3D Printing Maps for The Visually Impaired.

GIS-SIG Annual Conference 2023

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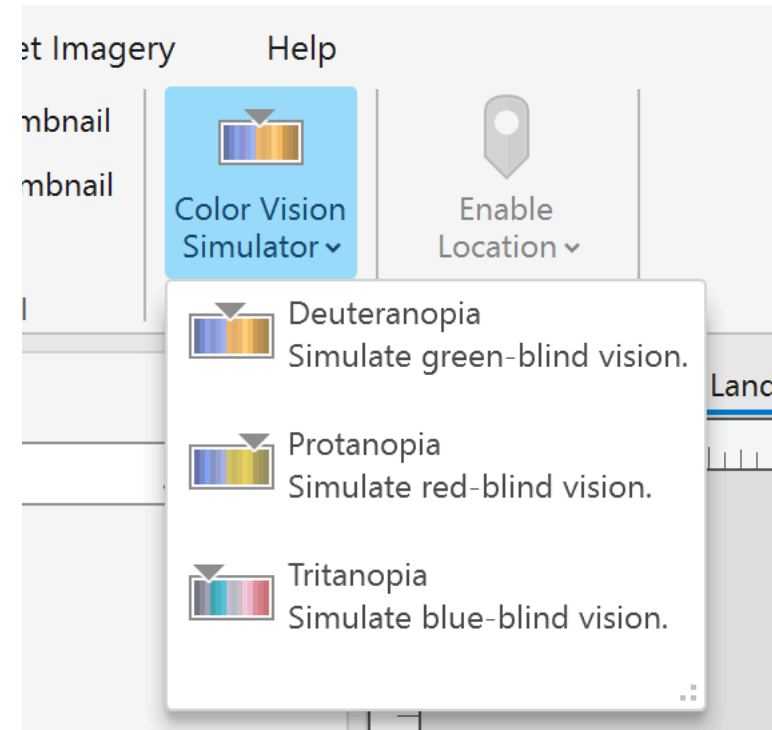
Introduction

- GIS can produce some outstanding visual maps

- We can use different tools within the software and from other sources that can help with some of the visual limitations such as color blindness or using a screen reader

  - Colorbrewer has colorblindness-friendly options

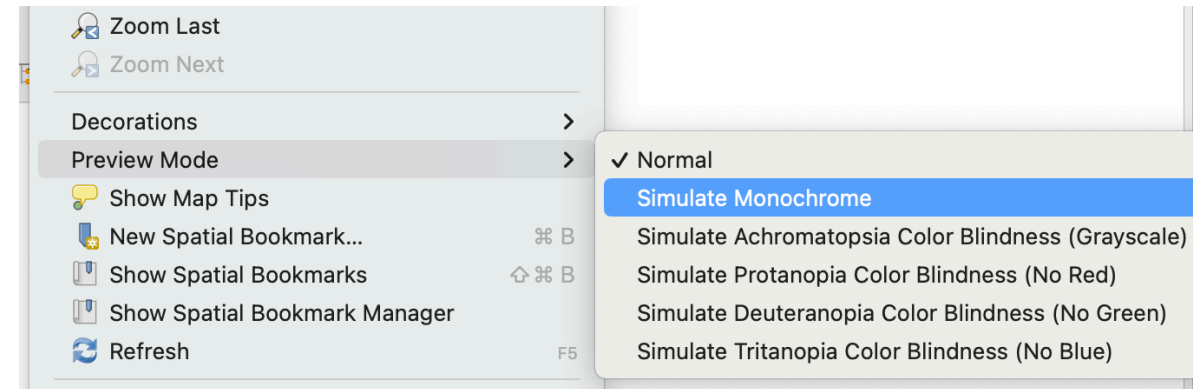 - ArcGIS Pro and QGIS have a colorblind preview option

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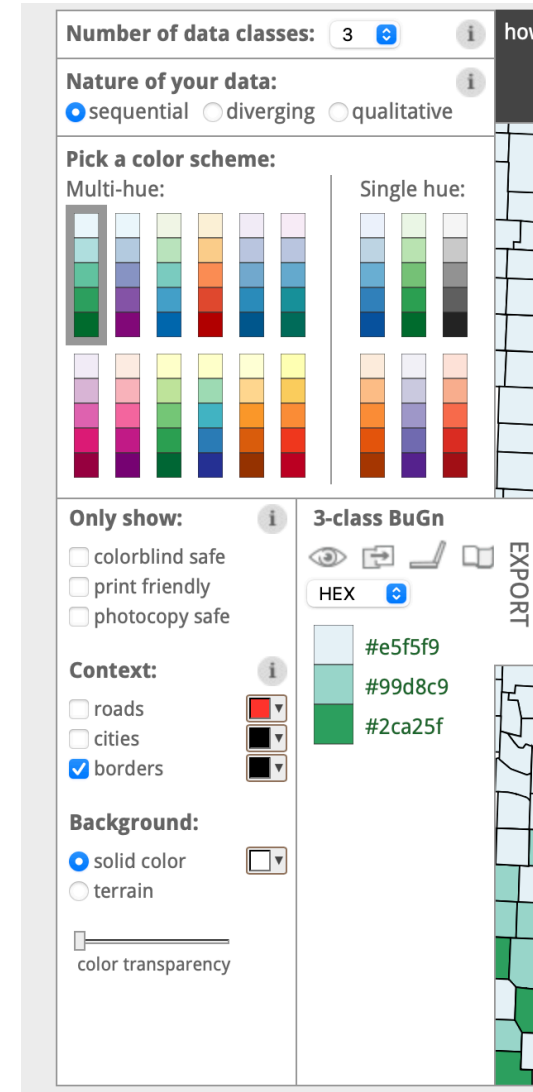
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  - ArcGIS Pro and QGIS have a colorblind preview option
    - ArcGIS Pro's tool is found in the View Ribbon
    - QGIS's tool is found in the View Menu
- But none of these tools are for people who have more severe visual impairments
- Using 3D Printing Technology along with GIS we can bridge this gap and make our maps more accessible

The Process of Creating a 3D Printed Map

- The process for creating a 3D printed map is mostly straightforward if you are familiar with Raster datasets

- Currently, there is no direct export for a 3D-printed file format in any GIS software

- But there is a tool in QGIS called DEM to 3D which provides a similar functionality

  - You need to have a processed elevation model with all of the different design elements already embedded into it

- Once you have the 3D print file you will still need to use a 3D modeling software and 3D splicing software to print the model

- 3D printing is not a fast process and depending on your model it can take a while to see the finished product.

The Example

- In this presentation, I will go through the different steps needed to create a trail map that shows the elevation of Oatka Creek Park
  - Some of you may have seen this map at last year's conference
- The layers that will be used are the Monroe County LiDAR, Park Boundary, and Trails available from https://www.monroecounty.gov/gis-Data
- You will also want a Braille font which you can get from https://brailleinstitute.org/freefont
- I did most of the processing and cartography in ArcGIS Pro
  - You will need 3D or Spatial Analyst for the steps
  - You can also use vector data instead of an elevation raster, you just need to have a raster to add layers, much like a layout.
  - ArcGIS Pro's Label Engine works very well for this kind of project
- You can do the process all in QGIS
- 3D Printers also have a limited size/resolution that they can print so make sure to keep that into consideration when exporting files

Area of Interest

- Before you get started using a reference layer (Park Boundary) to create an Area of Interest (AOI) which will limit your processing area

- Using that AOI clip your base elevation layer

- **NOTE: Make sure to use good naming conventions throughout the process because you are going to be making a lot of layers**
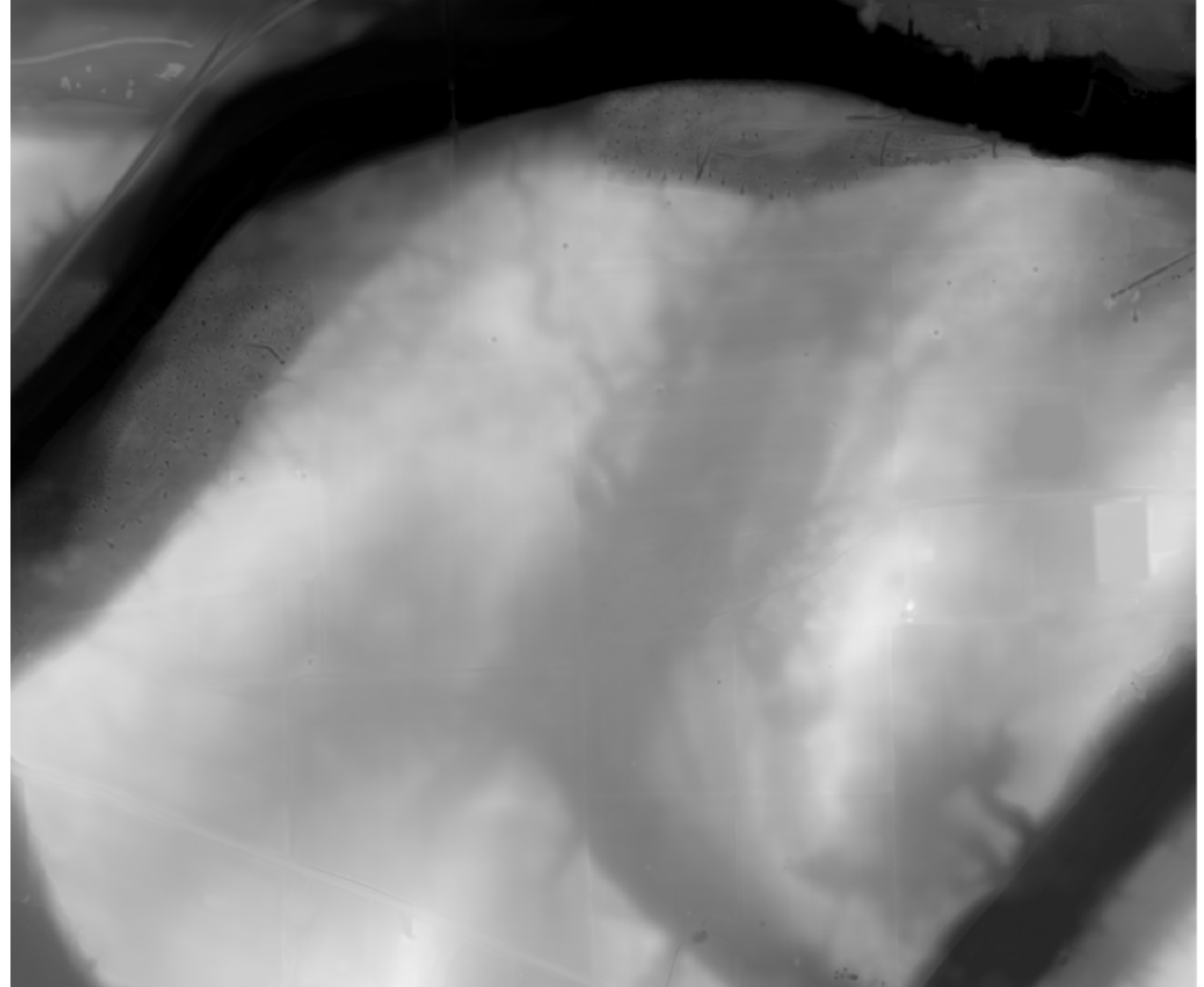
Considerations for Your Base Information

- When starting the process make sure to have a good base of information

- But you can run into issues with too much detail

- I would recommend using a bare earth model if you are using LiDAR over a surface model

- For Vector data make sure to have enough pixels to give good shapes but not too high of a resolution that you are creating large files
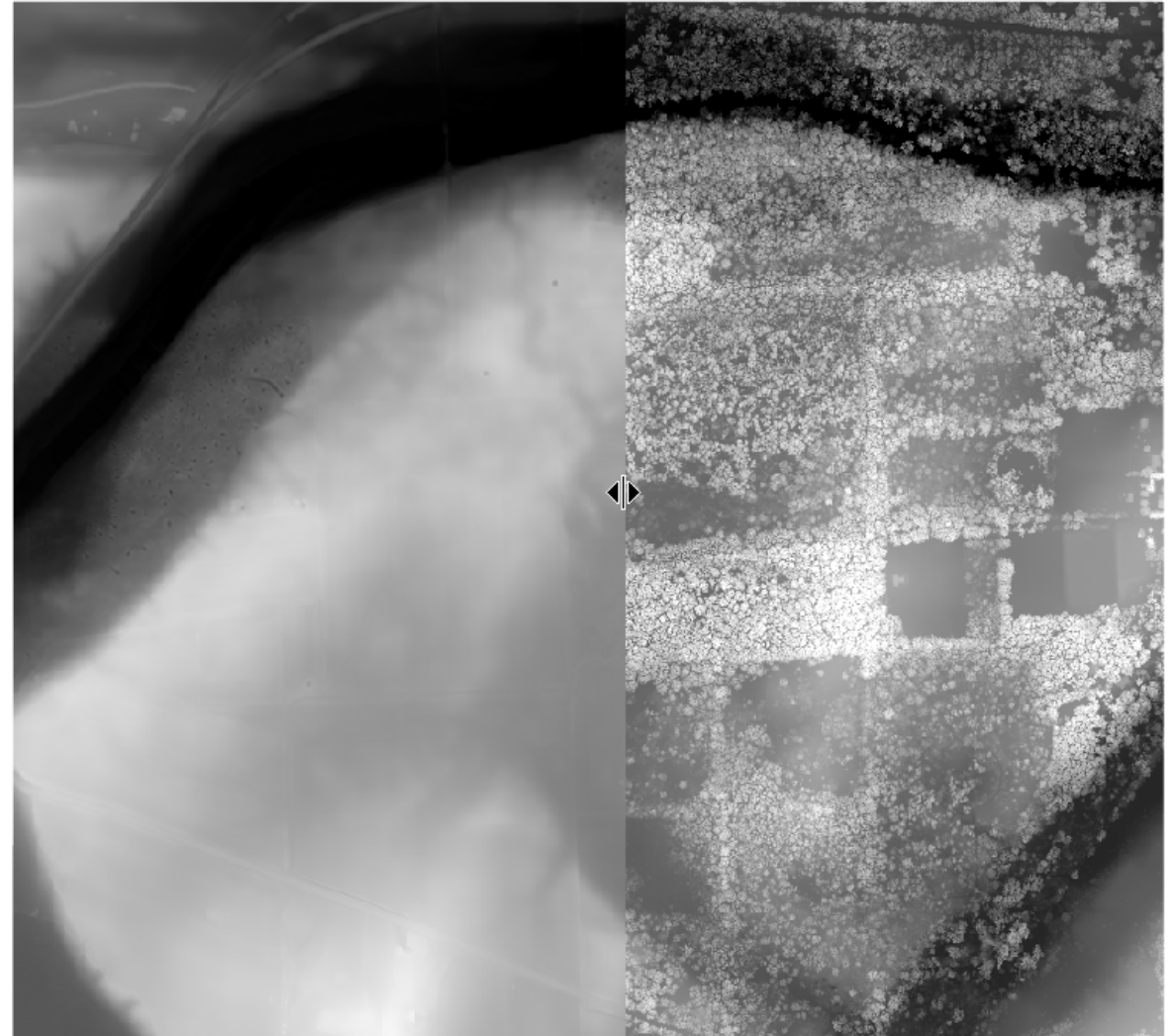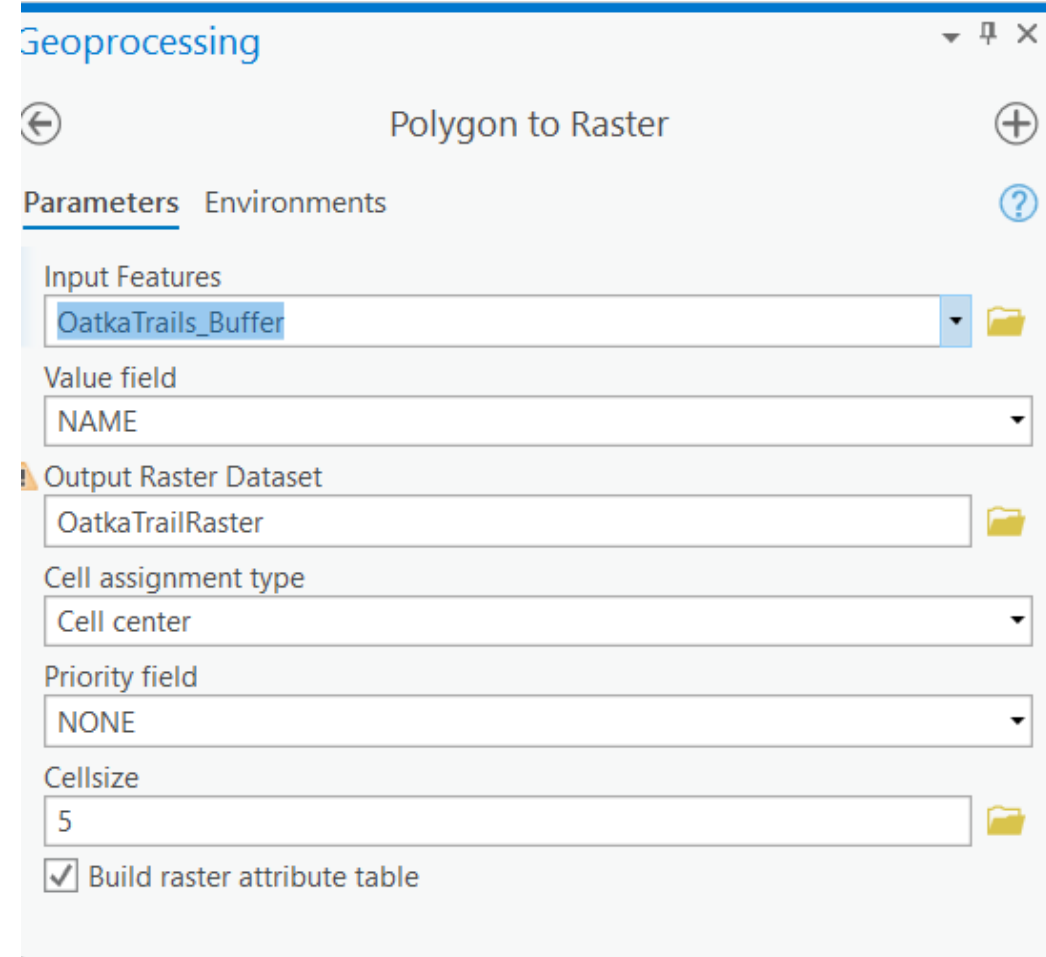
Now for the Trail Processing

- First load the trails into the project
- Vector data cannot be added to a raster layer directly so you will need to do some conversions
- The first thing is a line will need to have some kind of thickness
- Run a buffer on the line. Normally a trail may be only 6 feet wide but you need to think in terms of the raster resolution and what you think would be able to be felt by a person
  - This will take some trial and error
- For this example, a 25-foot width worked to give the best detail from the elevation
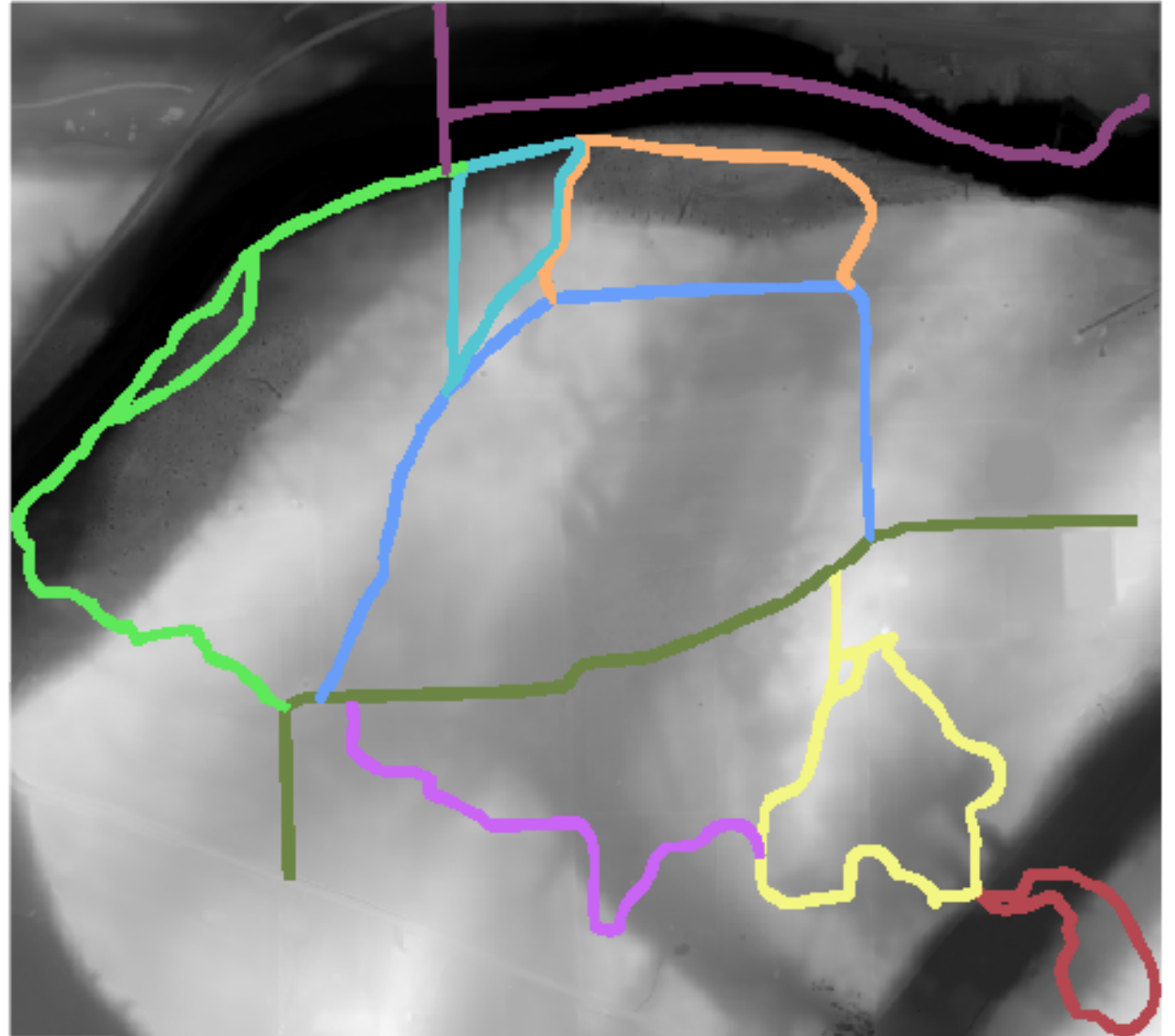
Trail Processing Continued

- Once You have your buffer create a raster of the trails and use the elevation model to populate the cell size

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- Now Reclassify the trail buffer to be the elevation off the surface of the ground

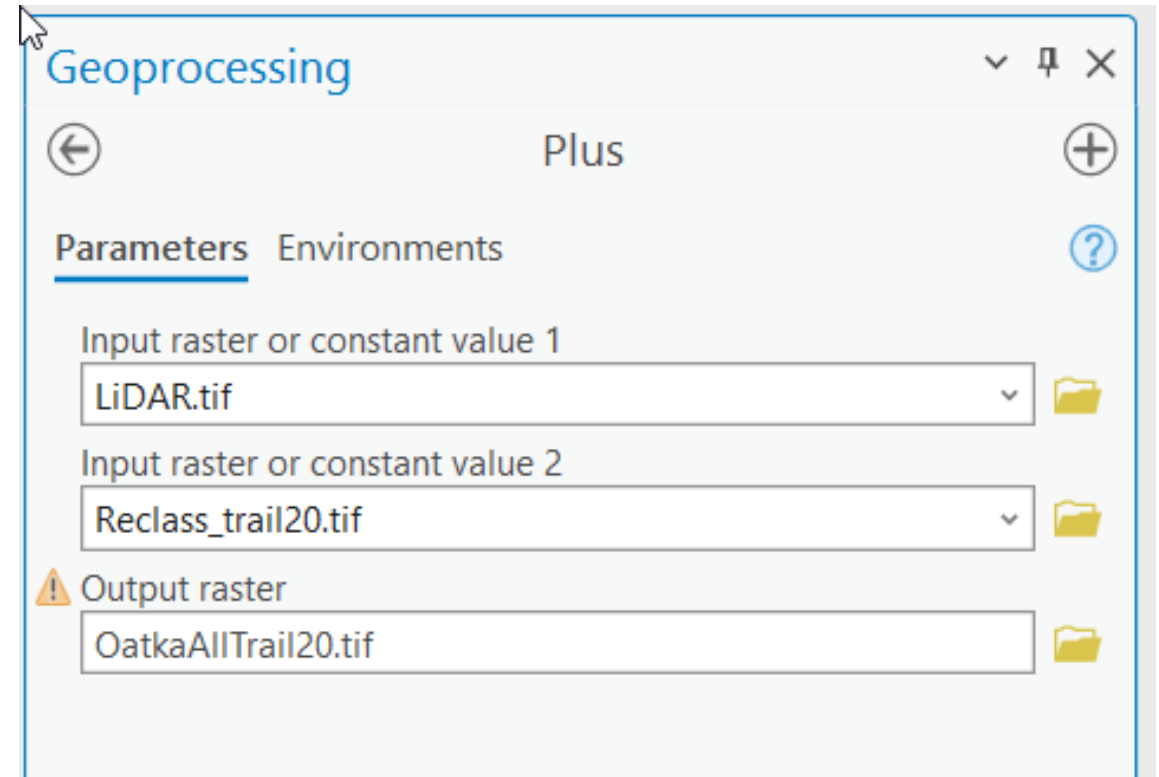 - I started with 5 feet and ended with some print tests and found 20 feet worked the best

Trail Processing Continued

- This will give a raster that has a 0 value for the background and a 20 value for the trails.

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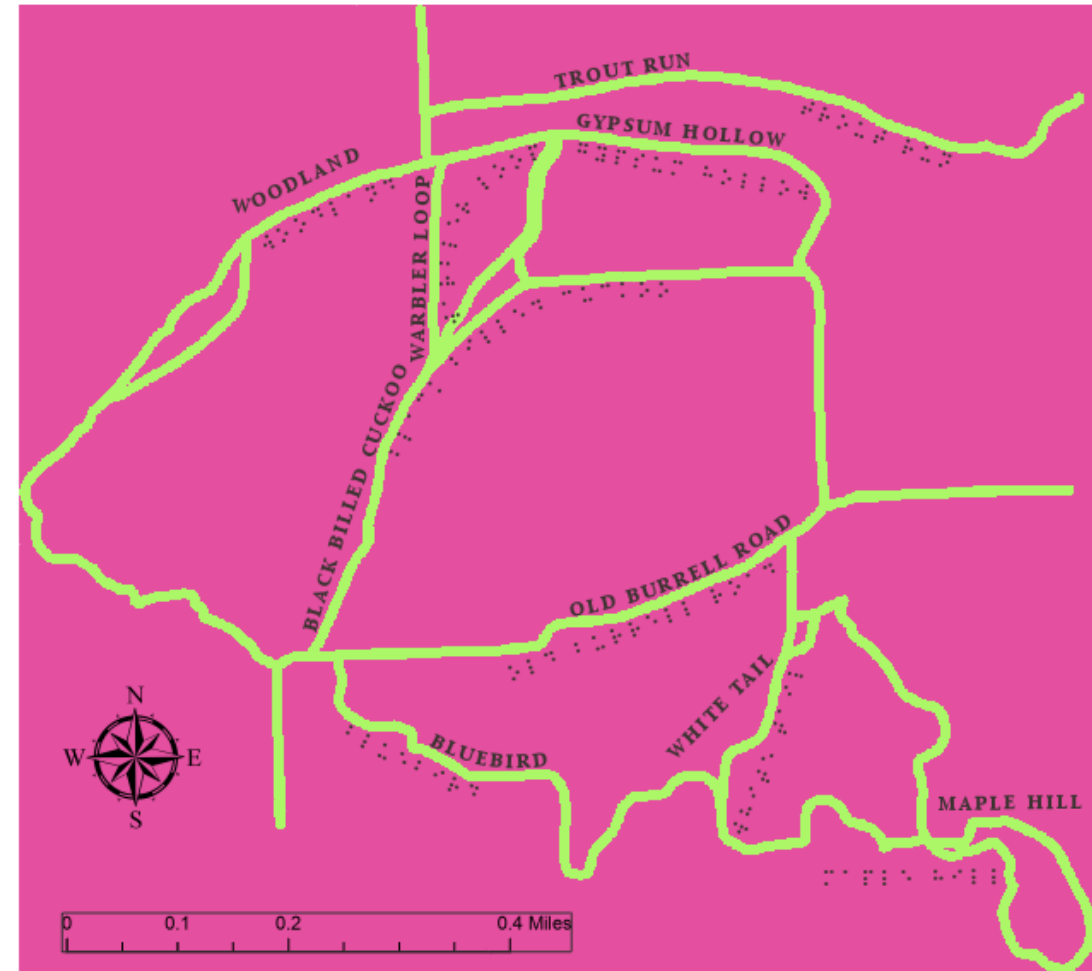- Add the Elevation Model to the trail data we just created
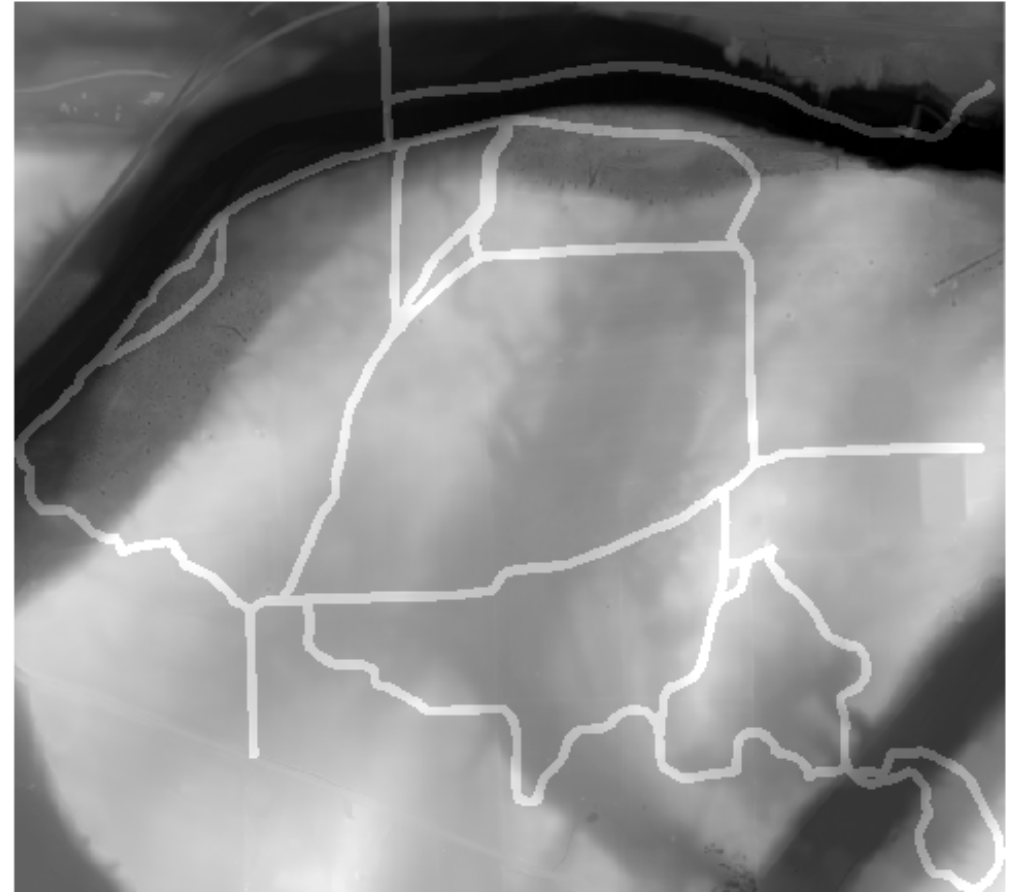
Labeling and Layout

- After getting the data ready and into the elevation model the next step is the labeling and layout.

- This is one of the hardest steps because of keeping it easy to read but also follows the trails and terrain

- For the example here I have one text in Braille and the other in Constantia just to have both forms to see how it work

- The text will need to be raised also at least 20 feet to stand out of the elevation below

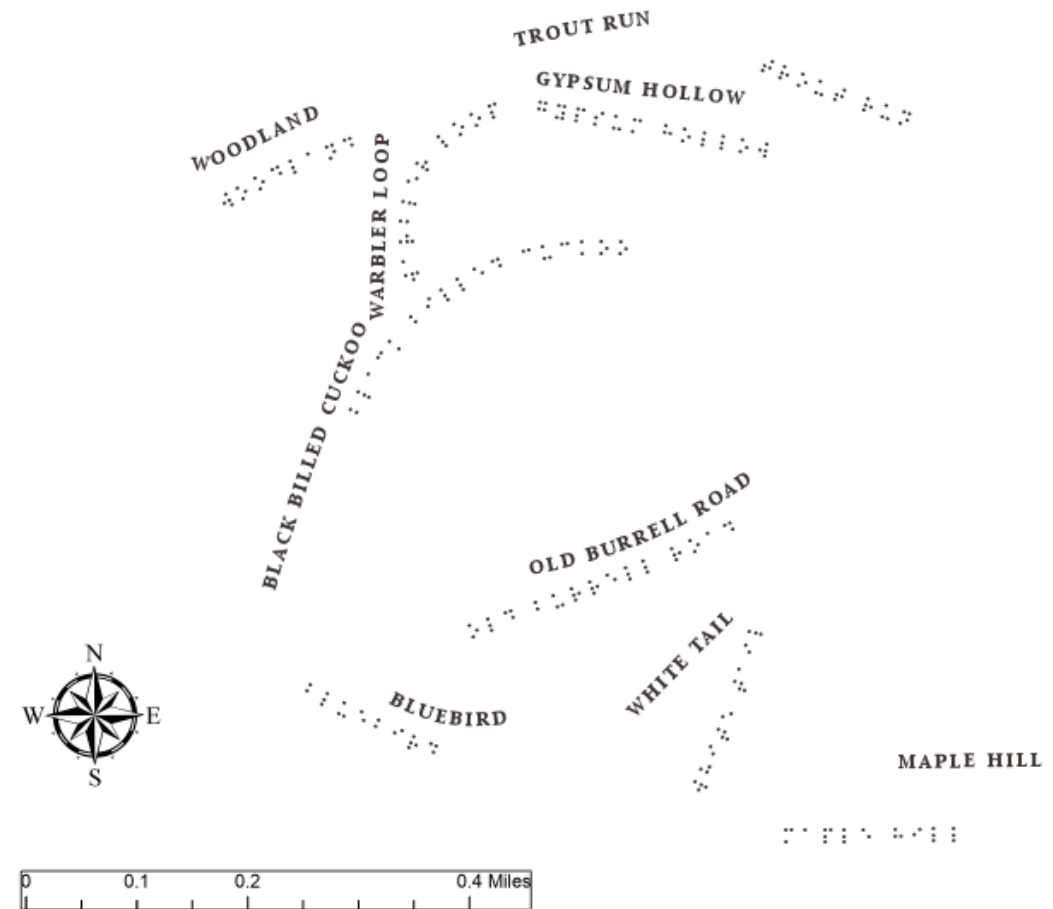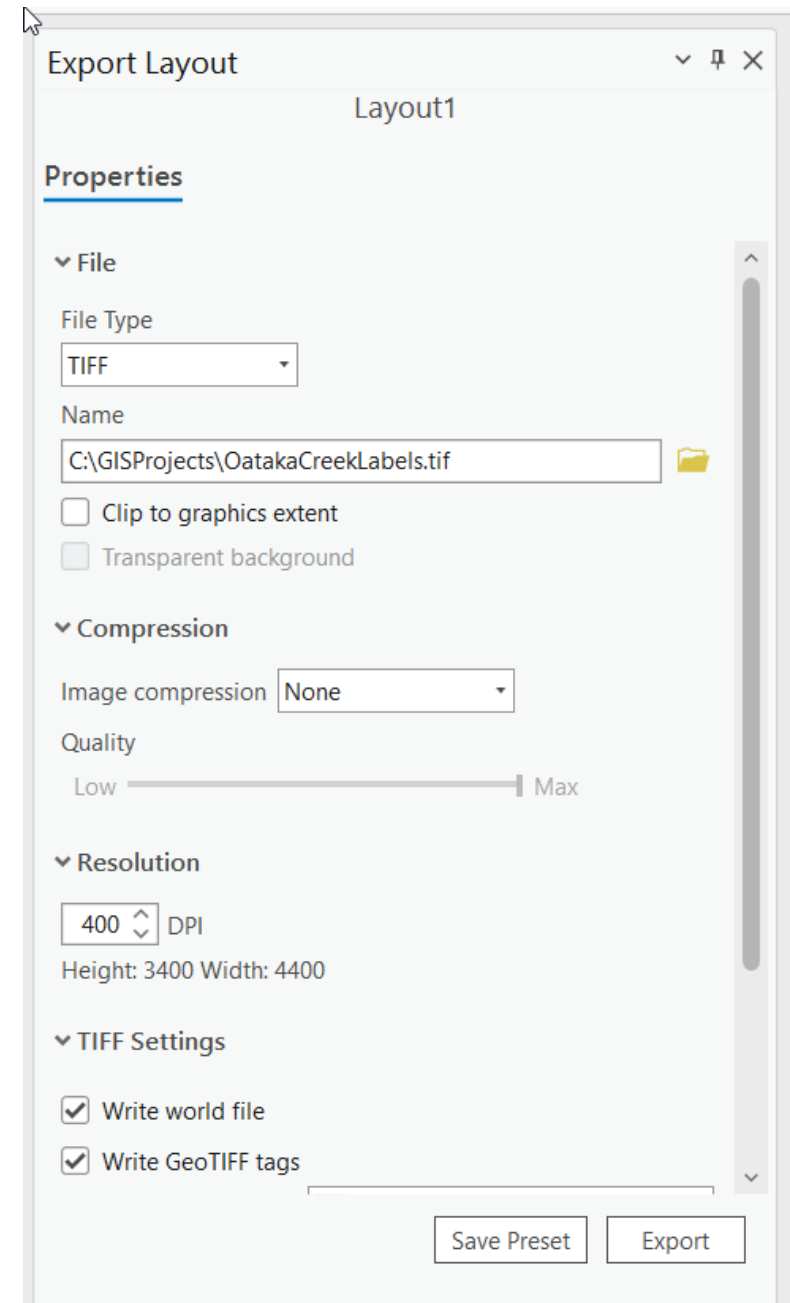- **Note: Limit the amount of labels to make it easier to use**

Labeling and Layout Continued

- Once you use the automated labels you will need to manually adjust them by converting to a graphic or annotation

- Then add any map decorations

  - I would recommend keeping the text and decorations all one color (black works)

- Turn off all background layers and export the layout as a tiff with world file

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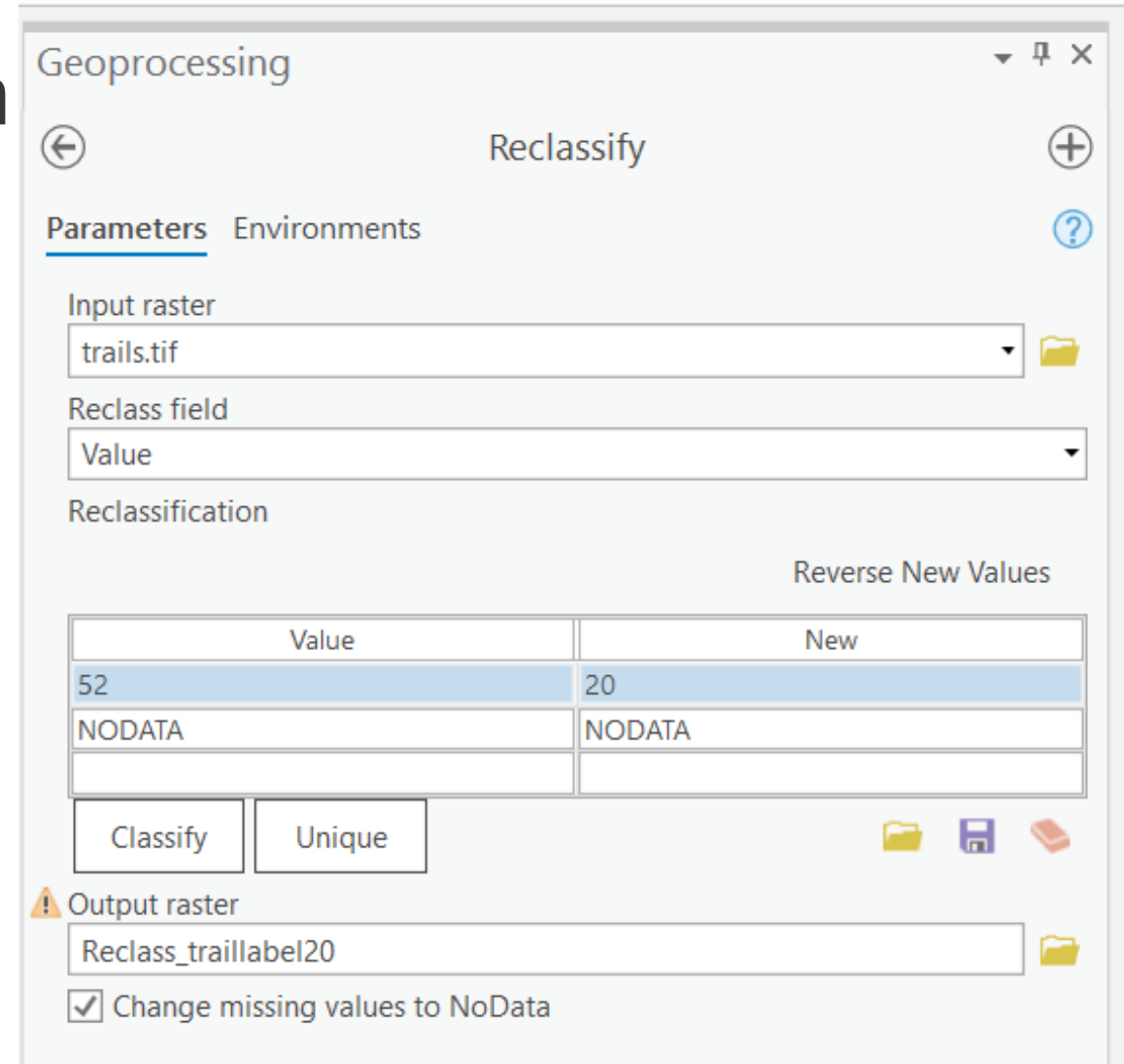- Turn off all background layers and export the layout as a tiff with world file

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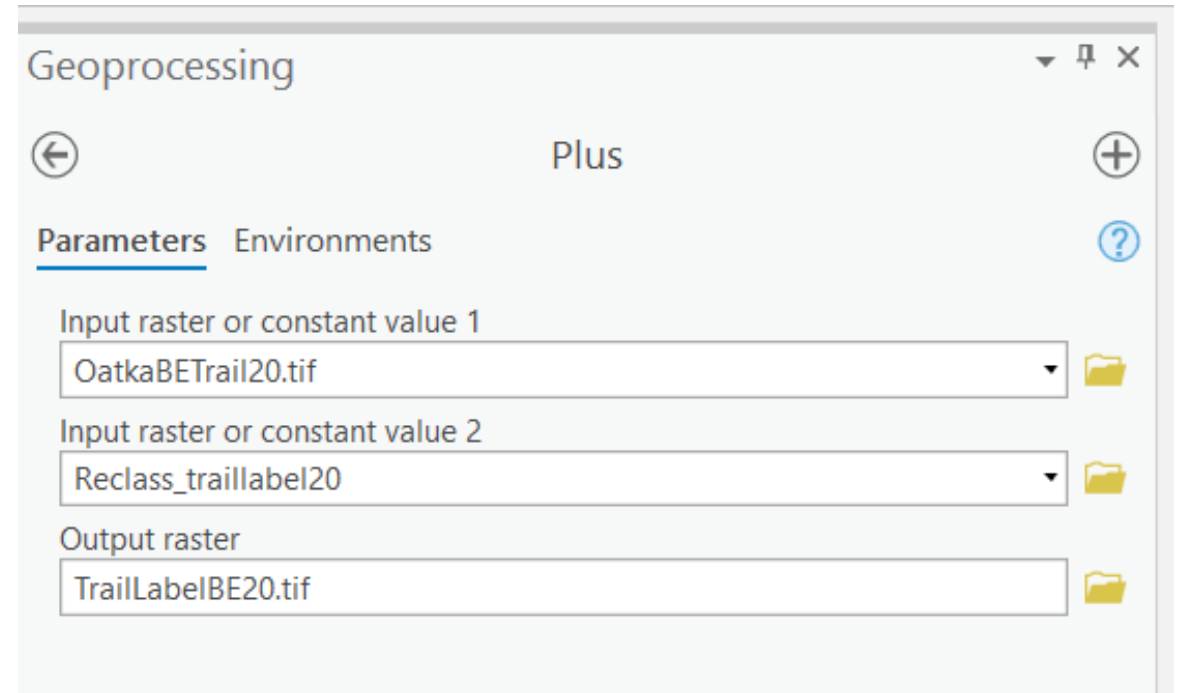
Adding the Labels Back In

- Using that tiff file you just created add it back into the map.
  - The World File will place it right where it belongs.
  - You may need to experiment with the export to have a legible raster
- Next reclass the Labels to have all the text be a value of 20
 - Most of the time a black value in a layout will be a value of 52 in a tiff

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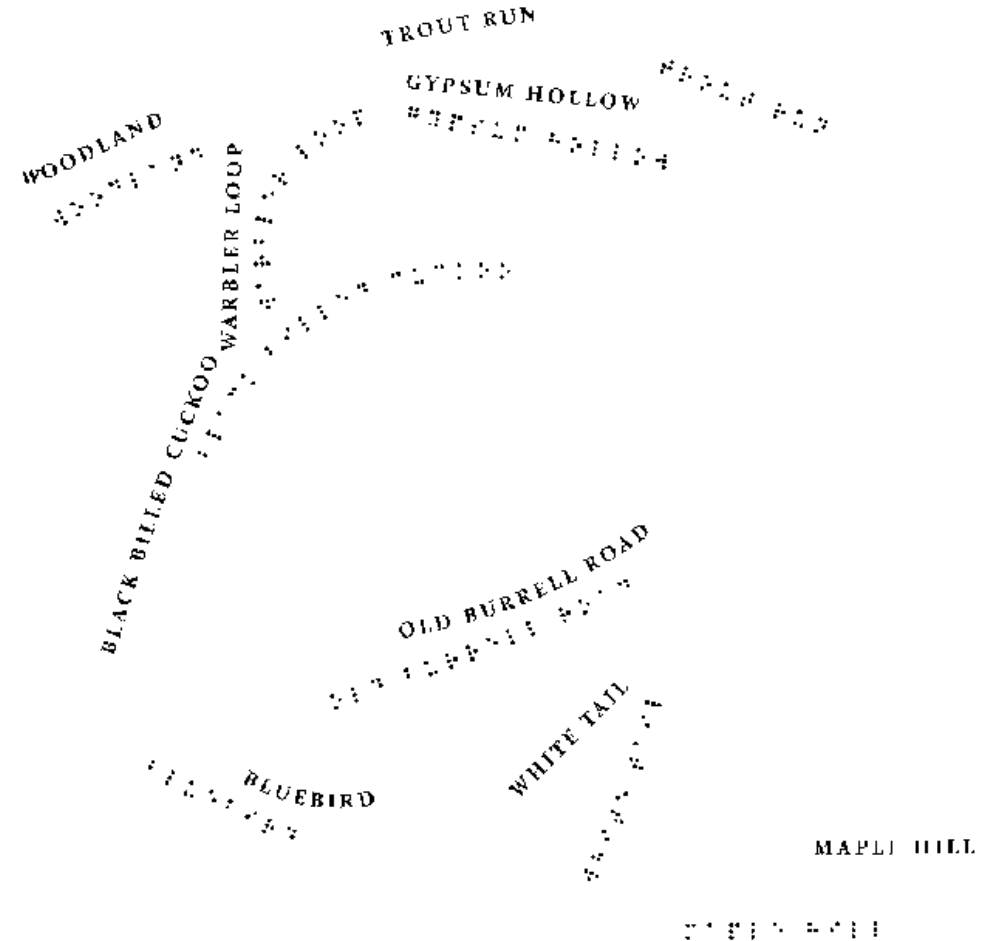
Adding the Labels Back In Continued

- Using the Addition Tool (Plus) again add the trails and the labels together

- This will create the Elevation model of all of the pieces with the text and trails elevated 20 feet
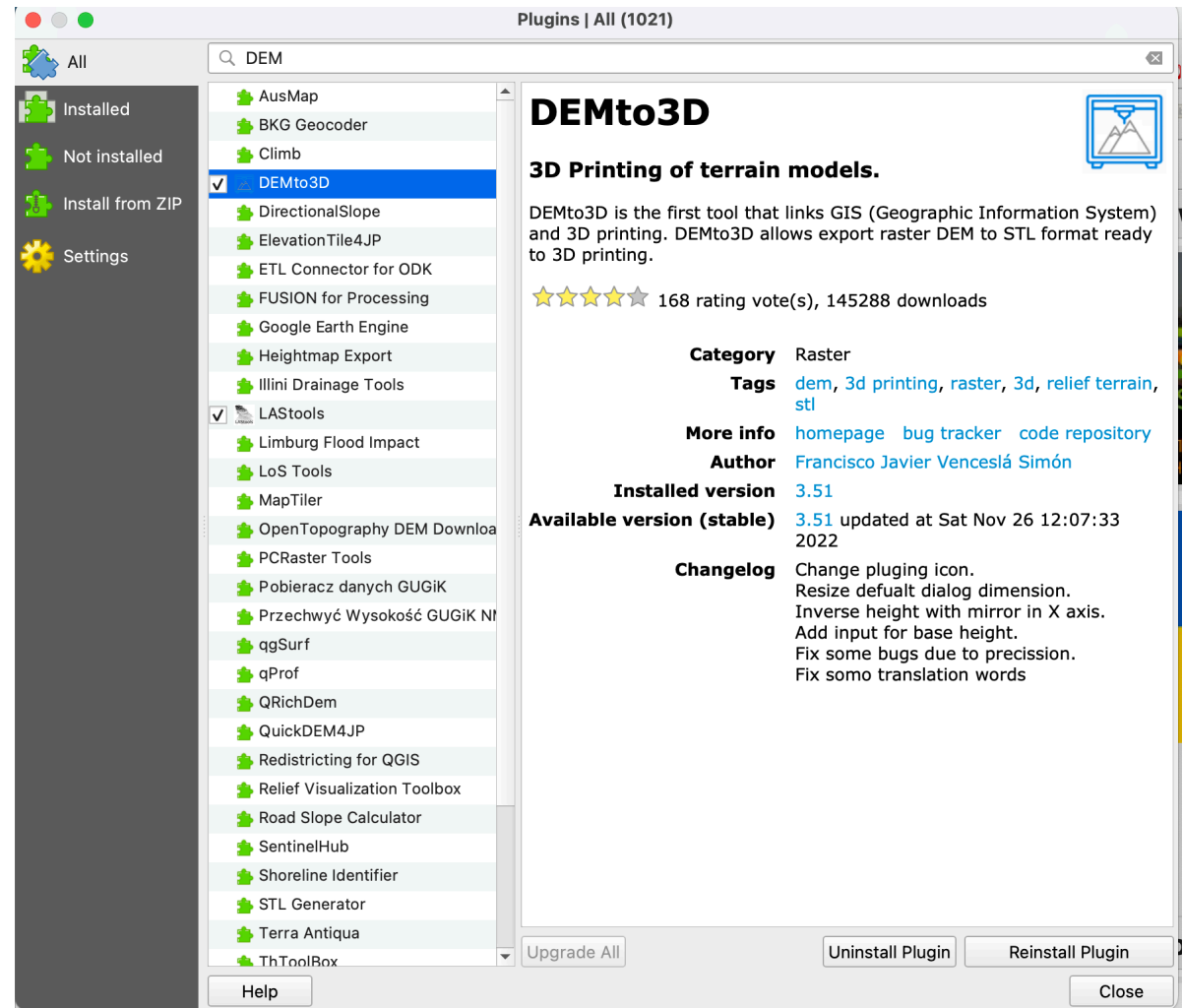
Adding the Labels Back In Continued
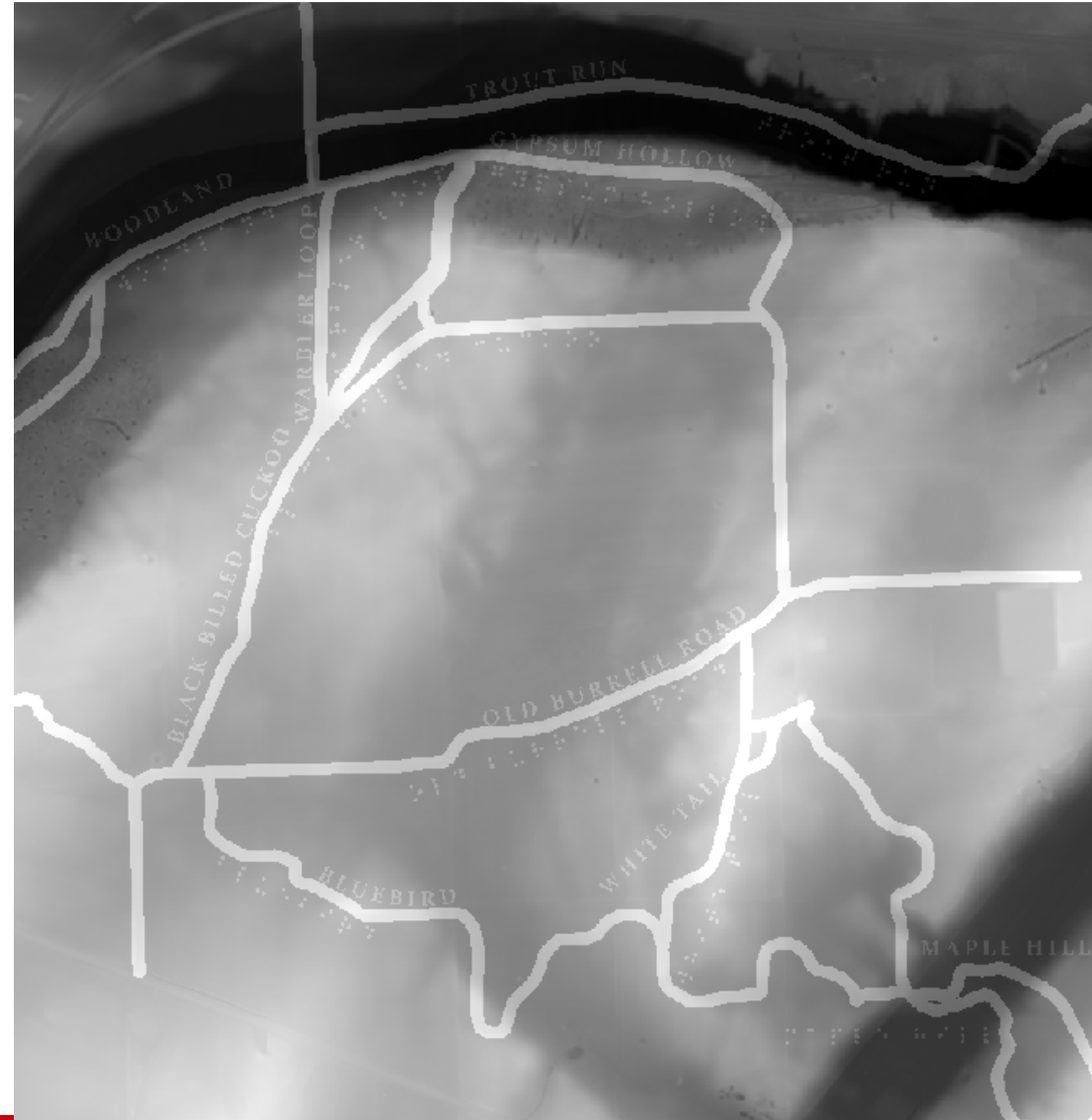
Getting the Map Ready to Print

- Now we need to get our map ready to print

- Take the Final Image from ArcGIS Pro (make sure it is a tiff file) and add it to QGIS

- In QGIS we also need a plugin because the function we want is not included by default

  - To Install the Plugin go to the Plugins Menu and Manage and Install Plugins
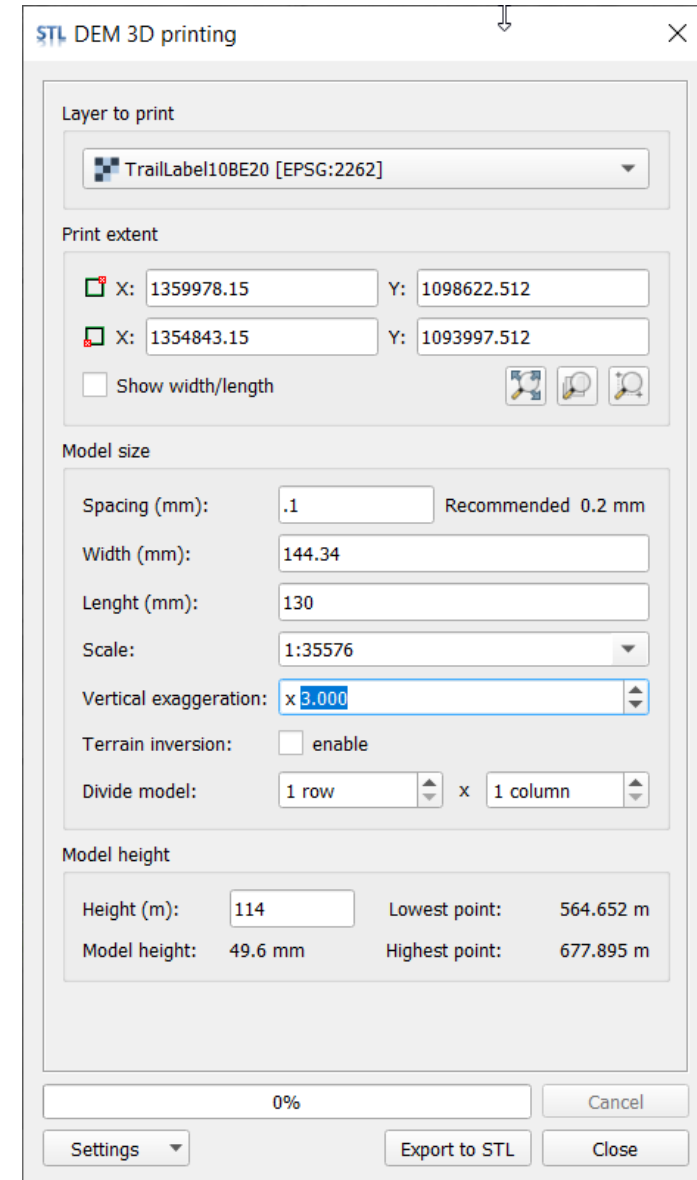
  - Search for DEM to 3D

Getting the Map Ready to Print Continued

- Once installed the Plugin will be found under the Raster Tools

- Open the DEMto3D option and then Run DEM 3D Printing
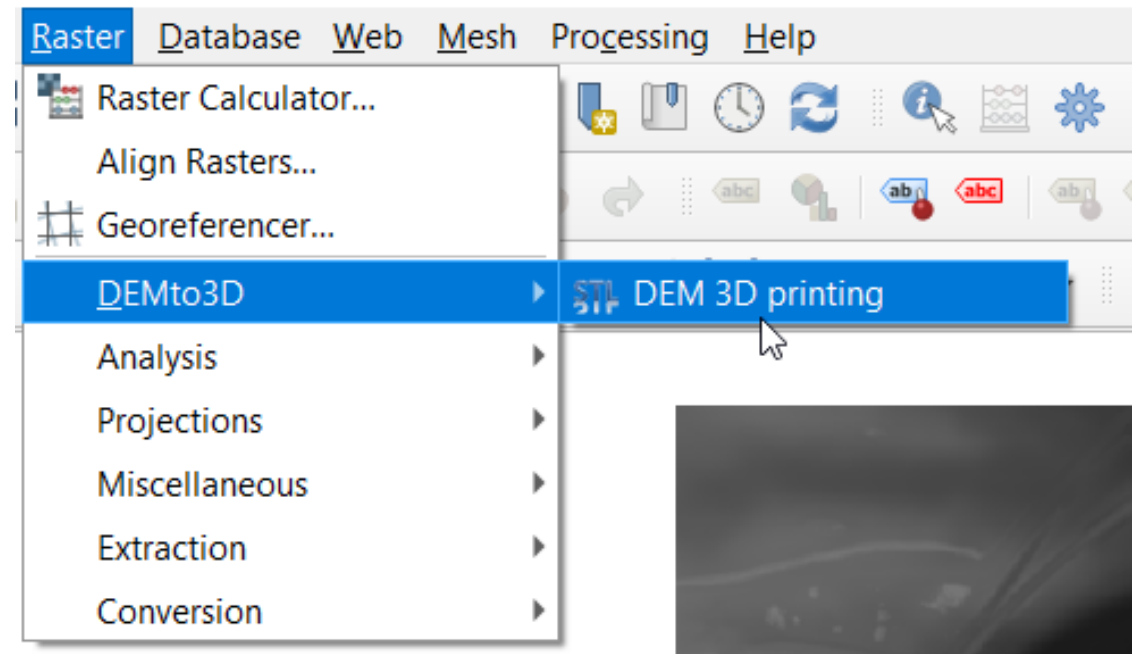
Getting the Map Ready to Print Continued

- Once installed the Plugin will be found under the Raster Tools
  - Open the DEMto3D option and then Run DEM 3D Printing
- Now you Load the Layer to Print (Your Elevation Data)
- Set the extent to the full extent of the model (we set this in the AOI
- The Model Size and Spacing will depend on your printer
  - Check the Specifications to find that out
- Lastly the Height in Meters that you want the model
  - This is the real elevation, not the print so use the raster to figure this out
  - The Model will be very thick at this stage
- Once you are all set run the tool

STL DEM 3D printing ✕

Layer to print

TrailLabel10BE20 [EPSG:2262] ▼

Print extent

X: 1359978.15   Y: 1098622.512
X: 1354843.15   Y: 1093997.512

☐ Show width/length

Model size

Spacing (mm):   .1   Recommended 0.2 mm
Width (mm):   144.34
Lenght (mm):   130
Scale: 1:35576 ▼
Vertical exaggeration: x 3.000
Terrain inversion: ☐ enable
Divide model: 1 row   x   1 column

Model height

Height (m):   114   Lowest point: 564.652 m
Model height: 49.6 mm   Highest point: 677.895 m

0%   Cancel

Settings ▼   Export to STL   Close

Getting the Map Ready to Print Continued

- After you have the STL it should work for the printer but there are a few finishing touches to do

- First, the model needs to be checked and repaired to make sure it will print

  - I used MeshLab for this

- Then I removed the extra thickness and added some more elements using the Windows 3D Builder

Getting the Map Ready to Print Continued

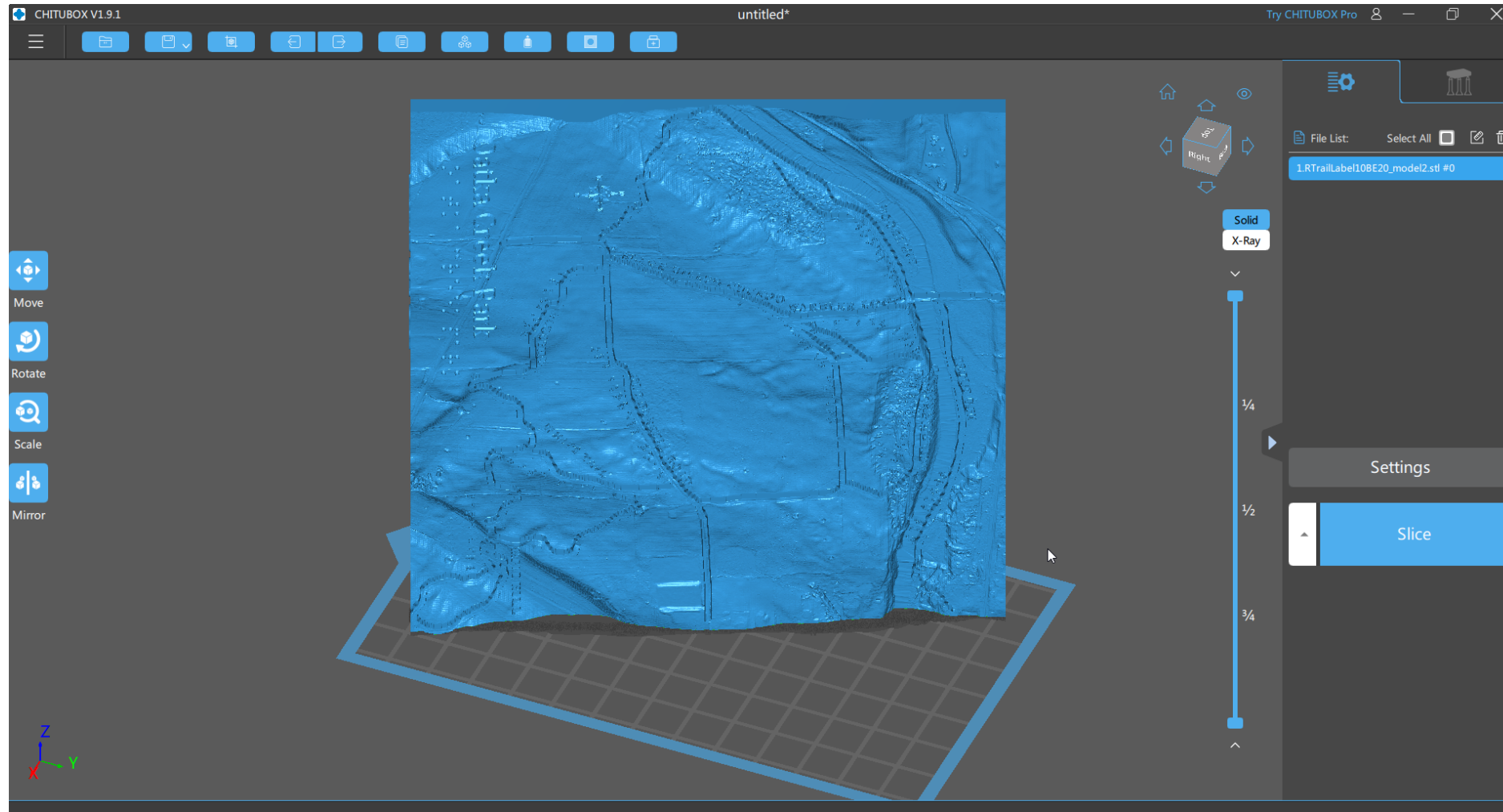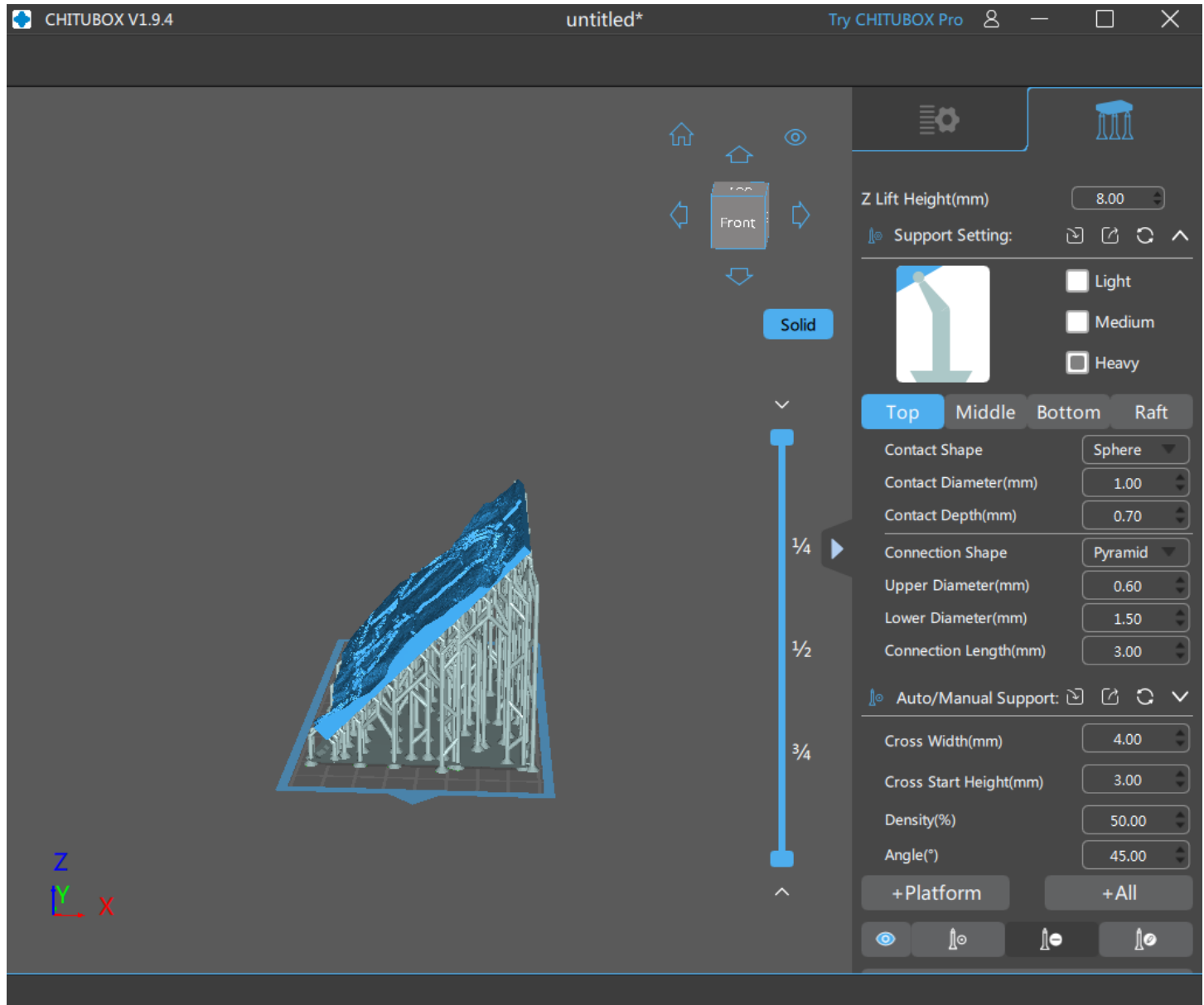# Getting the Map Ready to Print Continued

Printing the Model

- At this point, you are almost all ready to print

- You just need to use a slicing software designed for your printer to create the file that will be used

  - In my case Chitubox

- I also use this process to add supports and hollow out the model for better printing
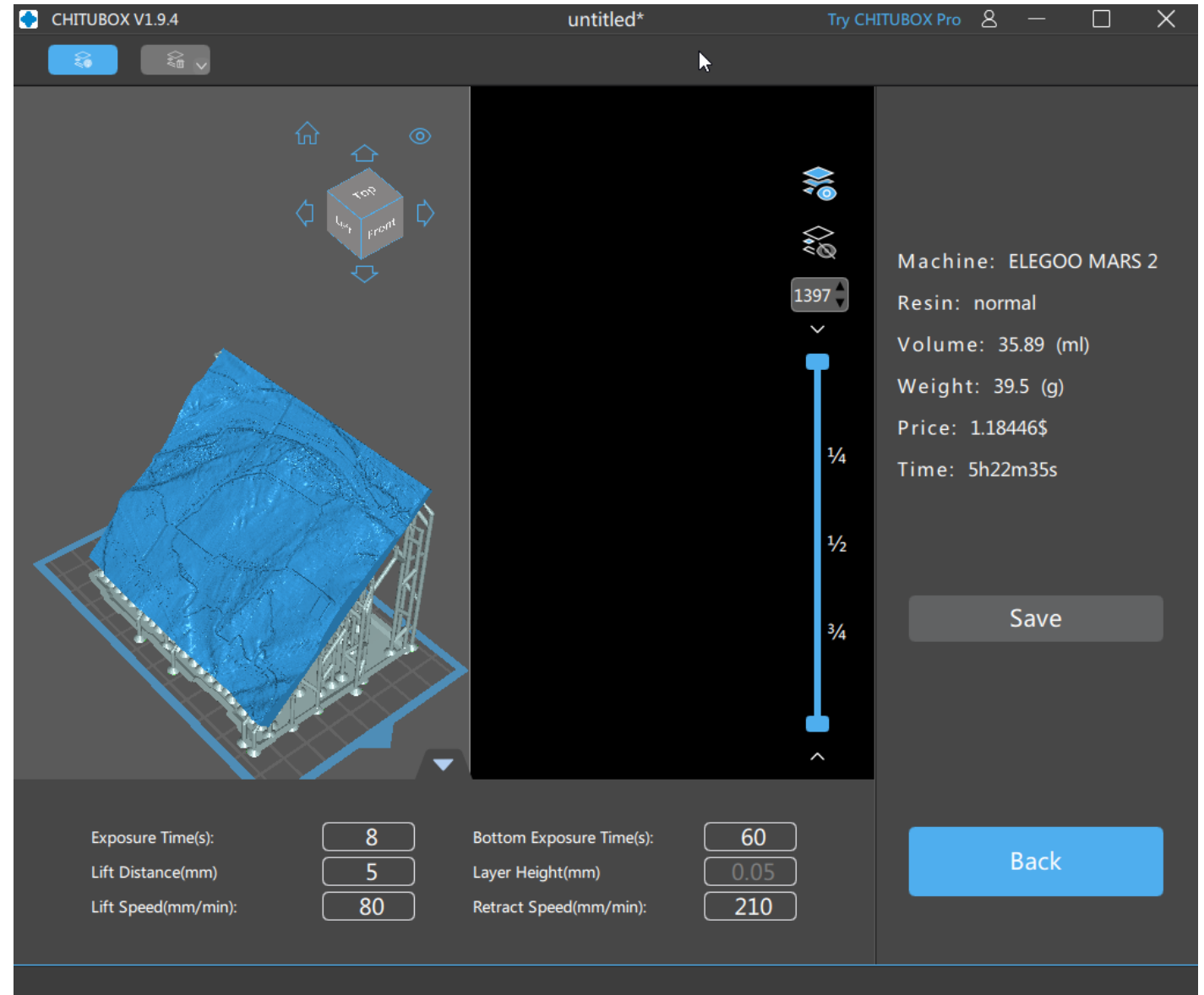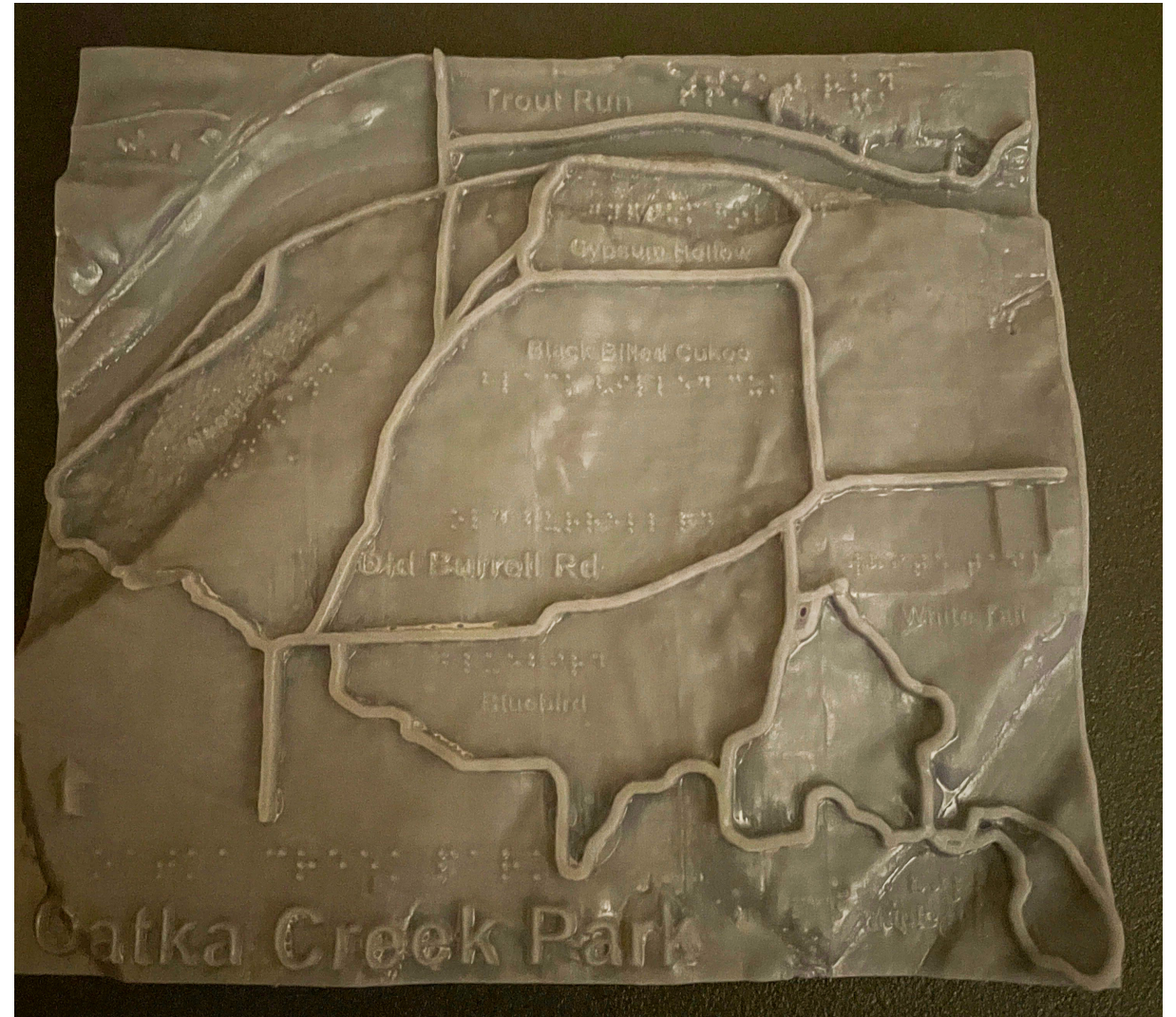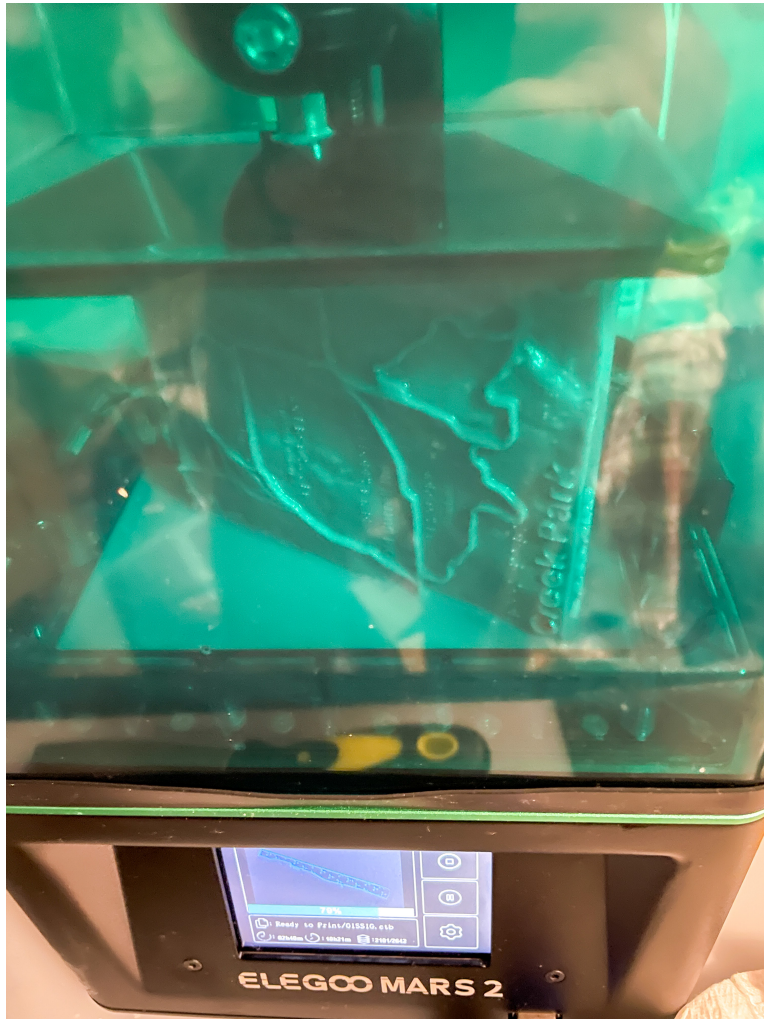
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Lessons Learned

- When starting the process make sure you have plenty of storage to run many attempts
- Printing small test prints are helpful because full-size ones will take hours to do

- **On the Resin Printer Side**
  - When Calibrating/Leveling your printer plate use 2-4 sheets of paper and set the 0 to just where you can pull them out.
  - Get a Screen Protector for your printing screen because it is very difficult to clean (and if you damage it you will have to replace it)
  - A Magnetic Printing Plate makes taking off the print easy
  - The software will estimate the cost of each print, but unless you do multiple back to back your cost will be higher
  - Make sure to do a good job washing the final product or you will have white masses on the print that will make it hard to read

Questions

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https://bit.ly/JDC2023GISSIG

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