are susceptible to flooding.

If you were asked by the urban planner in Wellsville City to help determine how much of the city was potentially affected by flooding, you could use ArcGIS Online. To calculate the total area of 100-year floodplain within Wellsville City, you must first create a filter that selects Wellsville City from the *Cache Cities & Towns* data layer. If you recall from the previous module, you will need to click on the *Filter* button that is located below the *Cache Cities & Towns* data layer.

In the first box of the *Filter* window, click the dropdown menu and select *NAME*. In the second box, select *is*. Below the third box, click on the button next to *Unique*, and then select *Wellsville City* in the box above. Click *APPLY FILTER AND ZOOM TO*. ArcGIS Online will now only display the feature in the *Cache Cities & Towns* data layer called Wellsville City.

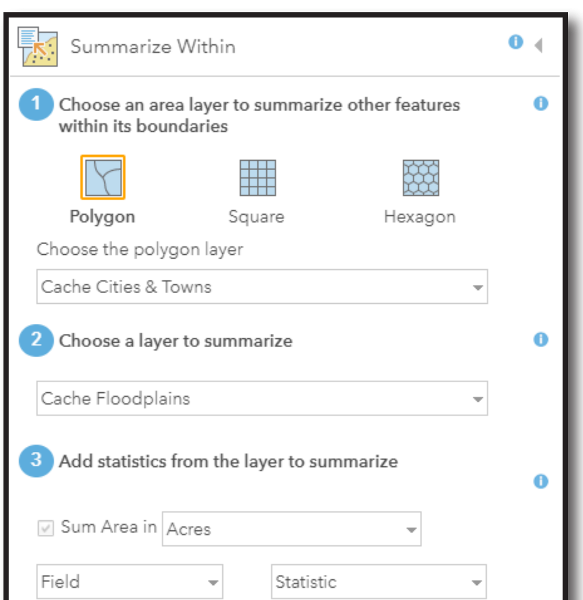


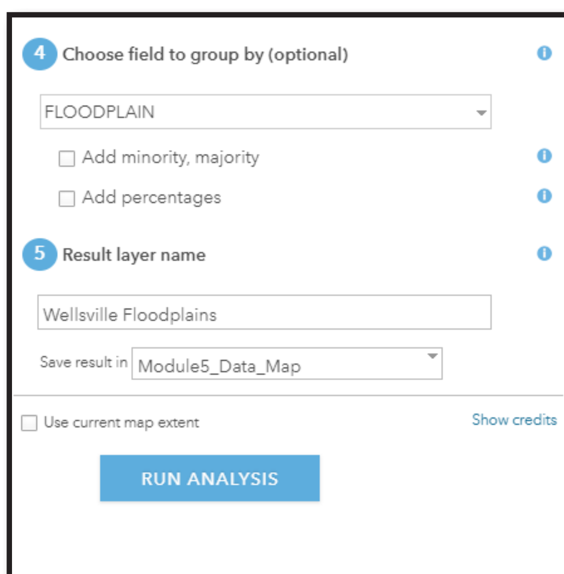
To calculate the total area of floodplains within Wellsville City, you will to need to follow the same steps that you learned in the previous module for calculating wetlands within Lewiston City. With Wellsville City selected, you can now summarize the area of floodplains within the city boundary. To summarize the area of floodplains within Wellsville City, click on the *Analysis* button. Under *Perform Analysis*, click on *Summarize Data*, and then select *Summarize Within*.

Below *(1) Choose an area layer to summarize other features within its boundaries*, select the *Polygon* option. Below *Choose the polygon layer*, select the *Cache Cities & Towns* data layer. Since a filter has been applied that has selected Wellsville City from the data layer, the analysis will only be performed for that city.

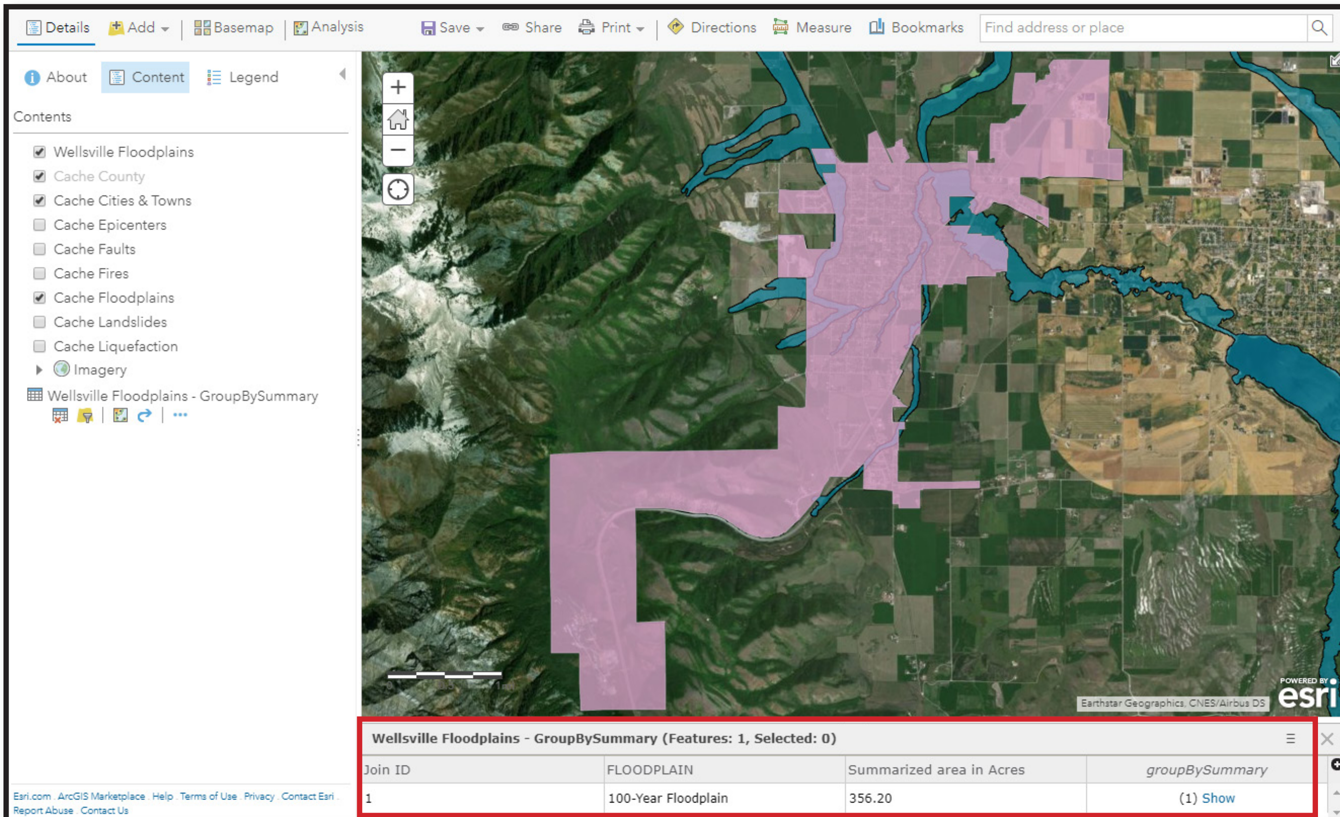
Below *(2) Choose a layer to summarize*, click the dropdown menu and select *Cache Floodplains*. Below *(3) Add statistics from the layer to summarize*, next to *Sum Area in*, click the dropdown menu and select *Acres*. You can leave the default settings for the Field and Statistic fields.

Below *(4) Choose field to group by (optional)*, click the dropdown menu and select *FLOODPLAIN*. Below *(5) Result layer name*, click in the first box and give the new data layer a name called *Wellsville Floodplains*. Uncheck the box next to *Use current map extent*. Click *RUN ANALYSIS*. This analysis will take several minutes to run.





The analysis will produce two outputs in the *Content* window. A new data layer called *Wellsville Floodplains* and a new table called *Wellsville Floodplains – GroupBySummary* will be generated. Click on the *Show Table* button below the *Wellsville Floodplain – GroupBySummary* table. The column *Summarized area in Acres* displays the total area (in acres) of 100-year floodplain in Wellsville City.



Turn off the *Wellsville Floodplain* data layer and the *Cache Floodplains* data layer by unchecking them. Close the *Wellsville Floodplain – GroupbySummary* table. Remove the filter associated with the *Cache Cities & Towns* data layer by clicking the *Filter* button and then by clicking *REMOVE FILTER*.

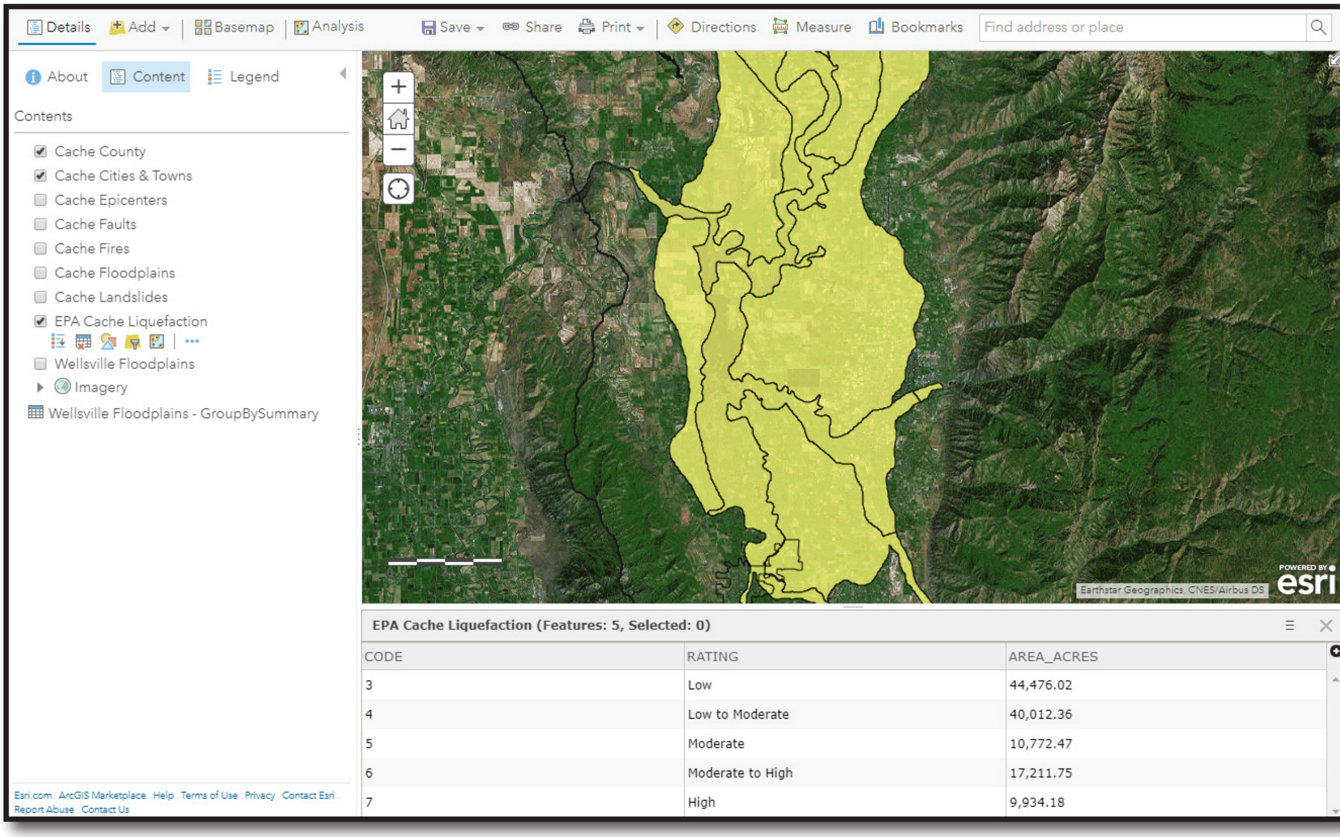
Turn on the *Cache Liquefaction* data layer. This data layer represents areas in Cache County that are susceptible to liquefaction during earthquake events. While these area may appear to be solid and dry, they are largely saturated with water and may lose strength during earthquake shaking. Open the attribute table associated with the *Cache Liquefaction* data layer by clicking on the *Show Table* button. The liquefaction potential is identified in the attribute table.

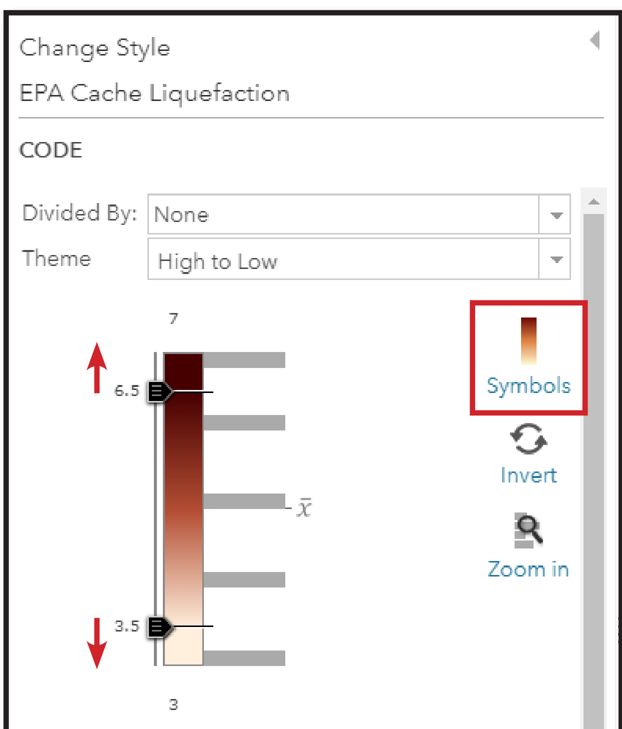
Urban planners and administrators should be cautious when permitting urban and industrial development on lands susceptible to liquefaction, particularly those that have been assigned high and moderate-to-high ratings. To better visualize the location and distribution of liquefaction potential, you will need to change the symbology of the data layer.

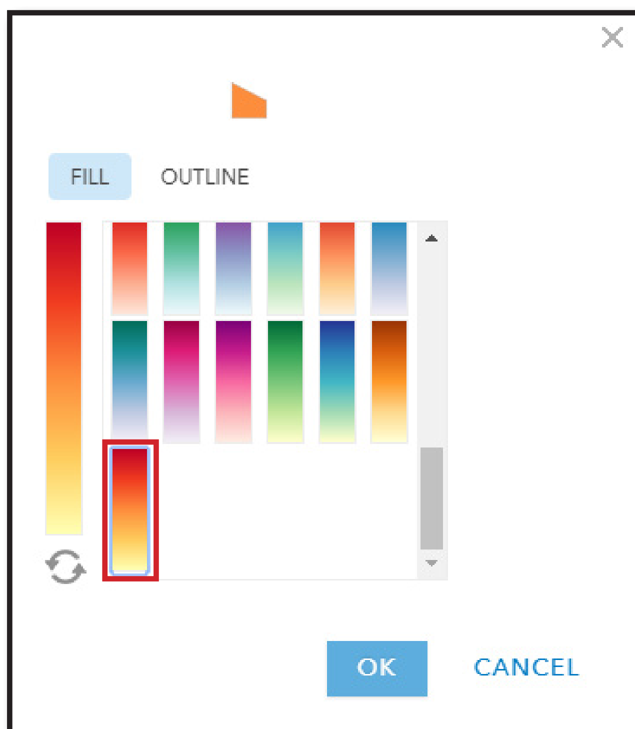
To symbolize the *Cache Liquefaction* data layer, click on the *Change Style* button. Beneath *(1) Choose an attribute to show*, click the dropdown menu and select *CODE*. The *CODE* represents the liquefaction potential or rating. There are five different classes, ranging from 3 to 7, with 3 representing areas with low liquefaction potential and 7 representing areas with high liquefaction potential. Below *(2) Select a drawing style*, click *SELECT* below *COUNTS AND AMOUNTS (COLOR)* and then click on *OPTIONS*. The symbology, or style, options will allow the data to be displayed in a way that is more meaningful.

There are a few different ways to symbolize the *Cache Liquefaction* data layer. In this instance, you will want to show the low liquefaction potential areas with a light yellow color and the high liquefaction potential areas with a dark red color. Click on the *Symbols* button and find the light yellow to red color ramp. To show the entire range of the data, you will need to make some adjustments in the *Change Style* window. Click on the sliding arrow next to the value

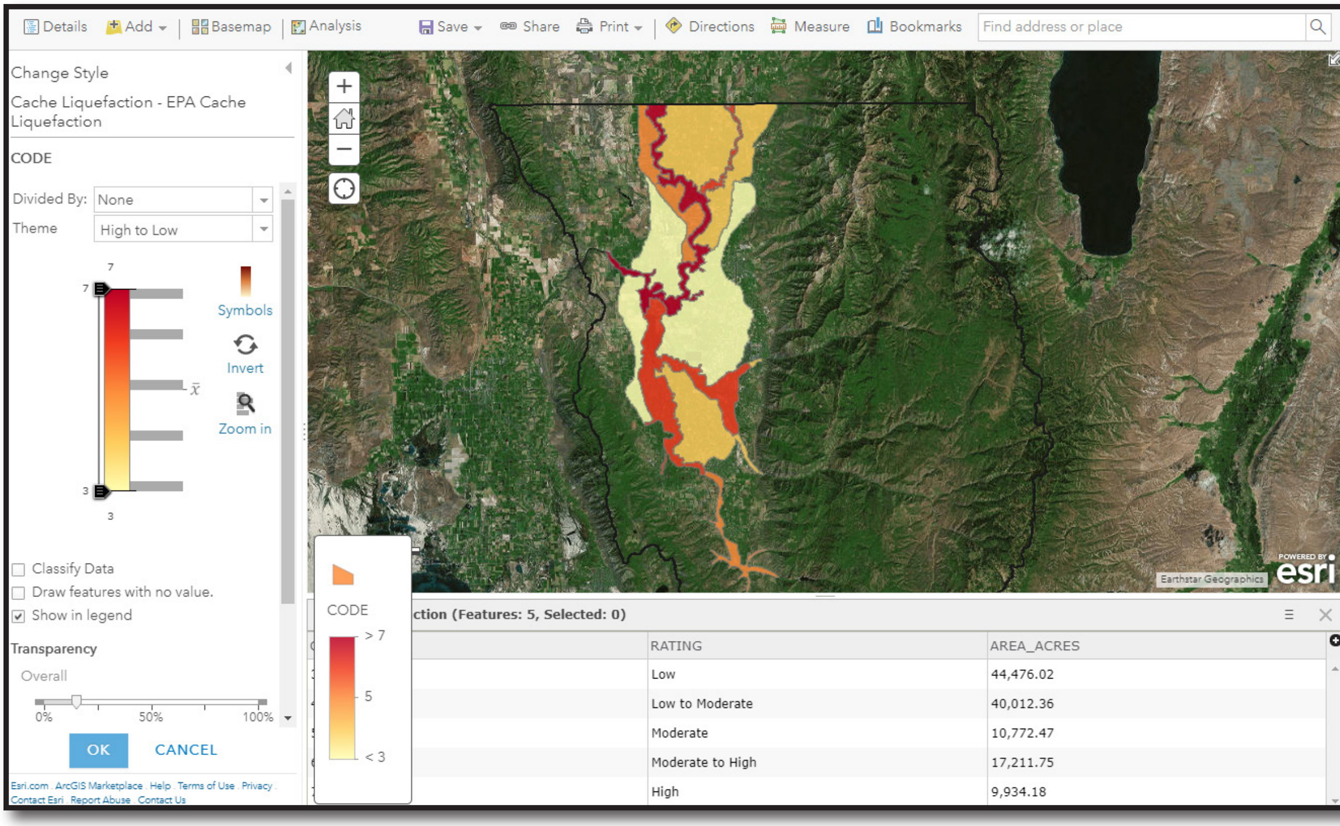
3.5. Drag the arrow down to the bottom of the scale or color ramp. Similarly, click on the sliding arrow next to the value 6.5 to the top of the scale or color ramp. The range should be from 3 to 7.



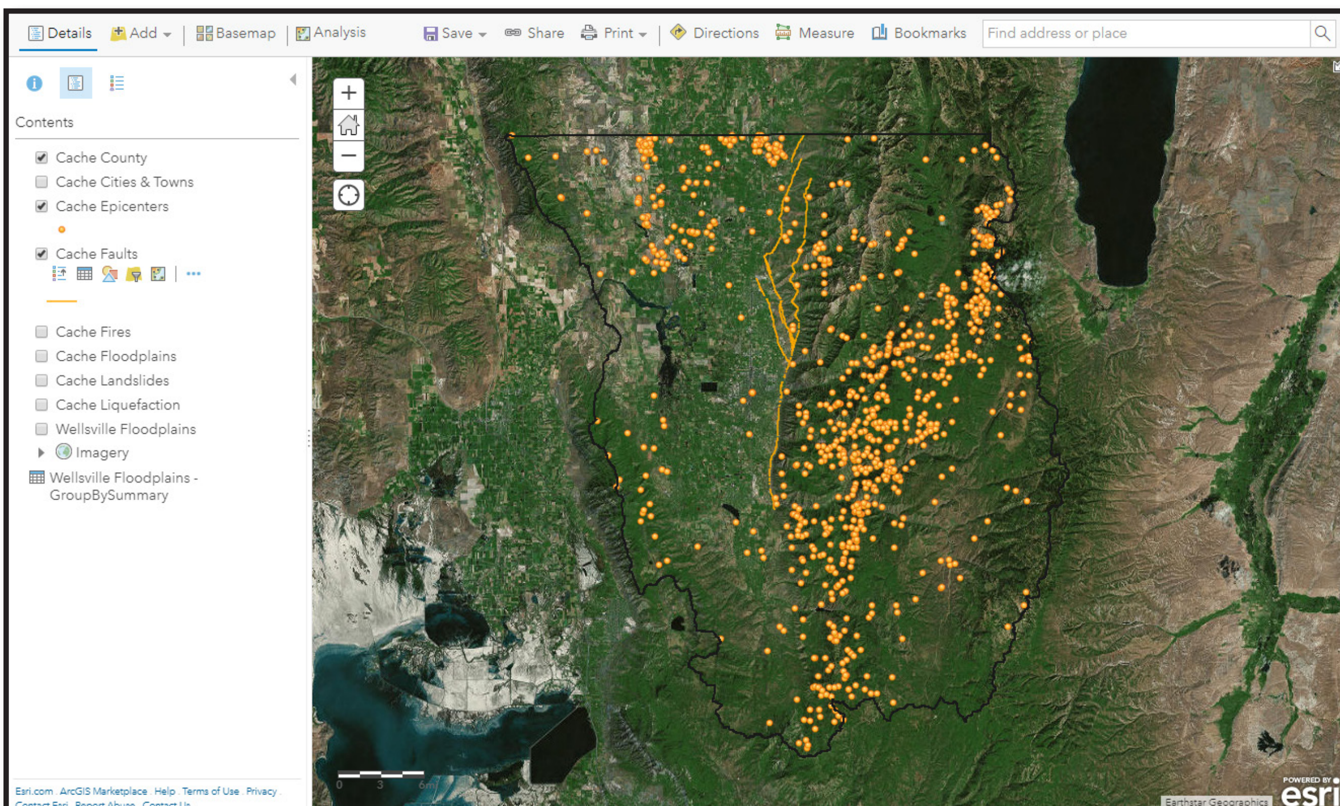




Click OK to apply the new symbology to the *Cache Liquefaction* data layer and then click *DONE* to save the changes.

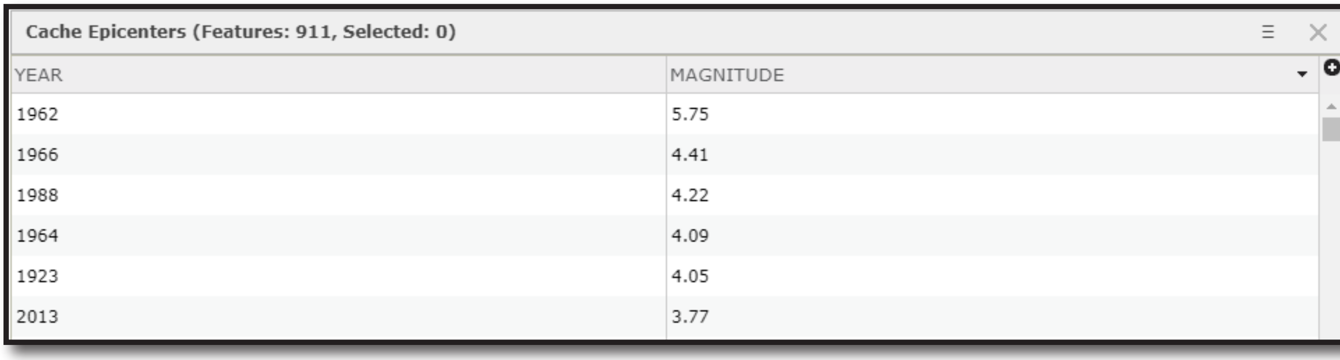


Turn off the *Cache Liquefaction* data layer and turn on the *Cache Epicenters* and *Cache Faults* data layers. The *Cache Epicenters* data layer represents a modern recorded history of earthquakes in Cache County. Epicenters represent the point on the surface of the Earth directly above the subterranean earthquake focus. The *Cache Faults* data layer represent active fault zones, or areas where sections of the earth have moved relative to each other.



Cache County, and the adjacent Wasatch Front, are considered geologically active earthquake zones. Therefore, it is important to plan for earthquakes and to develop rules and regulations that minimize or restrict urban development in dangerous area. Planners and administrators can use both epicenters and fault zones, as well as liquefaction zones, to develop plans and regulations.

Inspect the *Cache Epicenters* data layer and identify where the majority of epicenters are located. A large portion of epicenters are located in the mountainous regions, but there are several epicenters on the valley bottom, particularly on the north end of Cache County. Open the attribute table of the *Cache Epicenters* data layer by clicking on the *Show Table* button. The attribute table reveals the magnitude and year of the earthquake. For example, the largest recorded earthquake in Cache County occurred in 1962 and had a magnitude of 5.75. This earthquake epicenters was located east of Richmond City, Utah. Richmond City experienced significant damage during this earthquake. You can read the newspaper article that recalls this 1962 earthquake (https://bit.ly/2l7W01i).

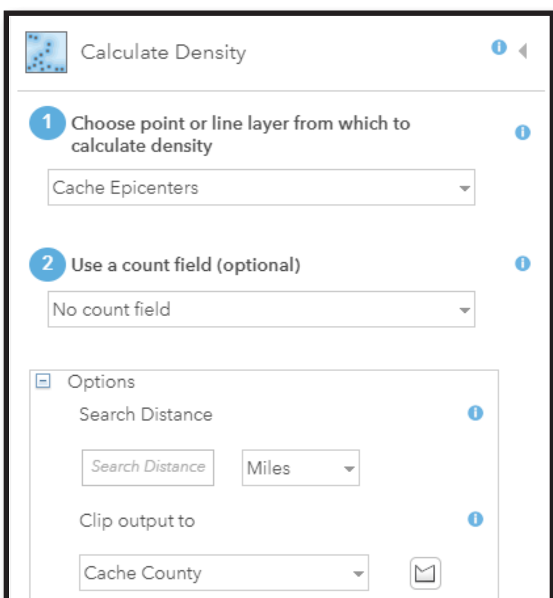


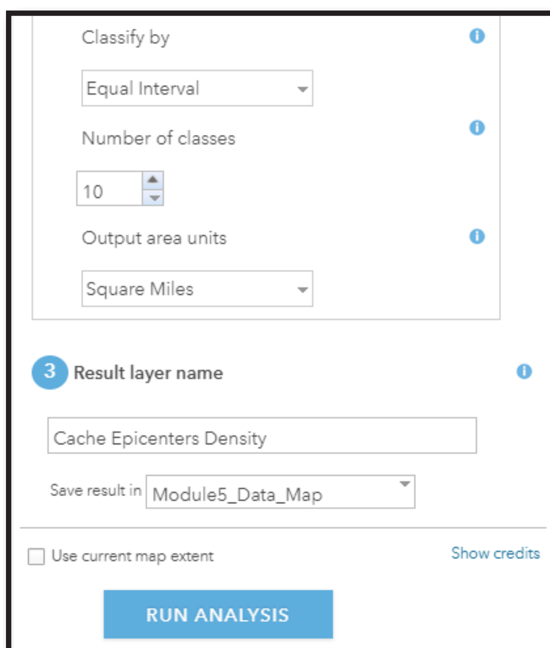
Cache Epicenters (Features: 911, Selected: 0)

YEAR	MAGNITUDE
1962	5.75
1966	4.41
1988	4.22
1964	4.09
1923	4.05
2013	3.77

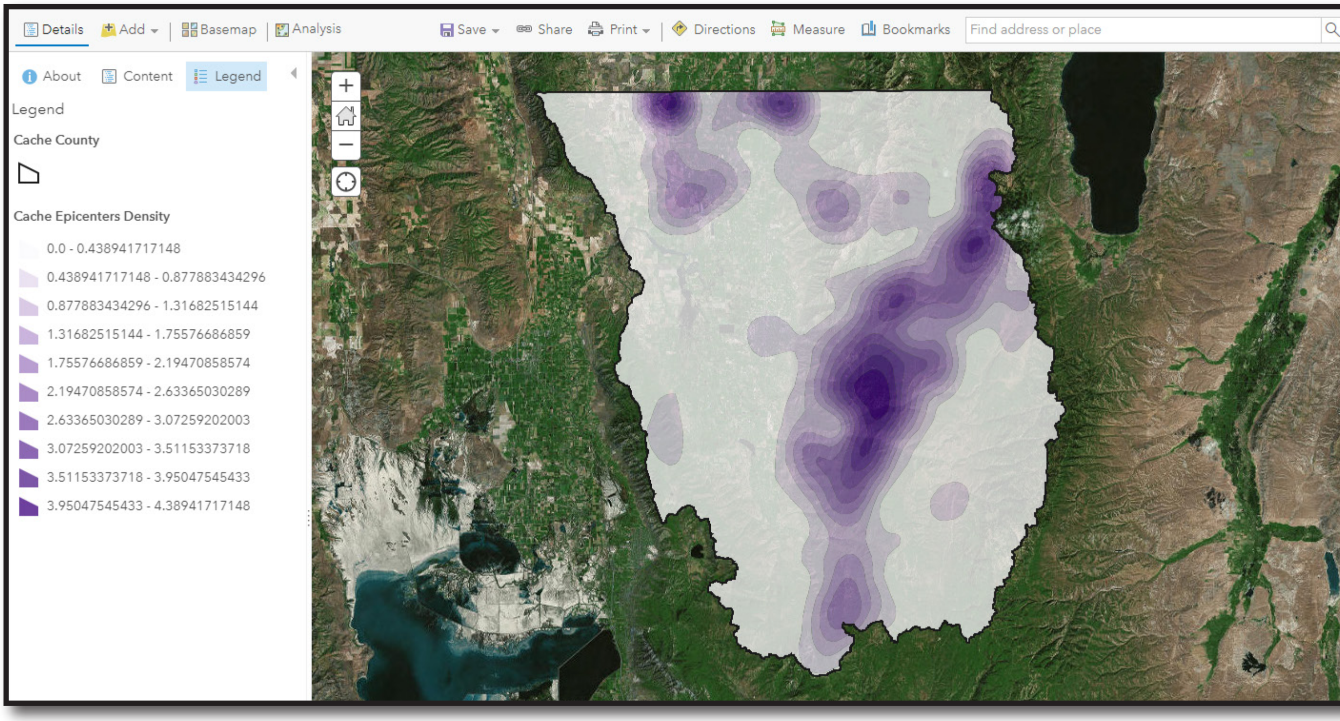
While the individual point features can provide a great deal of information, it can be difficult to use this data to identify where there are higher risks to life and property. To better understand this data layer, you can use ArcGIS Online tools to evaluate clusters, or the density, of points.

To create a cluster or density map of the *Cache Epicenters* data layer, click on the *Analysis* button. Under *Perform Analysis*, click on *Analyze Patterns*, and then select *Calculate Density*. Below *(1) Choose point or line layer from which to calculate density*, click the dropdown menu and select *Cache Epicenters*. Below *(2) Use a count field (optional)*, do not make any changes. Click the plus sign (+) next to *Options*. Below *Search Distance* box, click the dropdown menu and select *Miles*. Below *Clip output to*, click the dropdown mean and select *Cache County*. Below Classify by, leave as *Equal Interval*. Below *Number of classes*, select *10*. Below *Output area units*, select *Square Miles*. Below *(3) Result layer name*, type *Cache Epicenters Density*. Uncheck the box next to Use current map extent. Click RUN ANALYSIS. This analysis will take several minutes to run.

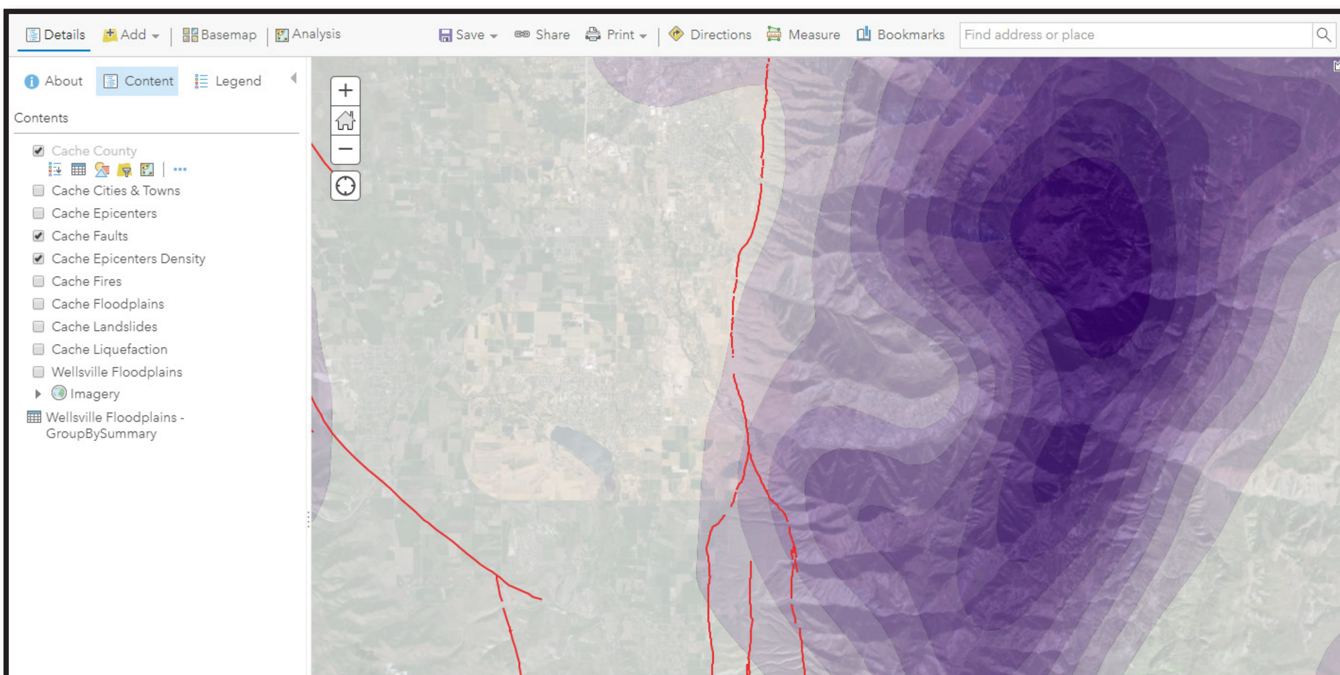




The output of this analysis is called a **density surface map** and it has calculated the number of epicenter points per square mile. To better view the output, turn off the *Cache Epicenters* data layer and *Cache Faults* data layer. The dark purple colors indicate where there are several epicenters within a square mile distance. The concentric bands represented by lighter shades of purple indicate fewer epicenters. Based on this analysis, planners and administrators can determine where certain precautions should be taken in relation to earthquake occurrence.

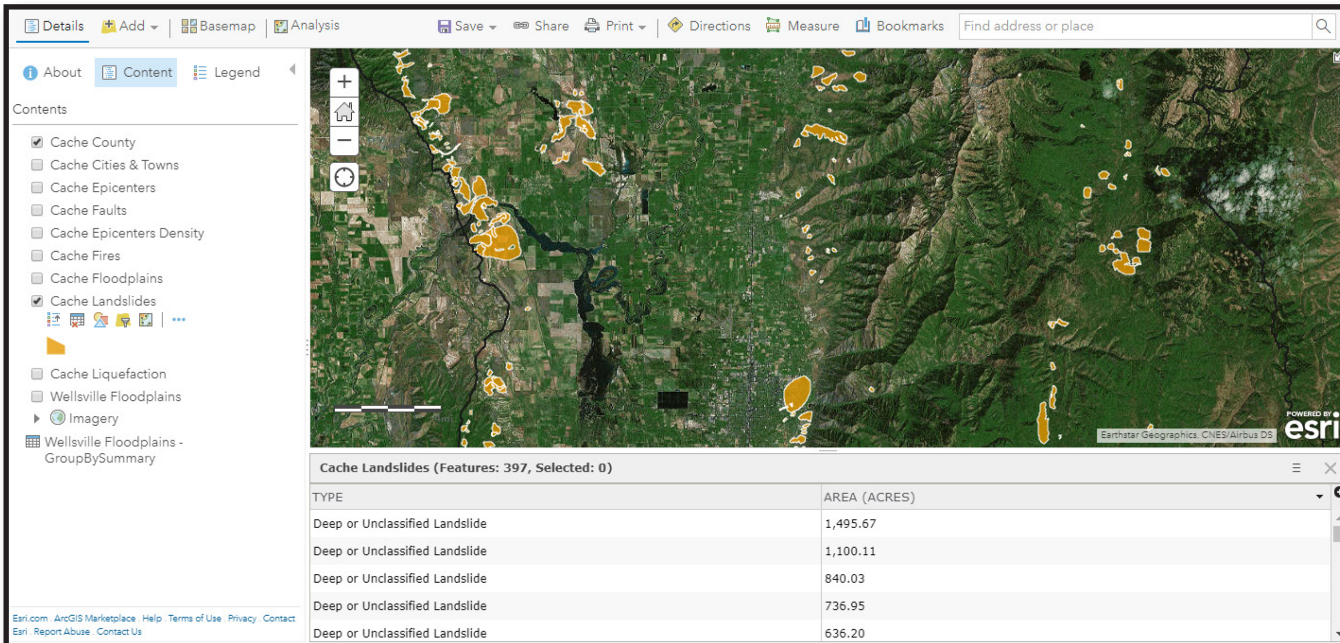


Leave the new data layer called *Cache Epicenters Density* on, but move it below the *Cache Faults* data layer. Remember that you can rearrange the order of data layers by left clicking on the three vertical dots that are located to the left of each data layer. Turn back on the *Cache Faults* data layer. Examine the map and identify any patterns between the density of epicenters and the locations of fault zones. You will likely notice that the epicenters are not always located near fault zones. This is why it is important for planners and administrators to understand the locations of epicenters and fault zones.



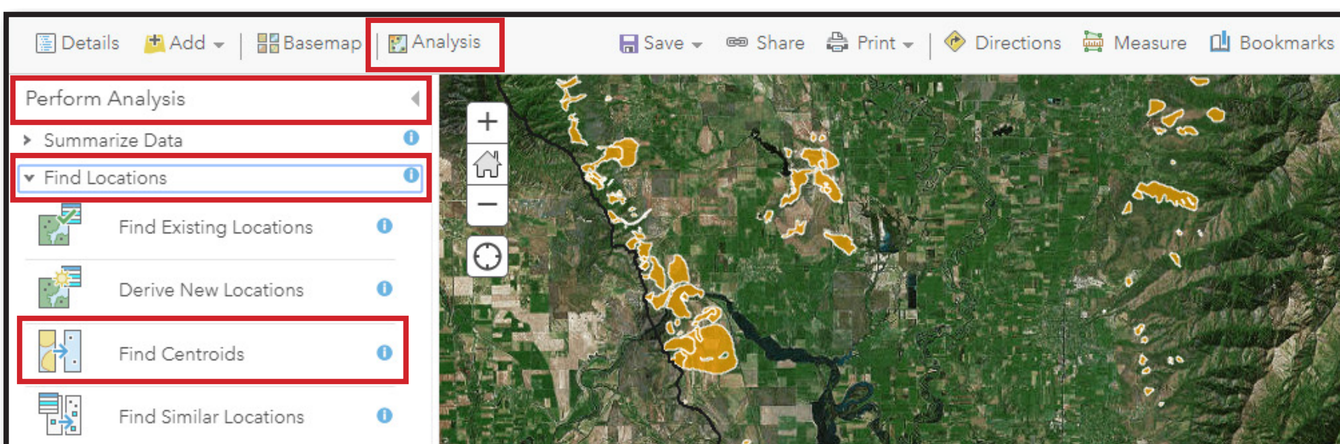
Active fault zones can be one of the most significant threats to public safety and welfare. Therefore, strict regulations should be established that prevent or limit urban development in these areas. Often times, urban development around fault rupture zones is restricted. In some locations, these zones may be buffered by several hundred feet to minimize earthquake-related damage.

Turn off the *Cache Epicenters Density* data layer and the *Cache Faults* data layer and turn on the *Cache Landslides* data layer. The *Cache Landslides* data layer represents some of the recent and historic landslides in Cache County, as mapped by geologists. What do you notice about the distribution of these landslides in Cache County? You should notice that the majority of these landslides occur on steep slopes near the valley edges. You can open up the attribute table to review the type and size of the landslides. The largest landslide in this data layer is nearly 1,500 acres and is located along the western border of Cache County.

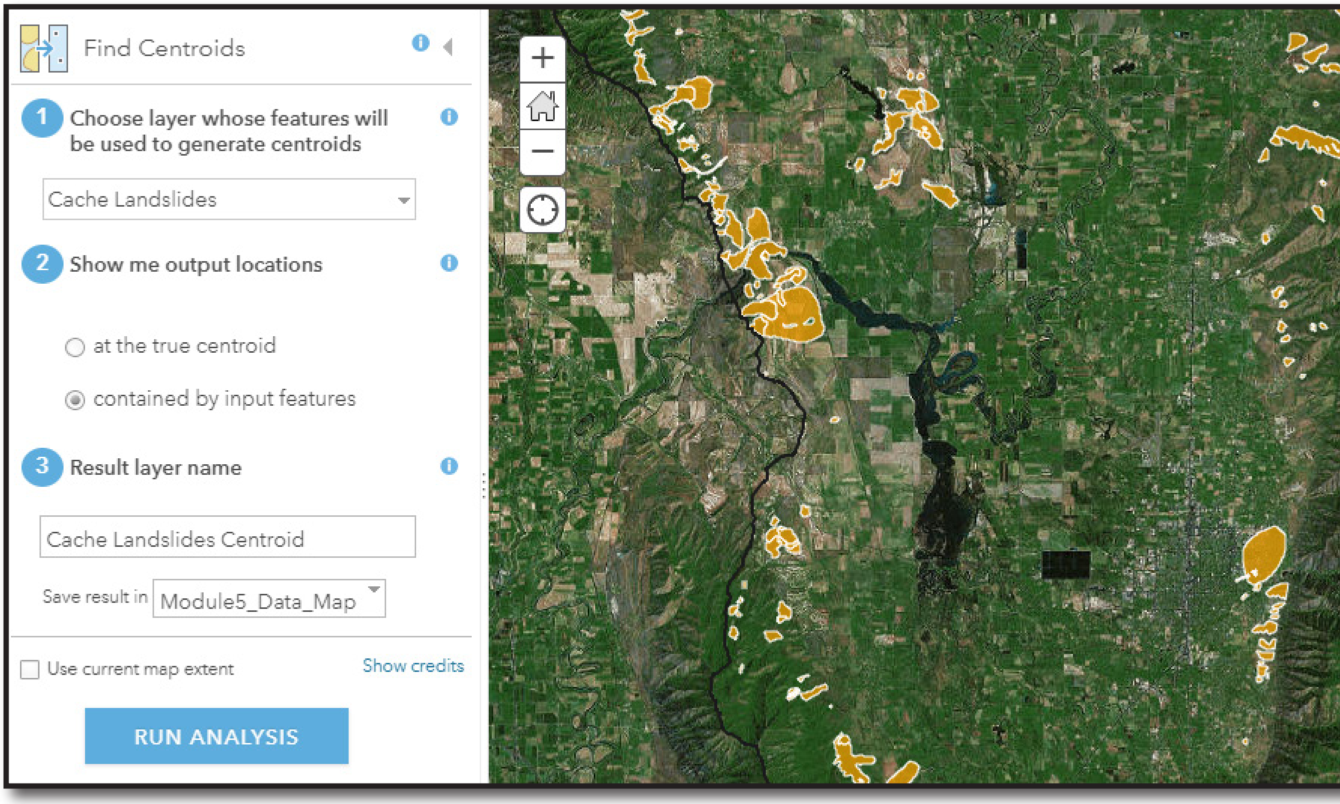


While the size of a landslide is an important consideration in determining risk to public safety and welfare, planners and administrators may also be interested in identifying areas adjacent to urban development that have experienced numerous landslides in the past. There are several ways to visualize the data, including the use of heat maps. Similar to density surface maps, **heat maps** represent the geographic density of features or events on a map. Heat maps are generated using point data. Therefore, the landslide polygons need to first be converted to points.

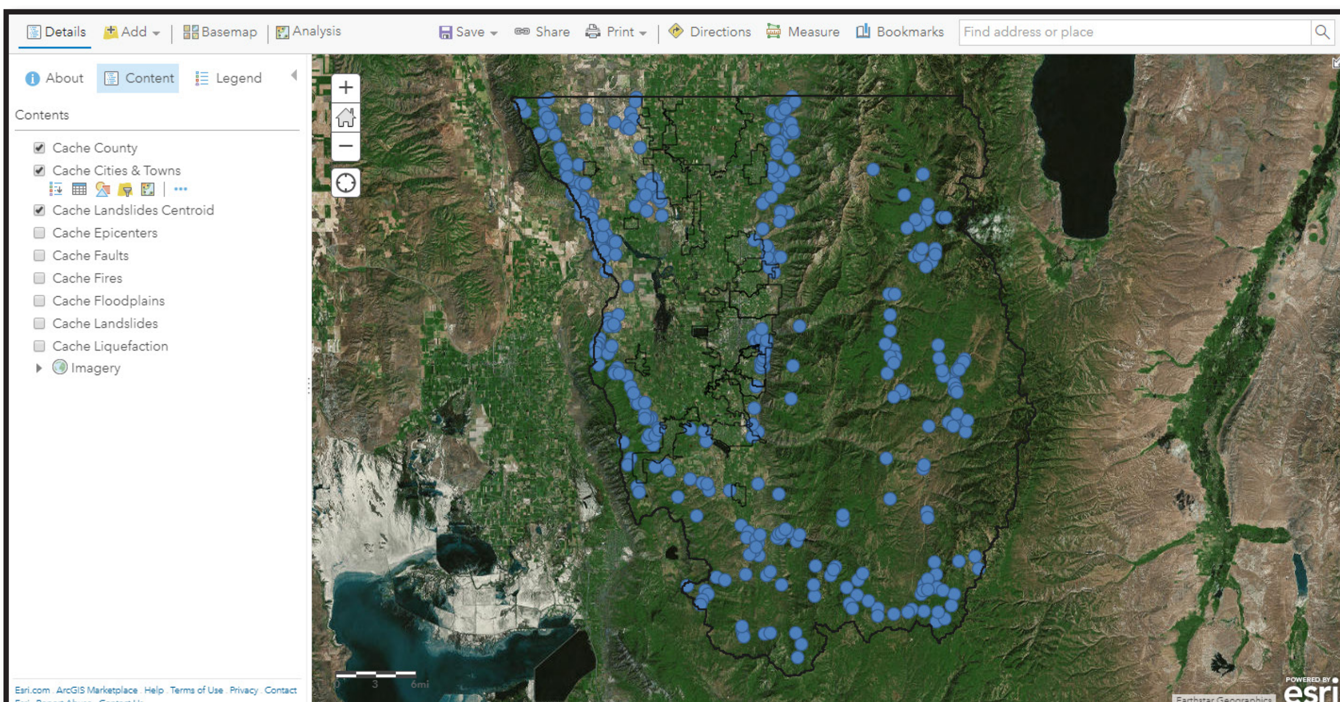
To convert the landslide polygon features to point features, you will need to use the *Find Centroids* tool. Click on the *Analysis* button. Under *Perform Analysis*, click on *Find Locations* and then select *Find Centroids*. Within the *Find Centroids* window, there are three options.



Below *(1) Choose layer whose features will be used to generate centroids*, select *Cache Landslides*. Below *(2) Show me output locations*, select the button next to *contained by input features*. Below *(3) Result layer name*, type in *Cache Landslides Centroid* Save the new data layer in your ArcGIS Online account. Uncheck the box next to *Use current map extent*. Click *RUN ANALYSIS*. This analysis will take several minutes to run.

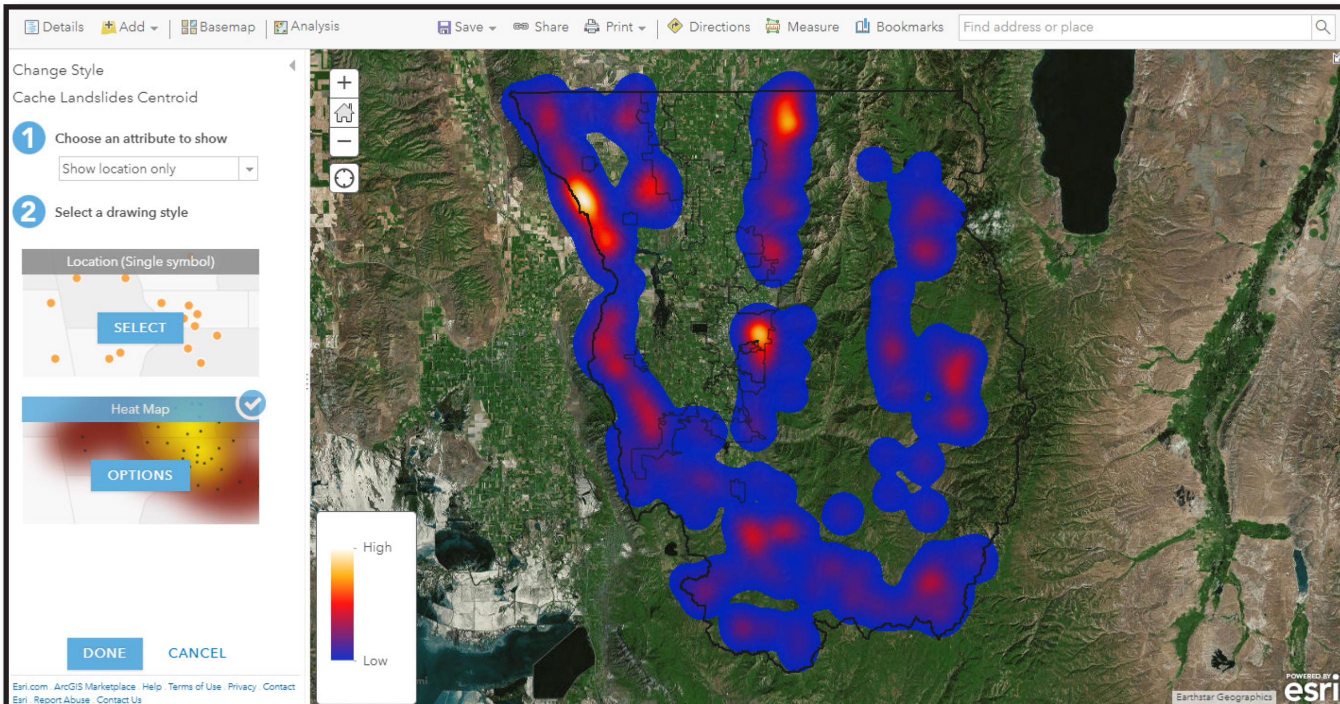


The output will be a point data layer. Each point represents one of the polygon landslides. Turn off the *Cache Landslides* data layer and make sure the *Cache Landslides Centroid* data layer is turned on and moved below the *Cache Cities & Towns* data layer. Turn on the *Cache Cities & Towns* data layer.

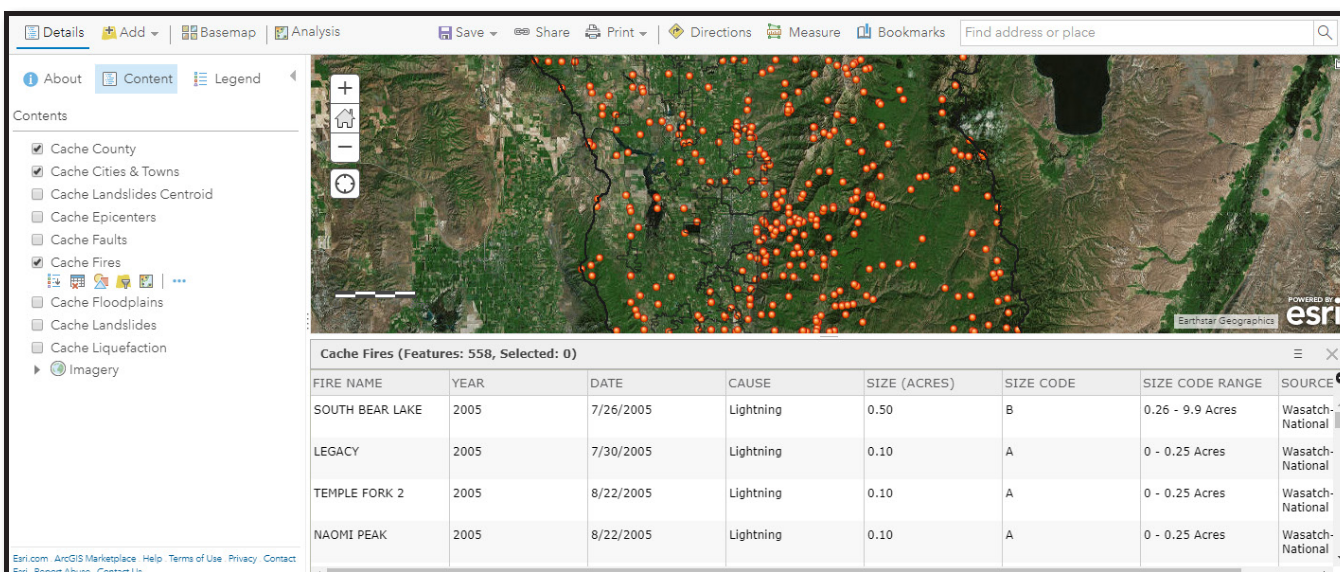


To make this map more meaningful, you will need to change the symbology of the point data layer. Click on the *Change Style* button below the *Cache Landslides Centroid* data layer. Below *(1) Choose an attribute to show*, select *Show location only*. Below *(2) Select a drawing style*, select *Heat Map*. Click *DONE* to close the *Change Style* window.

You will now have a map that can tell you more about the landslide data. The bright white and yellow areas are those that have a high density of landslides and the blue areas are those that have a low density of landslides. Inspect the heat map and identify where there are high densities of landslides in relation to cities and towns. What town appears to have a high density of landslides within their boundary? Logan City appears to have a high density of landslides on the eastern edge of the municipal boundary. Now that you know this, you can use some of the other analysis tools to assist planners and administrators make more informed decisions about urban development in Cache County.

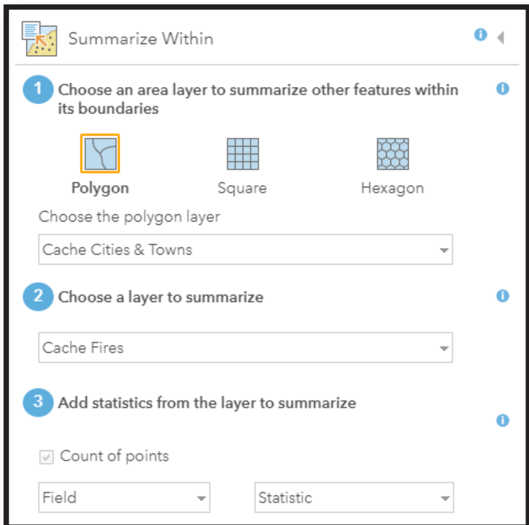


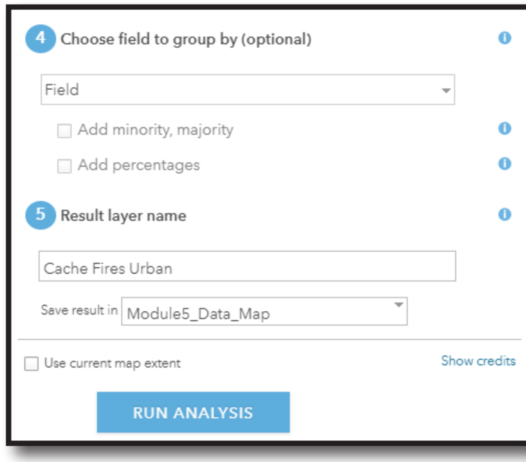
Turn off the *Cache Landslides Centroid* data layer and turn on the *Cache Fires* data layer. The *Cache Fires* data layer represents recorded wildland fires in Cache County from 1992 to 2015. Between this time period, there were 558 fires in Cache County. Some of these fires were small, while others were very large. Open the attribute table to identify the size of the fire, the date and year of occurrence, and the cause of the fire.



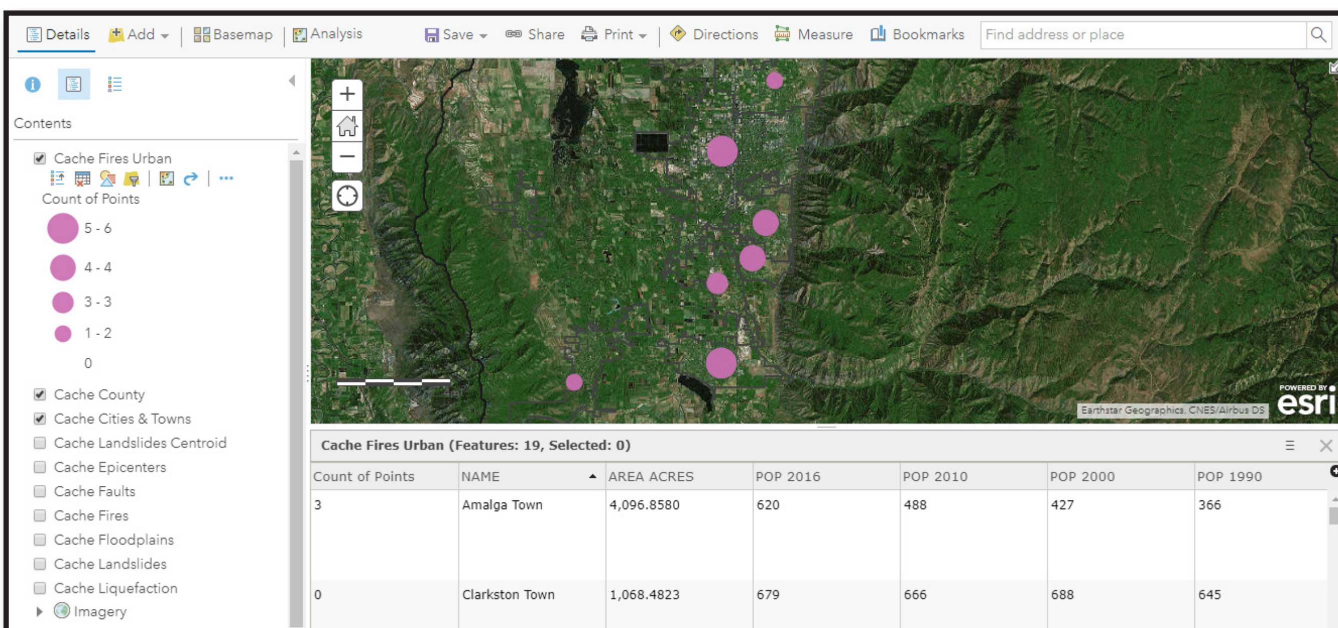
Since more fires are occurring in proximity to urban development, it is important for planners and administrators to understand fire risk within a city or town so they can prevent life- and structure-threatening events. If you were asked to help an urban planner identify the fires that occurred only within city or town boundaries, you could use ArcGIS Online. Click on the *Analysis* button. Under *Perform Analysis*, click on *Summarize Data* and then select *Summarize Within*. You have used this tool in previous exercises, so you should recall that it calculates a total number of events within a given area.

Below *(1) Choose an area layer to summarize other features within its boundaries*, select the *Polygon* option. Under *Choose the polygon layer*, select the *Cache Cities & Towns* data layer. Below *(2) Choose a layer to summarize*, click the dropdown menu and select *Cache Fires*. Below *(3) Add statistics from the layer to summarize*, leave the default settings. Below *(4) Choose field to group by (optional)*, leave the default settings. Below *(5) Result layer name*, click in the first box and give the new data layer a name called *Cache Fires Urban*. Uncheck the box next to *Use current map extent*. Click *RUN ANALYSIS*. This analysis will take several minutes to run.





The analysis will produce a new data layer called *Cache Fires Urban*. The data layer will be automatically symbolized by using the *Counts and Amounts (Size)* option. The larger circles represent cities or towns with more fires and the smaller circles represent cities or towns with fewer fires. You can open up the attribute table to identify the exact number of fires within each city or town. The first column named *Count of Points* identifies the number of fires within each city or town boundary. This information can be used in conjunction with other information and data to develop fire management plans.



INVESTIGATION

In this module, you assessed the locations of lands that are susceptible to natural hazards. You spent more time learning how to calculate the area and quantity of features within cities and towns for the purpose of developing better county and municipal plans. You learned how to change basemaps in ArcGIS Online. You learned how to better symbolize point data by using density surface maps and heat maps. Using the skills you have learned, please answer the following questions:

1. Planners and administrators understand that building in floodplains must be done with extreme caution. Therefore, it is often better, in terms of public safety and welfare, to restrict urban development in these areas. If Wellsville City was developing a comprehensive city plan that protected floodplains for safety, wildlife habitat, and recreation, they would need to know the location and area of these floodplains. They may also be interested in knowing what percentage of the city was classified as floodplains. To determine this, you will need to know the area of floodplains within Wellsville City and the total area of Wellsville City. You determined the area of floodplains within Wellsville City in the first exercise of this module. You can find the total area of Wellsville City in the attribute table associated with the *Cache Cities & Towns* data layer. The equation to calculate the percentage is:

Percent Floodplain = (Acres of Floodplain with Wellsville/Total Area of Wellsville) x 100

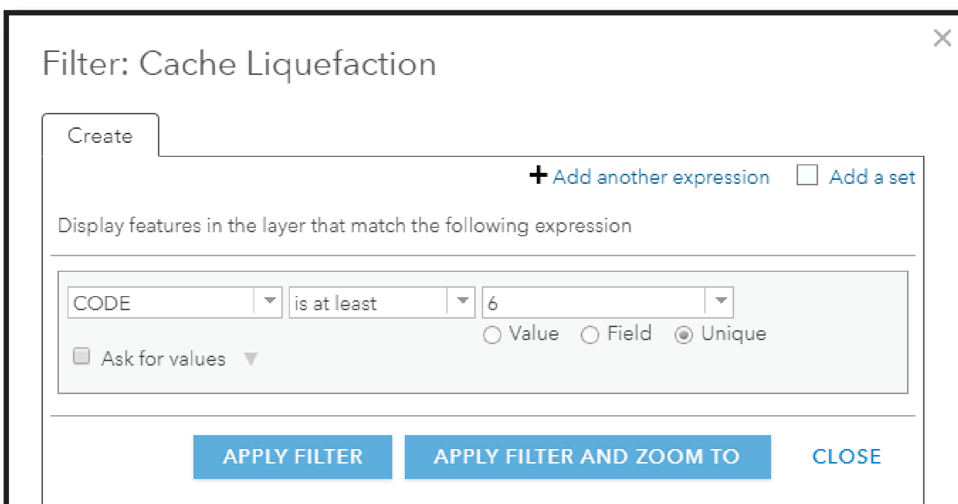
What is the total area (in acres) of the 100-year floodplain within Wellsville City?

What is the total area (in acres) of Wellsville City?

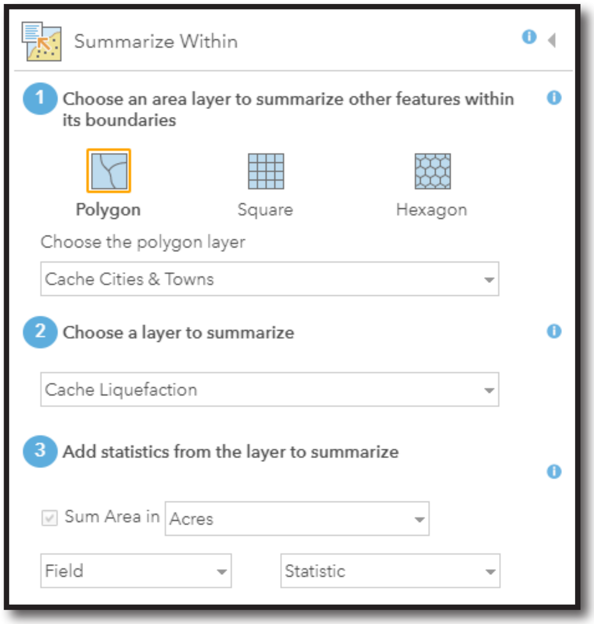
What percent of Wellsville City is classified as 100-year floodplain?

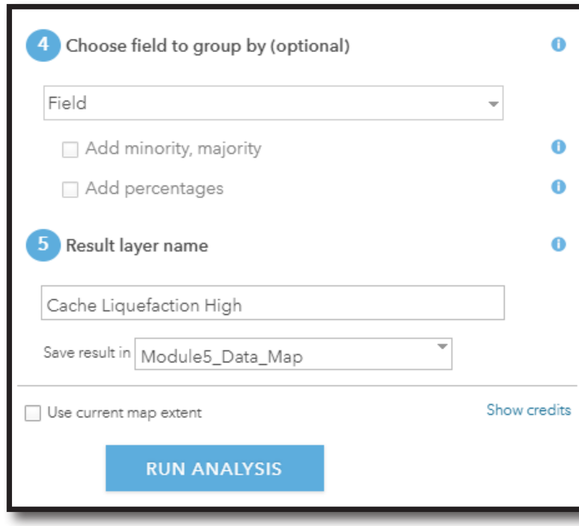
2. Urban planners and administrators should be cautious when permitting urban and industrial development on lands susceptible to liquefaction, particularly those that have been assigned high and moderate-to-high ratings. The county planner has asked you to just map the liquefaction zones with high (7) and moderate-to-high (6) ratings. Once you have done that, you will need to identify the top three cities or towns that have the greatest area of high and/or moderate-to-high liquefaction zones.

You will first need to create a filter in the *Cache Liquefaction* data layer that selects out high (7) and moderate-to-high (6) liquefaction zones. Your *Filter* window should resemble the following image.



Once you have applied the filter, you will need to use the *Summarize Within* tool to identify the cities and towns that have high and moderate-to-high liquefaction zones. You can name the new data layer *Cache Liquefaction High*. Your *Summarize Within* window should resemble the following image.





Your new data layer *Cache Liquefaction High* will contain a new field called *Summarized area in Acres*. This field will need to be sorted to identify the top three cities/towns that have the greatest area of high and/or moderate-to-high liquefaction zones. You will note that some cities and towns have a value of 0. This is because they do not have any high or moderate-to-high liquefaction zones within their municipal boundaries.

What is the total area (in acres) of high liquefaction zones in Cache County?

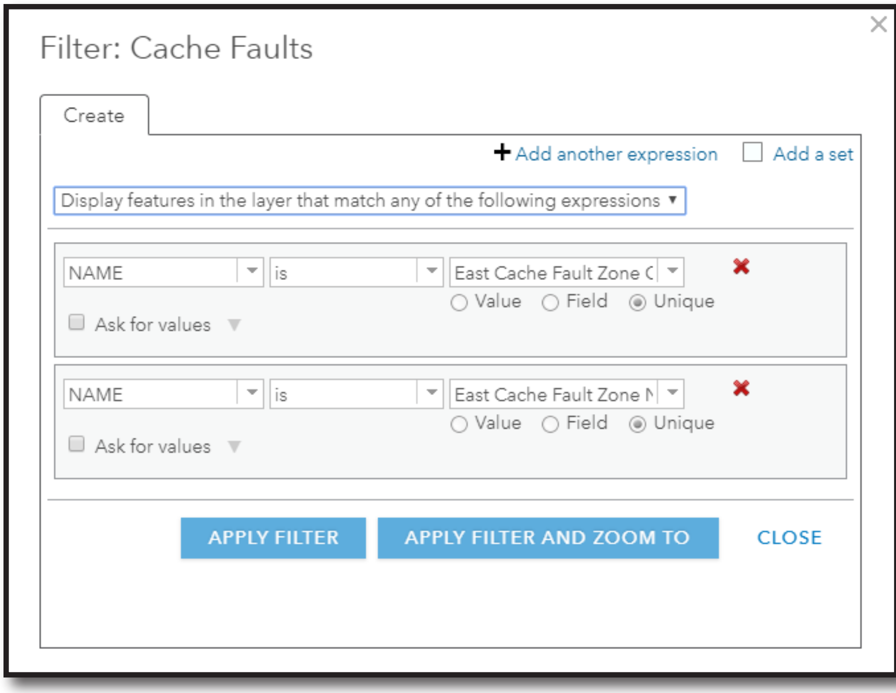
What is the total area (in acres) of moderate-to-high liquefaction zones in Cache County?

What three cities/towns have the greatest area of high and/or moderate-to-high liquefaction zones? Include names of cities and area (in acres) of liquefaction zones.

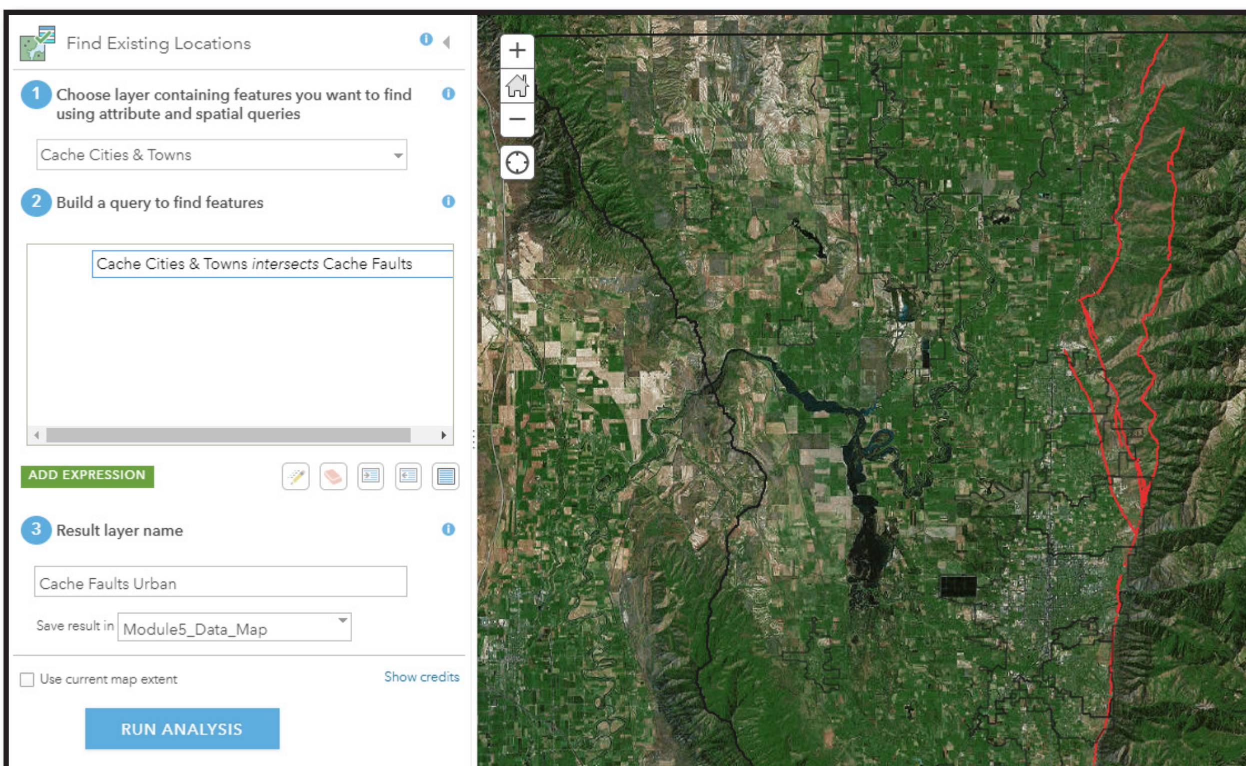
3. Since earthquake fault zones can be extremely dangerous to build on, planners and administrators should establish regulations and restrictions for building on and around fault zones. In most instances, these areas are better left undeveloped and maintained as natural open space for use by recreationists and wildlife.

One of the most visible fault zones in Cache County is the Cache Fault Zone on the east side of Cache Valley. The East Cache Fault Zone Central Section and the East Cache Fault Zone Northern Section traverse the most populated municipalities in Cache County. The county planner has asked you to identify what cities or towns would be affected by earthquake events that occurred along these two fault zones.

You will first need to create a filter in the *Cache Faults* data layer that selects out the East Cache Fault Zone Central Section and the East Cache Fault Zone Northern Section. Since you need to create two filters, you will need to use the *+Add another expression* button in the *Filter* window. Also, because the filter needs to find both faults, you will need to change how the filter is applied. You will need to click the dropdown menu in the top box and select *Display features in layers that match <u>any</u> of the following expressions*. Your *Filter* window should resemble the following image.



Once you have applied the filter, you will need to create a spatial query using the *Find Existing Locations* tool. A spatial query will allow you to create a new data layer from the *Cache Cities & Towns* data layer that shows only those cities or towns that intersect with the East Cache Fault Zone Central Section and the East Cache Fault Zone Northern Section. You can name the new data layer *Cache Faults Urban*. Your *Find Existing Locations* window should resemble the following image:



Inspect the attribute table of the *Cache Faults* data layer and the *Cache Faults Urban* data layer to answer the following questions.

How many cities might be affected by an earthquake event along the East Cache Fault Zone Central Section and/or the East Cache Fault Zone Northern Section?

Of these cities, what three that have the greatest 2016 population? Identify the names of cities and the 2016 population.

What is the total length (in miles) of the East Cache Fault Zone Central Section and the East Cache Fault Zone Northern Section?

4. Fires that occur within or near city and town boundaries pose a significant threat to public safety and welfare. Without proper fire management planning, there is a risk to life and property. Additionally, air and water quality may be affected and wildlife habitat may be destroyed or degraded. By evaluating the *Cache Fires* data layer and the *Cache Fires Urban* data layer that you created, answer the following questions:

What is the name and area (in acres)of the largest fire that has occurred in Cache County? What year did this fire occur?

What two cities or towns have the highest number of fires occurring within their boundaries? Identify the names of cities/towns and the number of fires?

How many fires have occurred within Logan City?