

## TUTORIAL 2 | TOPOGRAPHY AND CLIP

### Goals

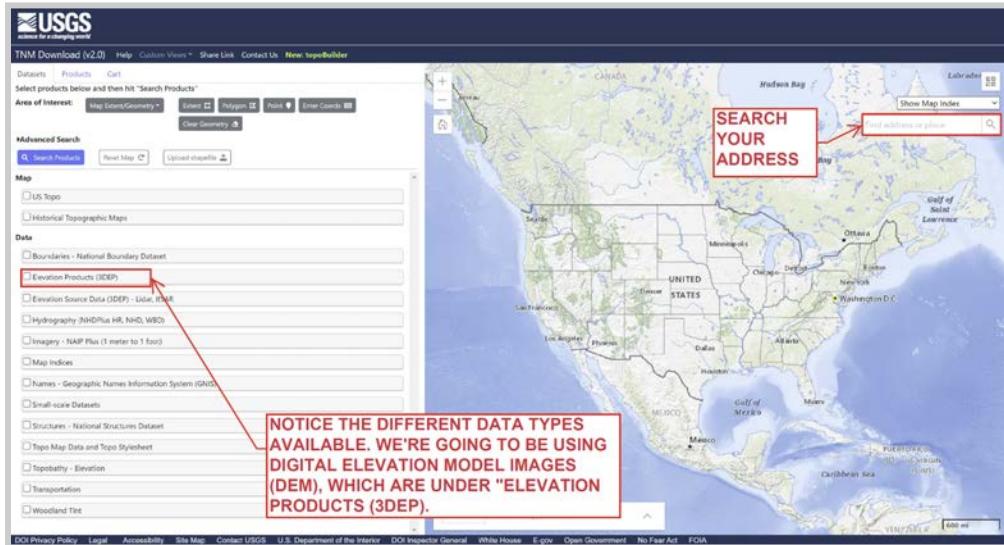
- Add topography to your city map.
- Learn where to find topographic data online.
- Extract topography lines from DEM.
- Use buffer and clip tools to reduce data scope.

### Introduction

Using the base map from Tutorial 1, in Tutorial 2 you will download USGS topographic data and use a simple QGIS tool to extract contour lines from it. From there, you will crop the topography lines to the city's administrative boundary. You will also practice graphic design and map export skills, as in Tutorial 1.

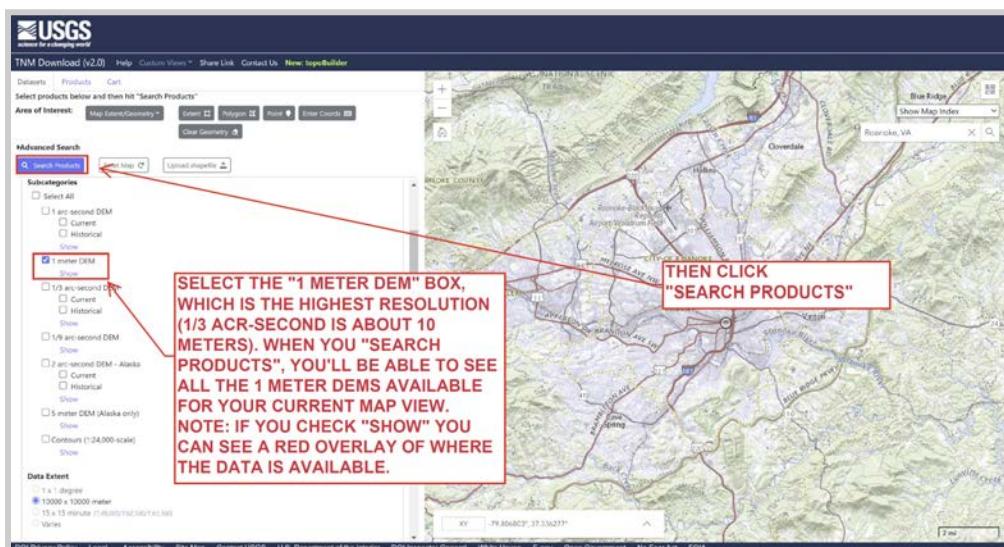
**Step 1: Download DEM data for your city from USGS (note: if USGS website is not working, please skip to Step 1c)**

1a Visit the USGS earthexplorer site: <https://apps.nationalmap.gov/downloader/#/>. Search for your city (Roanoke, Lynchburg, or Richmond VA).



1b On the left panel, check “**Elevation Products**”, and then “**1 meter DEM**”. “Search Products” to see a list of the DEMs in the area on the map.

A **Digital Elevation Model (DEM)** is a raster image of the bare land surface (excluding trees, buildings, or other surface objects) drawn only in black and white, where each pixel color corresponds to a specific topographic height. We will be using GeoTIFF DEMs, which are TIFFs (image file) with embedded geographic information.



Hover over “**Thumbnail**” to see each DEM’s outline on the map. Download ALL the DEMs which overlap your city by clicking “**Download Link**” in the left panel.

The top screenshot shows a search result for 'Roanoke, VA' with several 10km square DEM options. A red box highlights one item, and a callout box states: 'THESE IMAGES COME IN 10KM SQUARES, SO YOU MIGHT NEED TO DOWNLOAD MORE THAN ONE TO COVER YOUR MAP. CHECK THE OUTLINE OF THE DEM BY HOVERING OVER EACH ITEM.' The bottom screenshot shows the same map with five 10km squares outlined in red, labeled 1 through 5, indicating multiple downloads are needed.

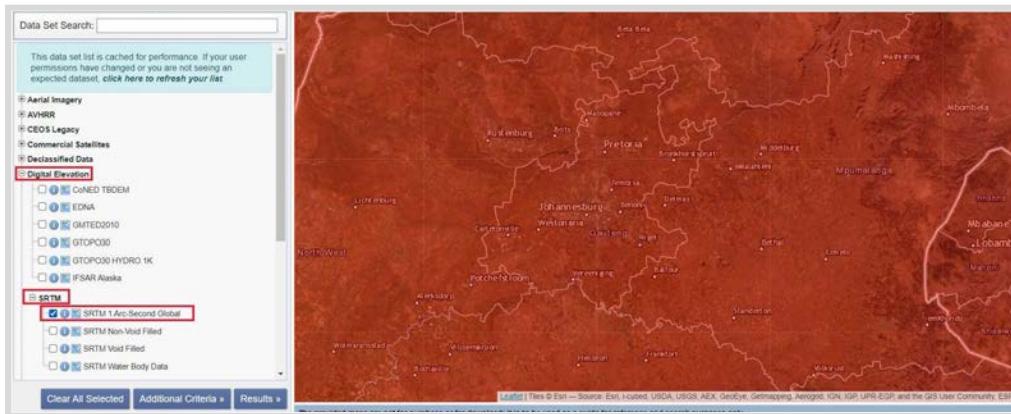
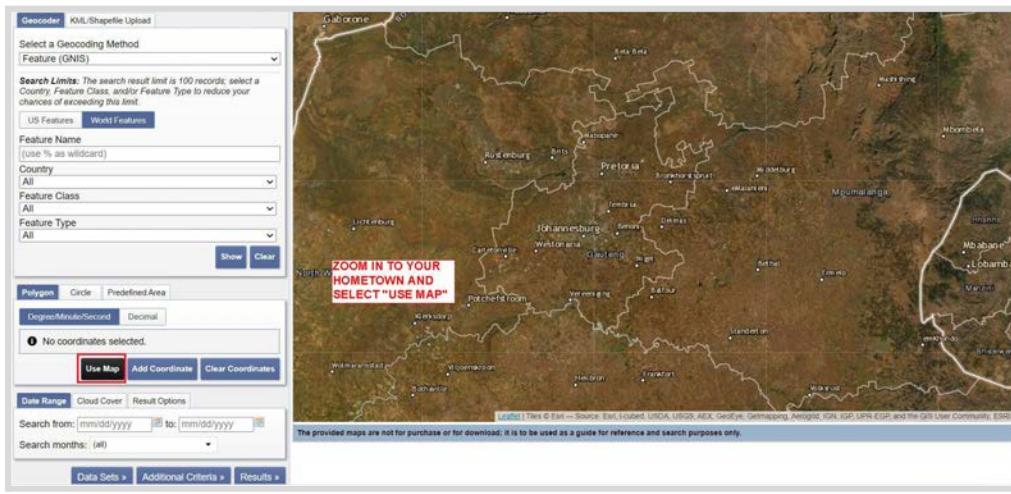
**Note:** follow steps 1c-1f only if the USGS website is not working

1c If the USGS website is NOT working, visit the USGS earthexplorer site: <https://earthexplorer.usgs.gov/>. You'll need to create a free account to download this data.

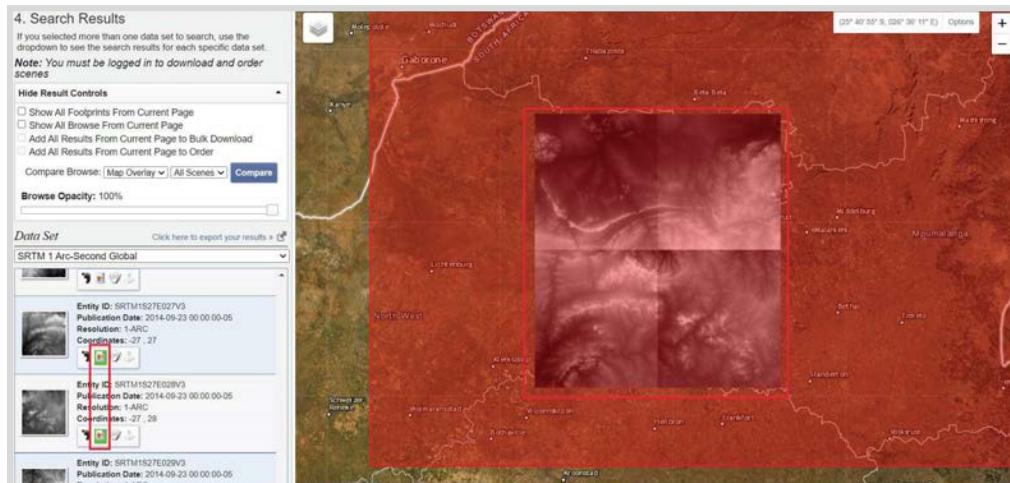
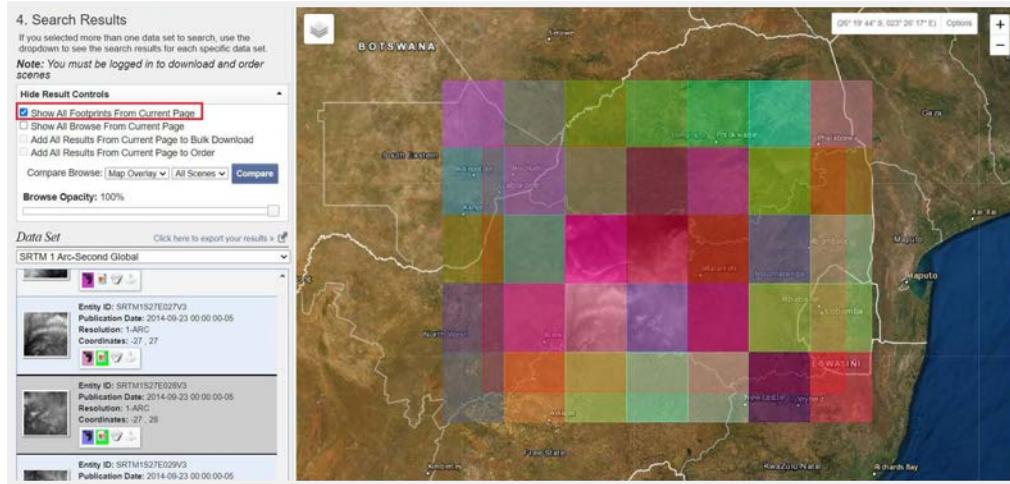
The screenshot shows the 'Search Criteria' page. The 'Search Criteria Summary' map displays a global view with a specific location highlighted over Africa. The search criteria include:

- Search Criteria: Data Sets, Additional Criteria, Results
- 1. Enter Search Criteria: To narrow your search area, type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the help documentation), and/or choose a date range.
- Geocoder: KML/Shapefile Upload
- Select a Geocoding Method: Feature (GNS)
- Search Limits: The search result limit is 100 records; select a Country, Feature Class, and/or Feature Type to reduce your chances of exceeding this limit.
- US Features: World Features
- Feature Name: (use % as wildcard)
- Country: All
- Feature Class: All
- Feature Type: All

1d To define our “Search Criteria”, we’ll scroll down and select “Use Map”. Then, in the next tab “Data Sets”, open “Digital Elevation” and then “**SRTM**”. This stands for Space Shuttle Radar Topography Mission, which surveyed the entire planet down to **1-arc second** resolution (about 30 meters).



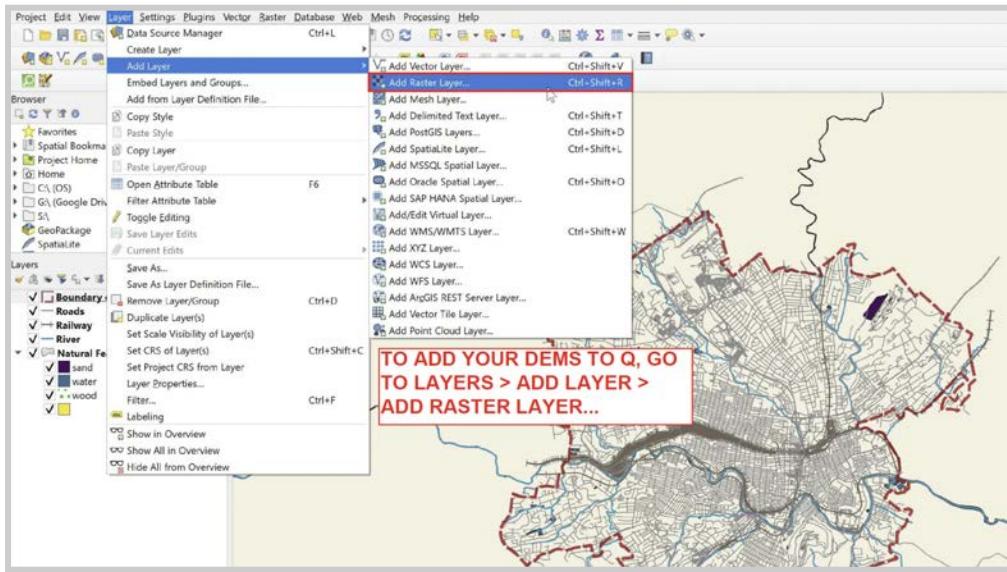
1e Now, check “**Show All Footprints**” to see the results on your map. You can click the Image icon (beside the foot) in the Data Set results to see the image in the map.



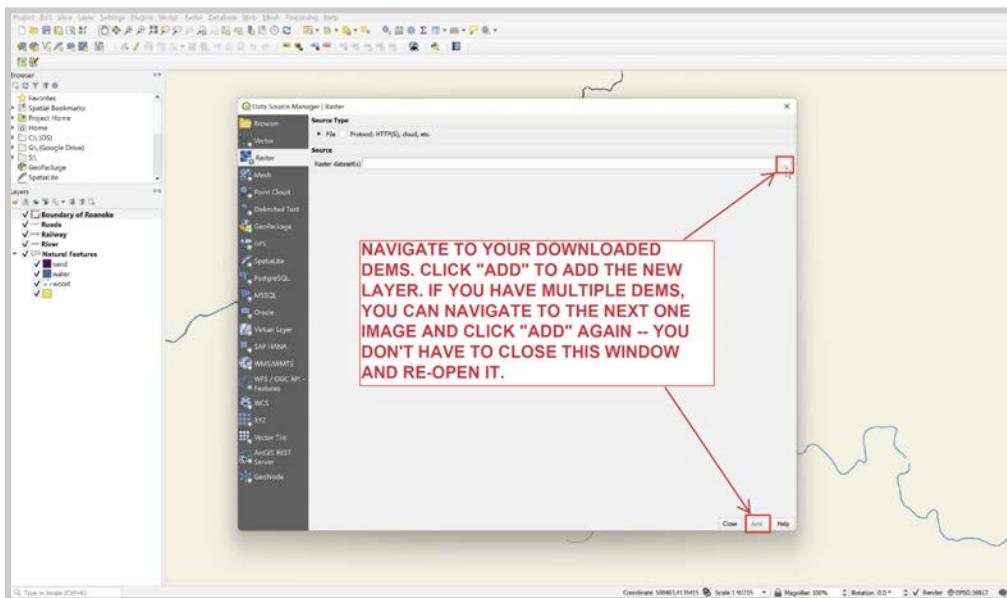
1f Download the DEMs that you need from your free account.

## Step 2: Import the DEM into QGIS as a Raster Layer.

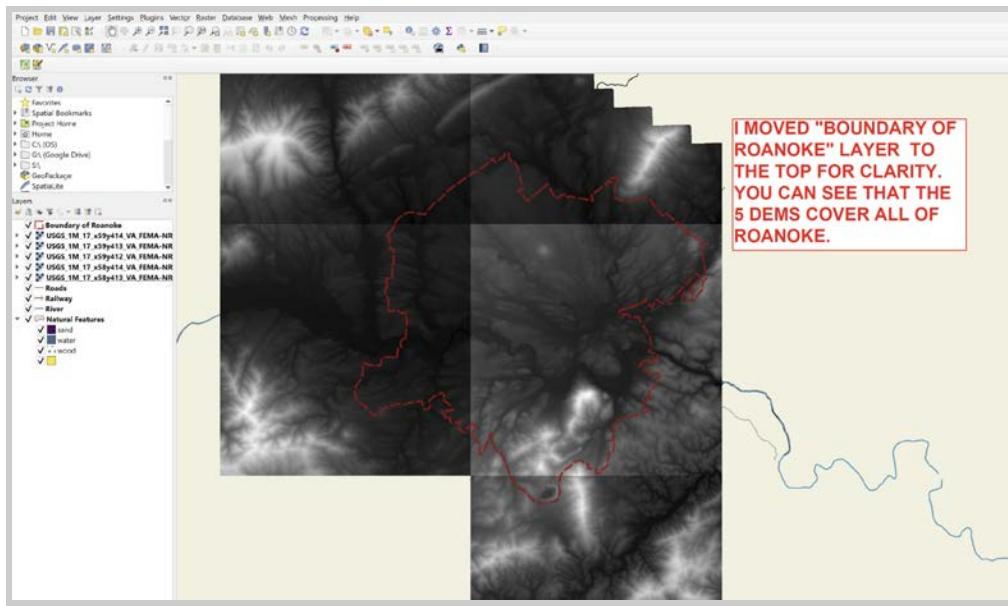
2a In your QGIS file from Tutorial 1, go to **Layer > Add Layer > Add Raster Layer...**



2b Click the ellipses (...) and navigate to your downloaded DEM image. Click “**Add**” to add the layer to your map. You can add multiple DEM layers by changing the Source location without closing the Data Source Manager window. You’ll see that the DEMs automatically locate themselves correctly on your map. This is because they contain latitude / longitude information which QGIS uses to place them.

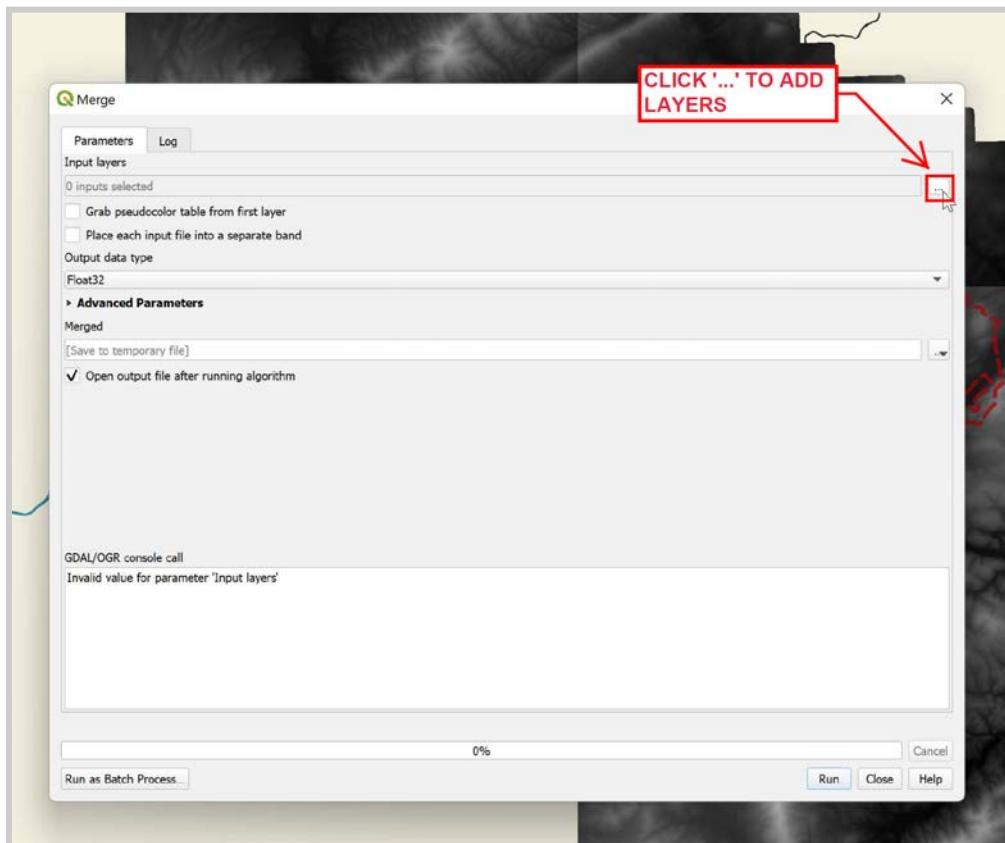
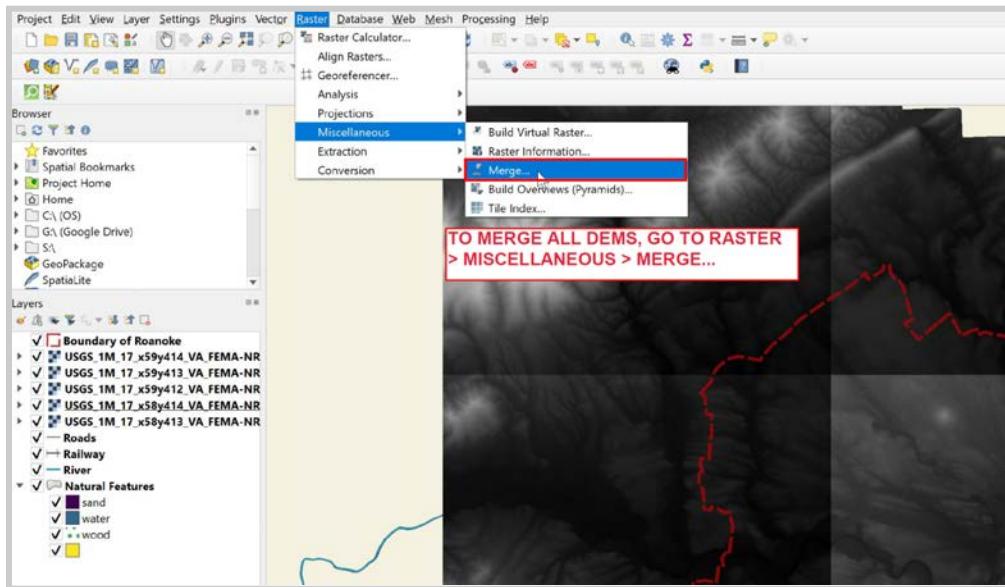


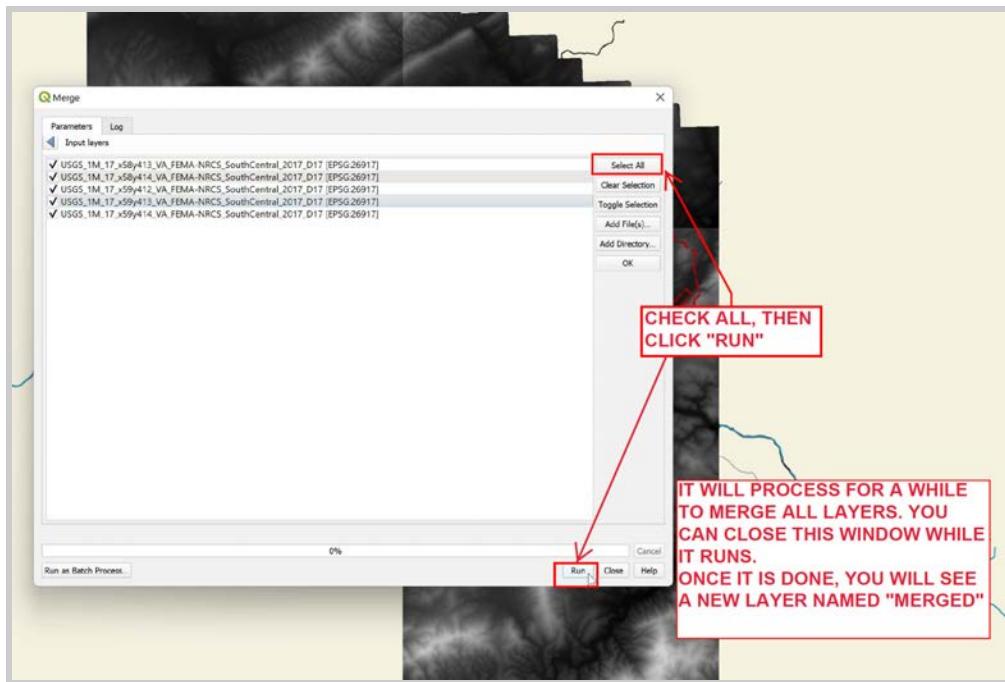
NOTE: the DEMs may not show up entirely depending on your Zoom level; if you don’t see them, try zooming in until they show up. They should work for the next steps regardless.



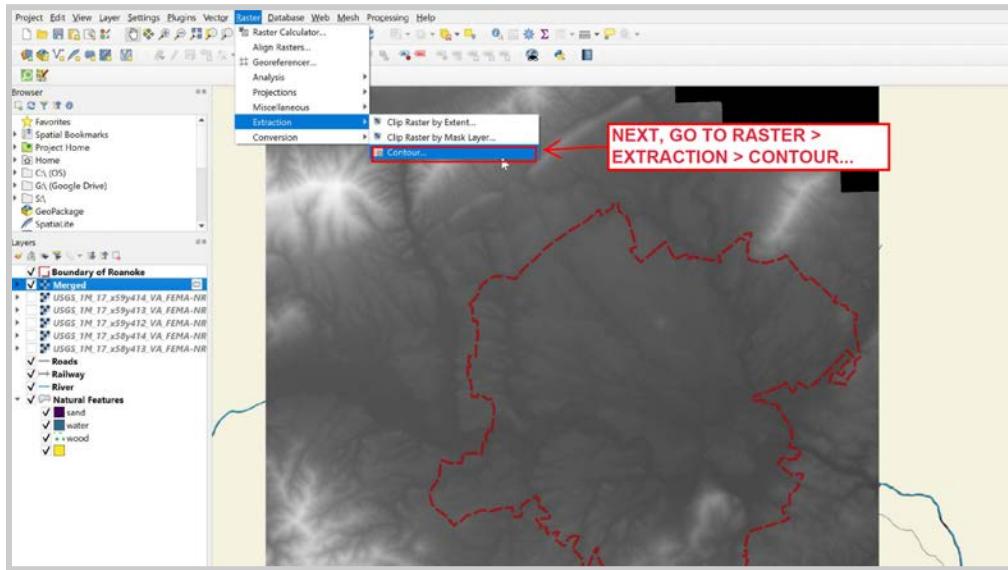
### Step 3: Extract topography lines with Raster > Extraction > Topography.

3a First, combine your four DEMs into one layer by going to **Raster > Miscellaneous > Merge**. Select your DEM layers and click “Run” to output a single layer. You can then remove the individual rasters from your project.

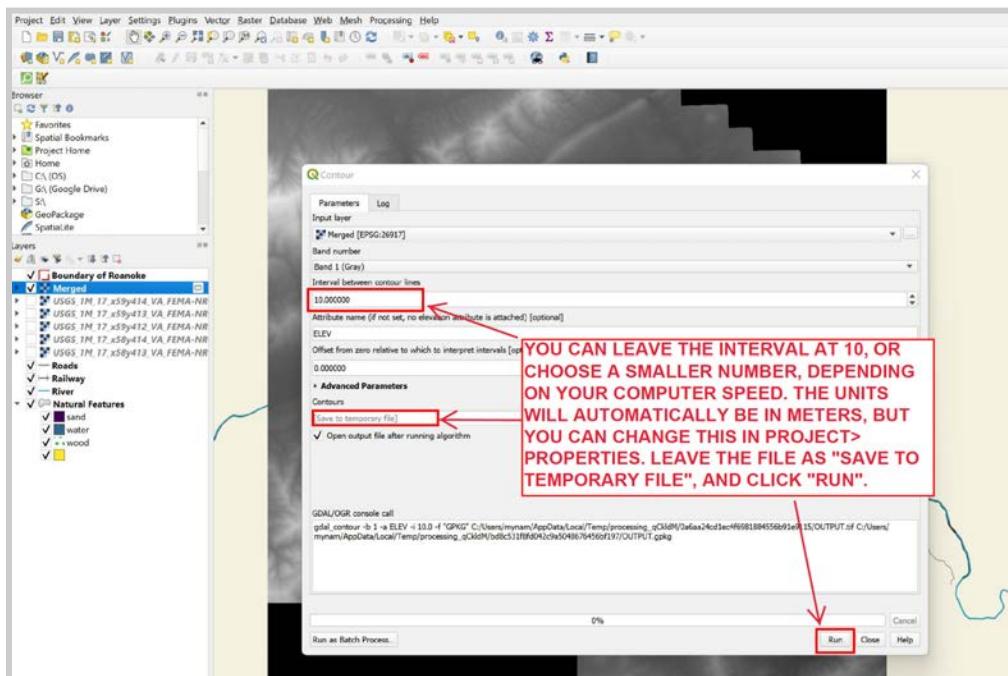




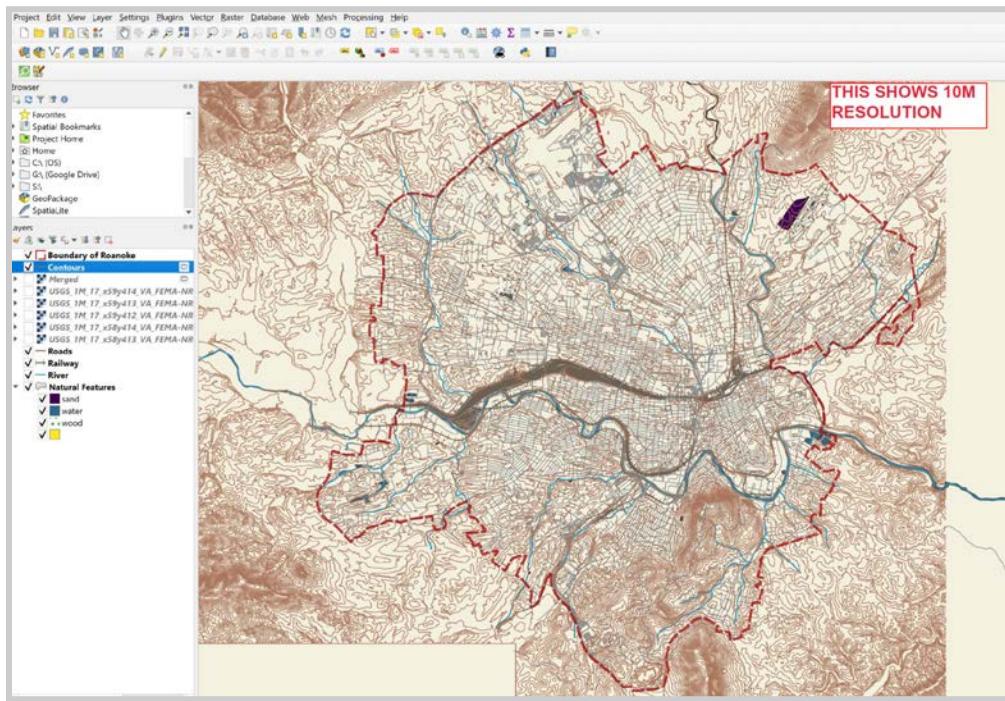
3b In the top menu, go to **Raster > Extraction > Contour...**



3c For “Input Layer”, select your DEM layer. Choose an interval for your contour lines. Since each DEM is 10 kilometers wide, it can take a long time to draw contour lines at small intervals. For the sake of this exercise, you can leave the interval at 10 (meters), or make it smaller (5 meters; you could go down to 1 meter, since the data we downloaded is 1 meter resolution – but this will look busy in the hilly area, take a long time, and be data-heavy). Finally, click “Run” to create the contours layer. **This may take several minutes.**



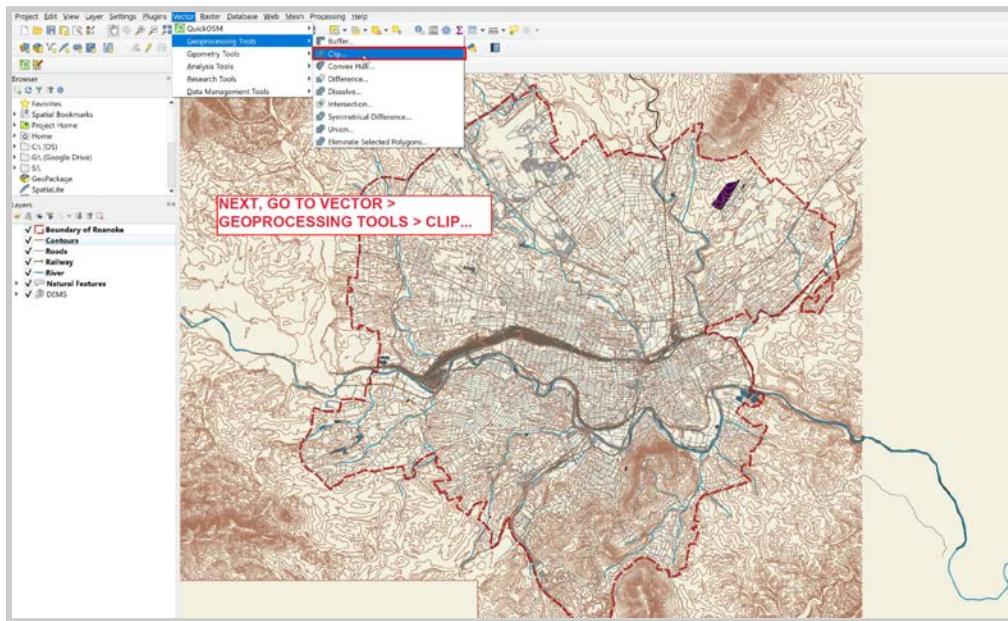
Here you can see the 10 meter contour intervals:



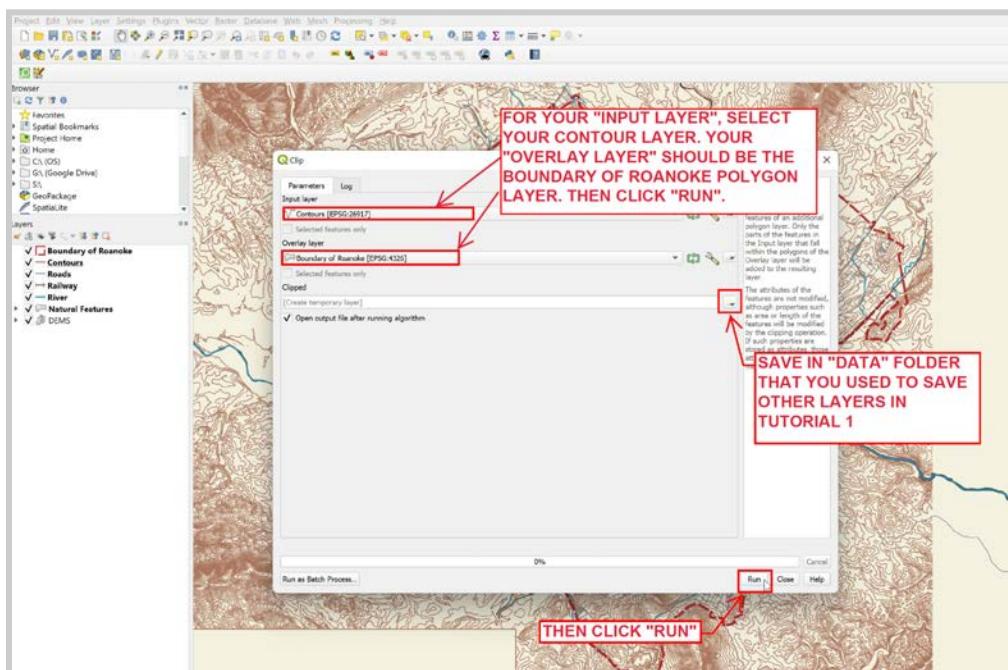
#### Step 4: Use the City boundary to clip your contour lines.

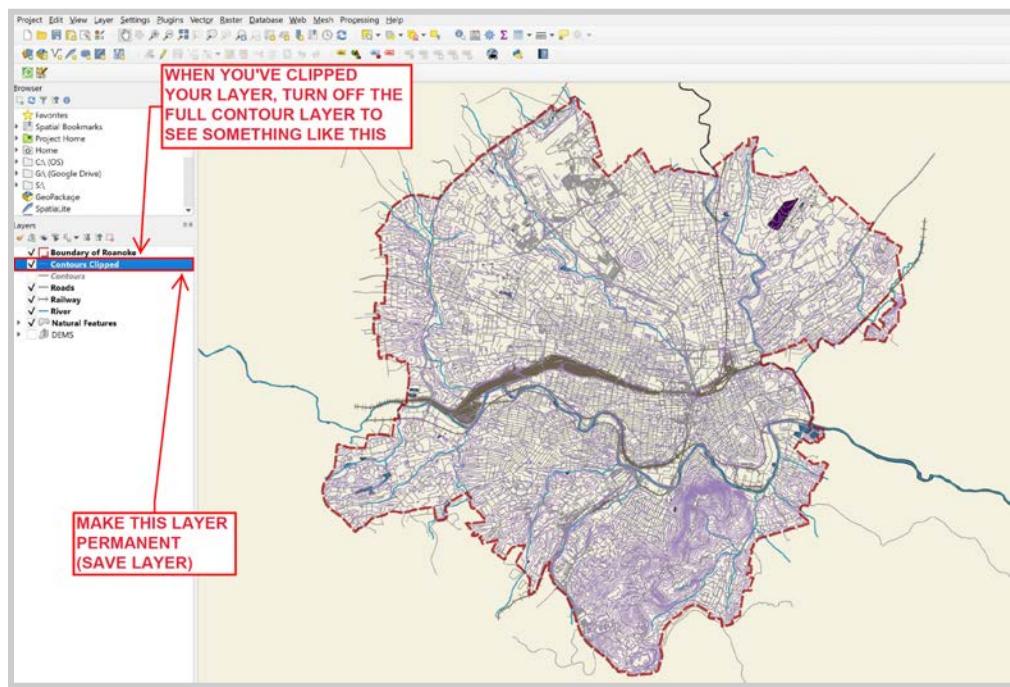
Note: use the administrative boundary **Polygon layer**, not a polyline layer, since Q searches for overlap.

4a In the “Vector” menu, select “Geoprocessing Tools” > “Clip...”



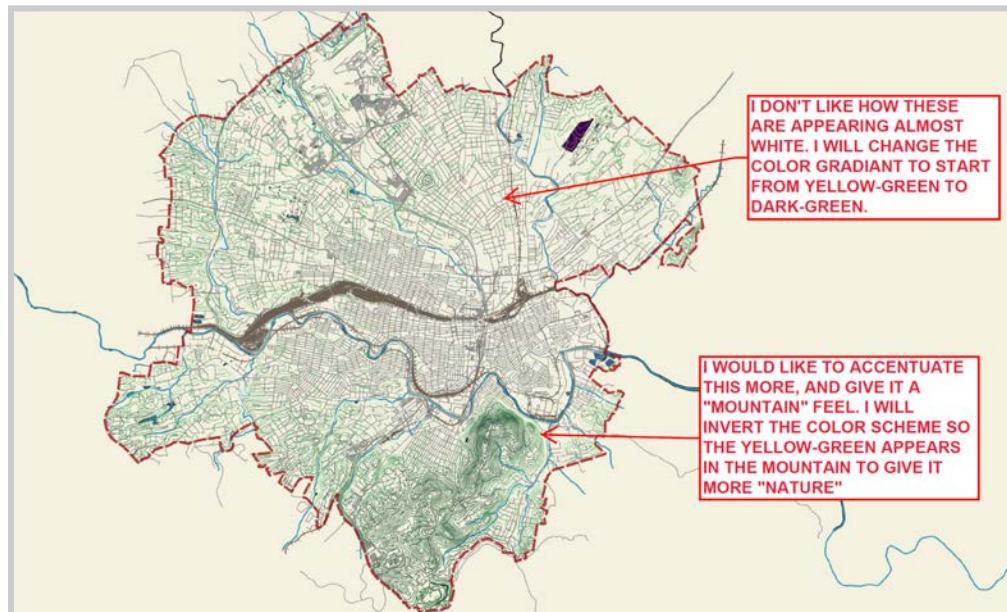
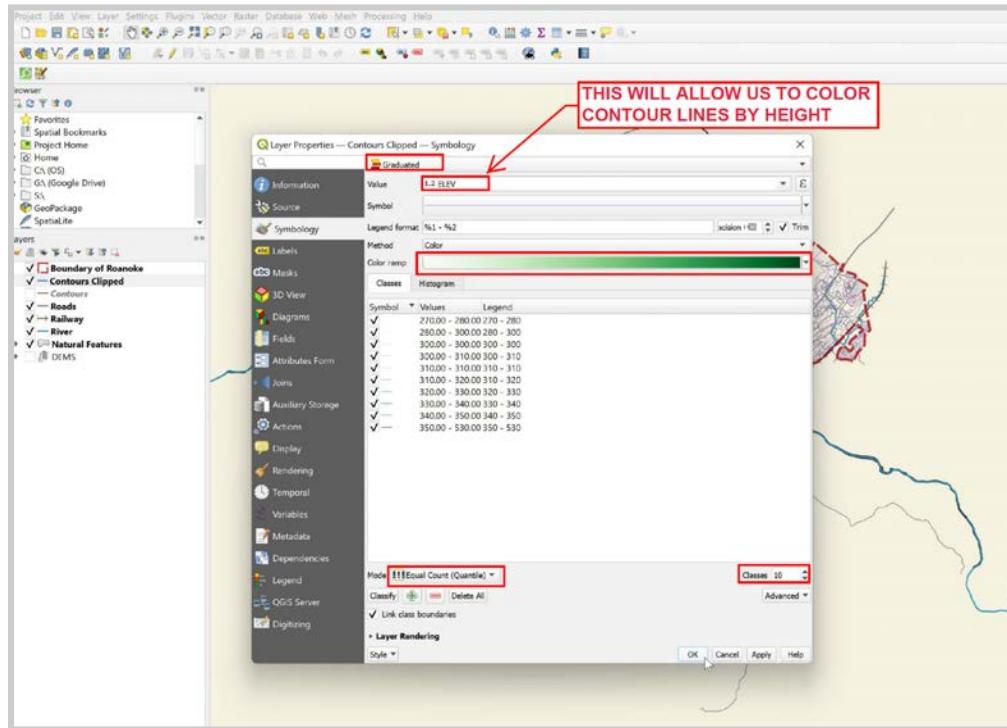
4b Add the contour layer for “Input Layer”, and the city administrative boundary for “Overlay Layer”. Click the ellipses (...) right of “Clipped” and name your new layer, and save it in your data folder. Click “Run”.

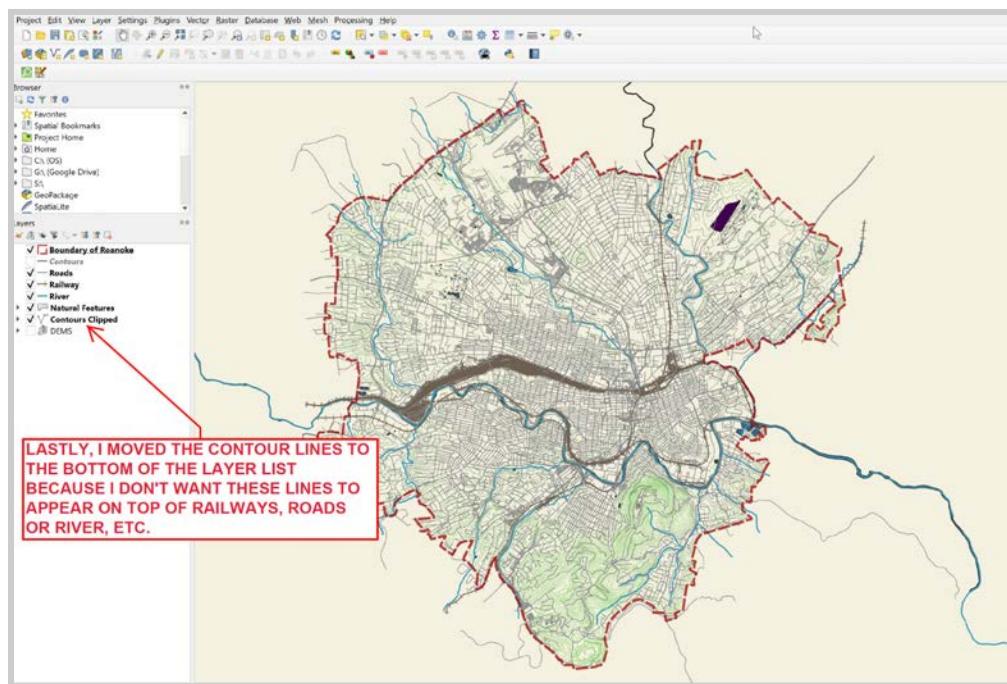
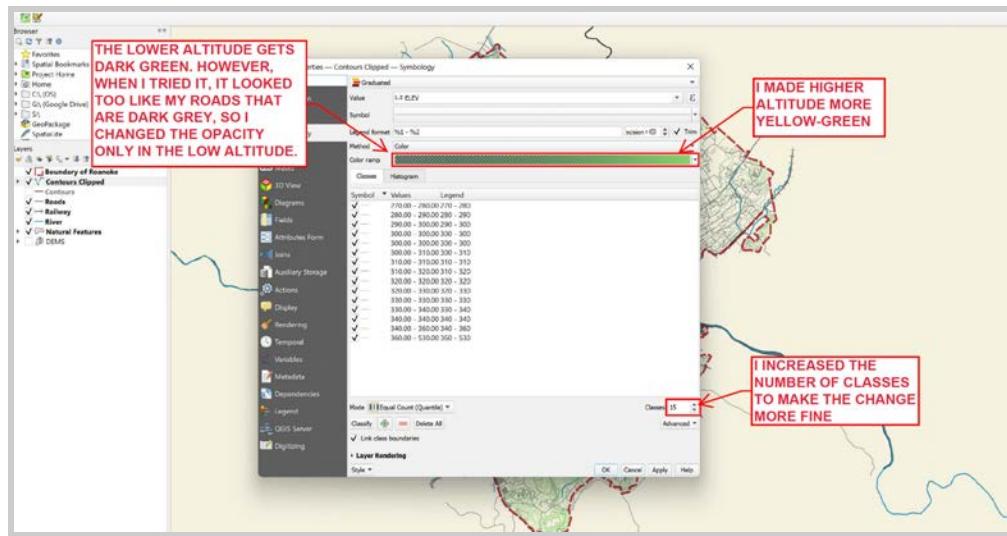




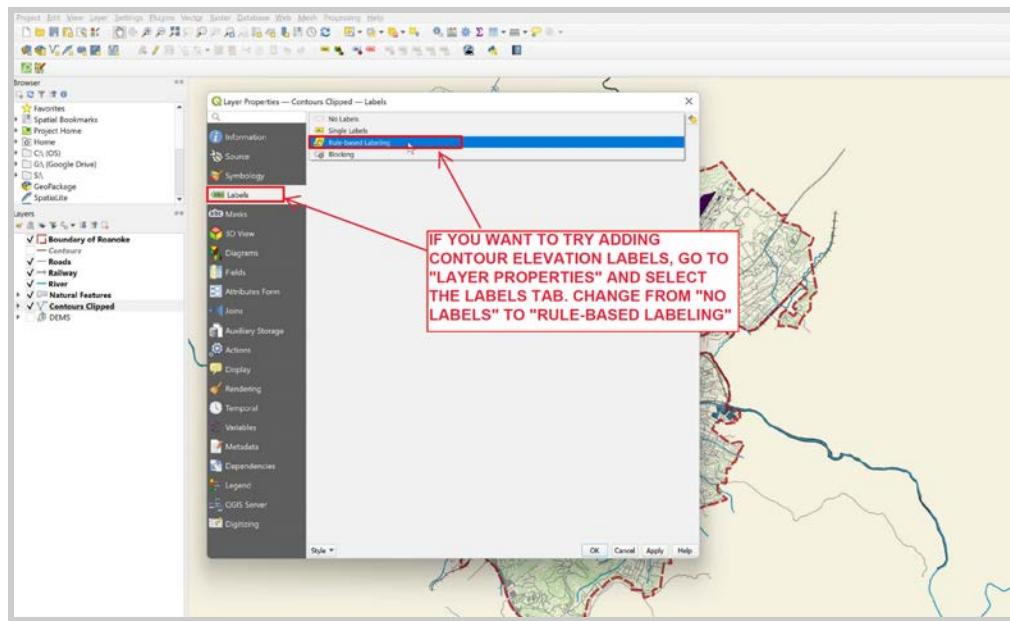
### Step 5: Style contour lines. Try adding elevation labels.

5a Style contour lines based on their height using the “**Graduated**” style (which colors by a number property). Select “**ELEV**” for Value. Make sure your “Mode” (lower left) is set to “Equal Interval”.

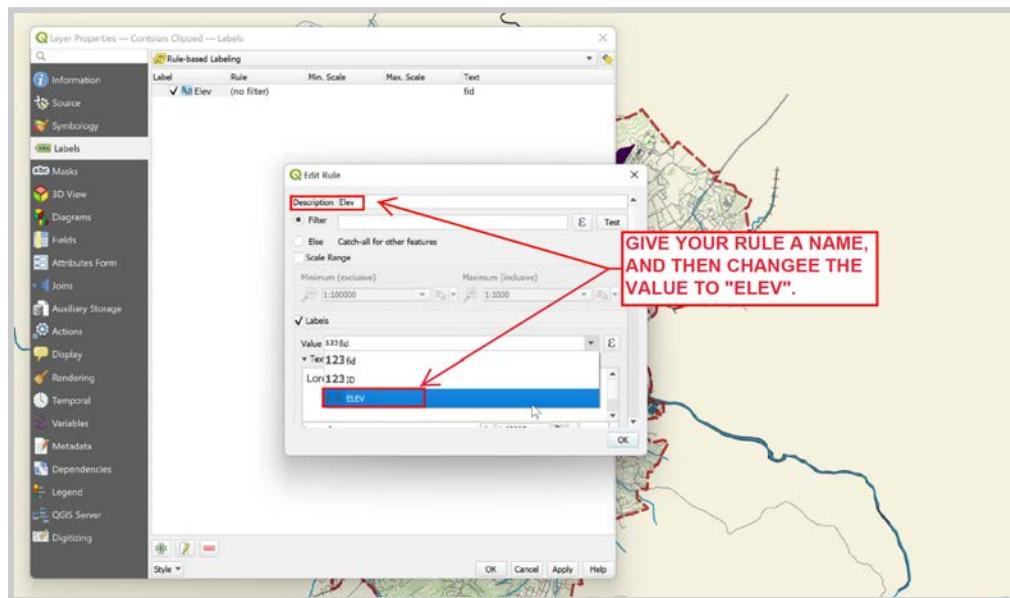


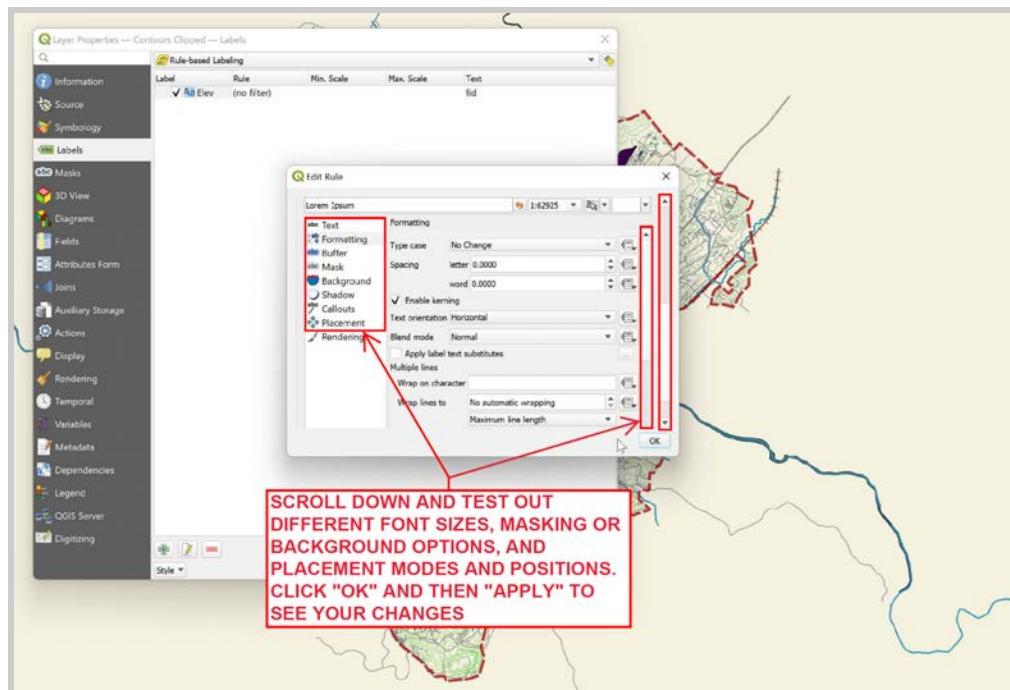


5b Try also adding **labels** to indicate contour elevation. In “Layer Properties” you’ll see a “Labels” tab. Select “Rule Based Labeling”.

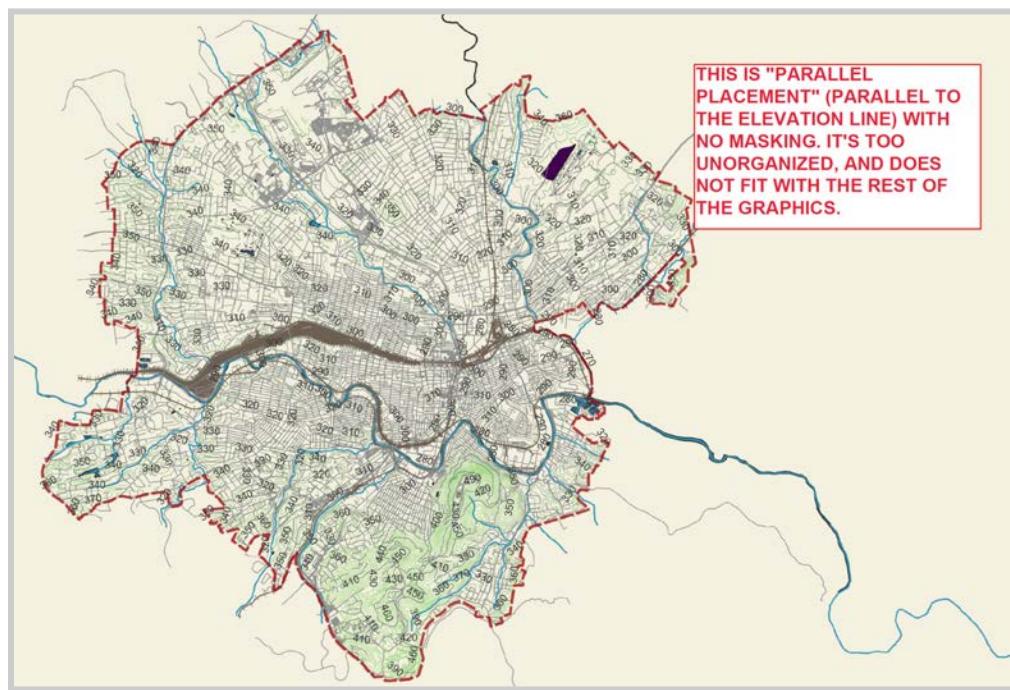


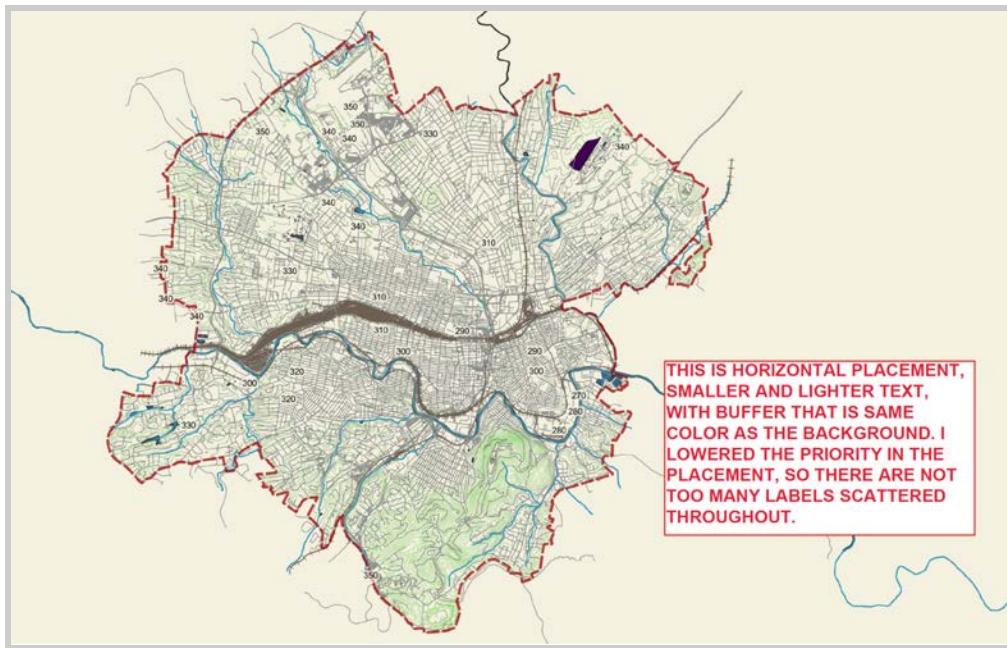
Click ‘+’ at the bottom to create a new rule. Name your rule and select “elev” as the “Value”. Try different appearances with “Text”, “Formatting”, “Placement”, “Mask”, and so on.





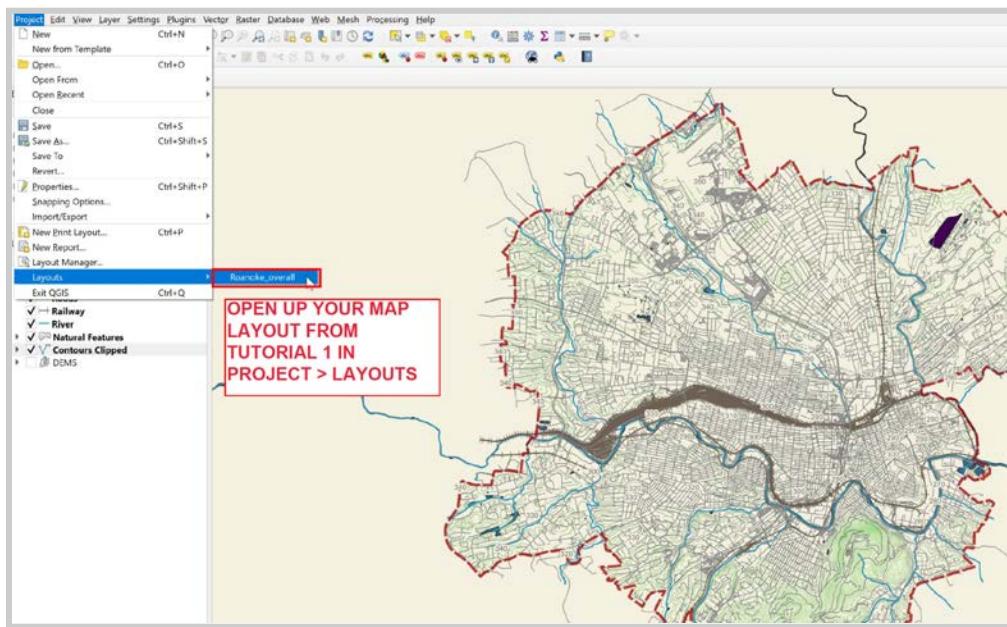
See a couple examples of label graphics:



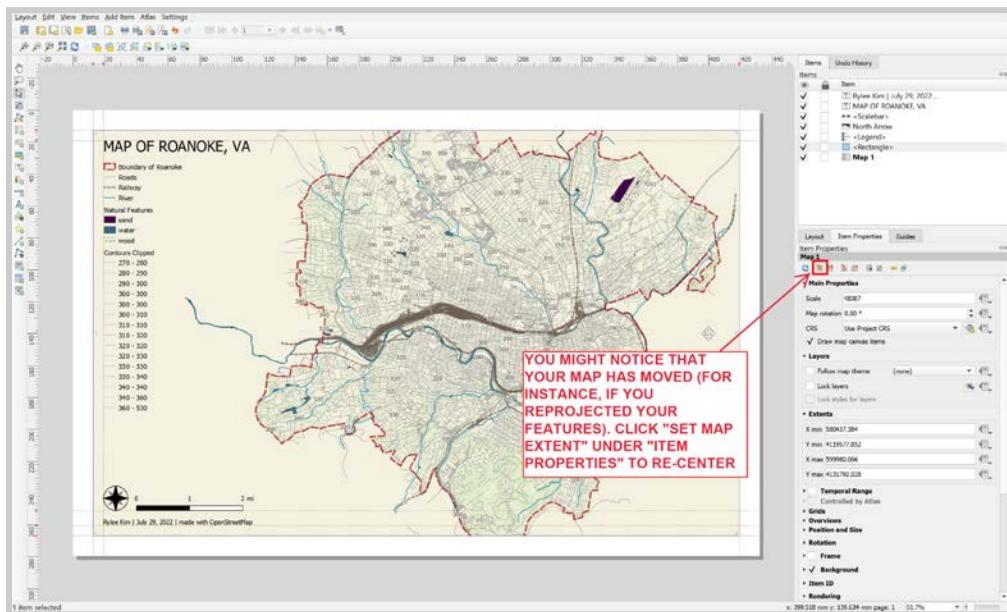


### Step 6: Re-export your PDF map.

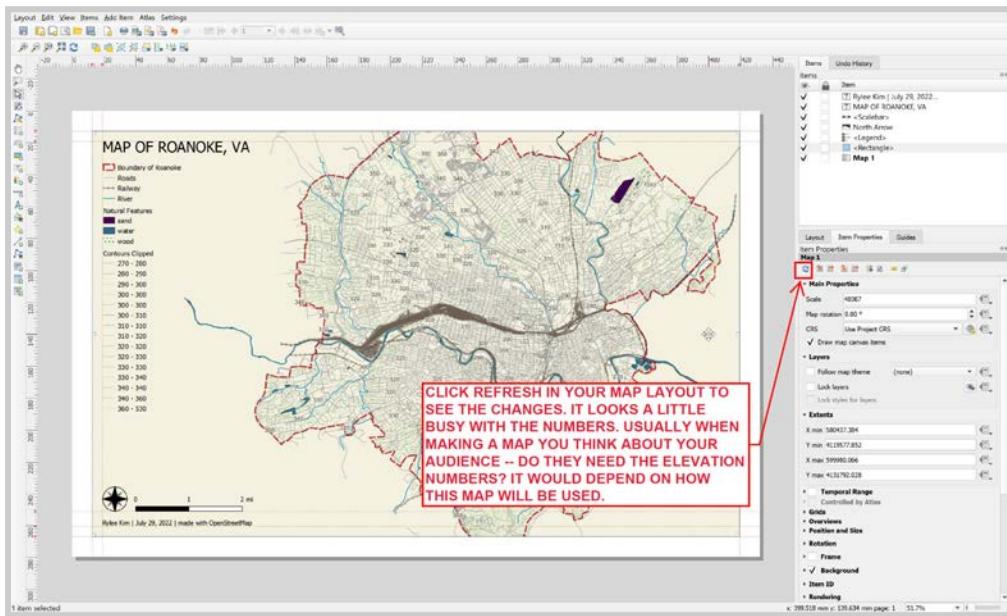
6a Open your Map Layout from last time (“Project” > “Layouts”)



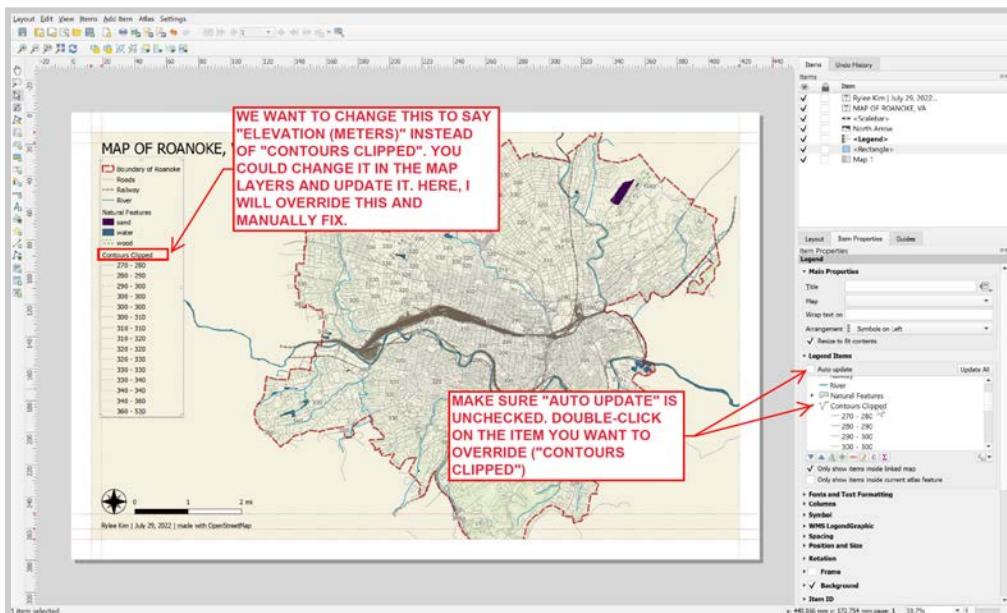
6b You may need to reset your map with the “Set Map Extents to Match” button in the “Item Properties” window.

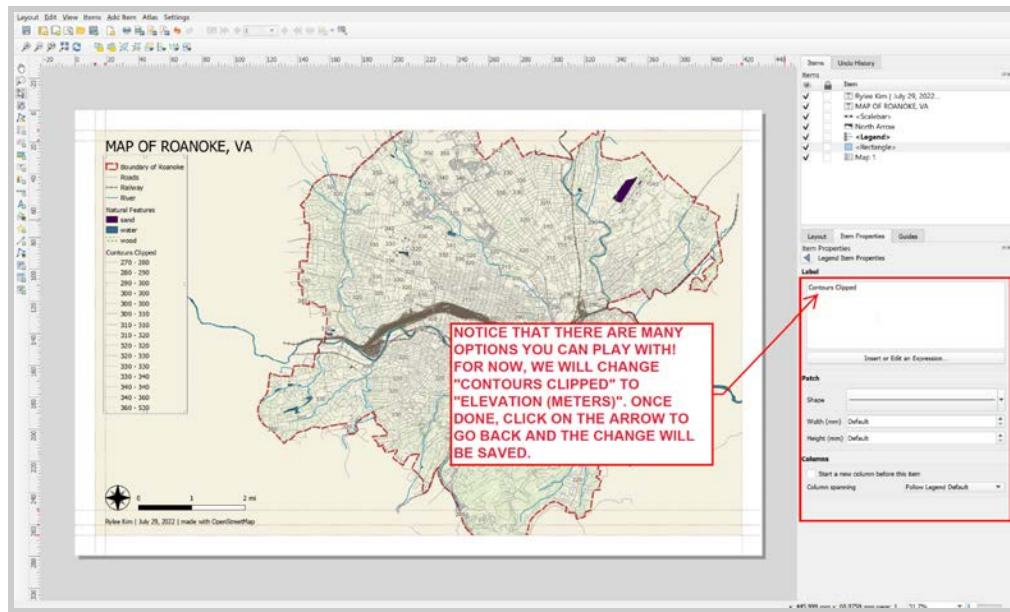


Try “Refresh” if you’ve made changes to your map that haven’t shown up.

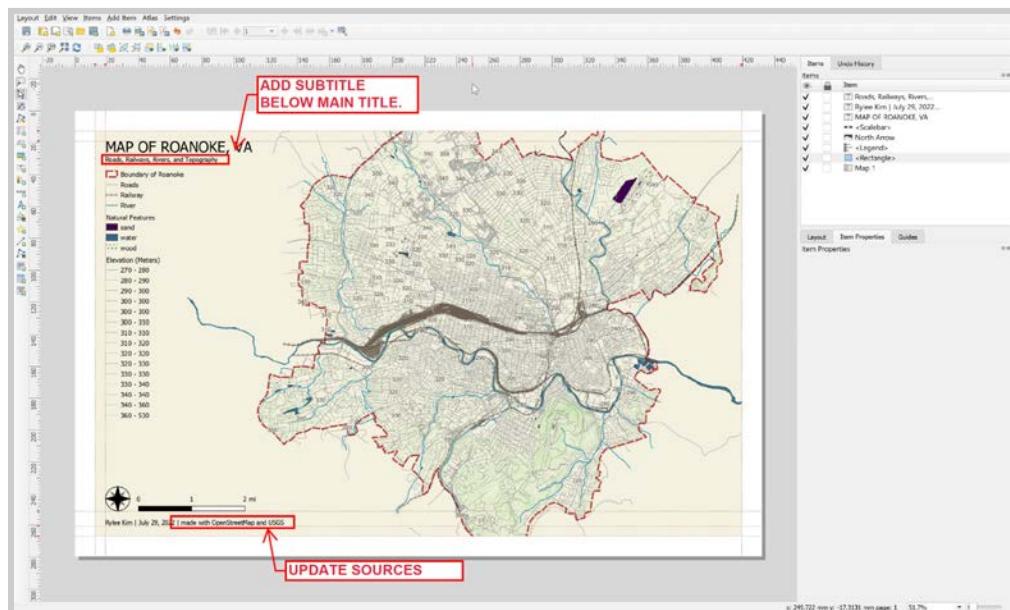


6c Check your updated **legend** and make sure each legend entry is clear and correct. Make sure that **units** in the topo legend are clearly labeled as meters. Manually edit it as needed.





6d Before exporting your map as a pdf, make sure to check the **scale, legend, title, and sources are updated**. The title for this map should reflect the new information (topo) that you've added. Add a **subtitle** to draw attention to relationships that you notice between the topography and the roads / natural features / other information in the map.



- Bonus -

**Step 7:** Examine how your previous data correlates to the topography. What kinds of road grids are on steeper or flatter ground? How do rivers relate to the topography? How does the railroad? **Visually identify** interesting topographical patterns.

**Step 8:** Add at least **three new zoomed-in maps** showing the patterns you identified. Remember to check the “Lock Layers” box in the Item Properties of your overall map to keep it from changing.

**Step 9:** On your overall map, draw a **dashed rectangle** showing where each zoomed-in map is located.

**Step 10:** Add a **short text description** below each map that describes the pattern you see. Make sure to include, as always, a north arrow, scale, title, subtitle, and byline. Export your map as a pdf.