

ArcGIS Basics – Hands-On Portion
5/21/2019
Research Computing Services
Instructor: Dennis Milechin

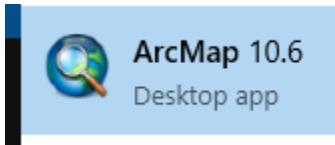
Note: RCS example programs are provided "as is" without any warranty of any kind. The user assumes the entire risk of quality, performance, and repair of any defect. You are welcome to copy and modify any of the given examples for your own use.

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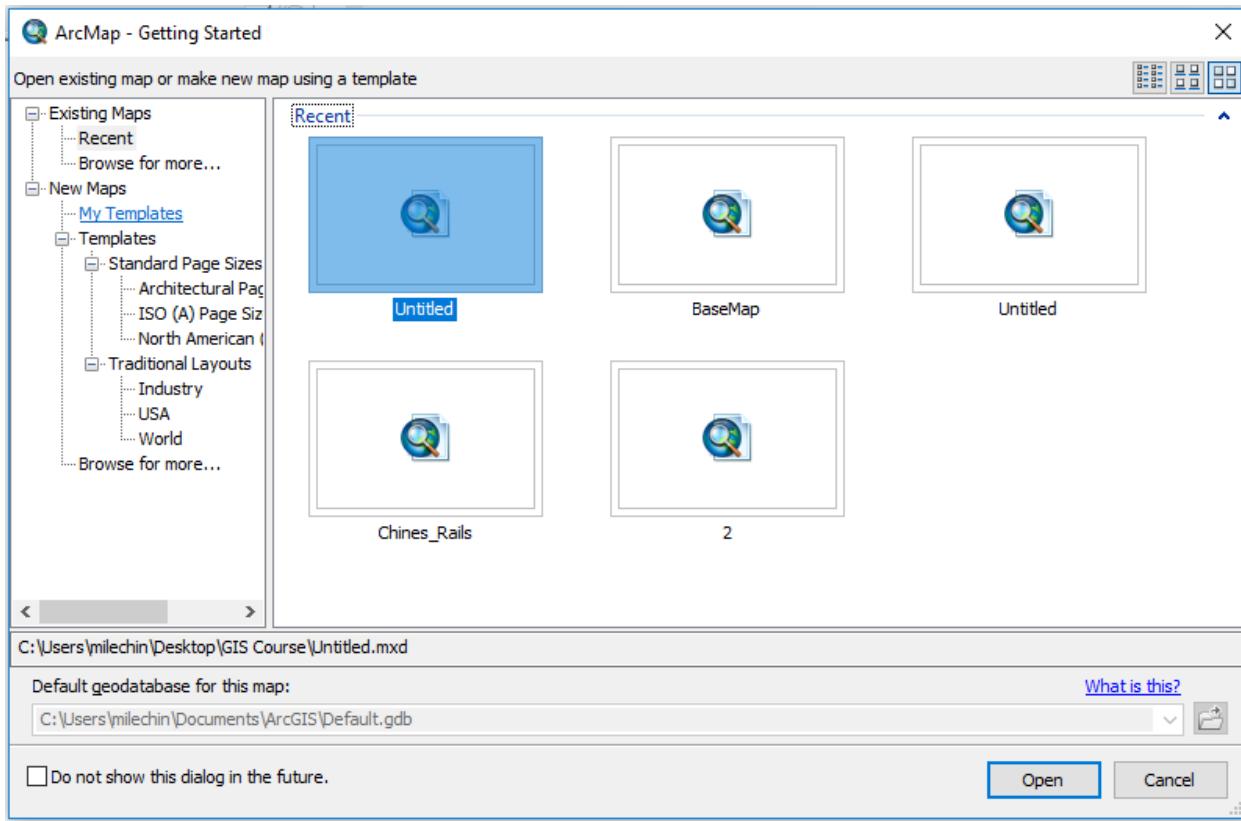
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Opening ArcMap

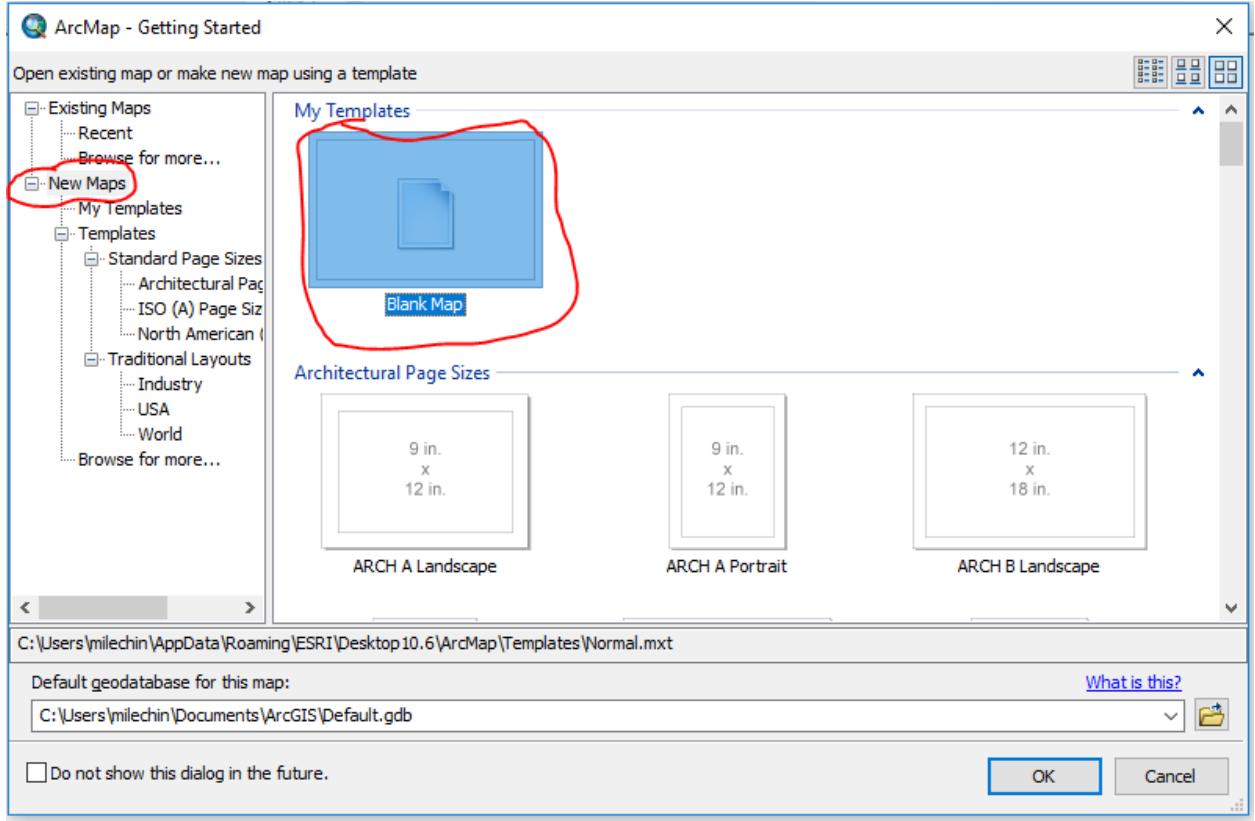
1. Find the ArcMap executable and start the program.



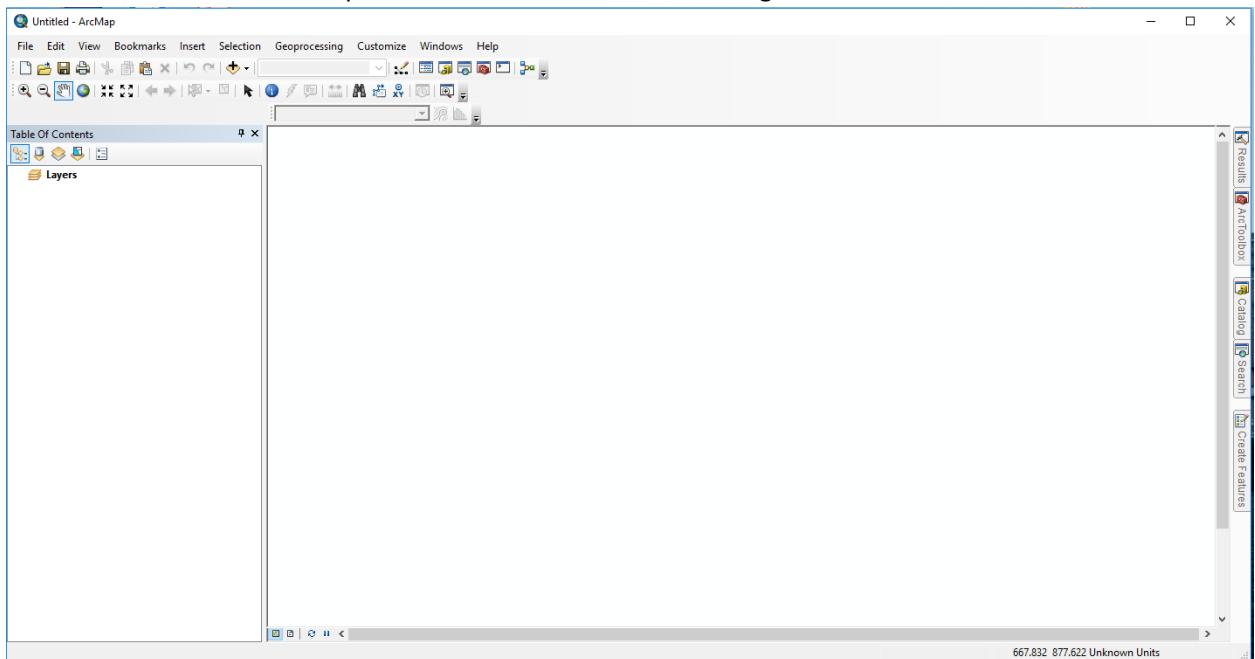
2. The program will open and a window will appear called "ArcMap – Getting Started". In this window you will see recent maps you might have worked on, or you can select a template for a new map project.



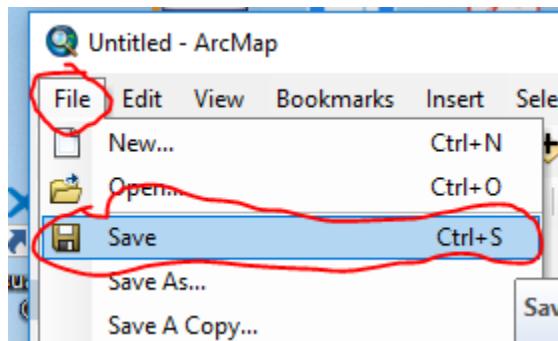
3. On the left side, the tree menu, let's click on “New Maps”, which will update the center panel, and we will select “Blank Map”. Click OK and the window will disappear and the ArcMap window in the background will be accessible.



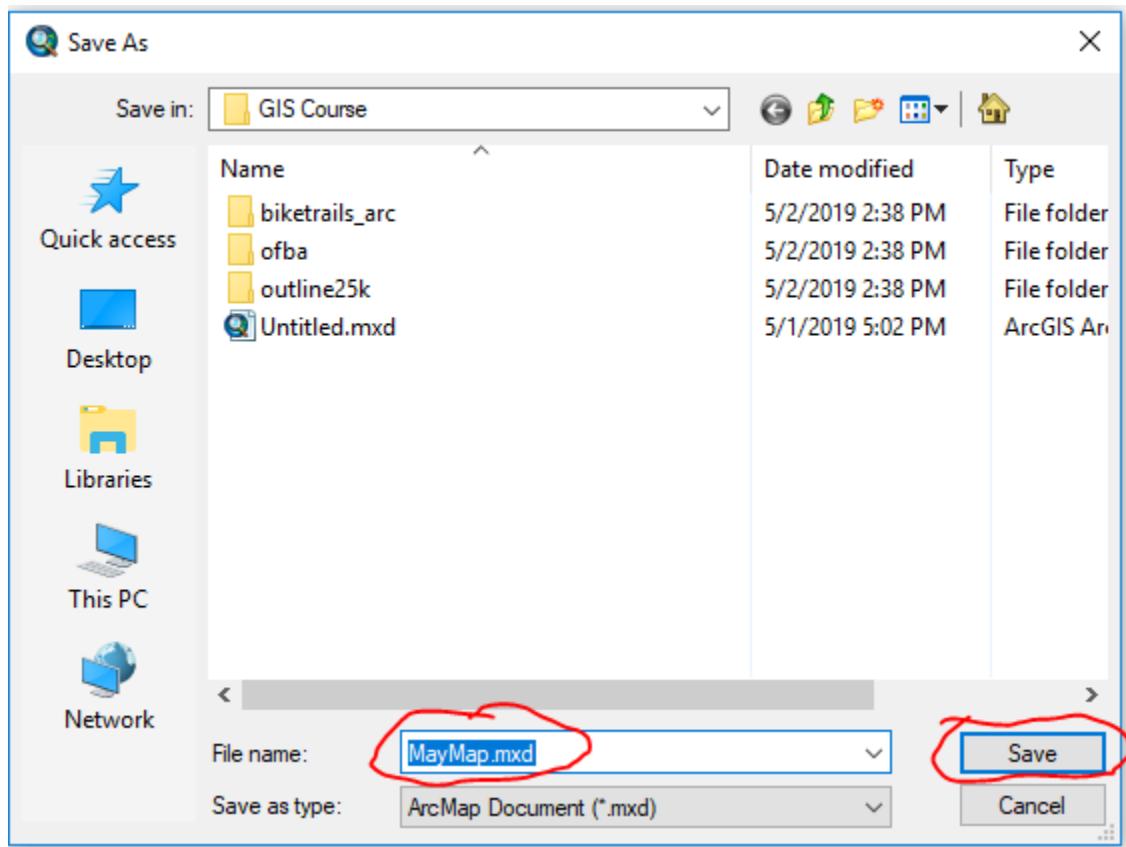
4. Now we have a blank ArcMap Window that looks like something below.



Let's save this map. Click on **File → Save**



5. A new window appears. Select a location you want to save the map file, give the map a name, and then click "Save".

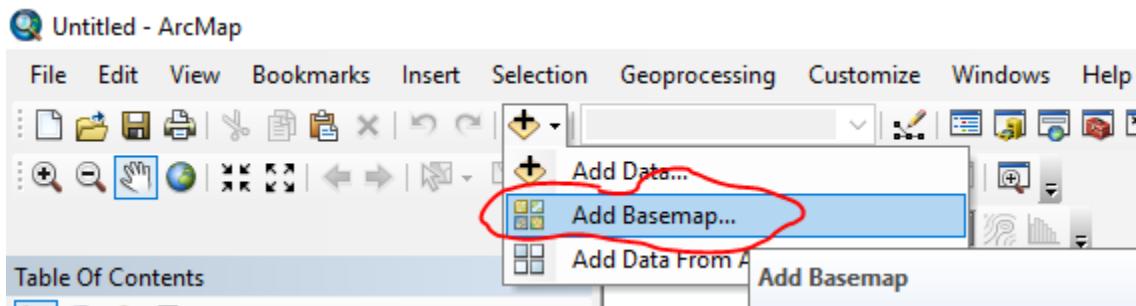


Notice that the ArcMap document file has an extension of ".mxd".

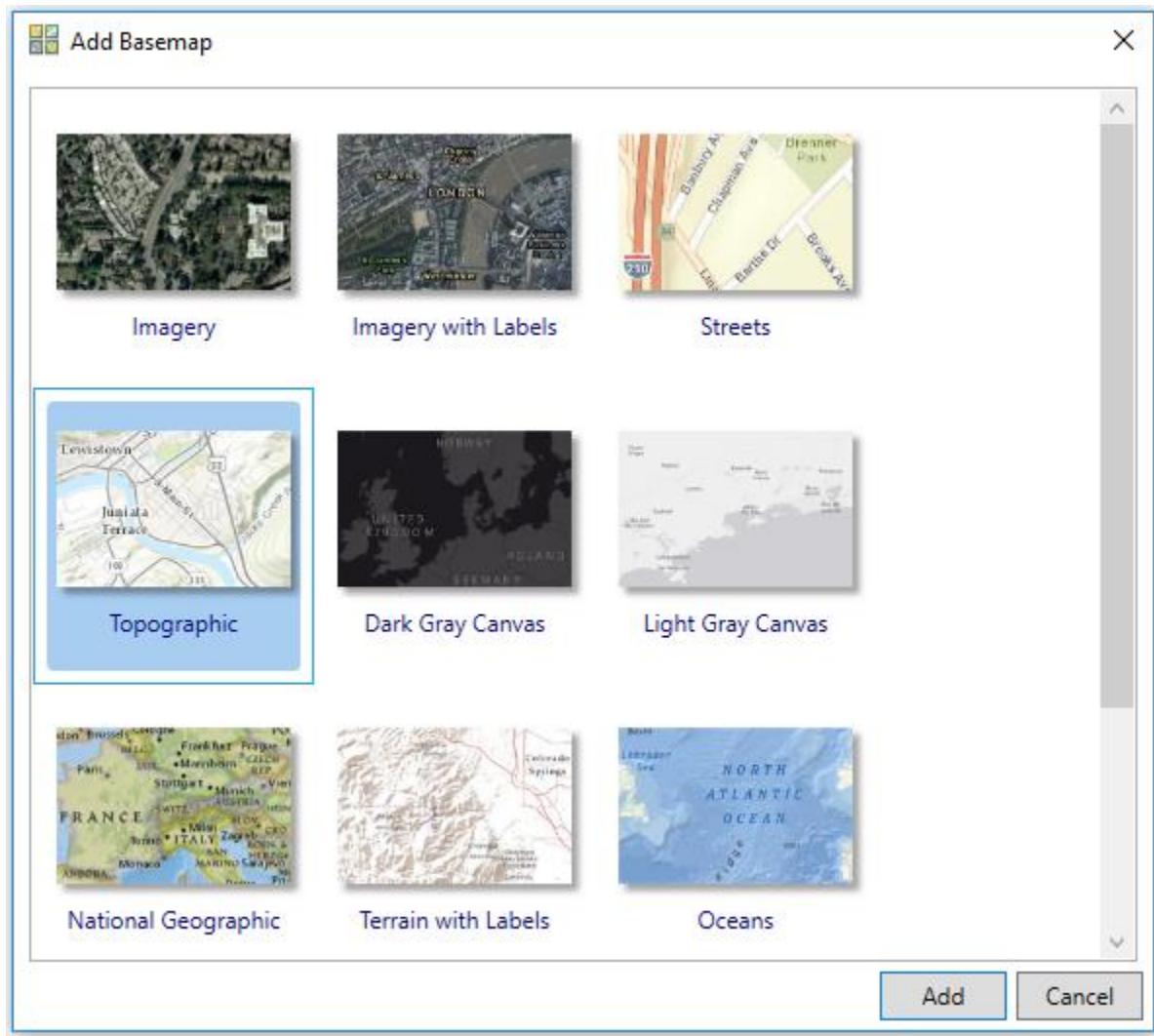
Now remember, ArcMap is basically a viewer for your data. You can't send an .mxd file to someone and expect them to open the file and view the data. You have to send them the data as well.

Add a BaseMap

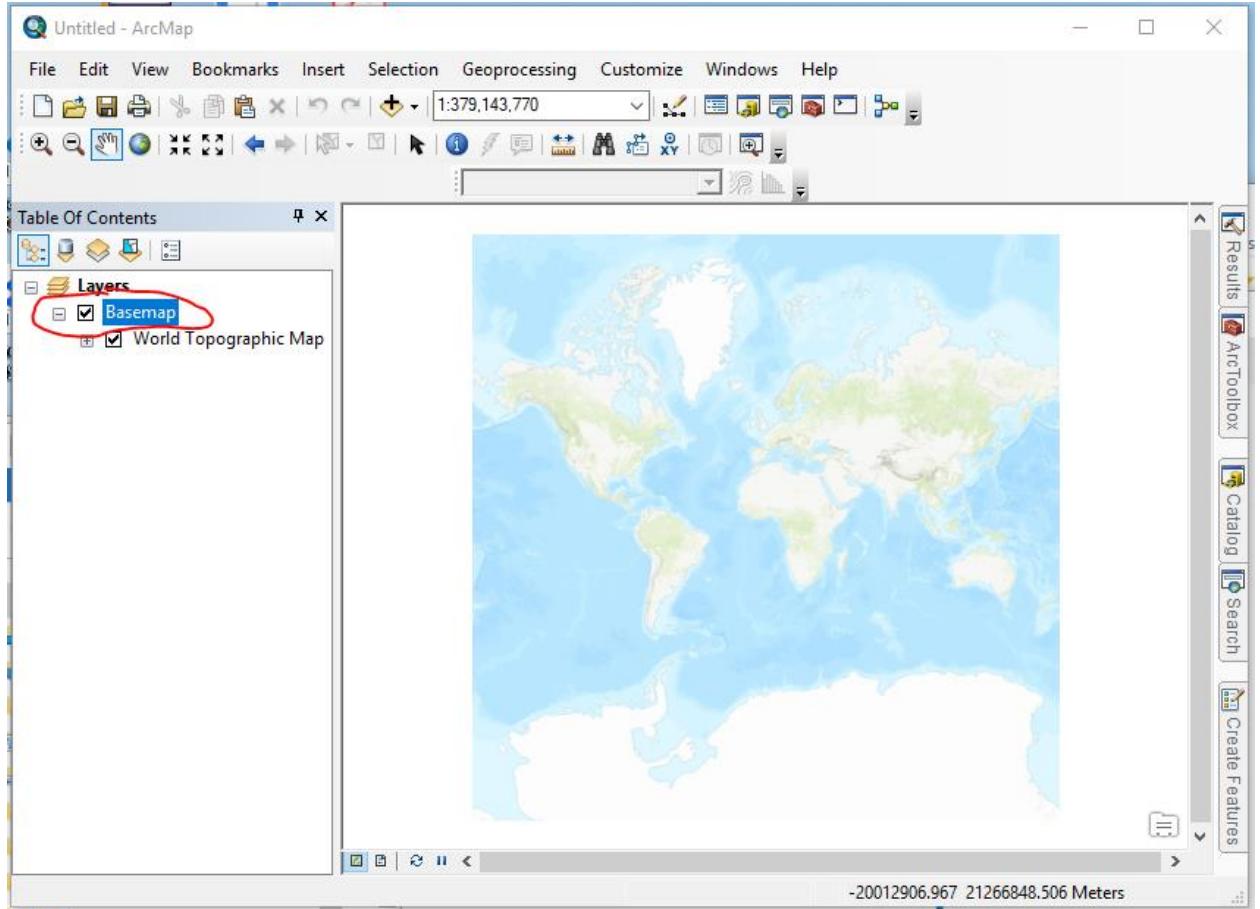
1. Click on the “Add Data”  down arrow and select “Add Basemap...”



2. A new window will appear. Here you can select a basemap of your choice. I am going to go with “Topographic”. Once you made a selection, click on “Add”.



3. Now you should see the basemap in the main mapping window. The basemap is coming from an ESRI online server, very similar to how you get Google Maps through your browser or on your smartphone. At the left, under the “Table Of Contents” you should see “Basemap” layer listed. If you don’t see a similar “Table of Contents” layout, then make sure the “List by drawing order”  tool is selected.



4. Next to the “Basemap” layer you will see a checkbox. When the check is present, the layer will be visible in the main mapping window. When the box is unselected, the layer will not be visible in the mapping area. This allows us to select the specific data that we want to see.

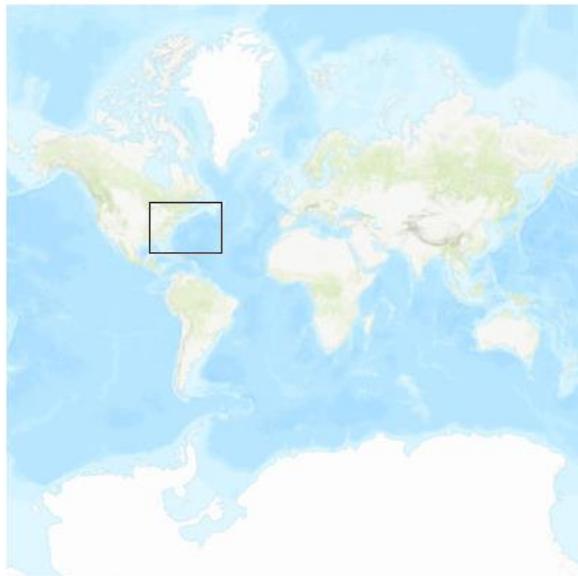


Basic Navigation

1. Now that we have a basemap, we can practice using our navigation tools.
2. We will focus on these tools:

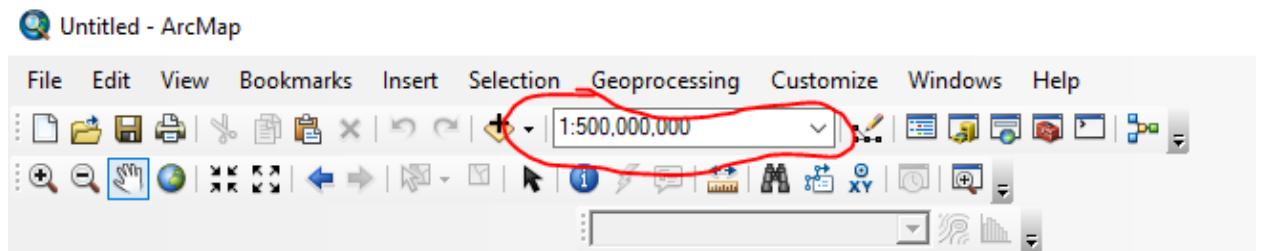


3. Make sure the hand tool is selected. Now move your mouse to the mapping window and click and hold the left button and move the mouse in a direction of your choice. This allows you to pan the map. You can unclick the mouse and then repeat this action.
4. You can click the back tool to go to the previous view. Or the forward button to go to the more recent extent.
5. To zoom, if you have a mouse with a scroll wheel, you can scroll the wheel towards you to zoom in and away from you to zoom out. If you don't have a scroll, you can use the zoom in tool by clicking the zoom tool , then going to the mapping area, left click and hold and drag a box around the area you want to zoom into. To zoom out, click on the zoom out tool and you can then draw a rectangle it will zoom out.



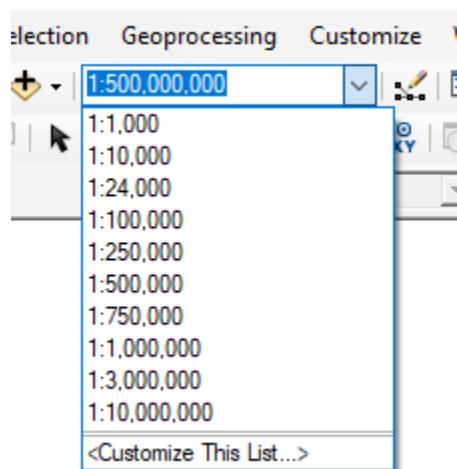
6. If you want to go back to the world view, you can just click the Full Extent Tool .
7. You can also use the “fixed Zoom” tool . These will zoom in and out based on the current location of the center of the map.

When playing around with the zoom, you might have noticed a number ratio changing near the top



This ratio represents the current scale of the view. In this snippet, 1:500,000,000 means that a feature you see in the mapping area is 500 million times smaller than its real size.

You can type in your own ratio, or select one from the drop down menu.



Download Tutorial Dataset

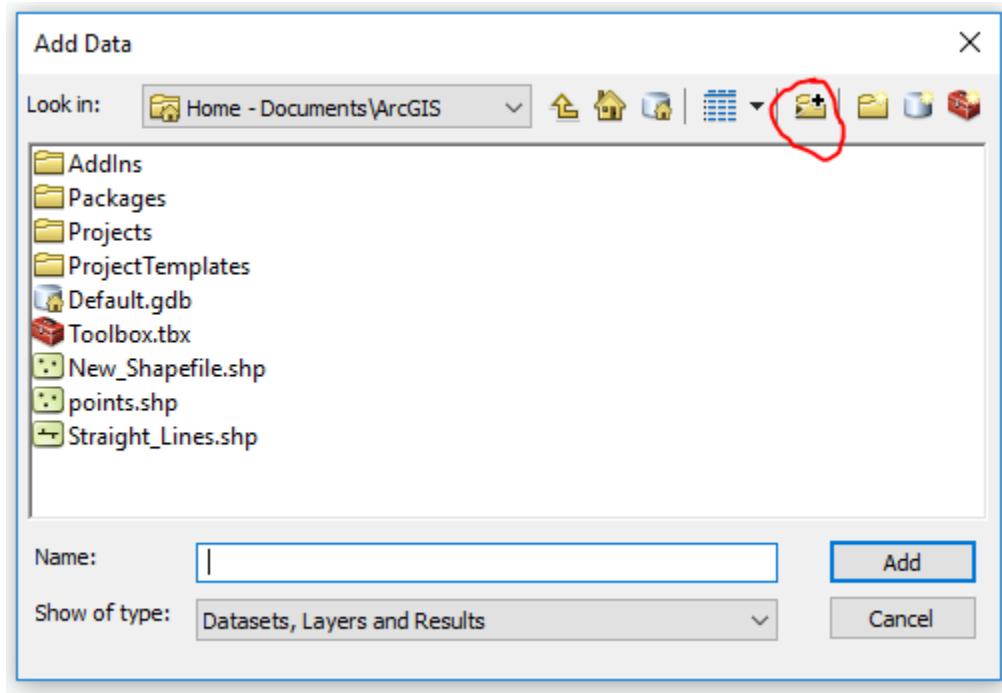
1. Download the following zip file and save it to the same location where you saved your “.mxd” file.
http://rcs.bu.edu/examples/arcgis/tutorial_files.zip
2. Unzip the folder. This collection contains shapefiles downloaded from the MassGIS Data Layers <<https://www.mass.gov/service-details/massgis-data-layers>> You can download many useful layers for Massachusetts on this website.

Importing Shapefiles

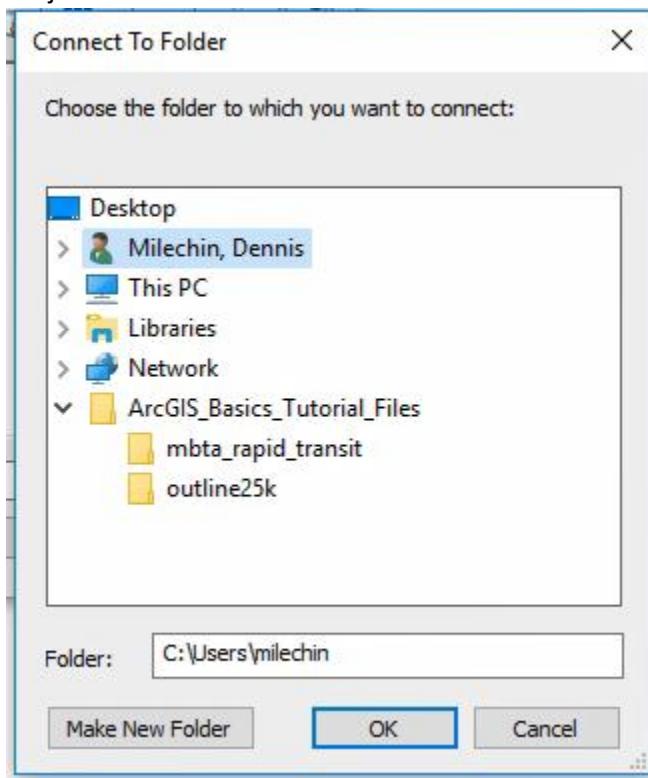
1. Let's reset our view to the full extent by using the Full Extent Tool .
2. Let's work on adding the data. Let's click on the "Add Data"  tool.



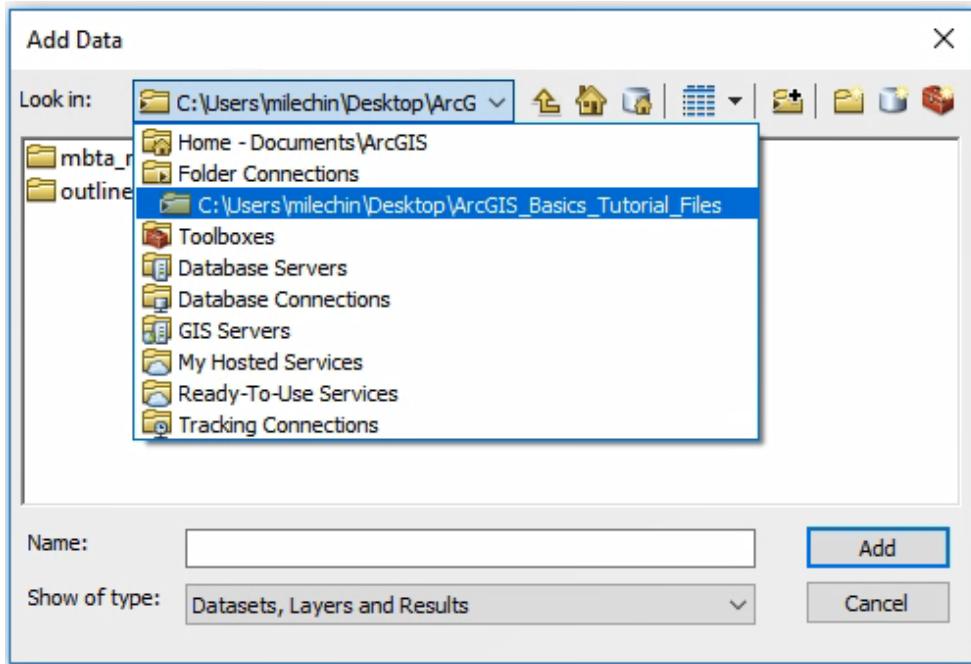
3. A new window will appear. Before we can add data, we need to tell ArcMap where it can find this data first. This step you only have to do once for each directory you want to include. You will need to click on "Connect to folder"  tool.



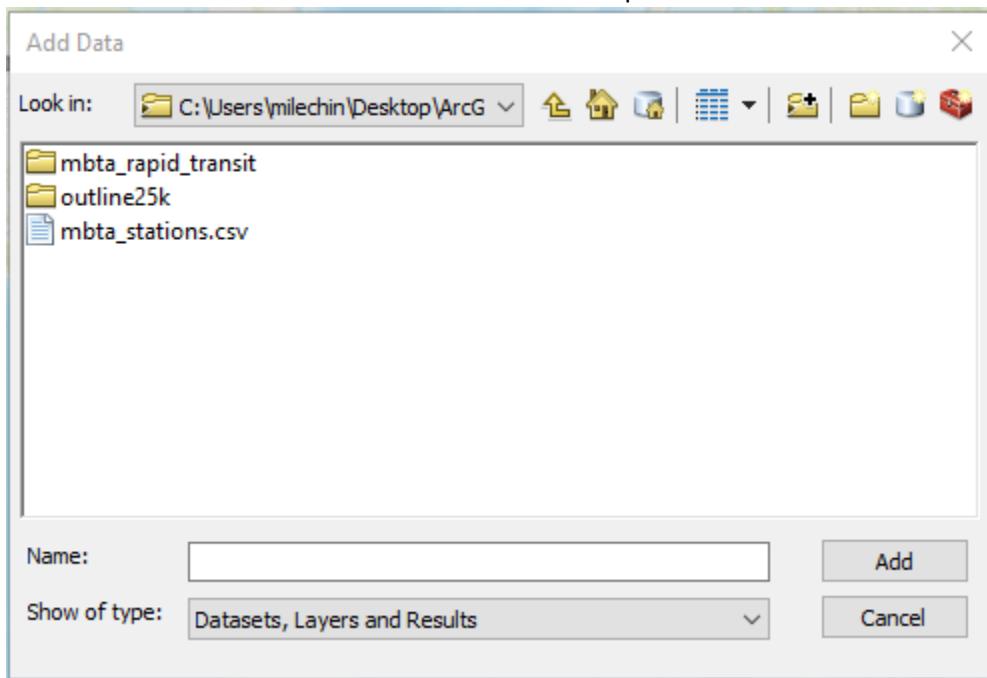
4. Again, a new window will appear. Here find a select the “ArcGIS_Basics_Tutorial_Files” folder we just extracted. And click OK.



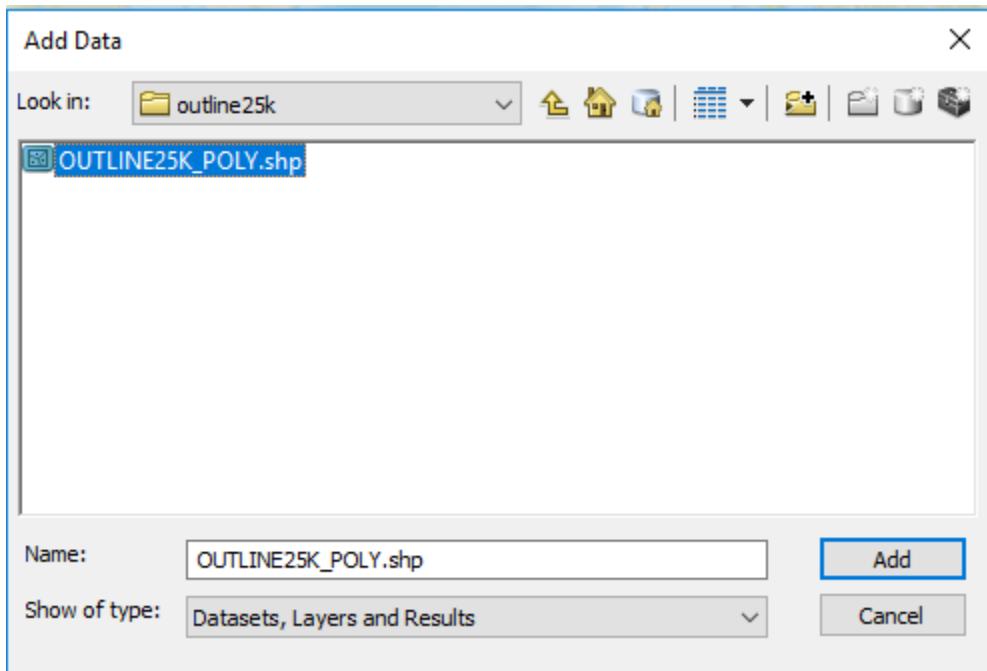
5. Now click on the drop down menu, and you should see the path to the folder we had just set under the “Folder Connections.”



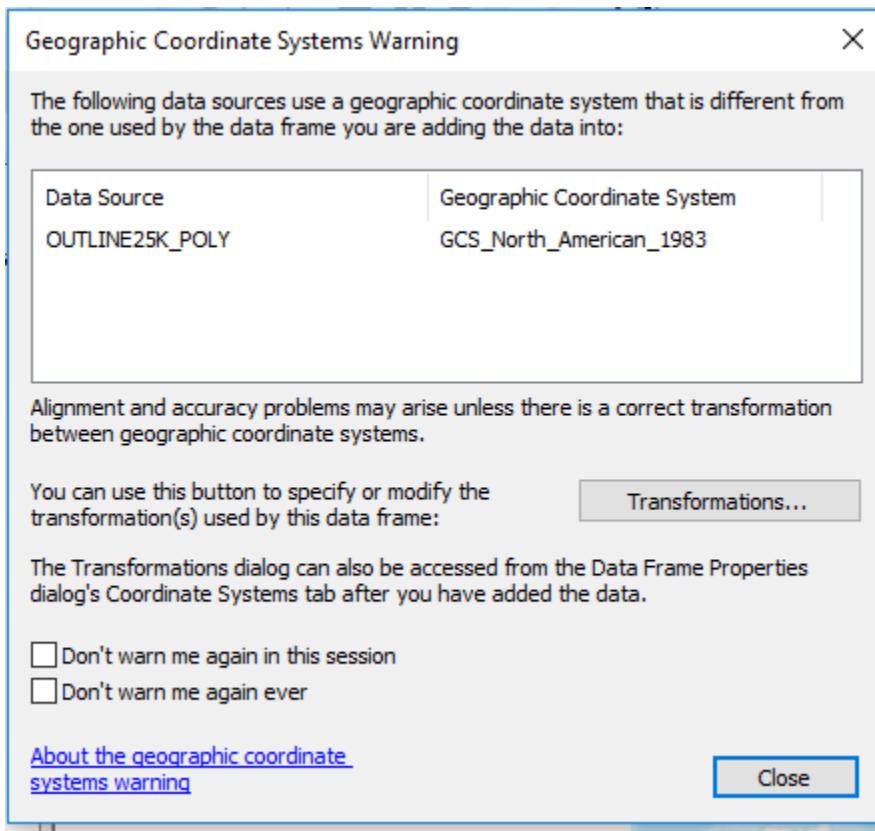
6. You should see a list of folder which contain the shapefile we will use in this tutorial.



7. Double click on the folder “outline25k”, and you will see one polygon shapefile called “OUTLINE25K_POLY.shp”, which is a polygon representing the shape of Massachusetts. *Notice that in ArcMap, only one file is shown, versus if you go to the actual directory, there are many more files.* Select the “OUTLINE25K_POLY.shp” file and click Add.

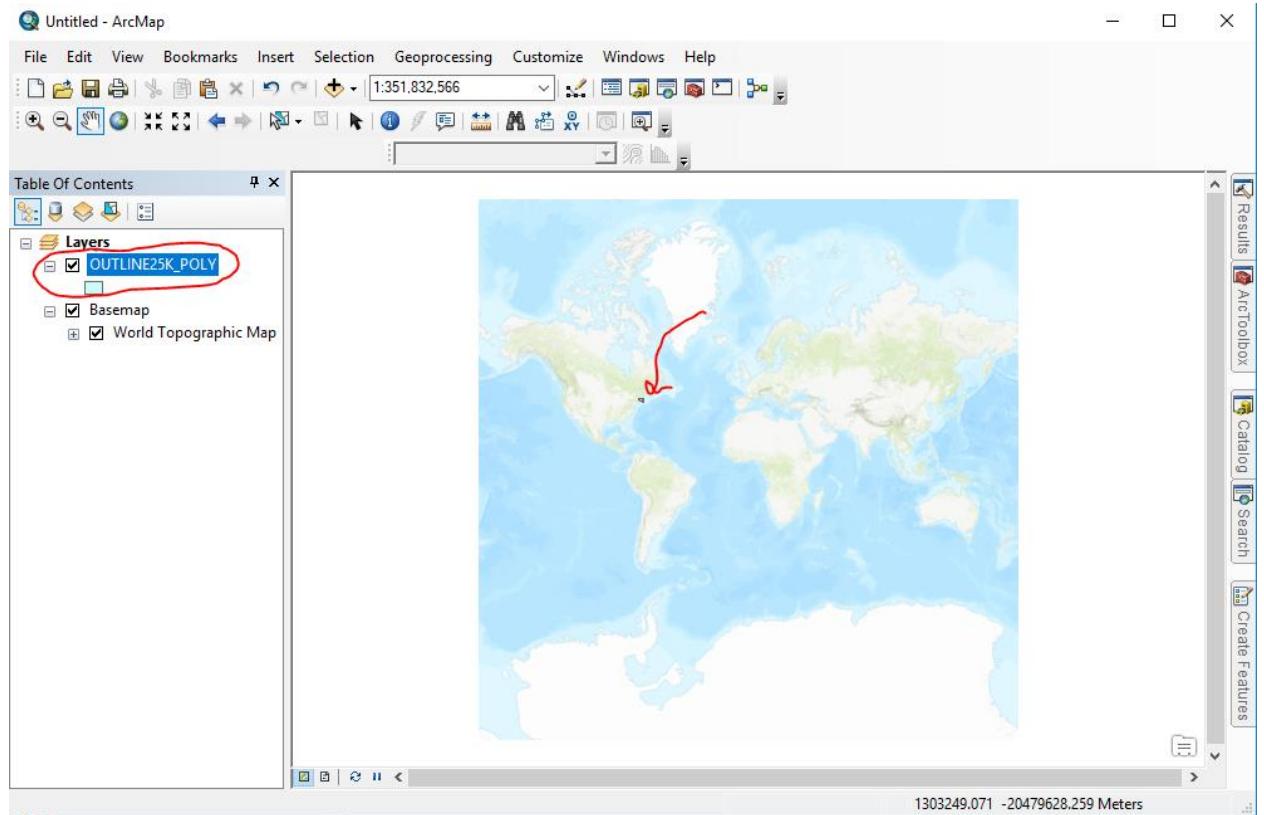


You may get an error message indicating a Coordinate System warning.

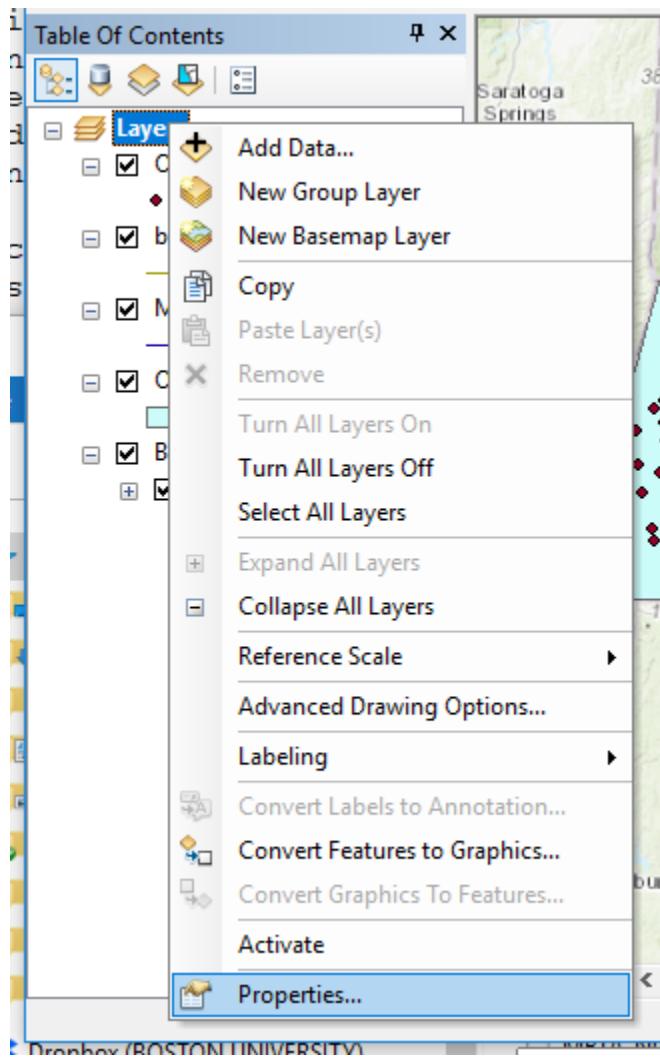


Remember the topic of Geographic Coordinate Systems? Each shapefile is assigned a geographic coordinate system and each one can be different. If they don't match the DataFrame you are importing to, then it will show this error. ArcMap will automatically choose the best conversion formula to transform the shapefile to the geographic coordinate system of the DataFrame, and is being transparent with that information with this warning message. We will let ArcMap handle the conversion and we will click "Close".

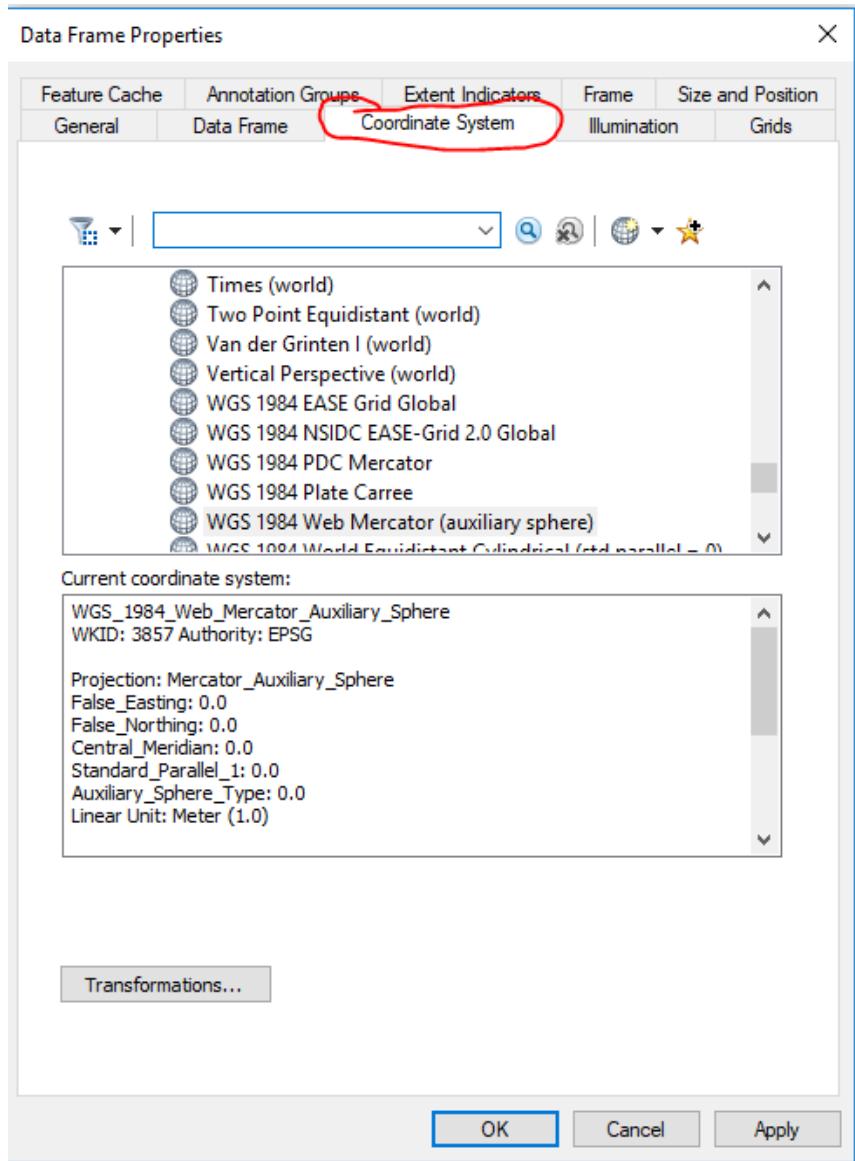
8. You should now see a new layer added to the “Table of Contents”. You might have a different colored rectangle, and that is OK, ArcMap chooses random colors when adding layers. In the mapping area you might see a new spec appear, that is the new layer we just added.



9. Before we proceed, lets update the DataFrame coordinate system, so we don't get this error message in the future for the Subway lines layer we will add later. Select the "Layers" DataFrame and right click, and select "Properties".

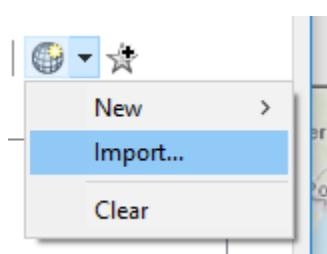


A new window will appear. Select the “Coordinate System” tab.

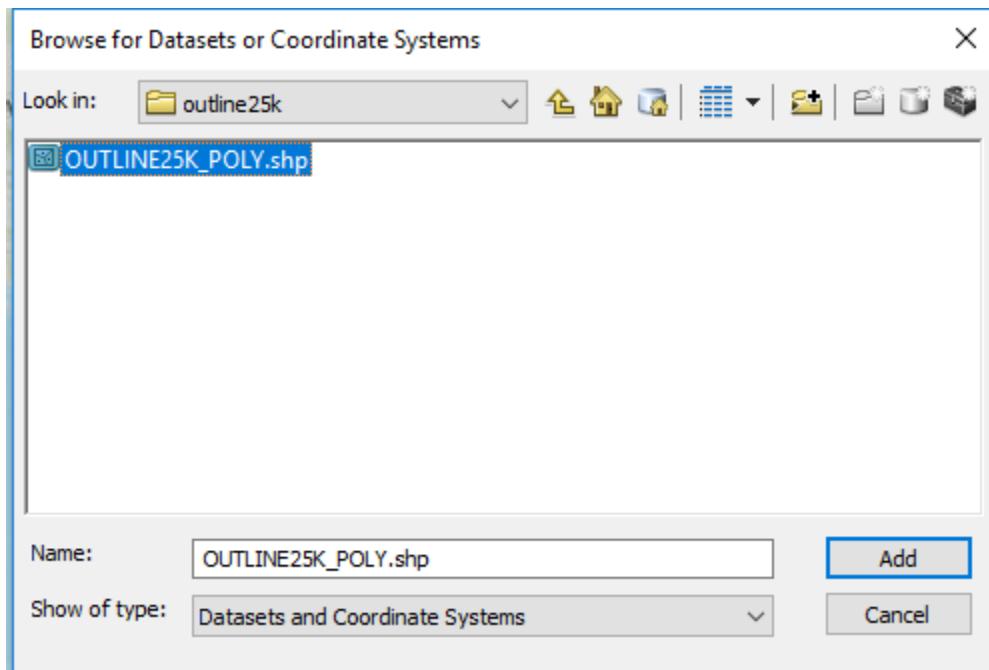


10. You can pick a coordinate system from the list, but if you want to apply a specific one from a

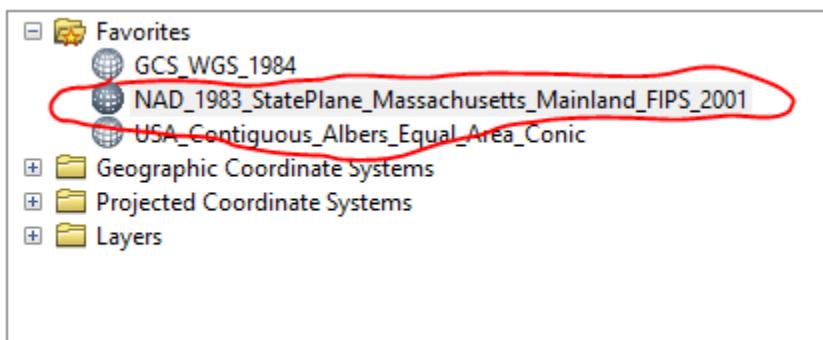
shapefile, click on the down arrow of the “Add Coordinate System” tool  , and select “Import”.



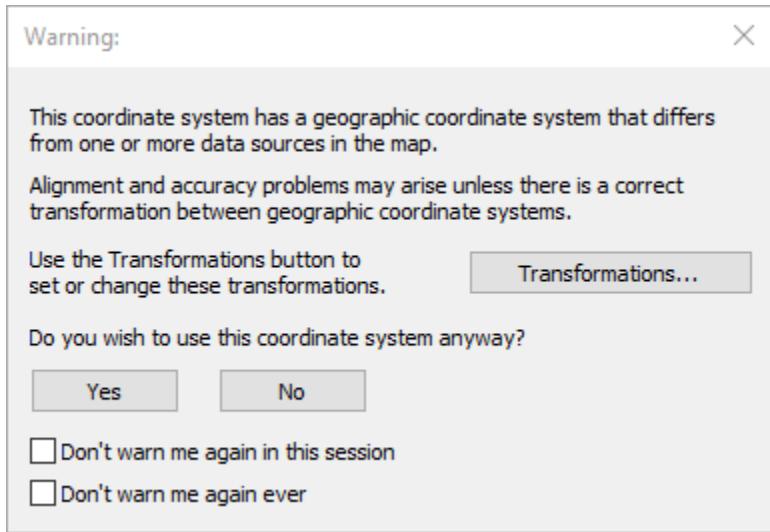
11. A new window will appear. Now find the shapefile we just added and select it, then click Add.



12. When we return to the previous window, you will notice that it imported the Coordinate System and Projection of the shapefile and put it under “Favorites” and selected it.



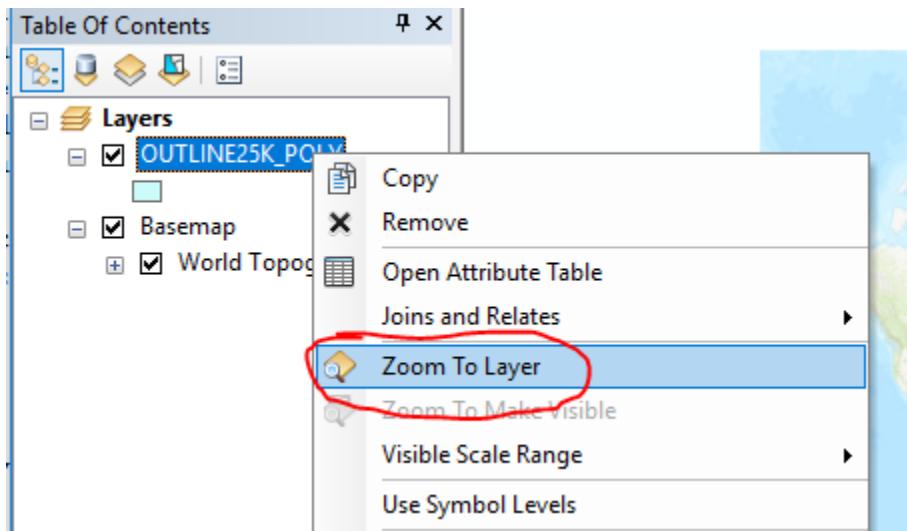
Now click OK in this window. You will get a warning message indicating that there is a layer that does not match the DataFrame coordinate system. The warning message is referring to the Basemap layer, which is always in a Web Mercator coordinate system. We will click "Yes" and proceed.



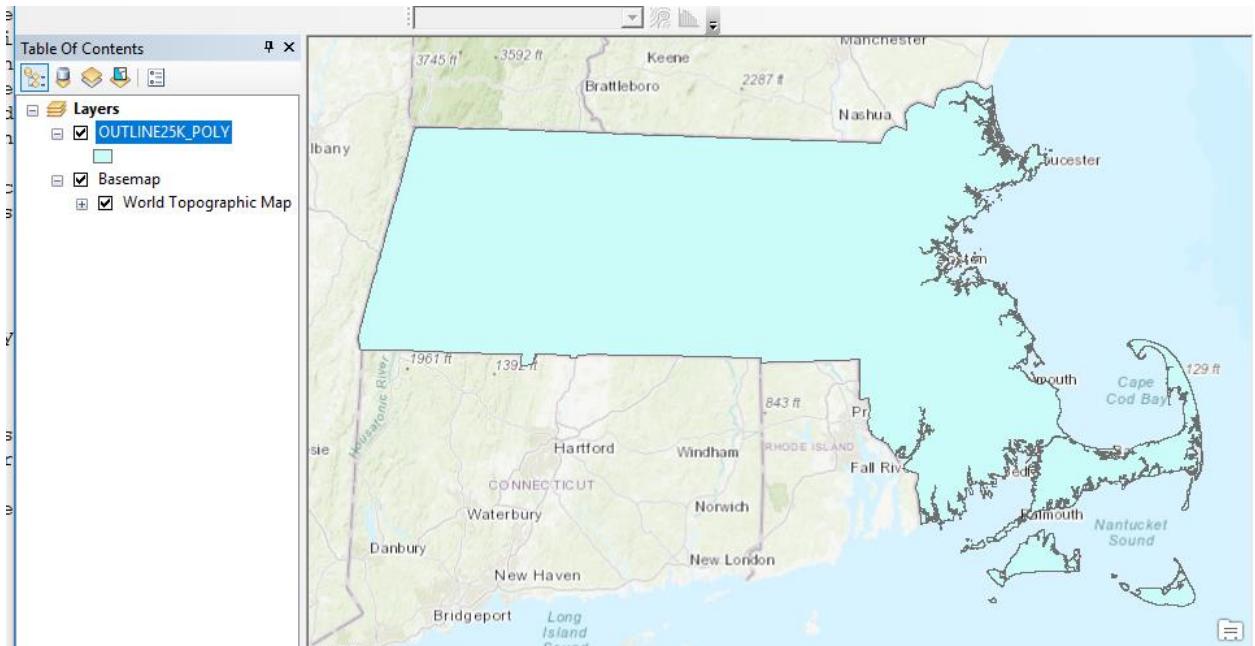
Now you should see that the projection has changed the view of the map.



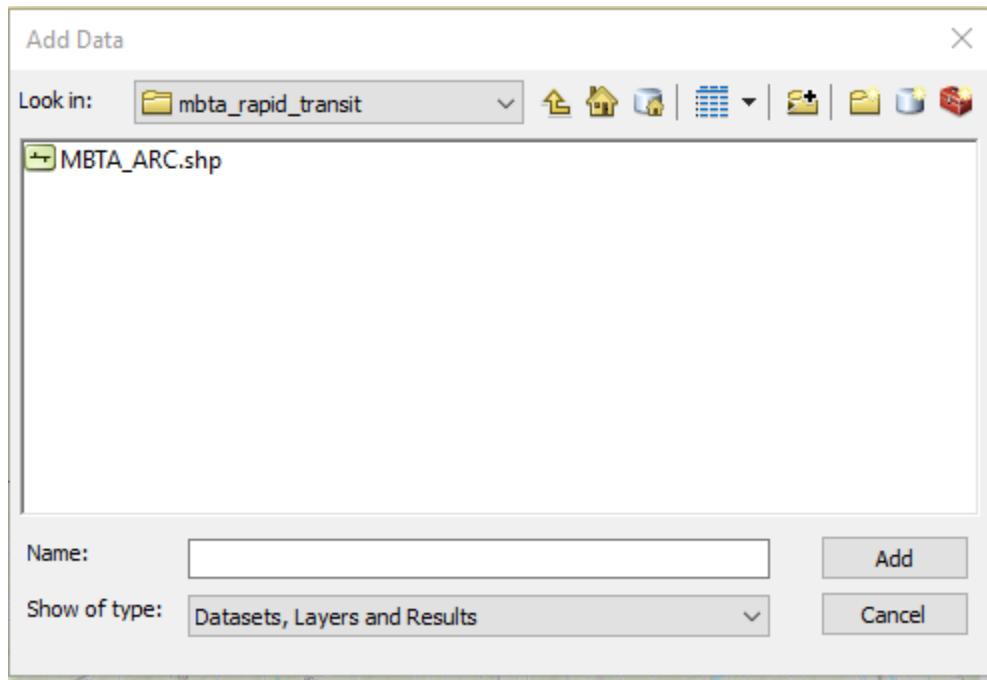
13. Now we are more interested in the layer we just imported. In the “Table of Contents” right click on the layer “OUTLINE25K_POLY” and select “Zoom to Layer”.



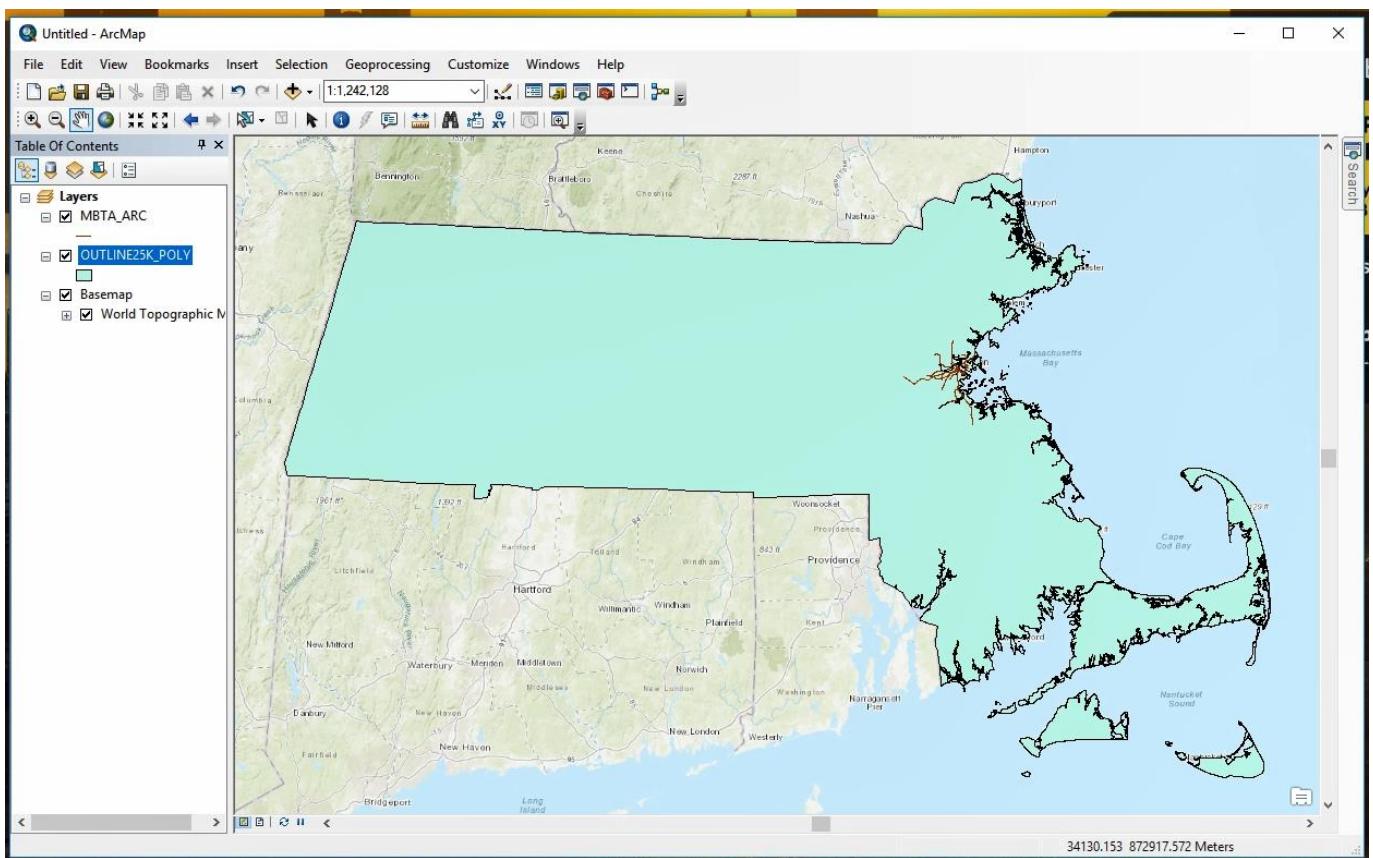
14. Now we see this shapefile is a polygon of the state of Massachusetts. Now you can check and uncheck the checkbox for this layer to make it appear and disappear.



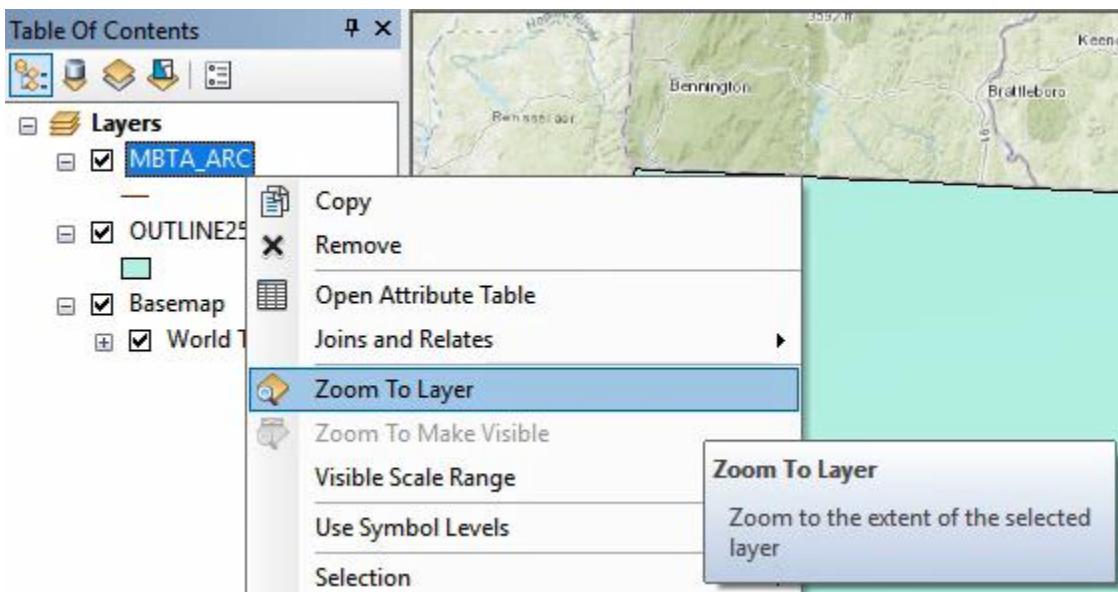
15. OK, lets add the subway lines data. Click on the “Add data”  tool, and import the MBTA_ARC.shp file from the “mbta_rapid_transit” folder.



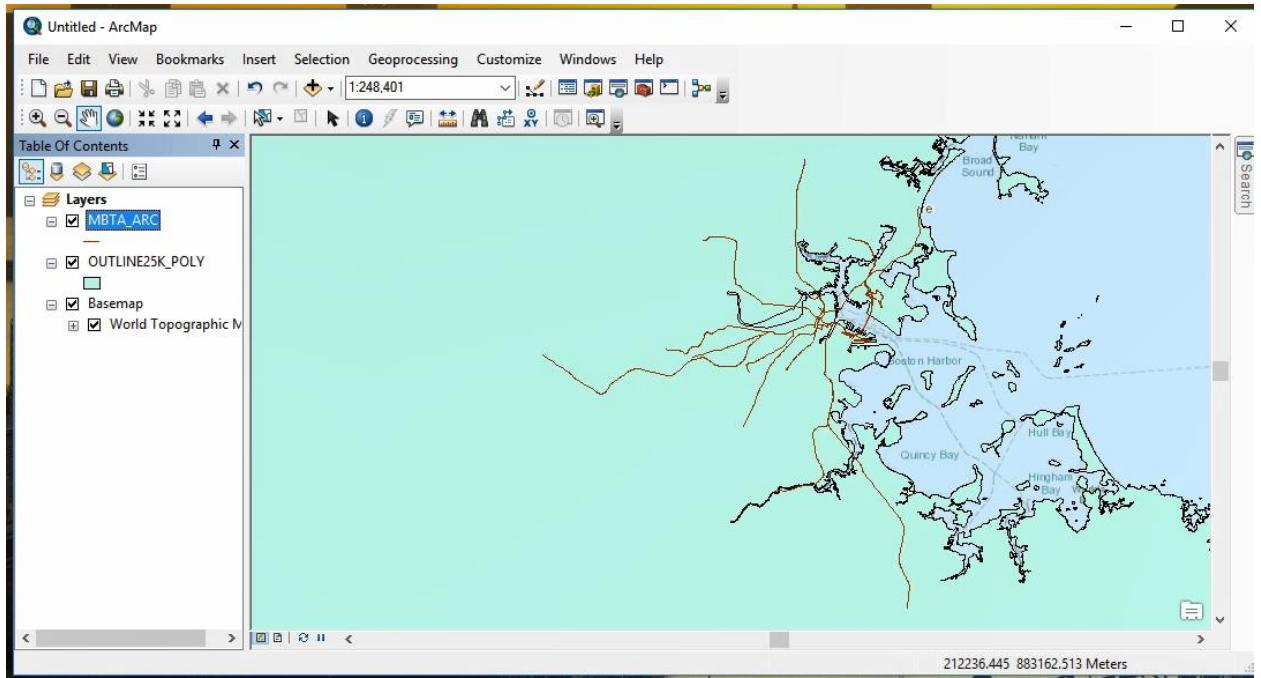
So now you should see some line added in the Boston area.



16. Now, let us focus on the Subway Lines. Select and right click on “MBTA_ARC” layer and select “Zoom to Layer”.



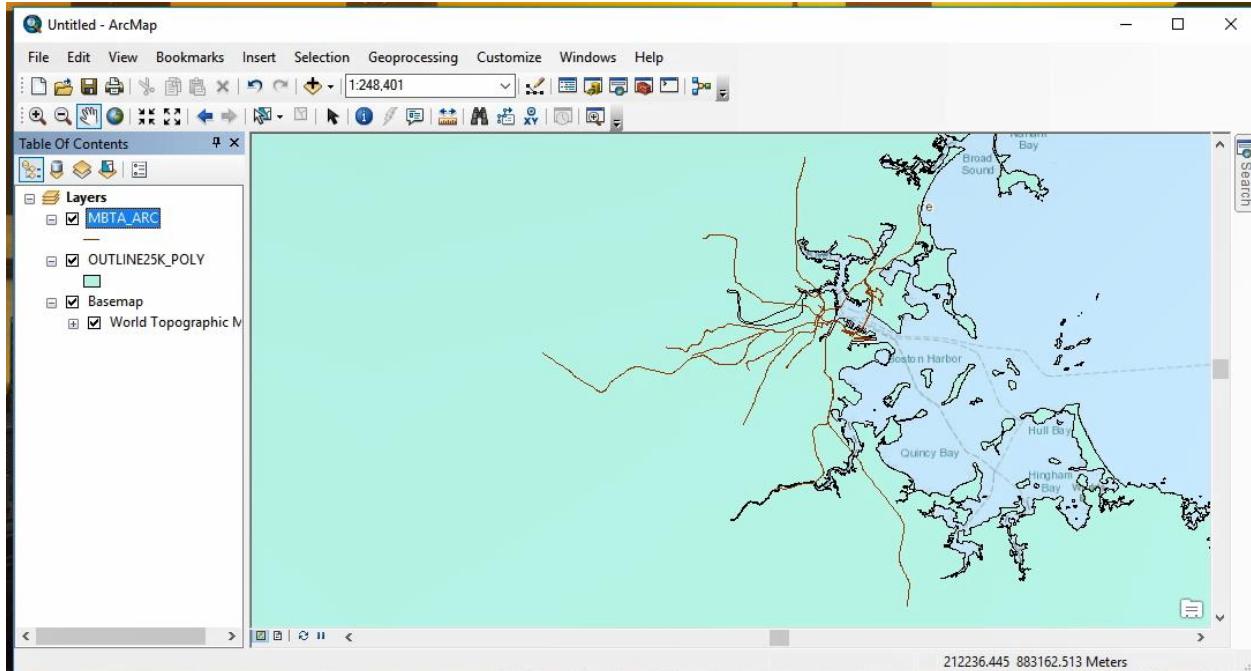
17. The map should zoom in to the extent of the Subway Lines.



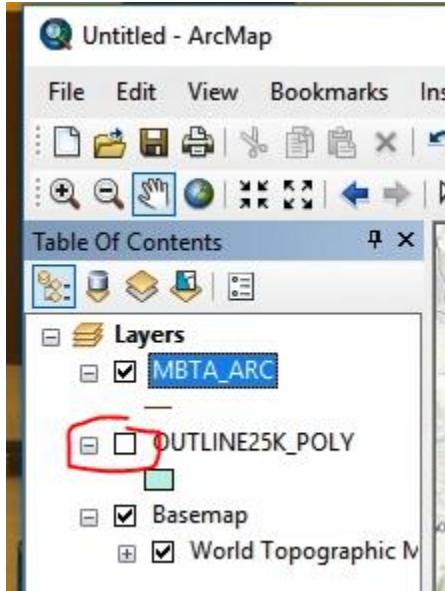
Now we can see the layer we just added.

Exploring Attribute Table

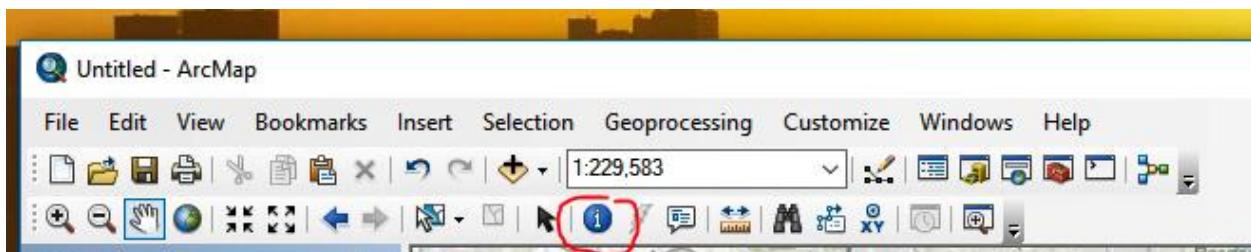
1. Let us first focus on the Subway Lines. Select and right click on “MBTA_ARC” layer and select “Zoom to Layer”.



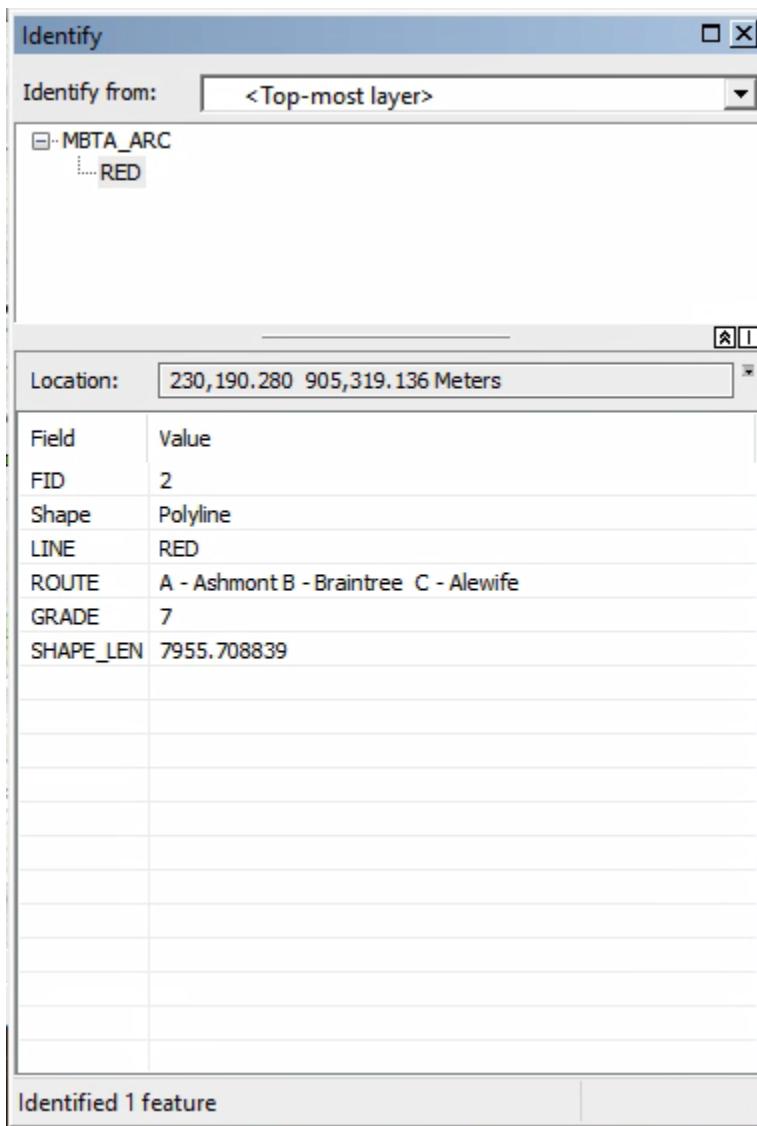
2. Let's remove the Massachusetts polygon by unchecking the “OUTLINE25K_POLY” layer for now. If you can't see your subway lines, lets uncheck the Basemap as well.



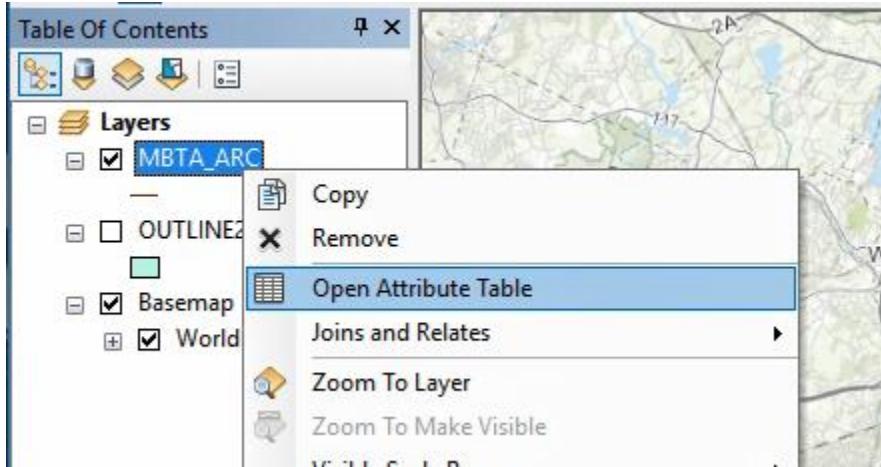
3. Lets explore the Subway Lines attributes. Lets look at one feature at a time. Click on the “Identity” tool .



4. Now hover over a Subway Polyline and click on it. A new window should appear displaying the attributes of that Polyline.



5. You can click “x” at the top right to close it. Now looking at each record like this is not efficient, so lets open the attribute table. Go to the “Table of Contents”, select “MBTA_ARC” and right click, and select “Open Attribute Table”



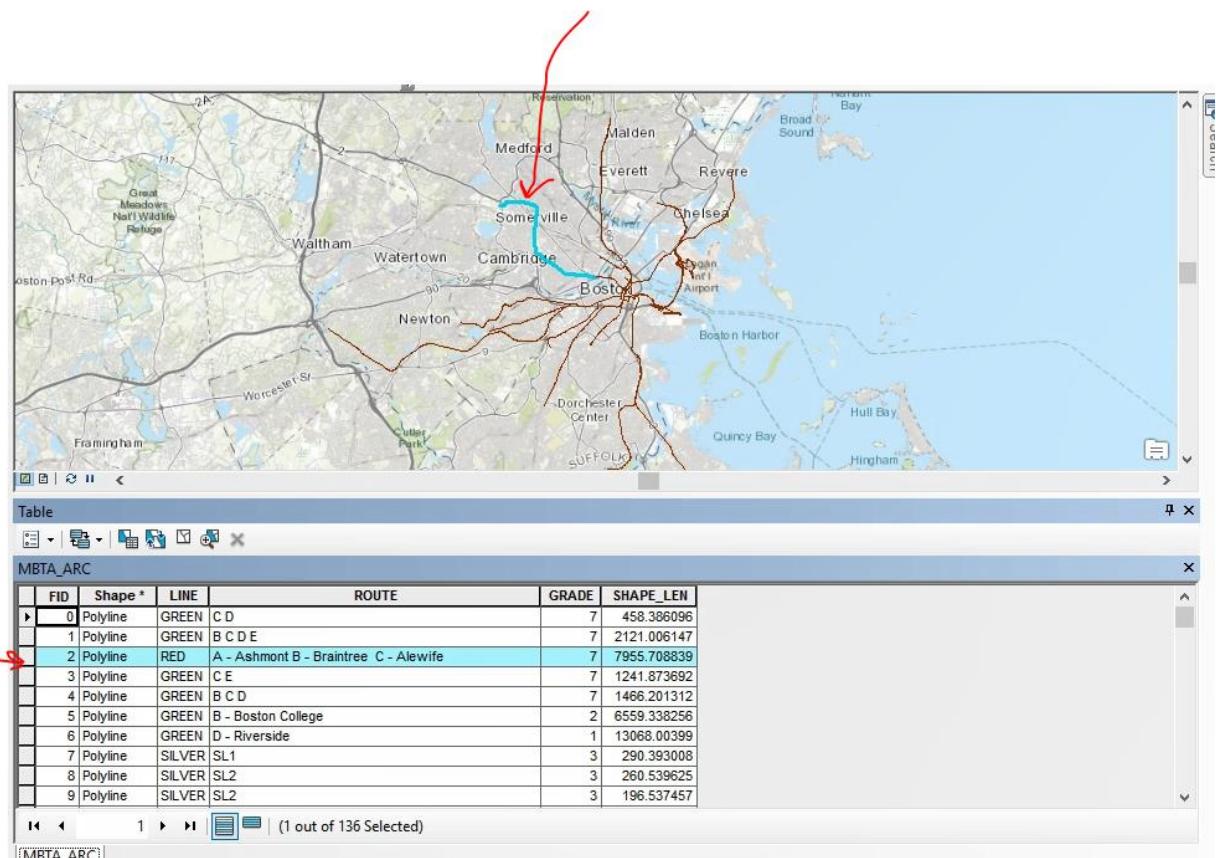
6. A new window should appear, which contains a table. Each column is an attribute, something that describes the feature (a row), which in this case is a Polyline for the location of a Subway line.

The screenshot shows the 'Table' window for the 'MBTA_ARC' layer. The table has columns: FID, Shape *, LINE, ROUTE, GRADE, and SHAPE_LEN. The data includes:

FID	Shape *	LINE	ROUTE	GRADE	SHAPE_LEN
0	Polyline	GREEN	C D	7	458.386096
1	Polyline	GREEN	B C D E	7	2121.006147
2	Polyline	RED	A - Ashmont B - Braintree C - Alewife	7	7955.708839
3	Polyline	GREEN	C E	7	1241.873692
4	Polyline	GREEN	B C D	7	1466.201312
5	Polyline	GREEN	B - Boston College	2	6559.338256
6	Polyline	GREEN	D - Riverside	1	13068.00399
7	Polyline	SILVER	SL1	3	290.393008
8	Polyline	SILVER	SL2	3	260.539625
9	Polyline	SILVER	SL2	3	196.537457

At the bottom left, there is a red circle around the 'MBTA_ARC' button in the toolbar.

7. I can select an entire row, by clicking on the grey cell on the far left. This will highlight the row, but it will also highlight the polyline on the map. This allows you to associate a row in the attribute table with the location on the map.

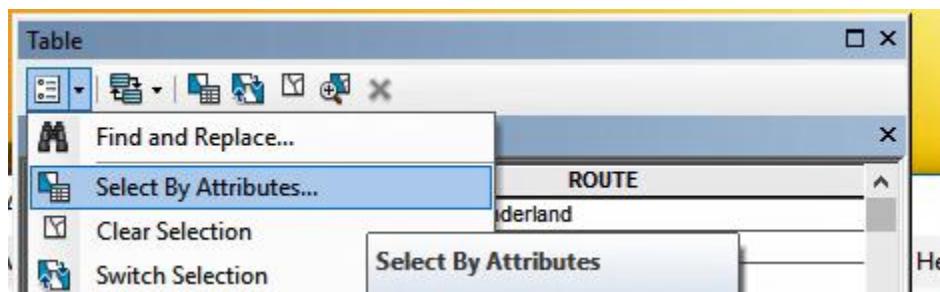


- One can also double click on the column name to sort the column. So if you double click on "LINE" you can group the colors coding associated with each subway line. You can also click and drag on the left side to select multiple rows.

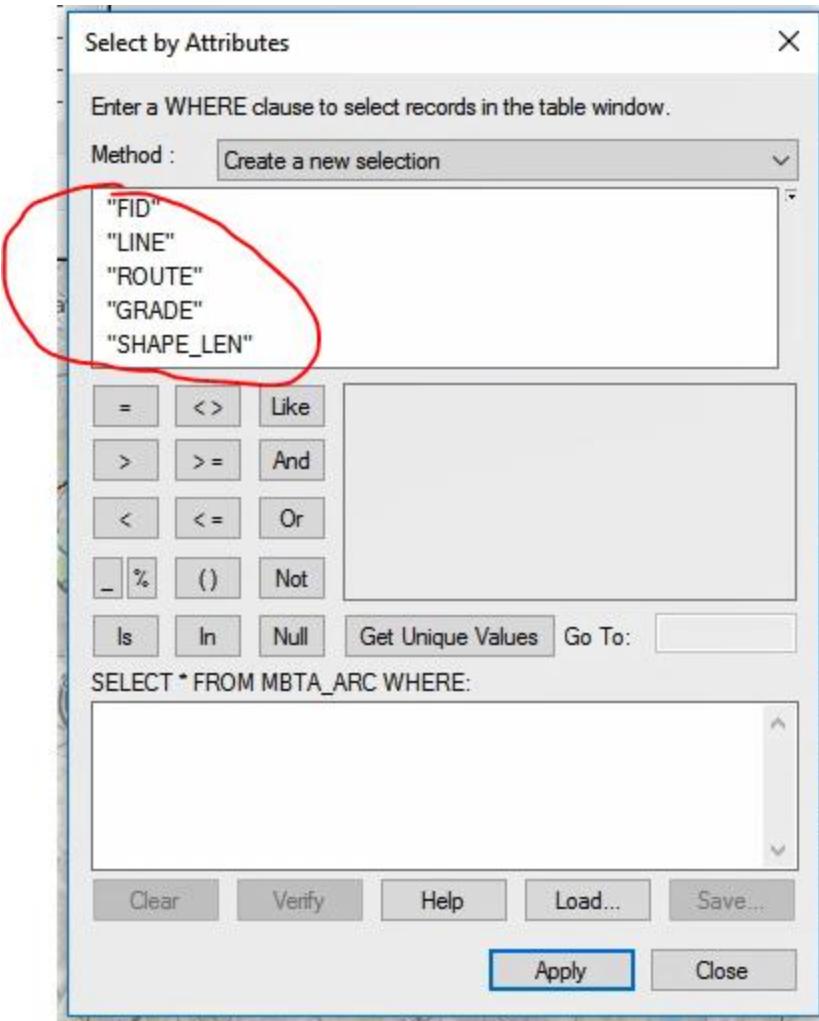
MBTA_ARC						
	FID	Shape *	LINE	ROUTE	GRADE	SHAPE_LEN
	36	Polyline	BLUE	Bowdoin to Wonderland	7	3228.194293
	37	Polyline	BLUE	Bowdoin to Wonderland	7	144.673947
	38	Polyline	BLUE	Bowdoin to Wonderland	1	494.303255
	39	Polyline	BLUE	Bowdoin to Wonderland	7	15.768618
	40	Polyline	BLUE	Bowdoin to Wonderland	6	268.978562
	49	Polyline	BLUE	Bowdoin to Wonderland	1	5410.217273
	0	Polyline	GREEN	C D	7	458.386096
	1	Polyline	GREEN	B C D E	7	2121.006147
	3	Polyline	GREEN	C E	7	1241.873692
	4	Polyline	GREEN	B C D	7	1466.201312

9. If you want to unselect everything, you can click the Clear Selection button .

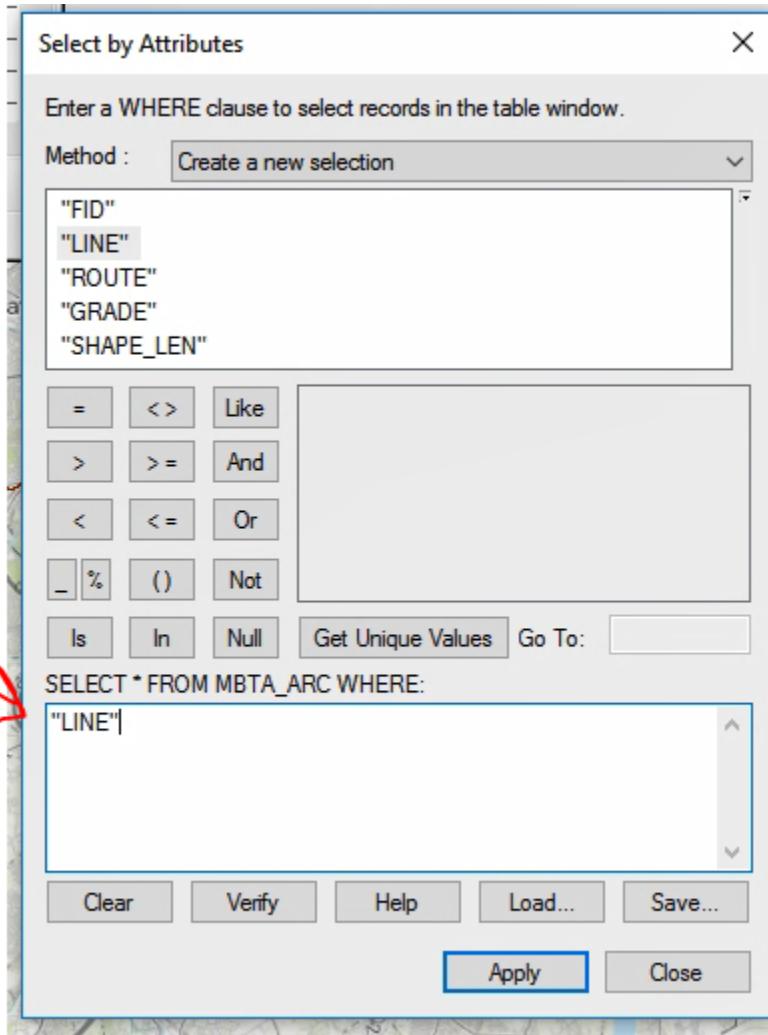
10. We can also select by Attribute. Click on the “table Options” tool , and select “Select By Attributes...”



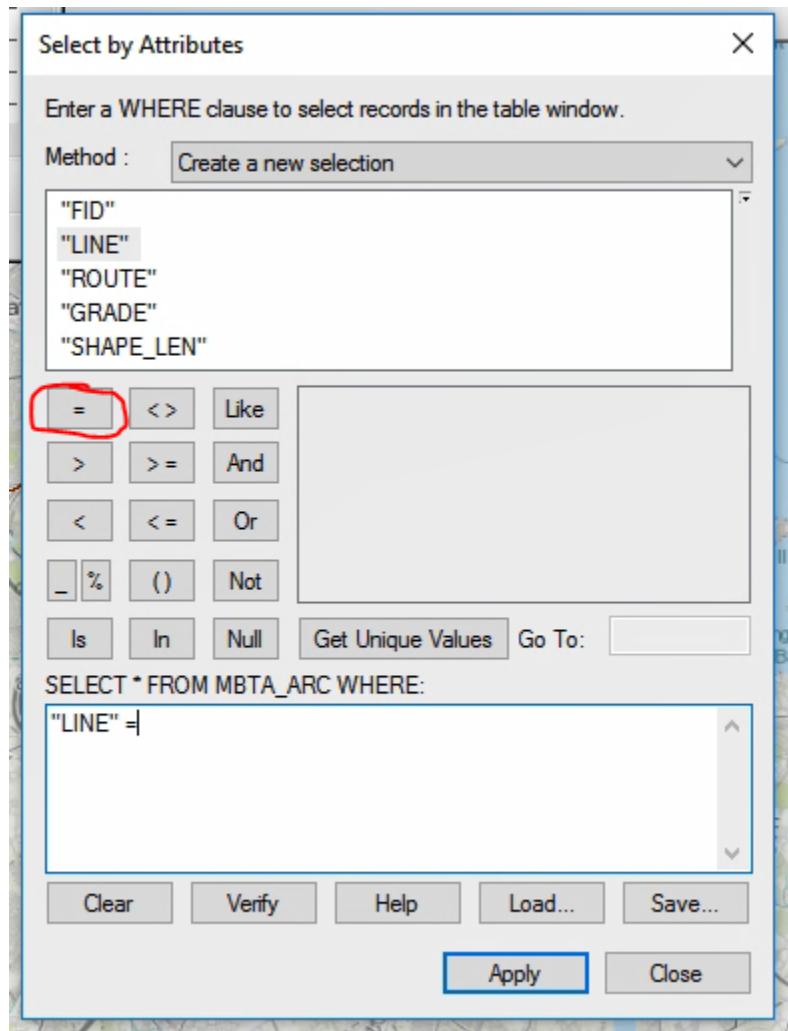
11. A new window will appear. This window assists us in assembling a SQL query to select features that satisfy our attribute selection. Near the top is a list of all the attributes associated with this layer. Let's say we want to select all polylines associated with the Green Line. First double click the “LINE” attribute.



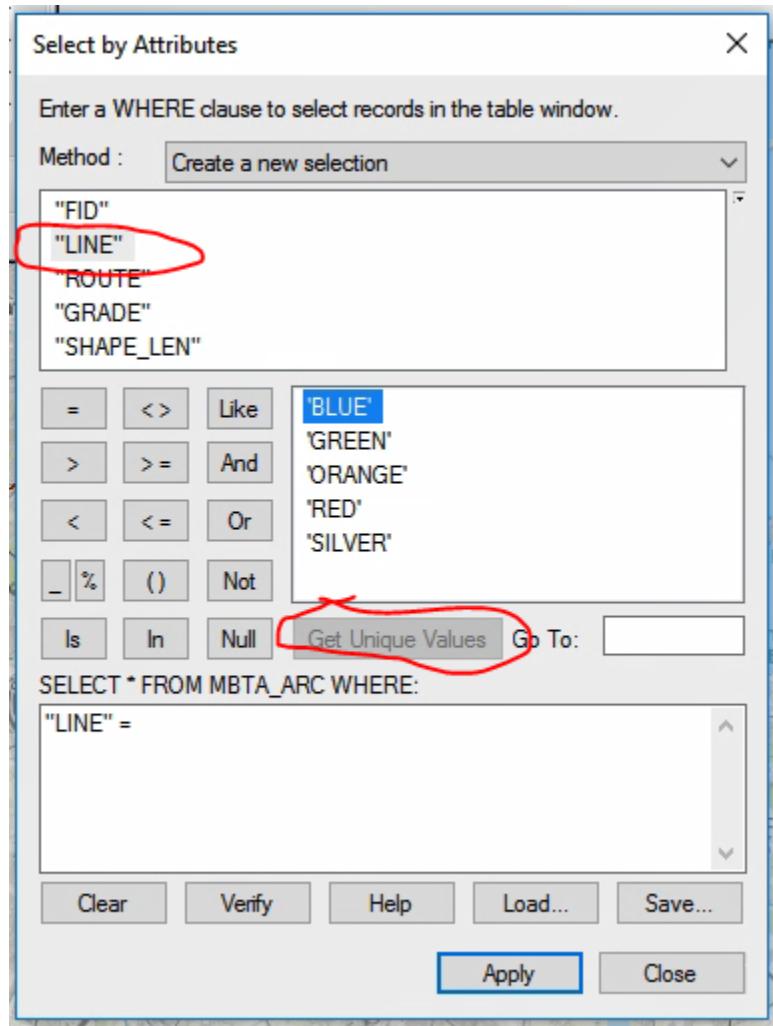
12. You will notice when you double clicked the "LINE" attribute, it added it to the text box below.
This is where we are assembling a query.



13. Next let's click the "=" button.

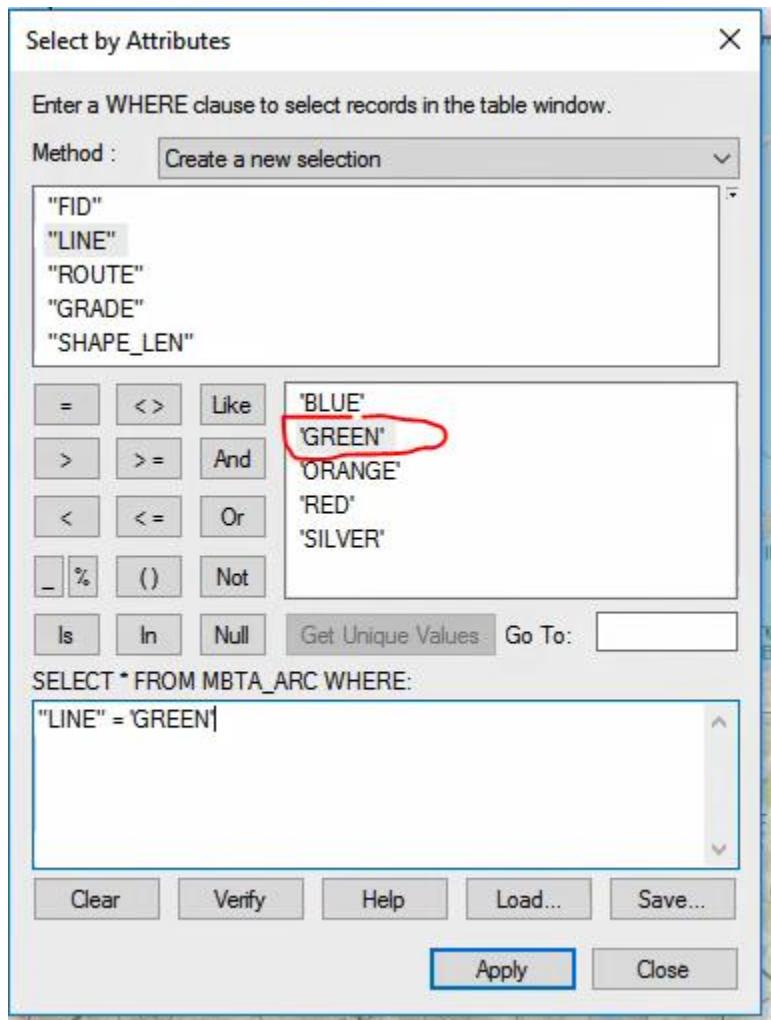


14. Next, while the “LINE” attribute is still selected at the top list, click on the “Get Unique Values” button.

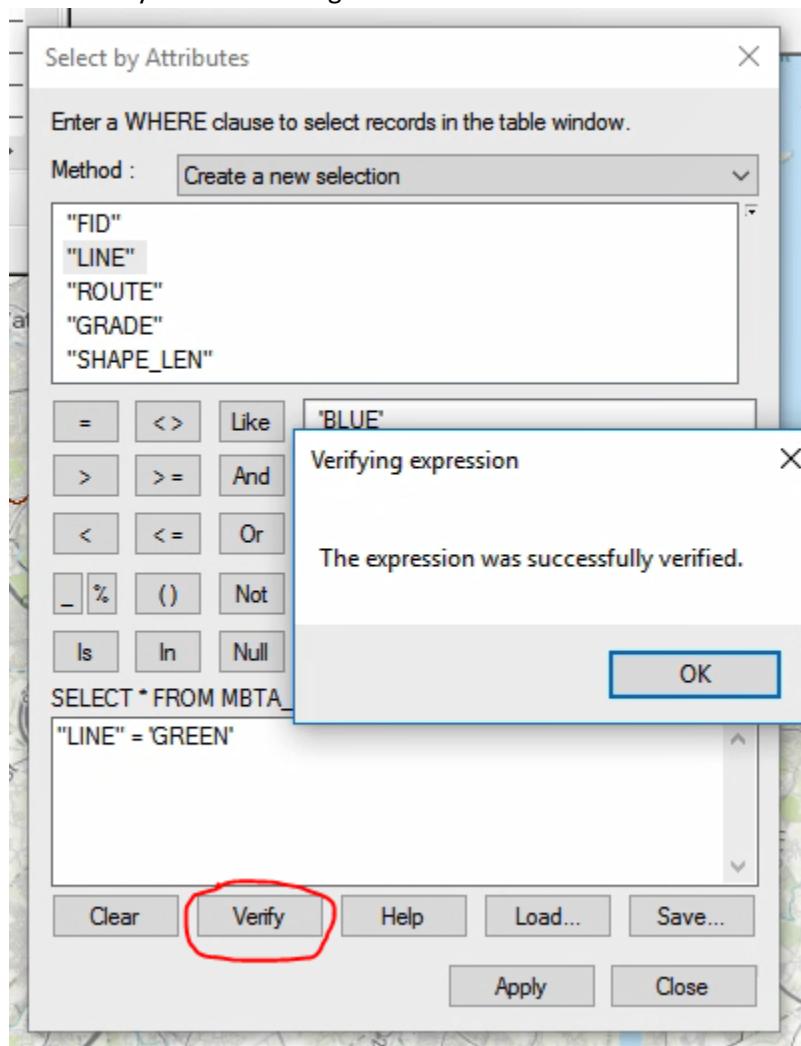


This will list all the unique values of that column.

15. Now let's double click on the 'GREEN' value. This finishes the assembly of the query.



16. Next we can click on “Verify” to make sure the query does not have any errors. You should get a successfully verified message.



17. Click OK to close the message and then click “Apply” and then “Close”.

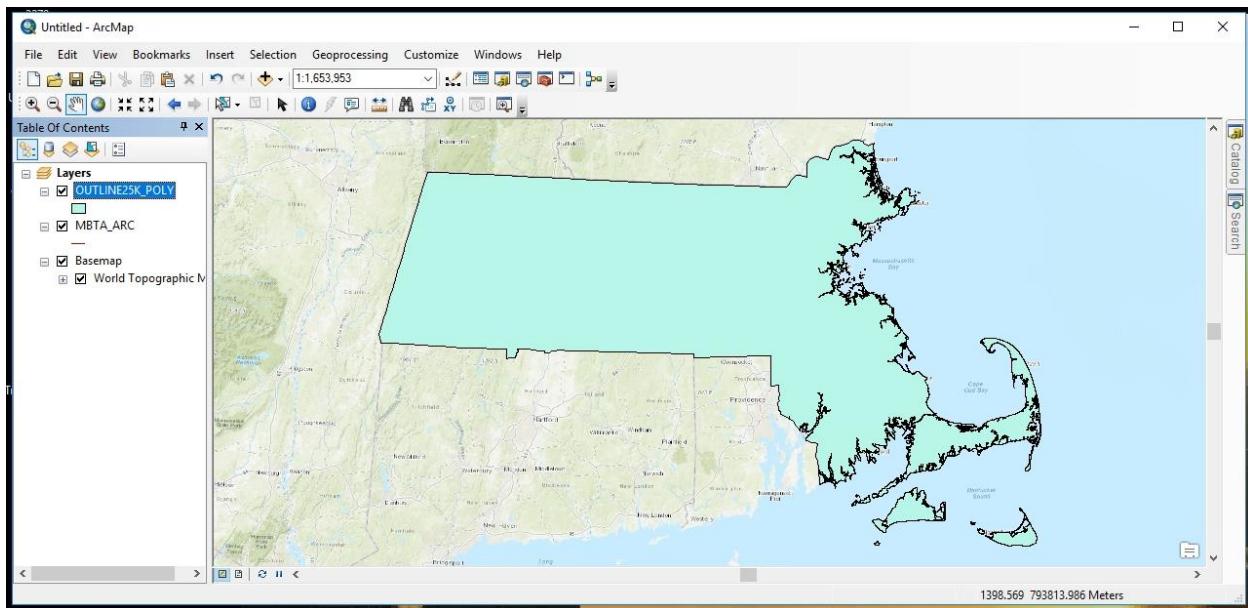
18. Now if we go back to the attribute table and scroll through it, you will notice all the rows that have "LINE" = 'GREEN' are highlighted. They are highlighted in the map as well.

FID	Shape *	LINE	ROUTE	GRADE	SHAPE_LEN
0	Polyline	GREEN	C D	7	458.386096
1	Polyline	GREEN	B C D E	7	2121.006147
3	Polyline	GREEN	C E	7	1241.873692
4	Polyline	GREEN	B C D	7	1466.201312
5	Polyline	GREEN	B - Boston College	2	6559.338256
6	Polyline	GREEN	D - Riverside	1	13068.00399
46	Polyline	GREEN	C - Cleveland Circle	2	3803.50199
47	Polyline	GREEN	E - Lechmere	4	1126.63349
50	Polyline	GREEN	E - Health Street	2	1595.51673
116	Polyline	GREEN	D - Riverside	1	1618.957543

19. These are the basic functionality of navigating an attribute table.

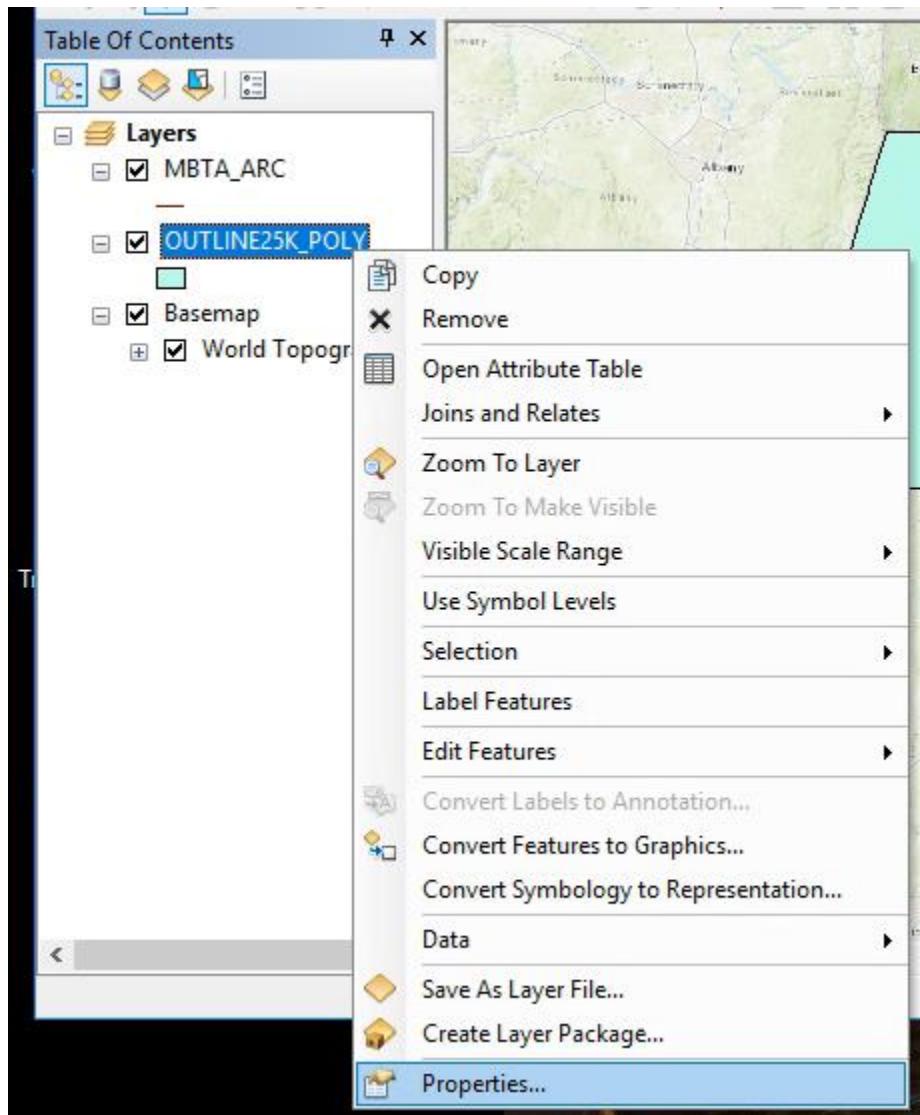
Formatting the Layers

1. We want to now update the colors and symbology of the map to make it visually appealing. Let's first turn on the layer "OUTLINE25K_POLY" and zoom out to the extent of the OUTLINE25K_POLY layer.
2. In the "Layers" DataFrame, the order of the layers matter. The layer that is on bottom is drawn at the back, while the layer at the top is drawn in the front. You can reorder the drawing order of the layers by selecting a layer, left click and hold the layer, and then drag it to the level you want it appear. Let's select "OUTLINE25K_POLY" and put it at the top.

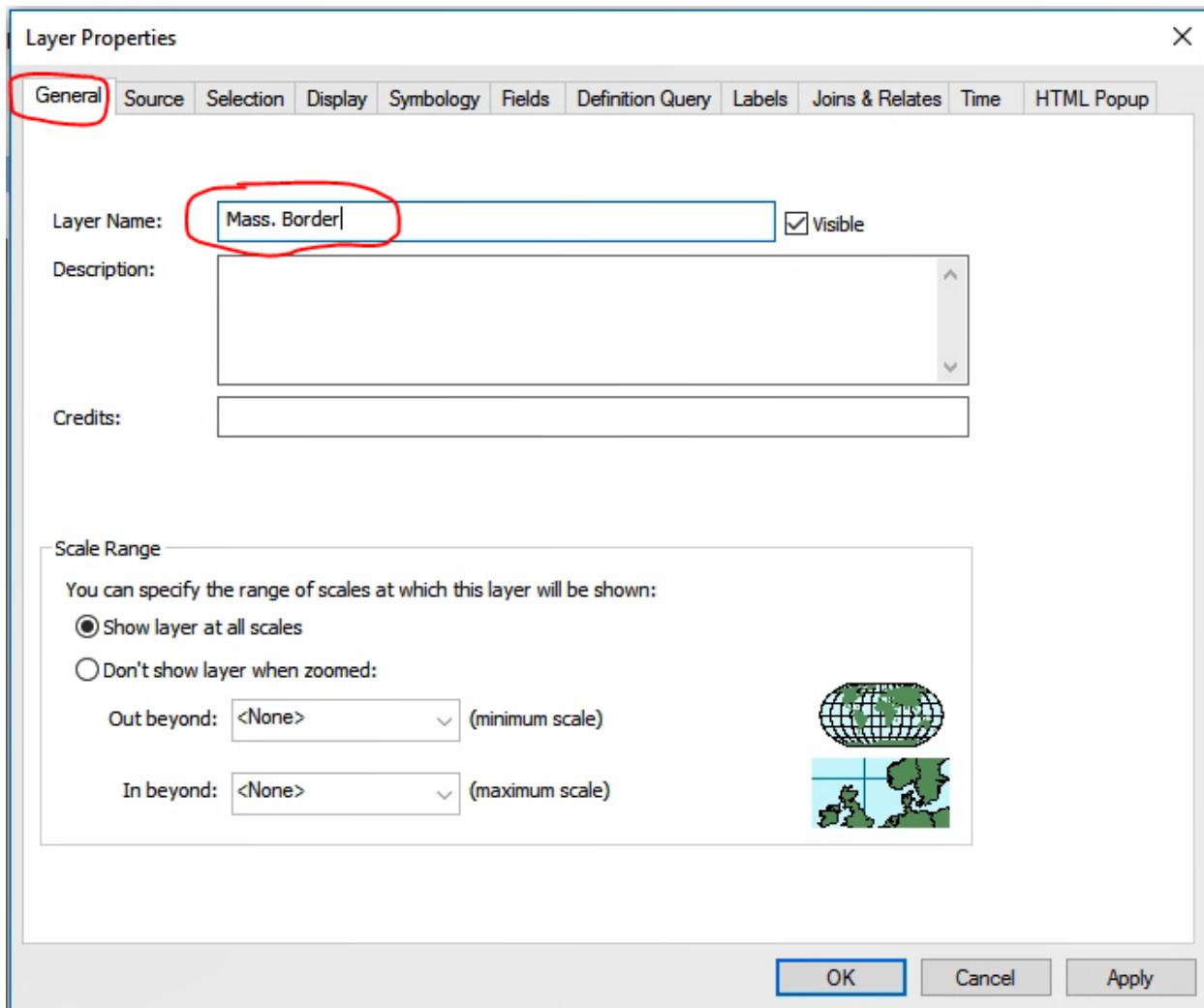


Notice how the lines for the subways have disappeared? This is because you are drawing the Massachusetts Polygon on top of all the subway line layer. If you uncheck the polygon layer, then you will see the subway lines are still there. This is not what we want, so let's drag the polygon layer back to right above the "basemap" layer.

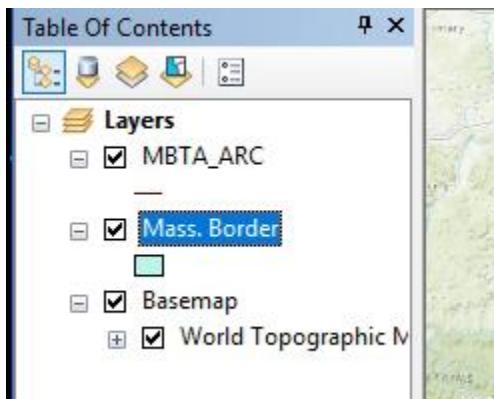
3. The names of our layers are not very informative, let's update them. Select "OUTLINE25K_POLY" and right click, and go to "Properties".



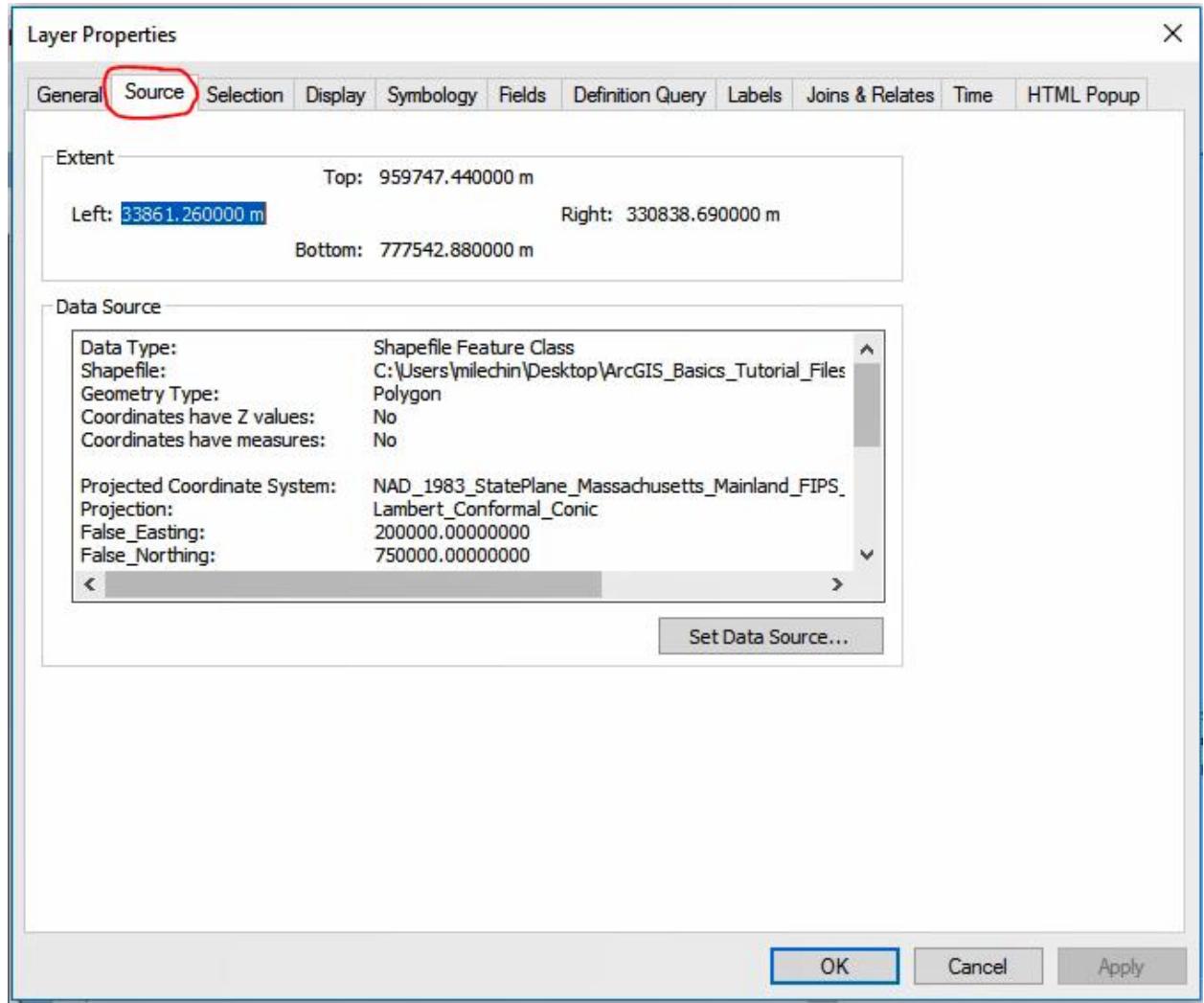
4. A new window will appear. This Layer Properties window will be used a lot to edit how the layer is displayed and what type of data is displayed. To update the name we want to go to the "General" tab and change the "Layer Name" field to "Mass. Border".



Then hit "Apply". If you look at the Table of Contents, you should see the layer name was updated.

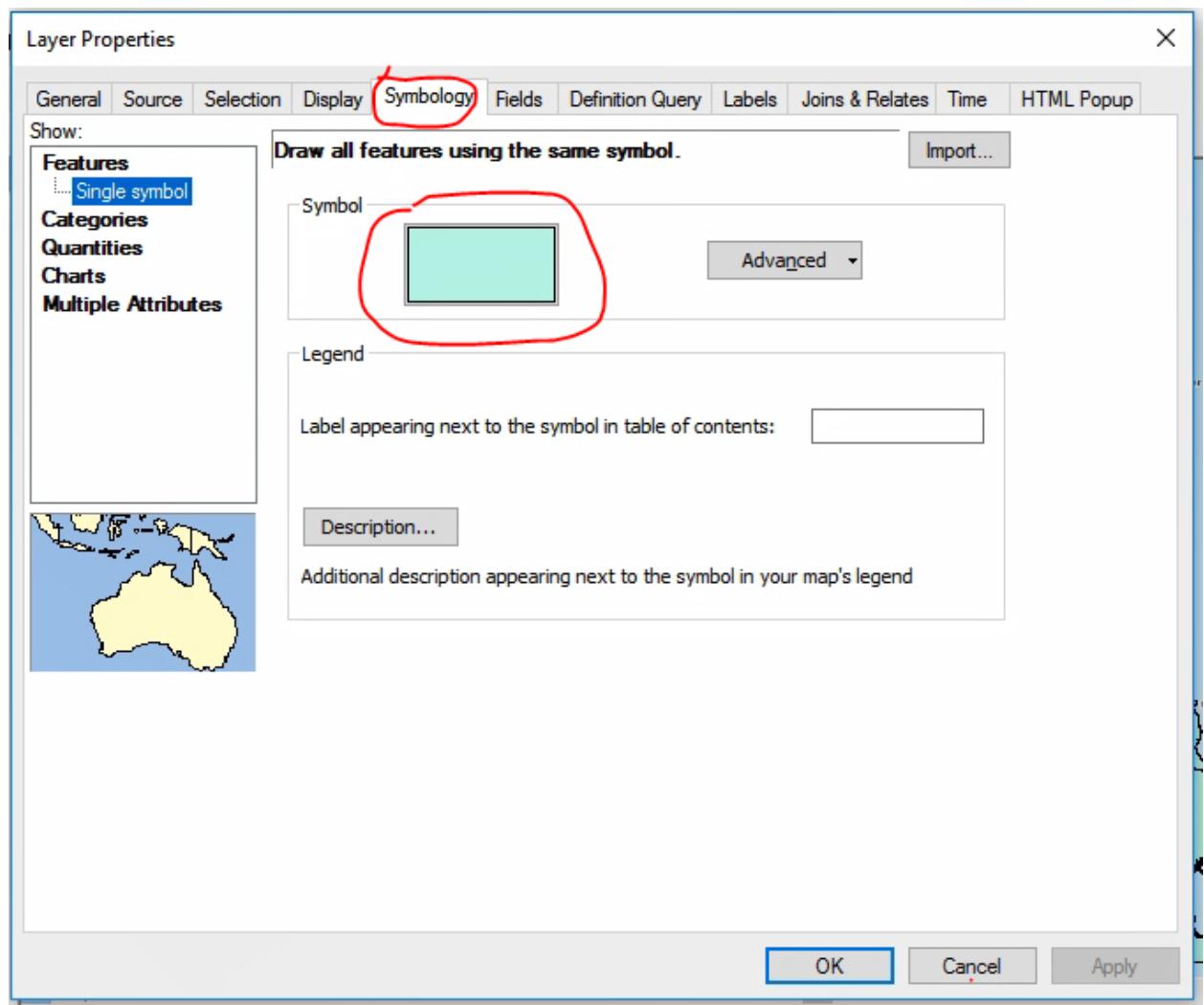


5. Let's explore the Layer Properties window some more. Click on the "Source" tab.

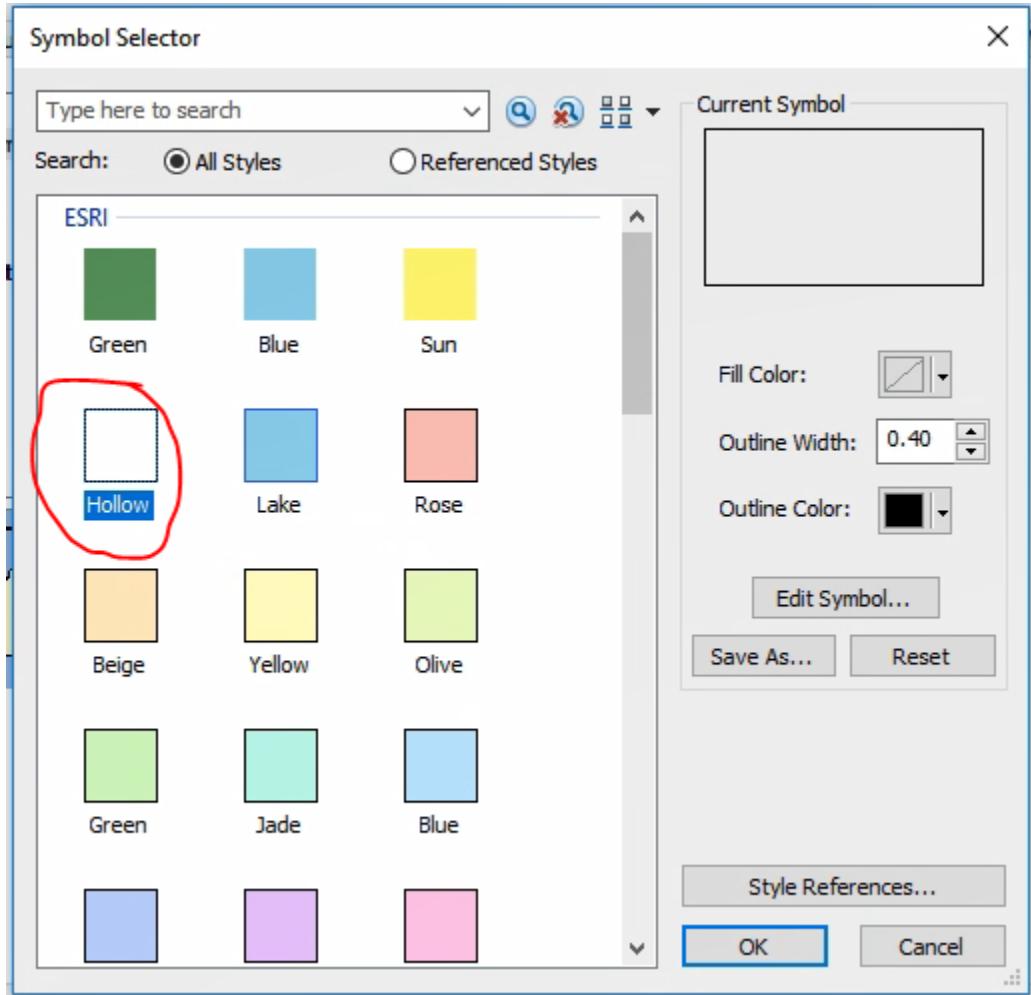


This is a useful tab to review, as it includes the location of the datasource, the geometry type, the projection, and extent.

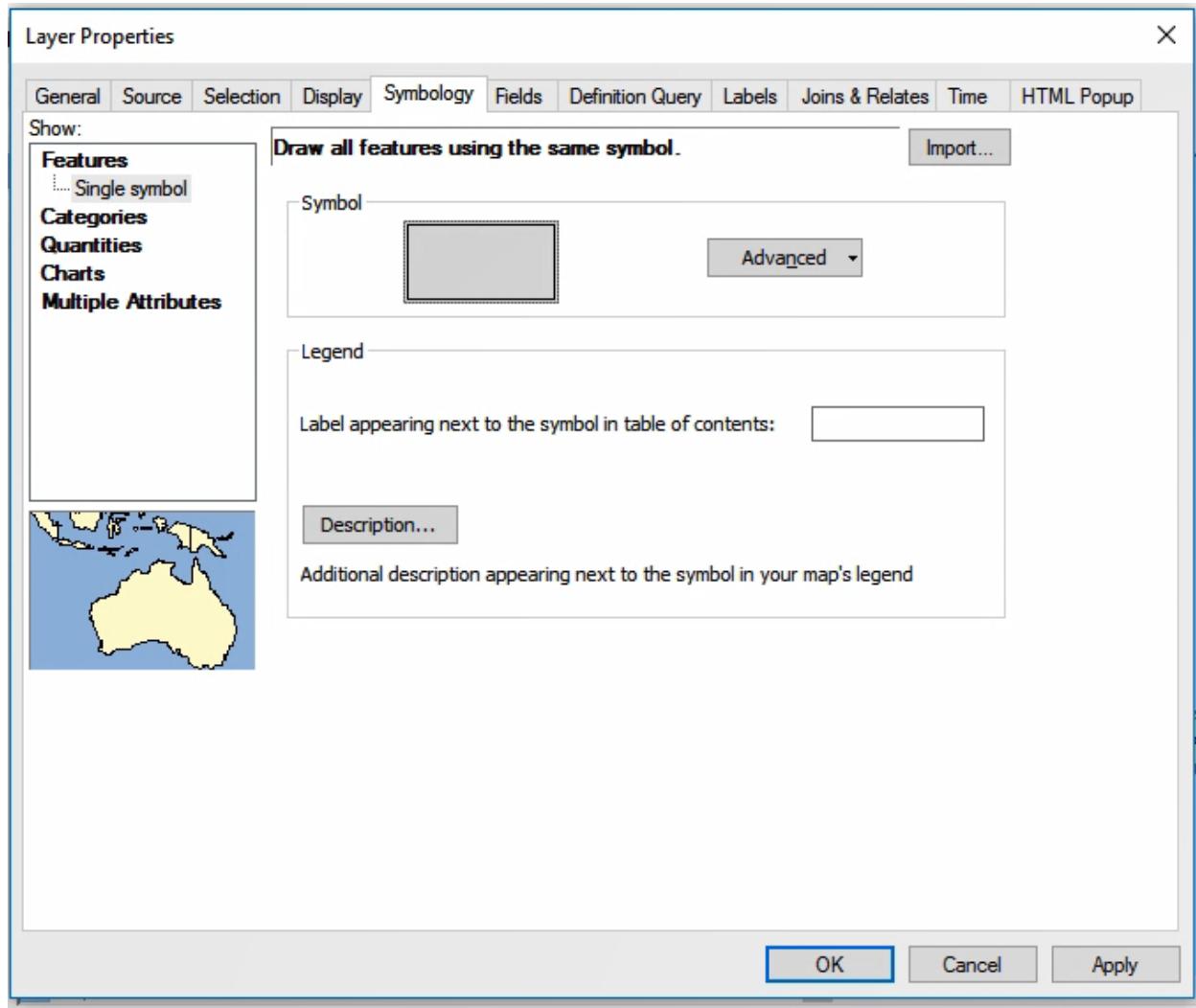
6. Next let's take a look at "Symbology" tab. This is where we can update how the layer is drawn on the map. Click on the "Symbol" rectangle so we can edit the look.



7. A new window will appear. On the left pane, one can select a pre-defined symbols, or one can create their own Symbol on the right. To keep things simple lets click on the “Hollow” Symbol and click OK. The “Hollow” symbol will just place a black border around the polygon with no fill color.

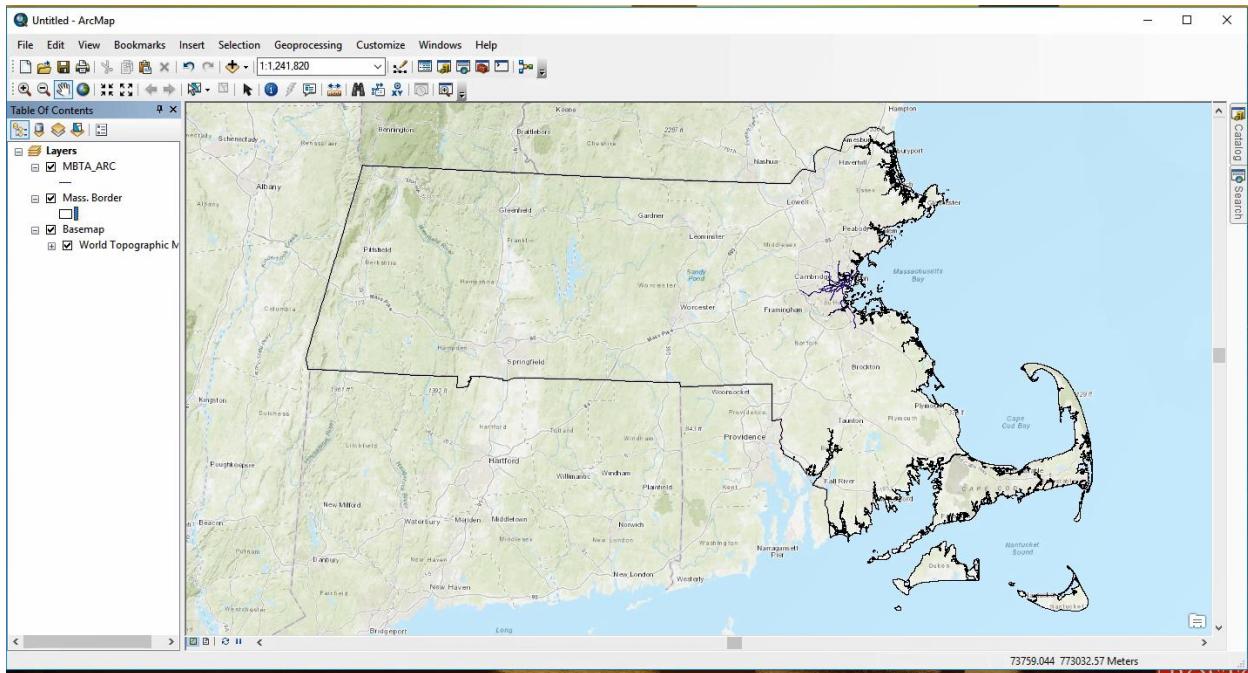


8. This will close the Symbol Selector window and we are back at the Layer Properties window.
You will notice the Symbol has changed to the one we selected.



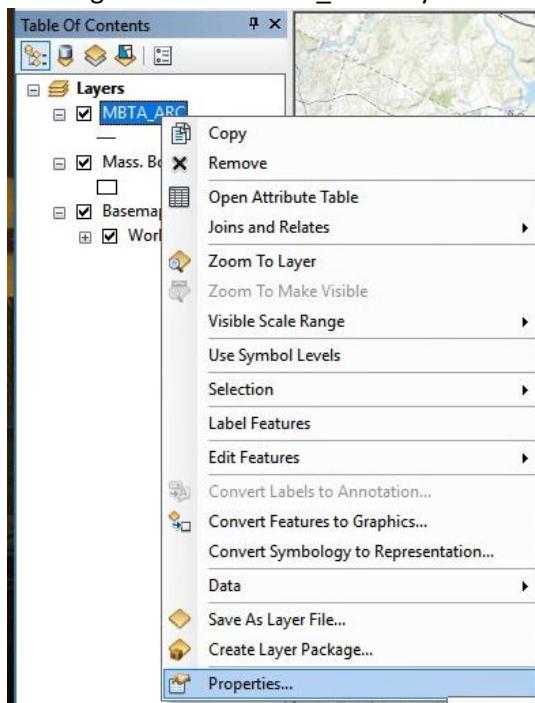
To apply the changes to our layer, we need to hit “Apply” or “OK”. Let’s hit “OK”, which will apply the changes but also close the window.

9. You should see that now we have a black border of the polygon with no fill color. You will also notice that the “Mass. Border” layer symbol was also updated.

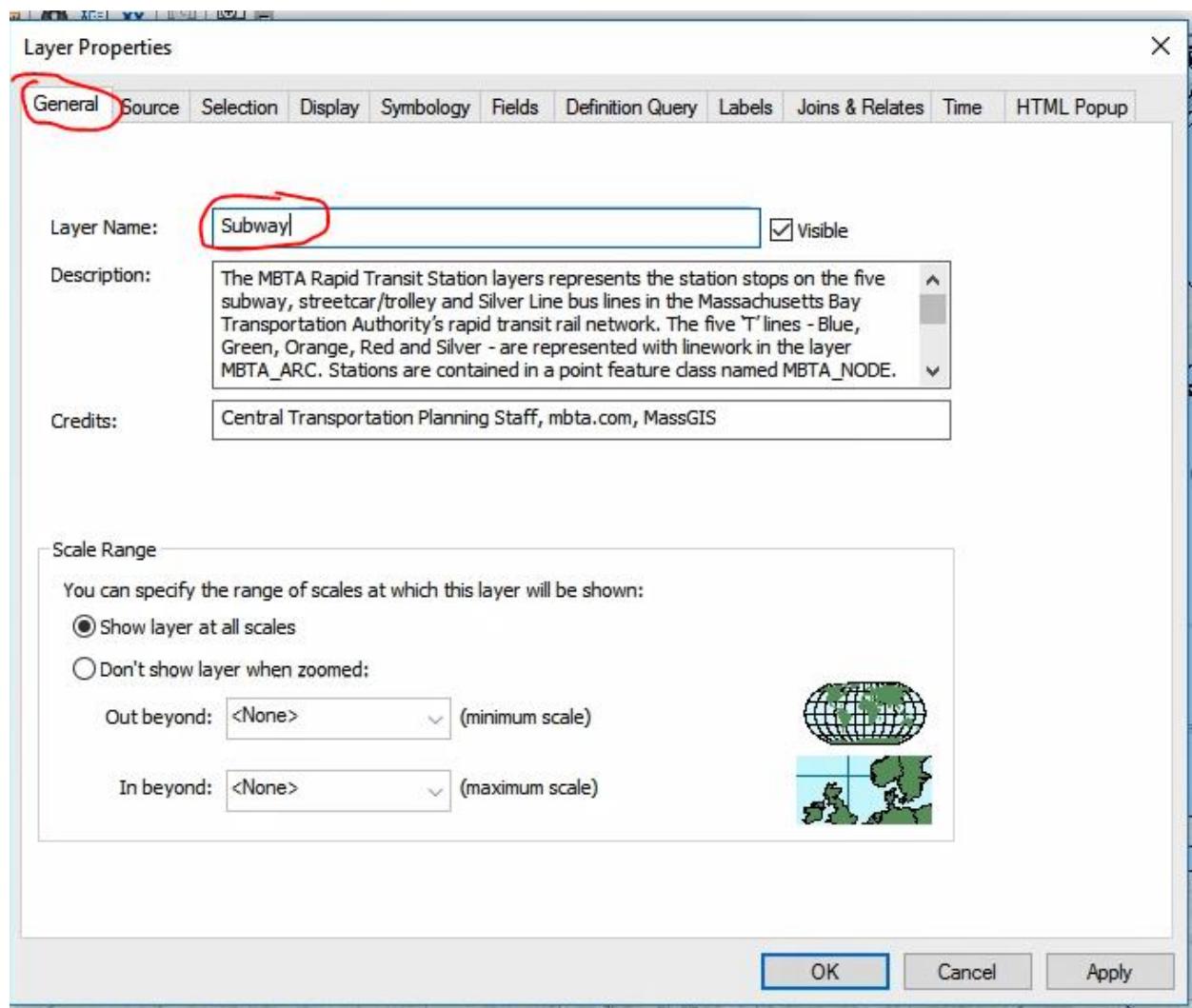


10. Let's color code the subway lines based on their colors. Let's first zoom in on the Subways by using the “Zoom to Layer” option.

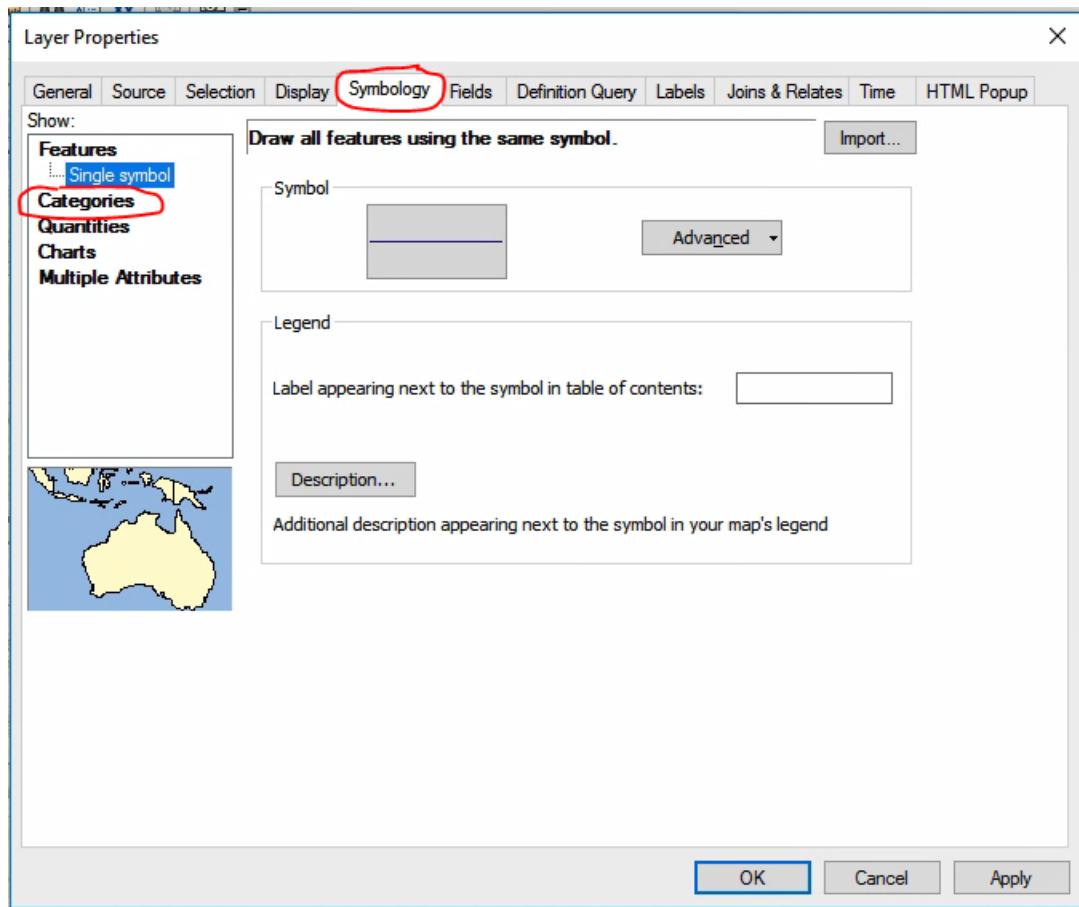
11. Then right click on “MBTA_ARC” layer and select “Properties”



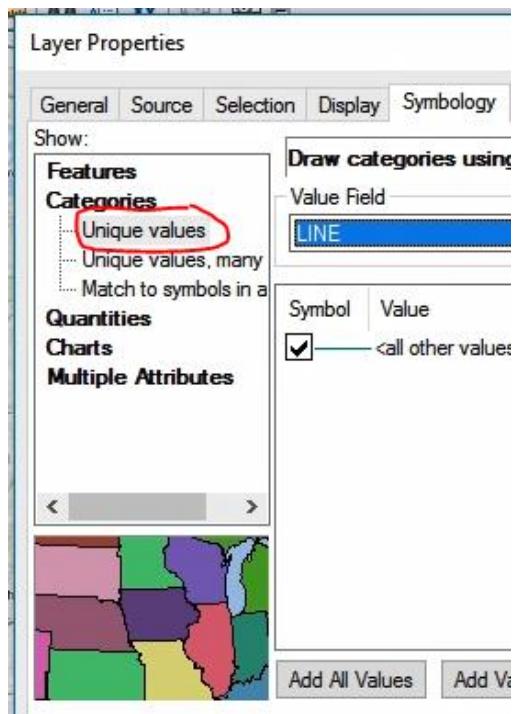
10. Let's update the layer name, by going to the "General" tab and changing the "layer Name" field to "Subway", then hit "Apply".



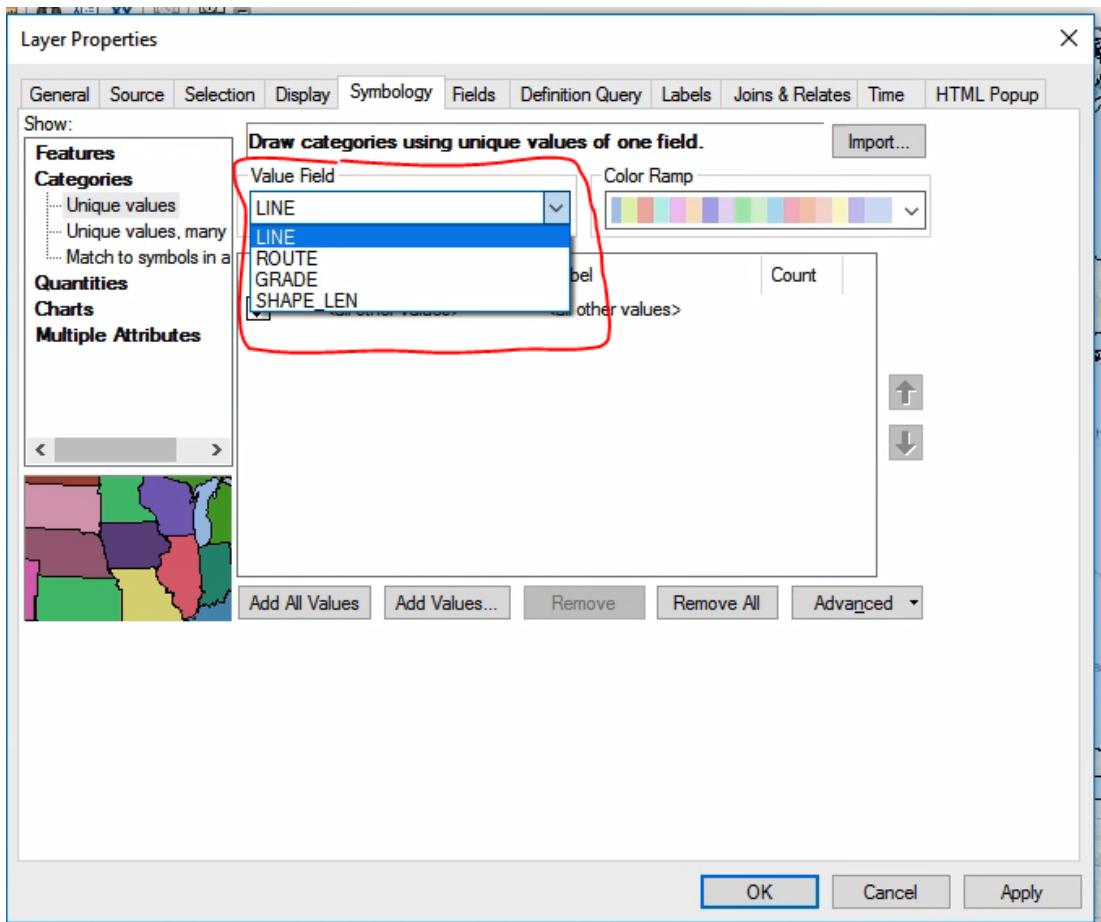
11. Next, let's go to the "Symbology" tab and then on the left side, click "Categories"



12. This will update the main panel and expand the Categories options. Make sure “Unique values” is selected under “Categories.”

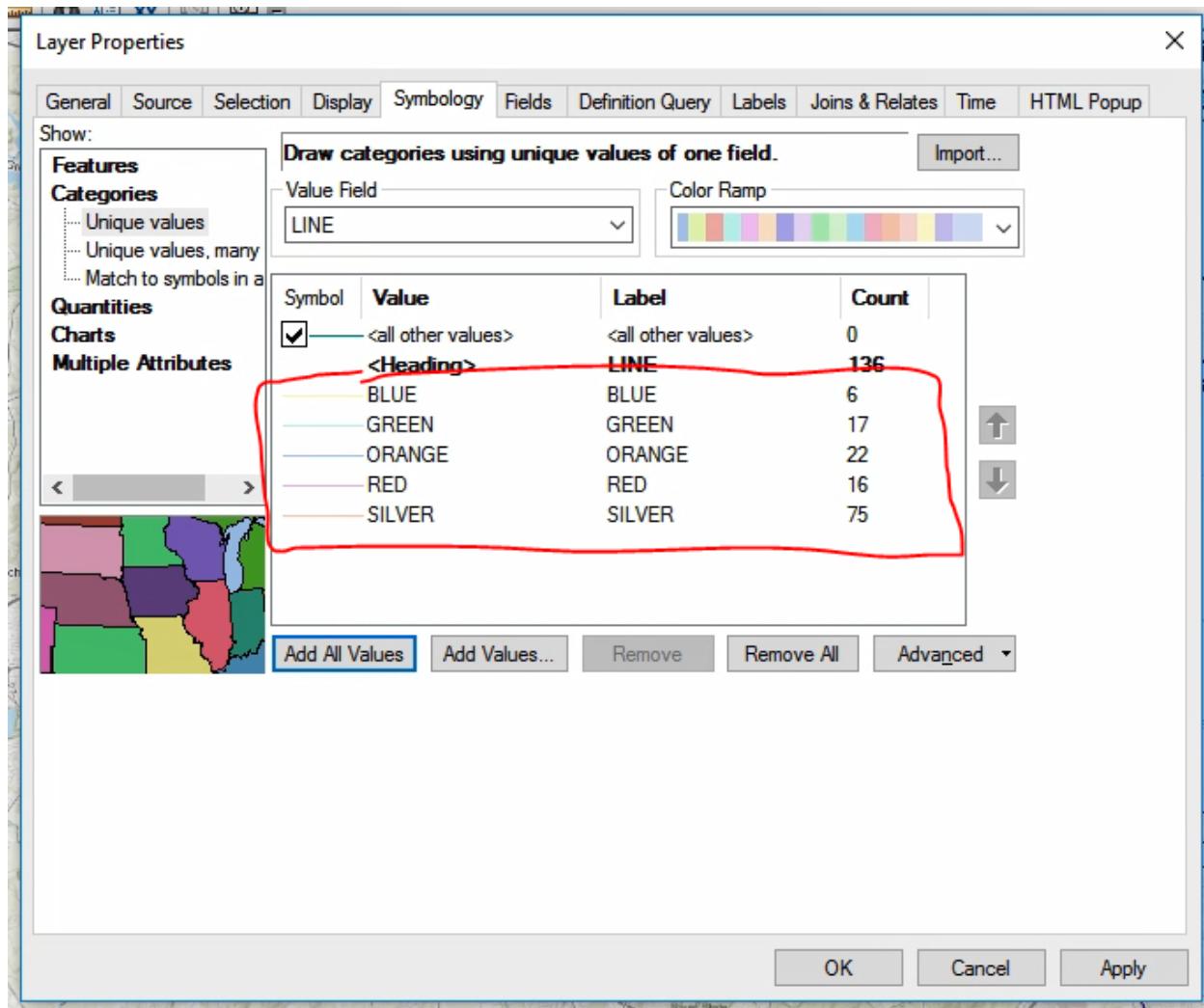


13. If we look at the drop down options for “Value Field”, we will notice these are the attributes of the features.

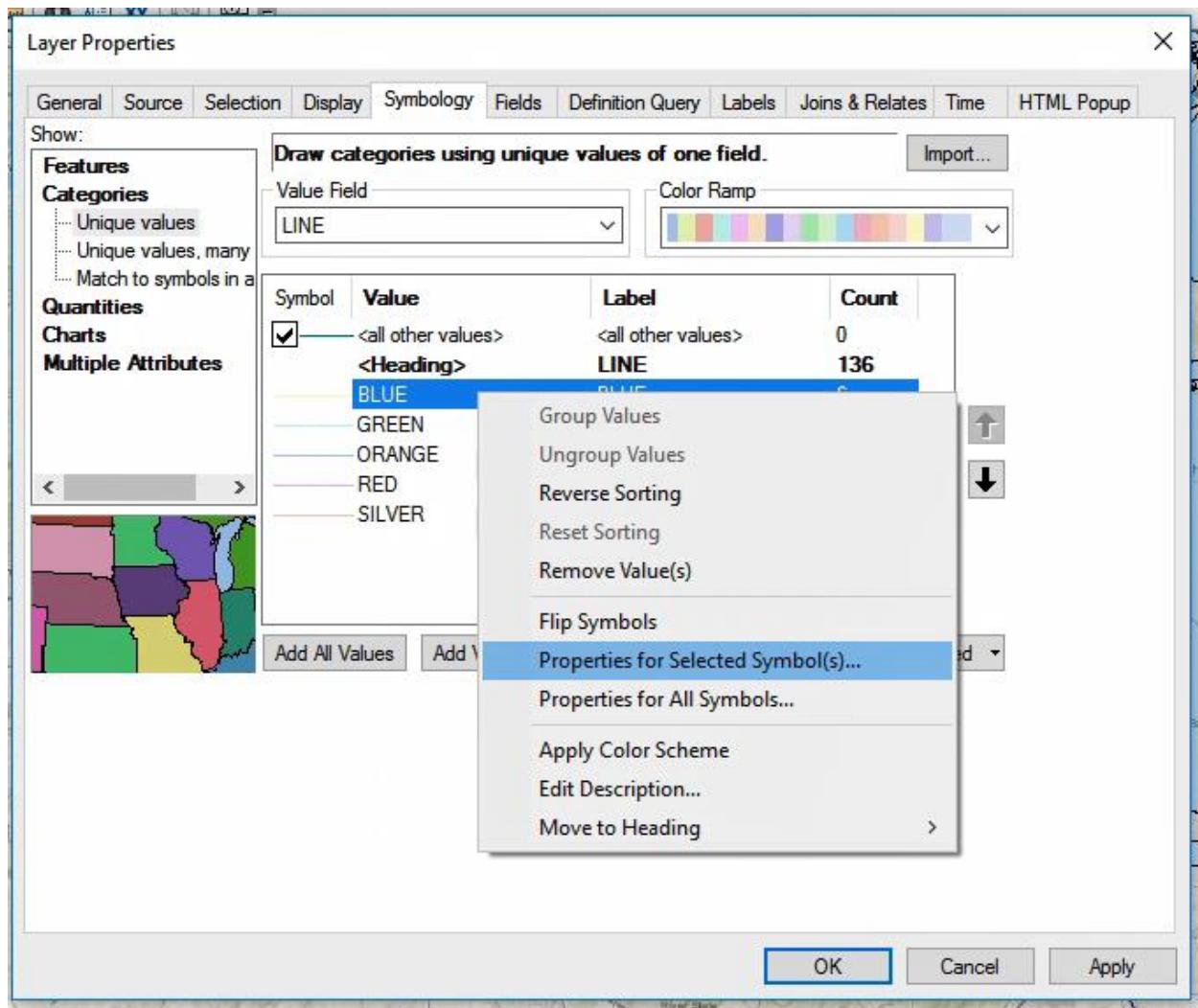


Since we want to color code by “LINE”, let’s select that Attribute.

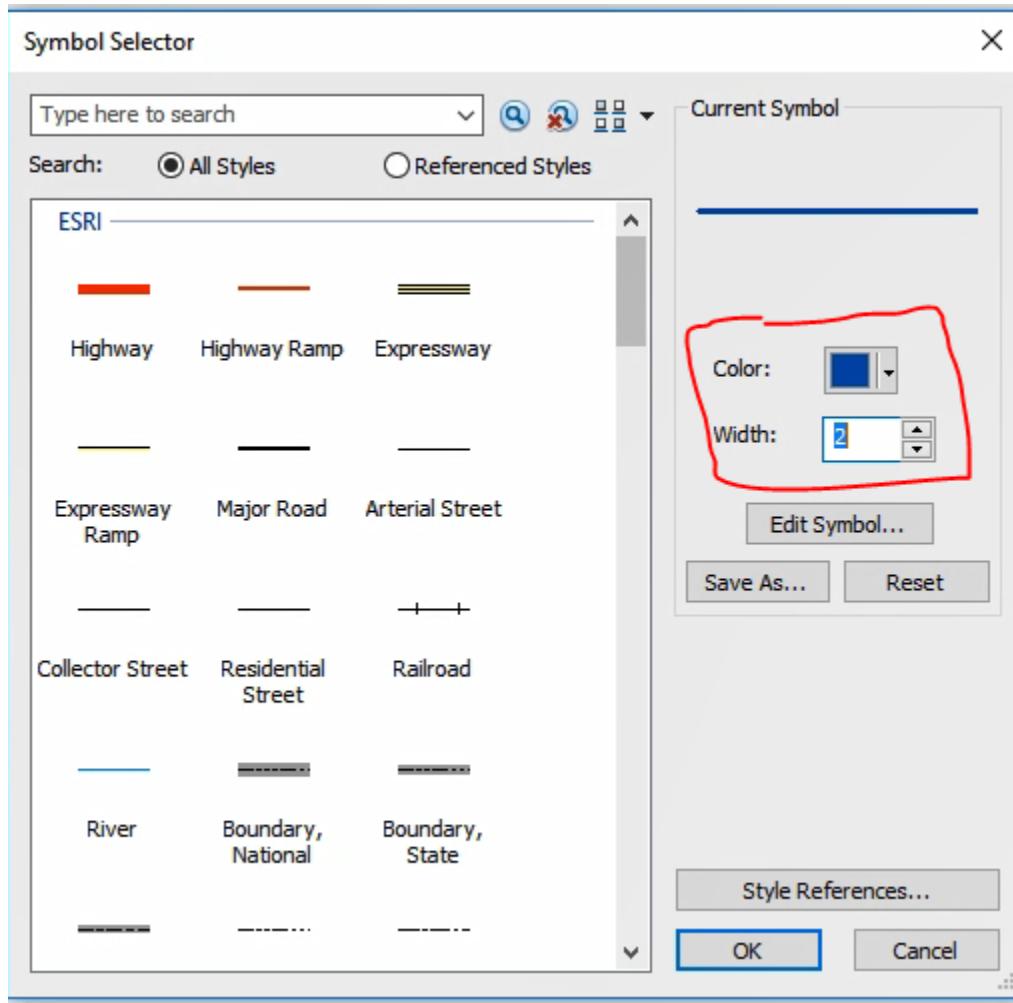
14. Next, click on “Add All Values” button. This will list all the unique values of “LINE” attribute in the center panel.



15. The colors chosen are not representative of the Subway Line colors. Let's update those.
Select the "BLUE" value row and right click, and select "Properties for Selected Symbol(s)".



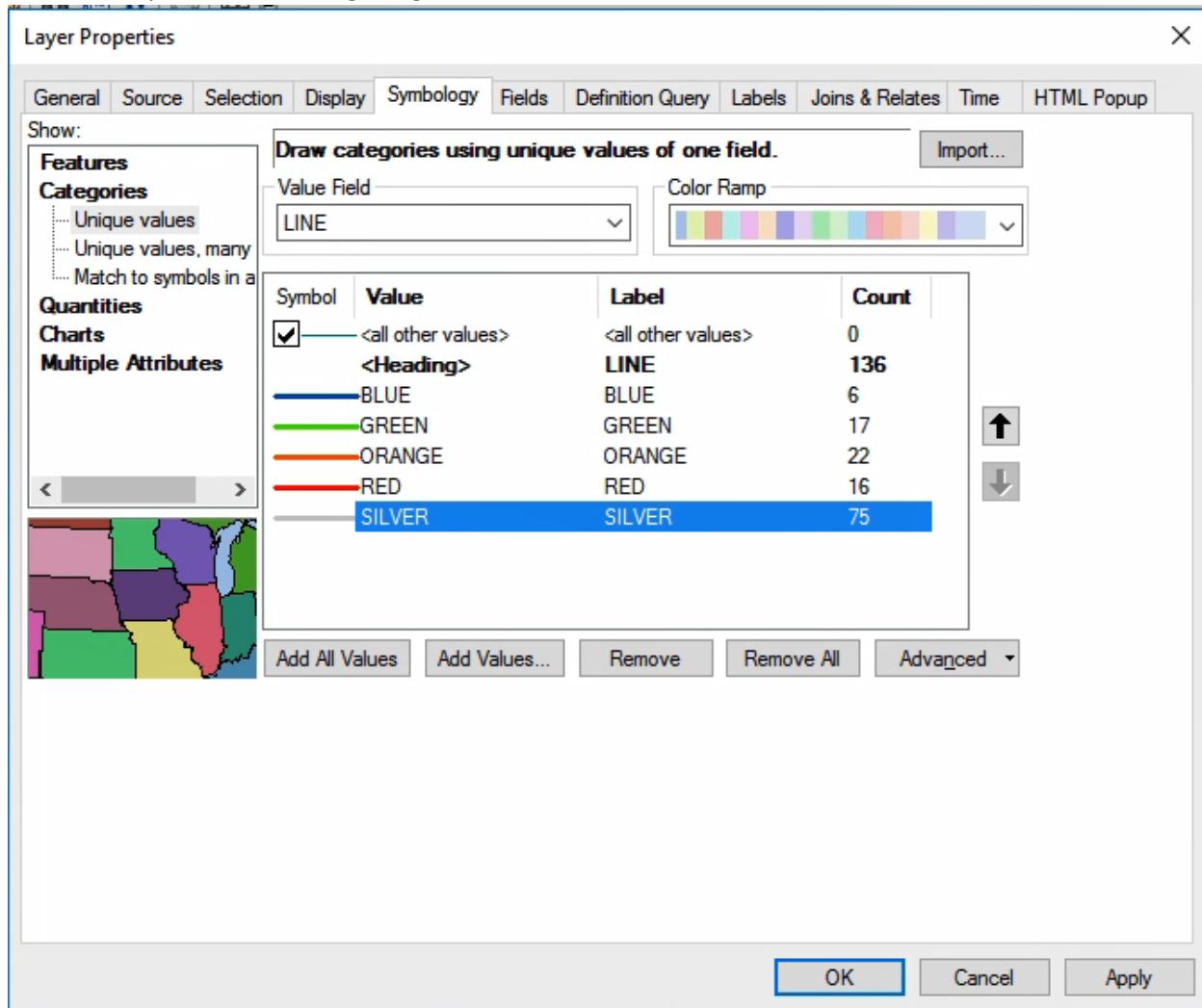
16. A new window will appear, and it should look a little familiar to when we updated the symbology for the Massachusetts Border. On the right side, lets select a “color” blue and increase the line width to 2.00, and Click OK.



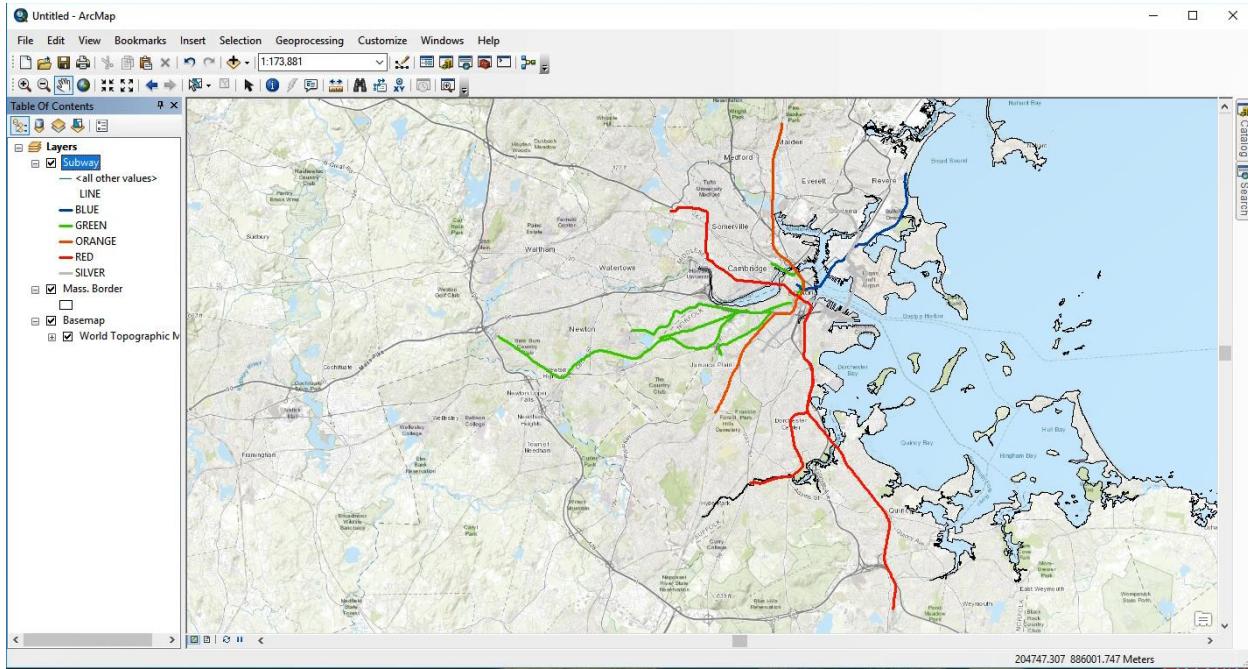
17. You should see the symbology for the BLUE line is now blue and thicker.

Symbol	Value	Label	Count
<input checked="" type="checkbox"/>	<all other values>	<all other values>	0
	<Heading>	LINE	136
	BLUE	BLUE	6

18. Update the colors of the other lines, but this time you can just double click on the color line you want to change to get the same edit window.



19. Then click “OK” to apply the changes. Now each subway line is color coded to their corresponding line name.



Import a CSV file with Coordinates

1. Let's add the station locations to the map. This is stored in the mbta_stations.csv which was part of the ArcGIS_Basics_Tutorial_Files.zip you downloaded earlier. If you open this file, you will see 6 columns:

STATION – The name of the MBTA station stop

LINE – What color subway line it is on

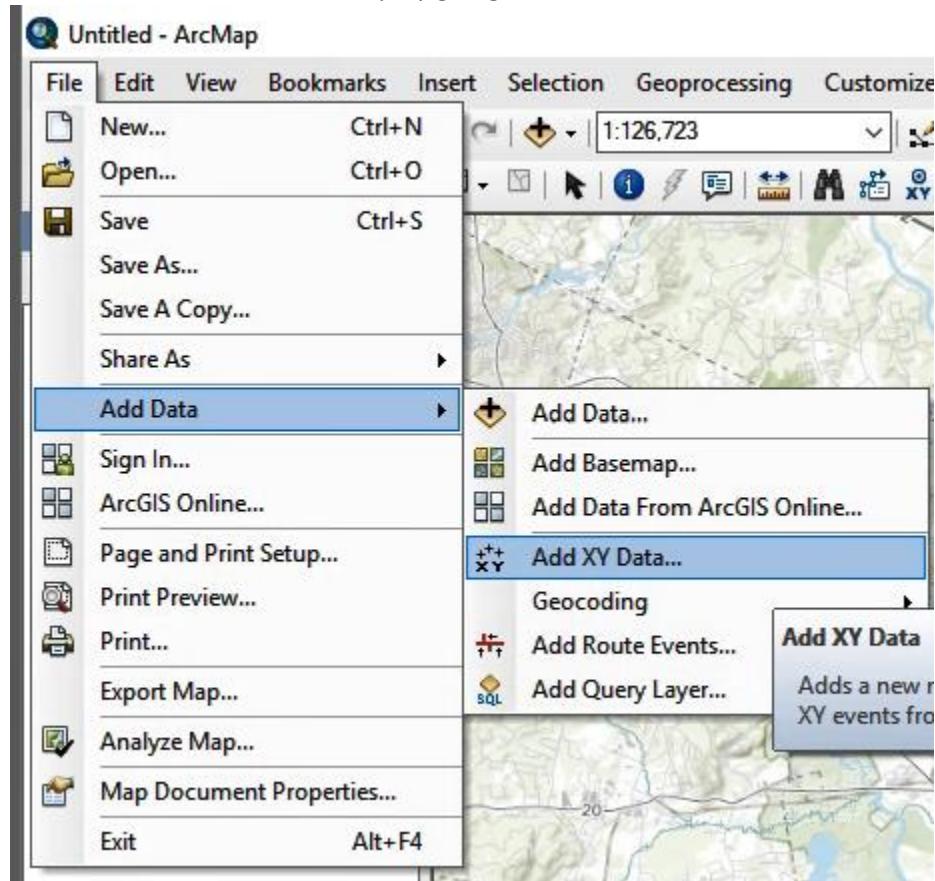
TERMINUS – Is this station the end of the line.

ROUTE – The name of the subway route

POINT_X – the X coordinate

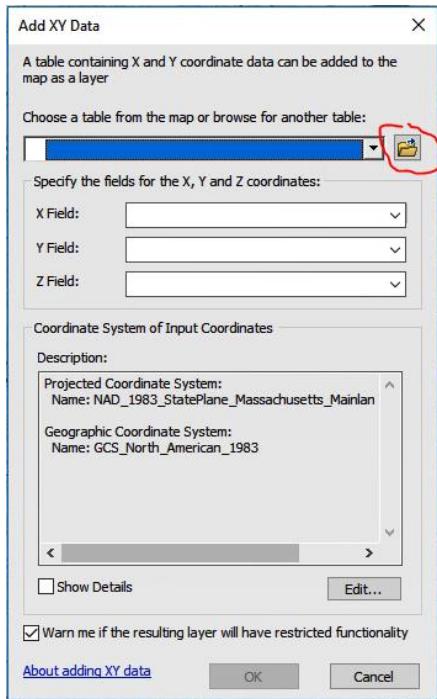
POINT_Y – the Y coordinate

2. We can add this data to ArcMap by going to **File** → **Add Data** → **Add XY Data...**

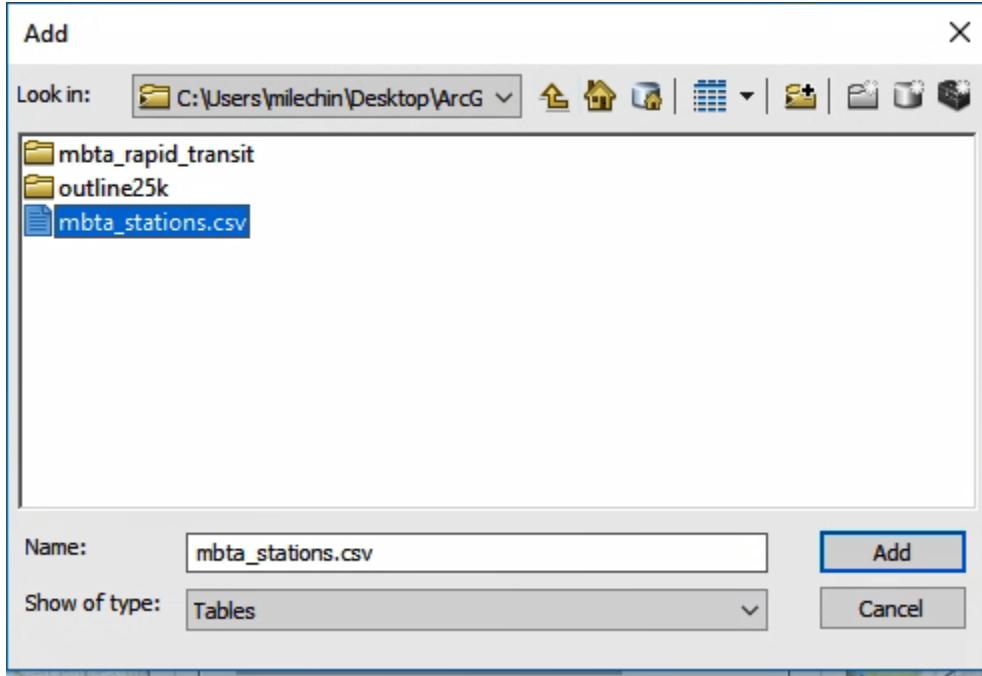


3. A new window will appear called “Add XY Data”. First we need to tell ArcMap where this file

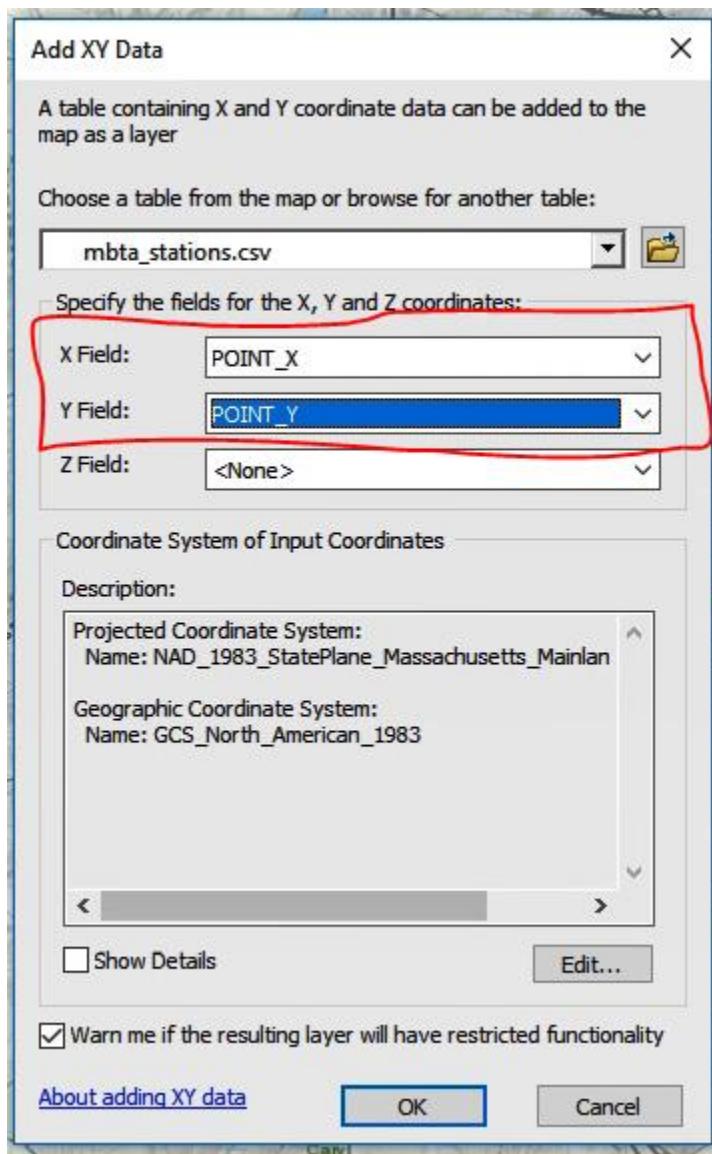
is by clicking the folder tool .



4. In the new window find the mbta_stations.csv file and select it, and then click “Add”.



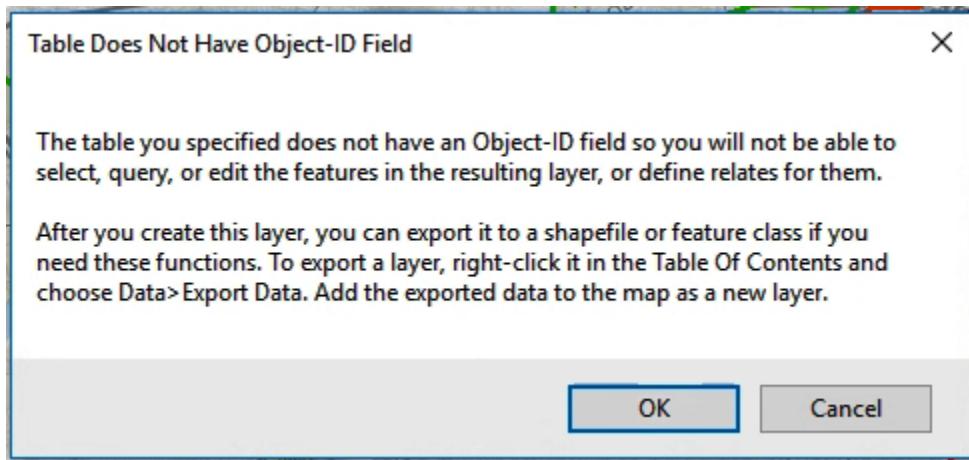
5. Now we need to specify the X Field and Y Field. These are the X and Y coordinates. So set “X Field” to “POINT_X” and “Y Field” to “POINT_Y”.



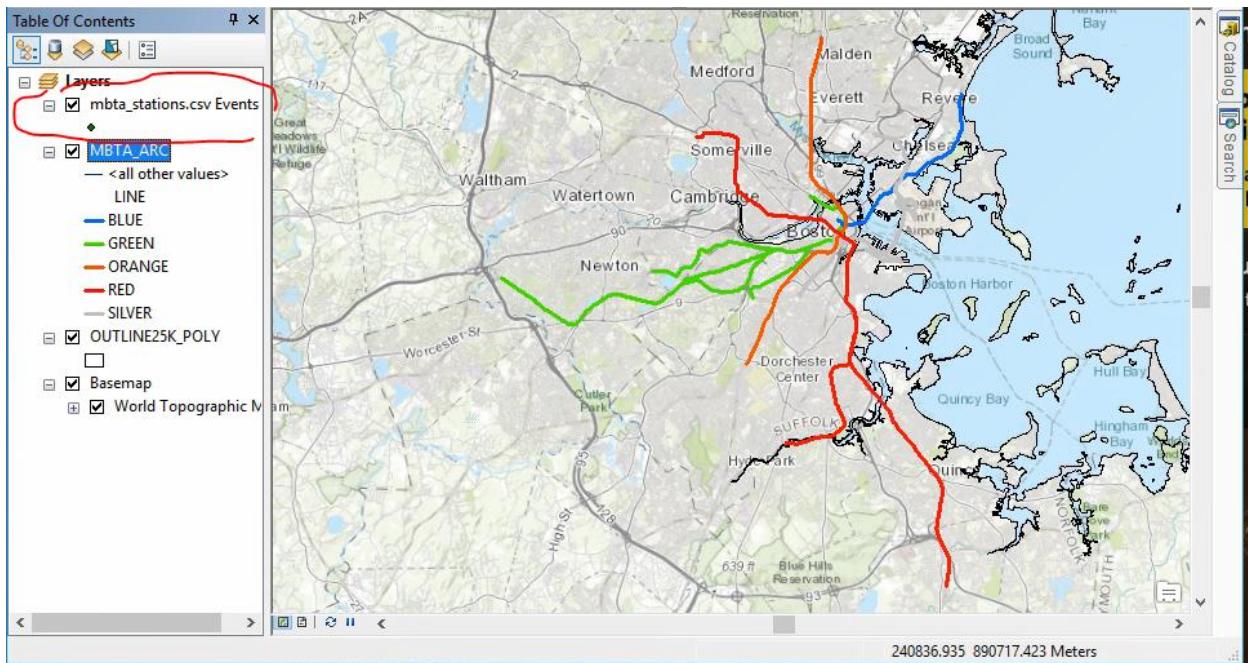
At the bottom is the Coordinate System ArcMap chose for the data, this is the same one as the DataFrame we set earlier. This is not the correct geographic coordinate system and projection, but let's see what happens when we choose the wrong one. Click “OK”.

- 6.

7. When you click “OK” it will indicate that the table you have does not have an “Object-ID” field, or column, and so you might be limited on what you can do with this data set. “Object-ID” is a unique identifier for a feature and is required by ArcMap for certain actions. You can add your own “Object-ID” field in the CSV file, or after importing the file you can export the layer as a shapefile, and that will generate an “Object-ID”. For now we are ok, and we can just click “OK”.

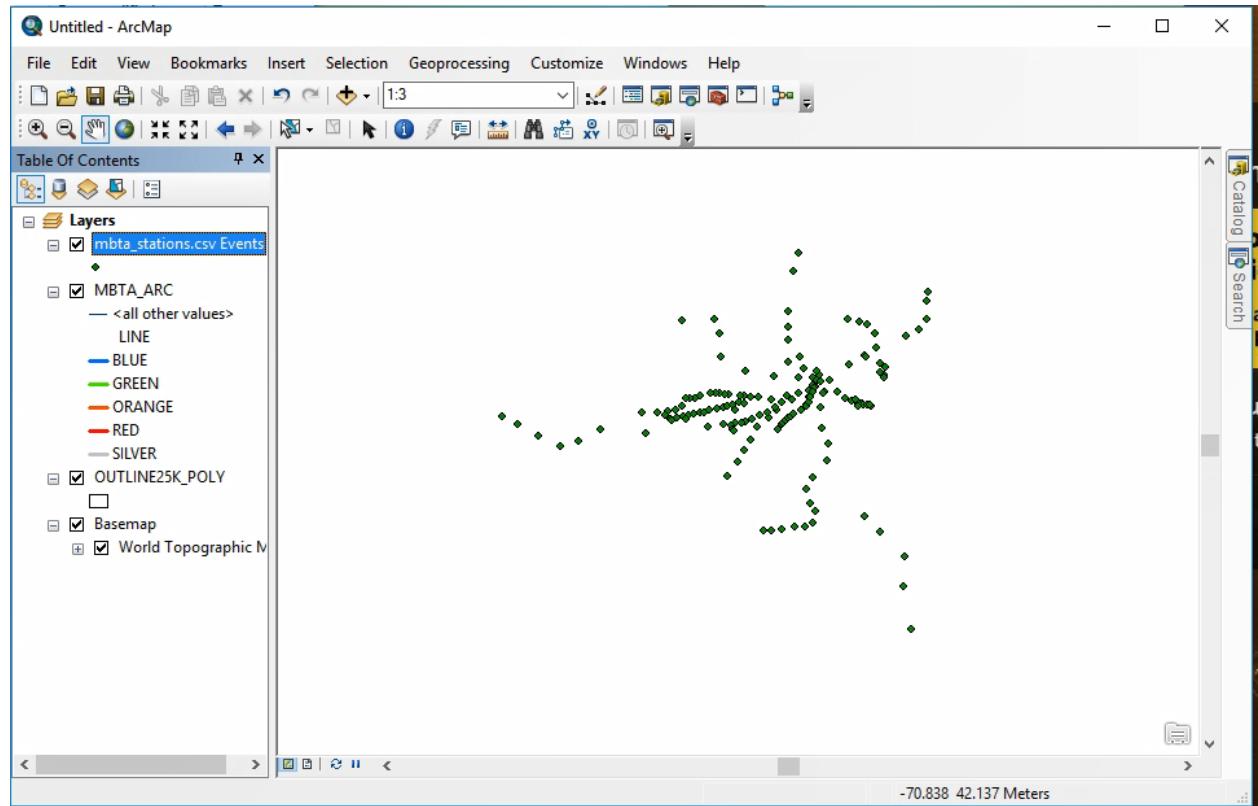


8. After clicking “OK”, you will notice that the points were added to the DataFrame, but you don’t see them on the map.

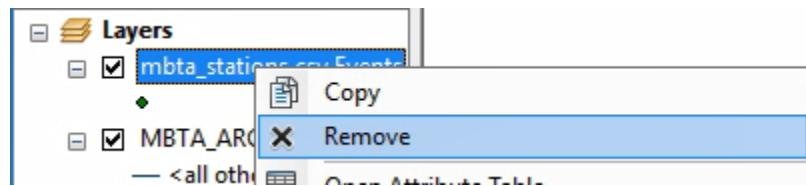


Where did they go? Let’s right click on “mbta_stations.csv” layer and do “Zoom to Layer”.

9. Now we see them, but all the other layers are gone! This is a sign that we have selected the wrong coordinate system for this data!

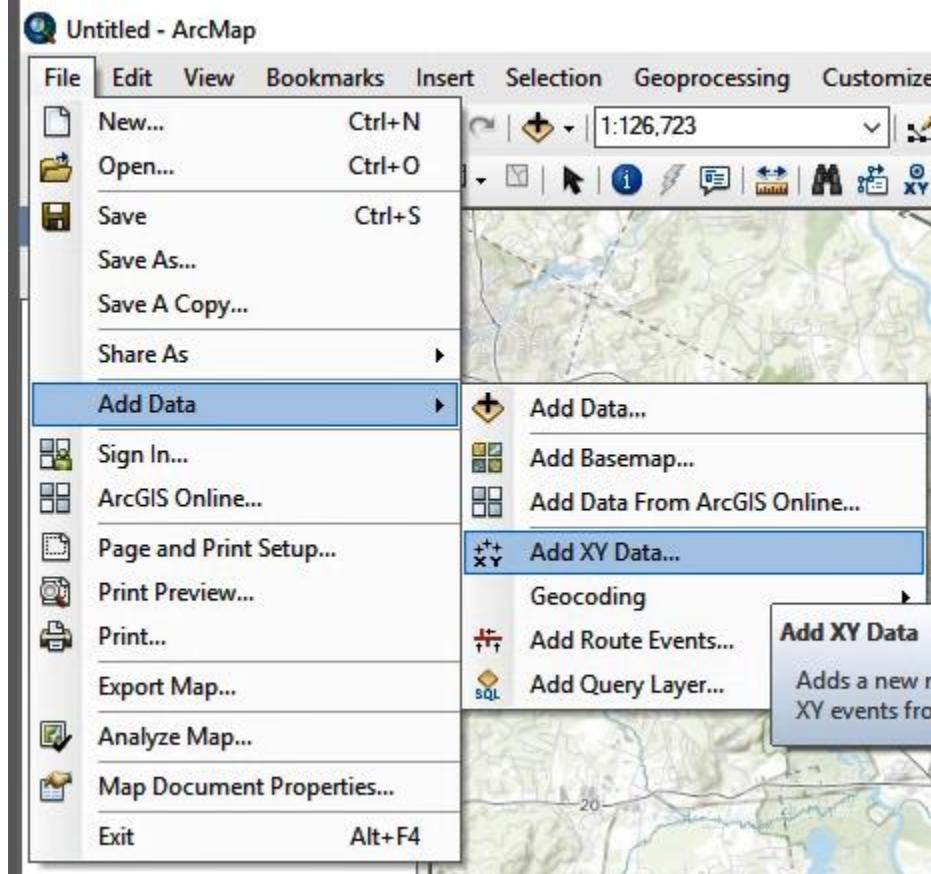


10. Let's remove this data, by right clicking on "mbta_stations.csv" and selecting "Remove"

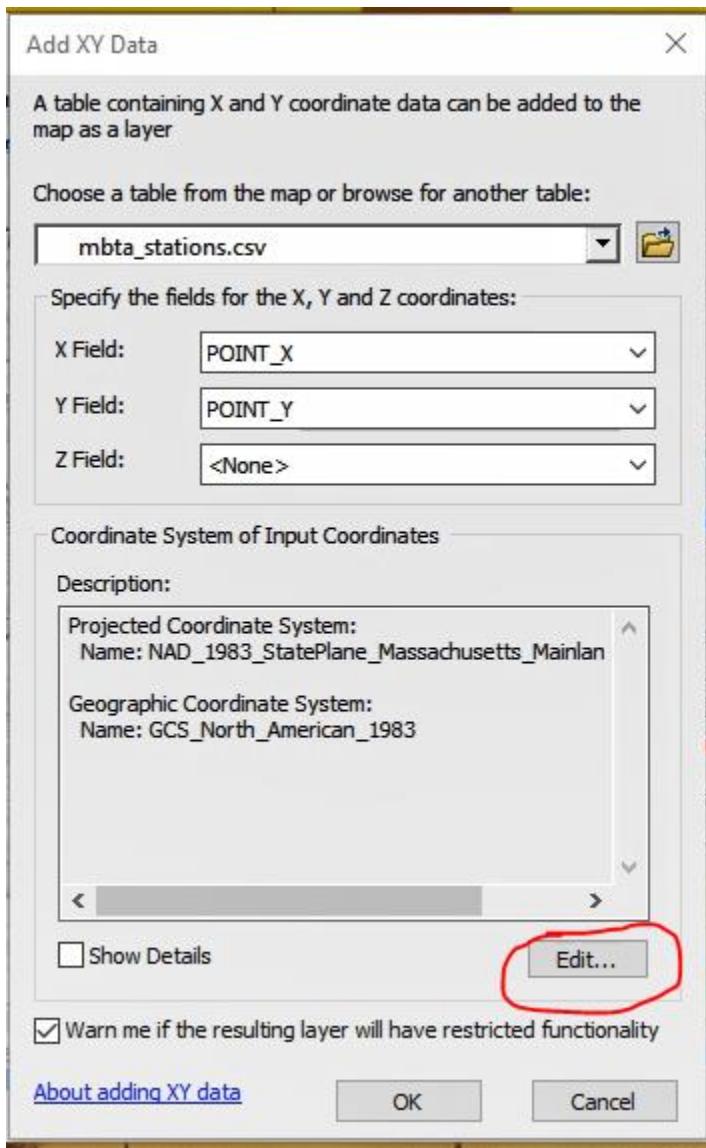


11. Let's return to our previous extent, either use the back button, or do a "Zoom to layer" on the "Subway" layer.

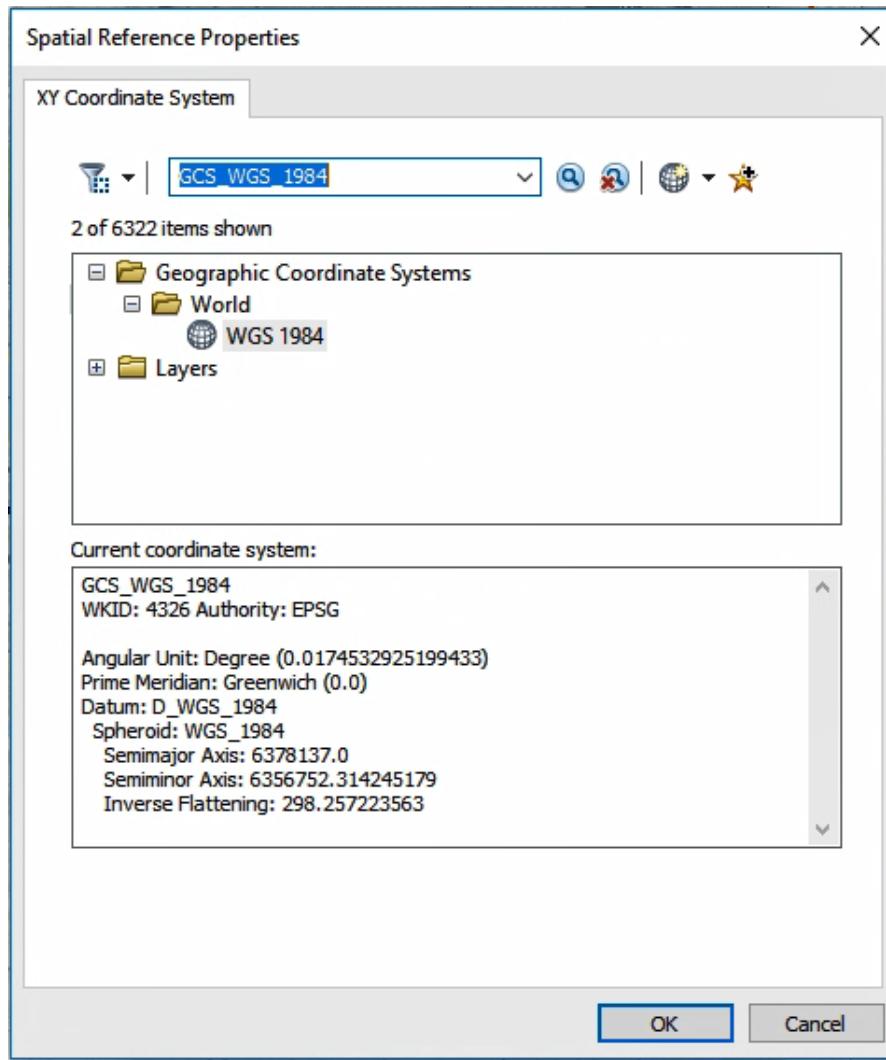
12. Let's go back to the "Add XY Data" window by going to **File → Add Data → Add XY Data...**



13. Fill out the form as we did before, but this time we are going to set the coordinate system manually, by clicking the “Edit” button.

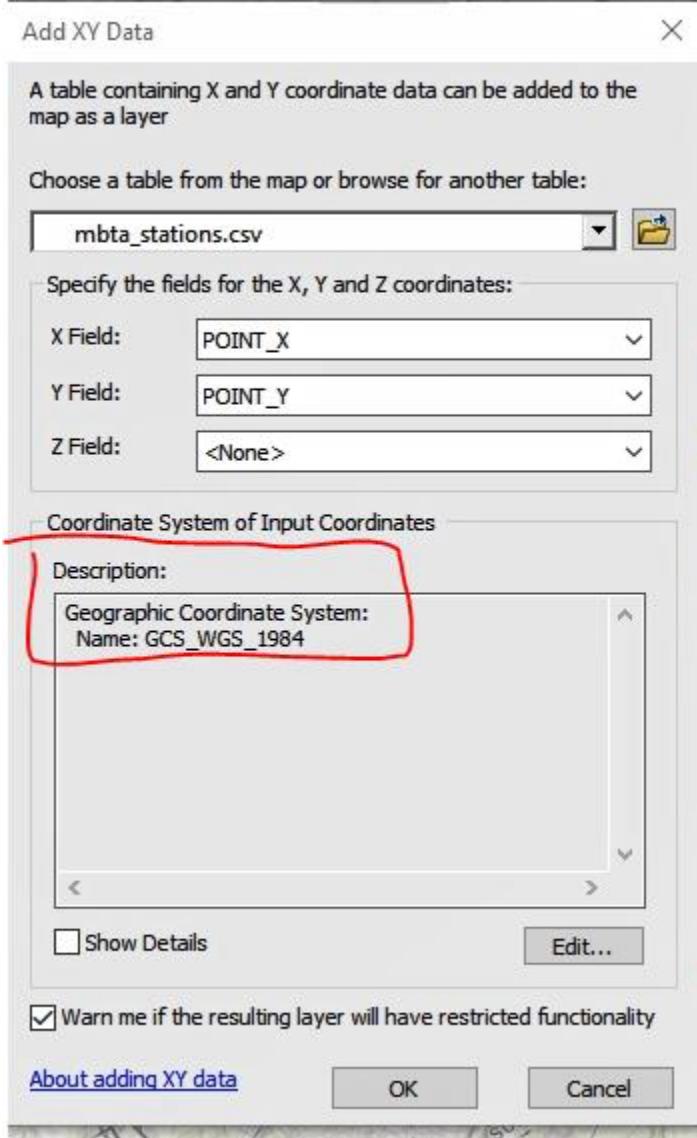


14. A new window will appear. When you receive a CSV file you need to ask what the coordinate system and projections are for the coordinates. For this file I know it is WGS 1984, as at the top search input field type in “GCS_WGS_1984” and click enter.

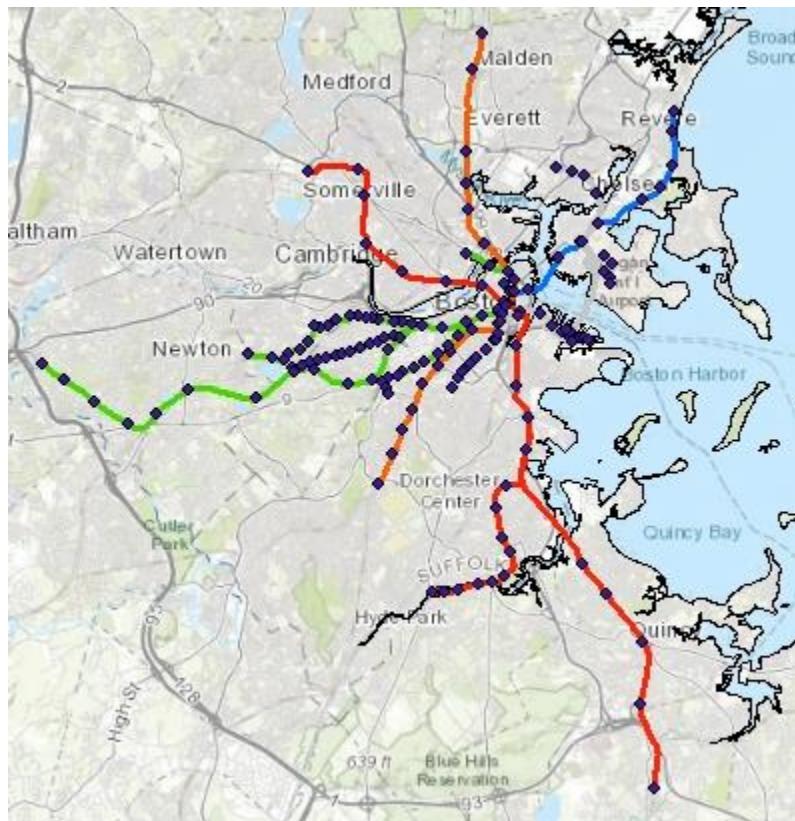


The panel below the search input textbox will filter down to only one coordinate system, the “WGS 1984”. Select that one and click “OK”.

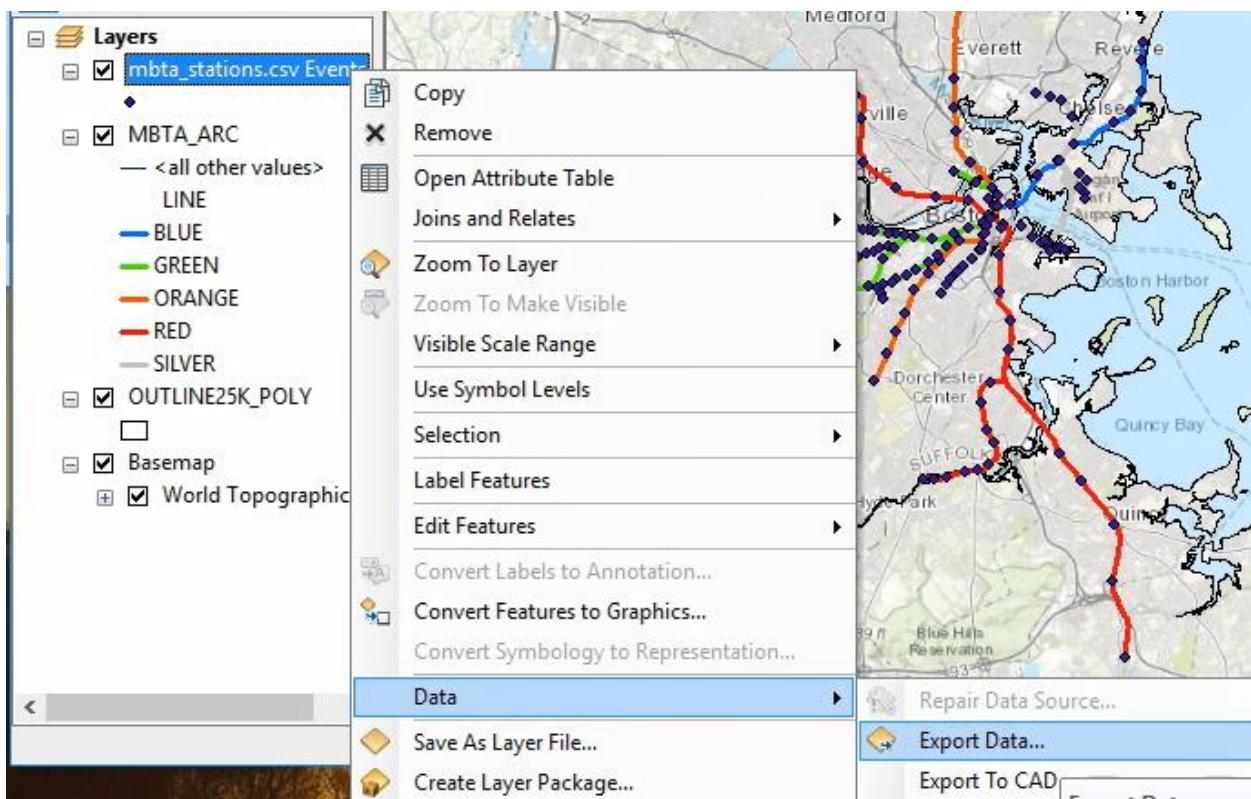
15. Now we have the correct one set in the “Add XY Data” window.



16. Click, "Ok". You will get the same "Object-ID" error message as before, just click "OK". Now we should see the station location as points.

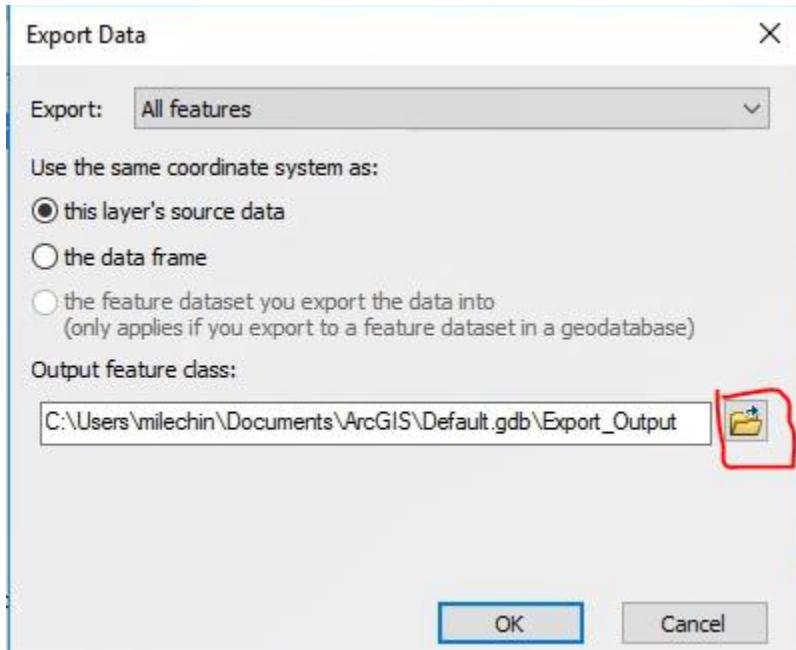


17. OK, now that we have the data imported, let's export this to a Shapefile, so that the "Object-ID" field is added. Right click on the "mbta_stations.csv" layer and go to **Data → Export Data...**

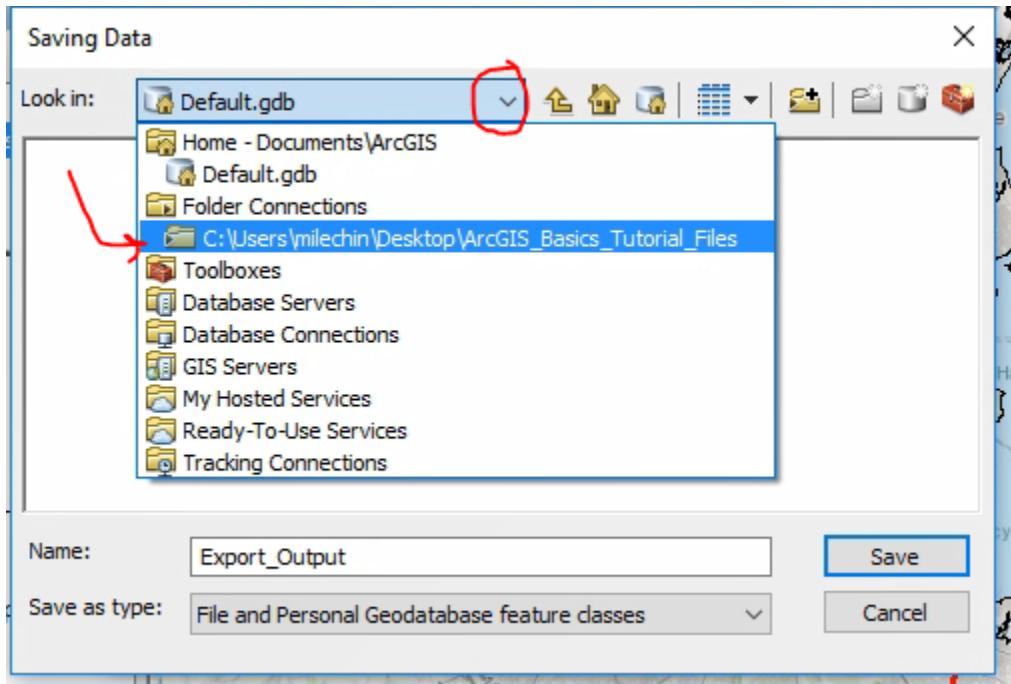


18. A new window will appear. The default options should be good, except we want to choose

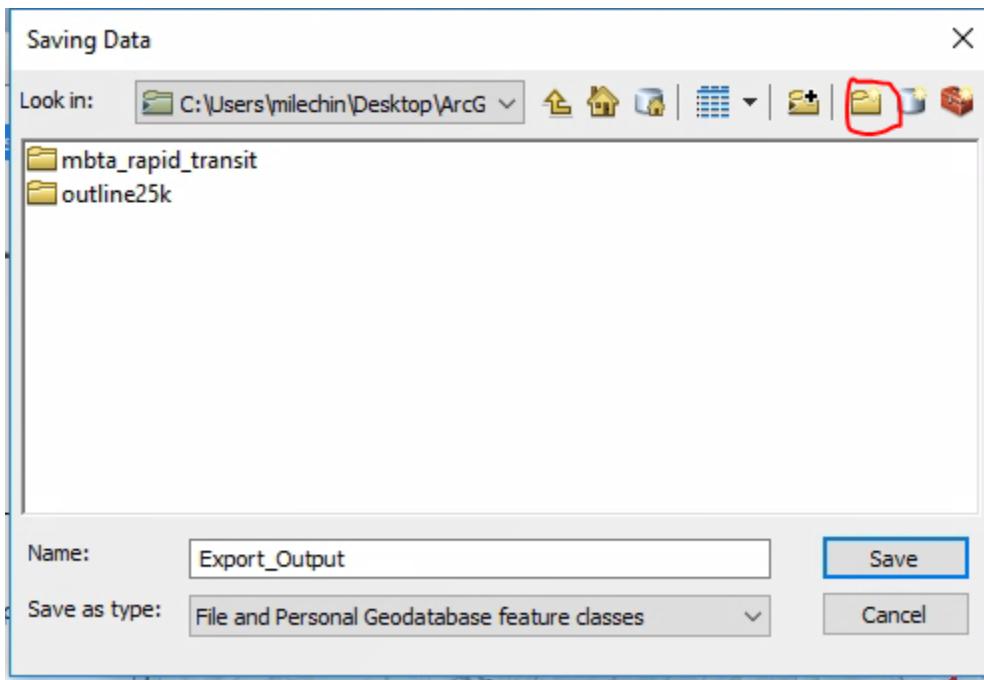
where we want to save the new shapefile, so click on the folder tool .



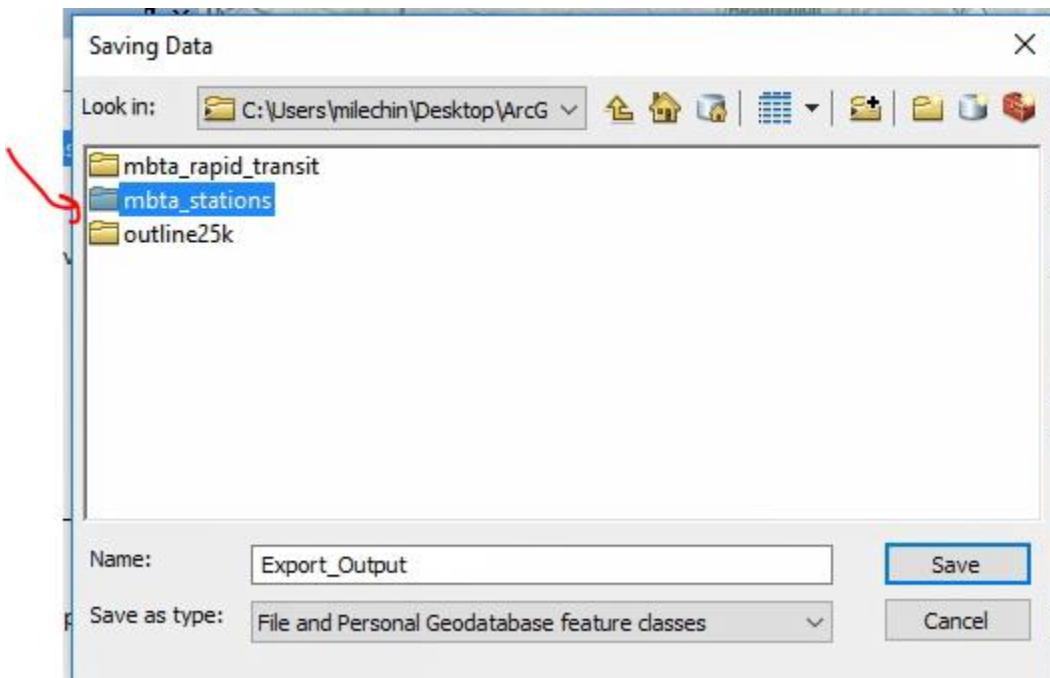
19. A new window will appear. From the drop down menu at the top select our tutorials folder connection we had created earlier.



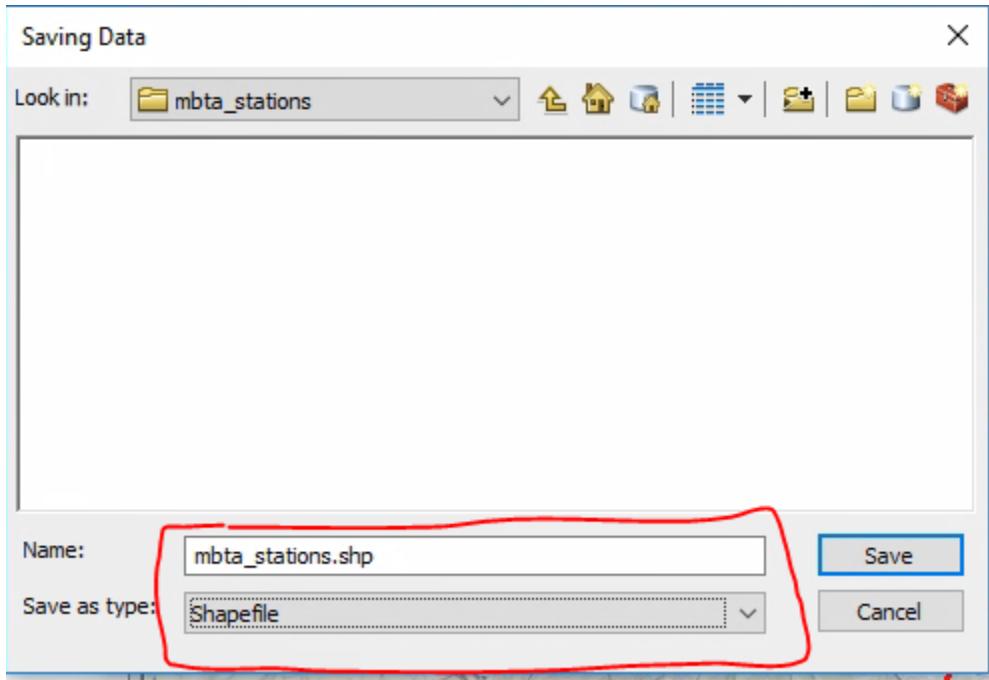
10. Now my personal preference is to create a folder for each shapefile, as we remember a shapefile consists of a collection of files. Click on the new folder tool .



20. A new folder will appear in the directory and name the folder "mbta_stations". Then double click on the folder to open it.

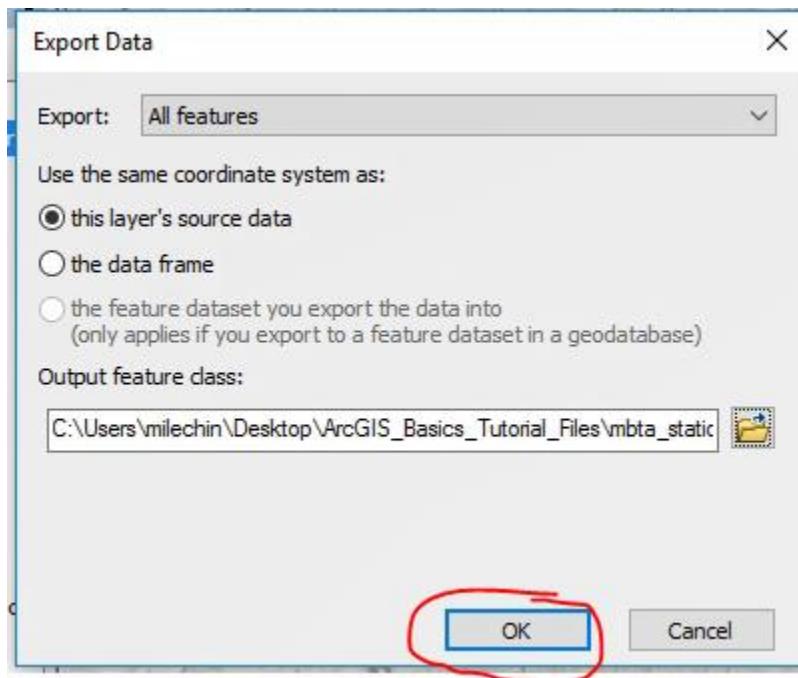


21. Now we can name the shapefile, lets call it “mbta_stations.shp” and set “Save as type” to “Shapefile”.

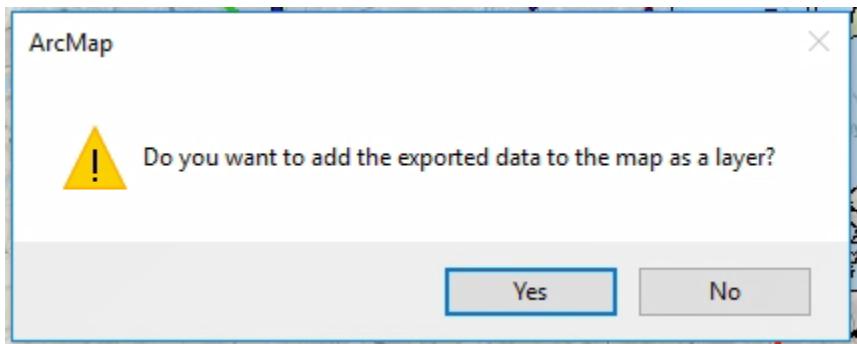


Now click “Save”.

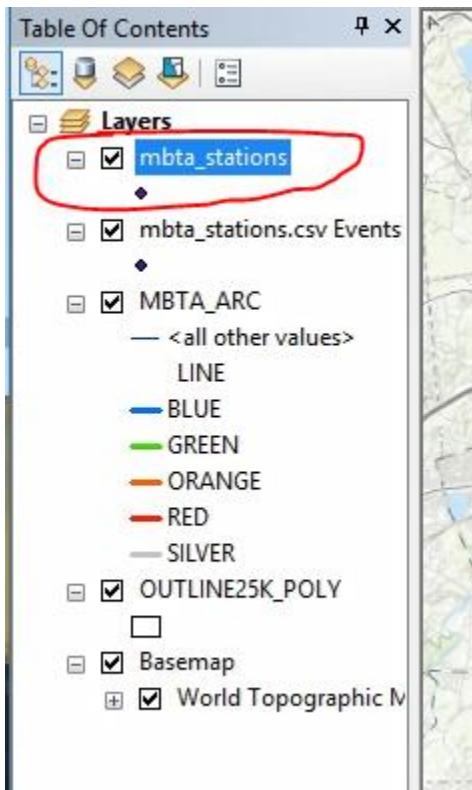
22. Now we are back at the “Export Data” window, now we can click OK.



23. Now a new message will appear asking if you want to add this new Shapefile to the map as a layer. Click “Yes”.



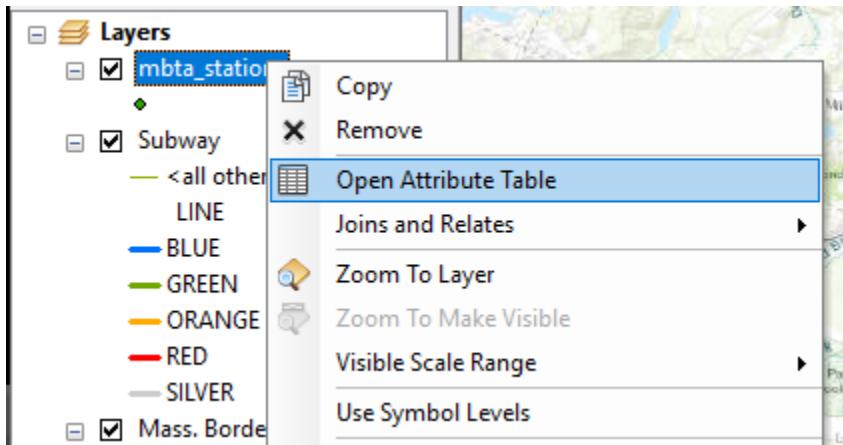
24. Now we see the newly created shapefile listed at the top of our DataFrame.



25. We can now remove the “mbta_stations_.csv” layer, by right clicking on it and selecting “Remove”.

Adding Labels

1. Let's add labels to the stations. First let's look at the attribute table of "mbta_stations", by right clicking on the layer and selecting "Open Attribute Table"

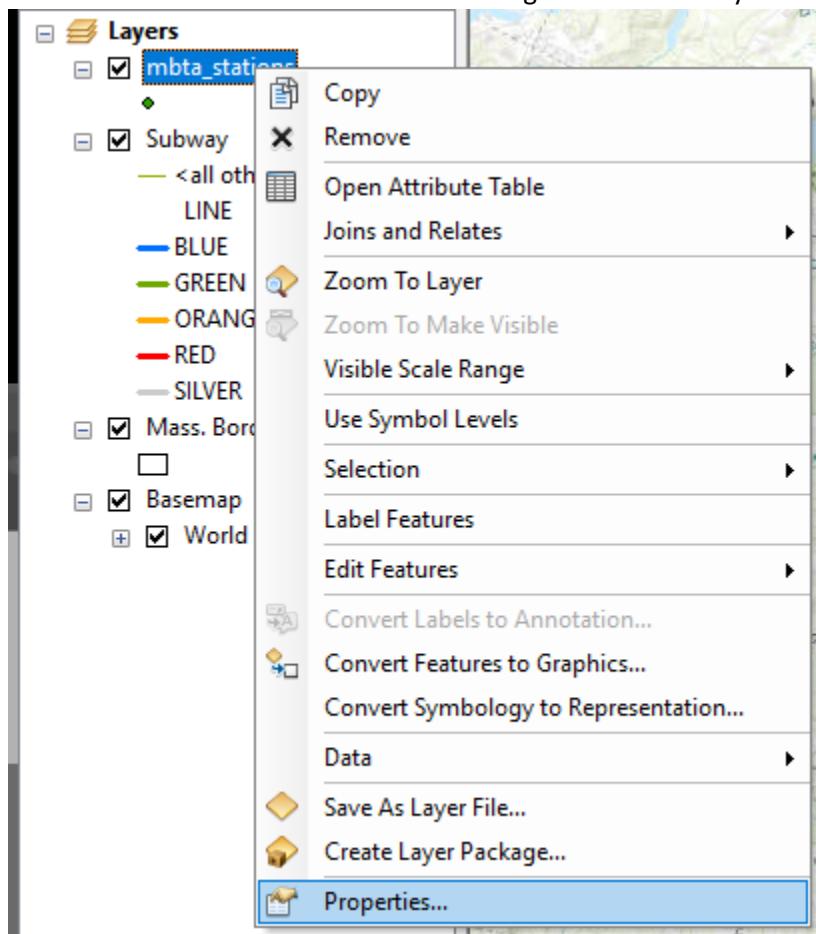


2. Looking at the table column names, we see we want to use "STATION" as the source of our labels.

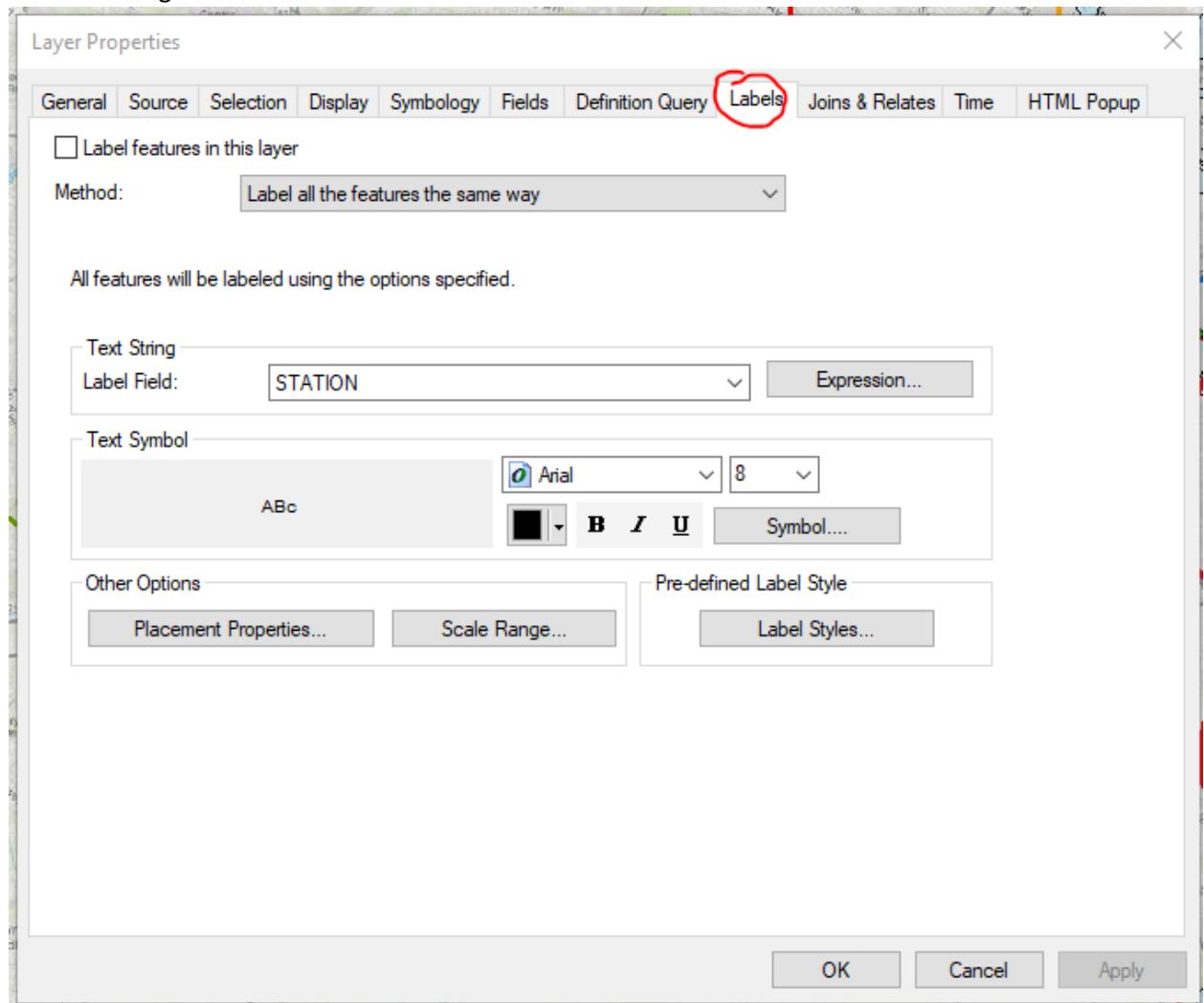
A screenshot of the ArcGIS attribute table for the 'mbta_stations' layer. The table has columns: FID, Shape *, STATION, LINE, and TI. The 'STATION' column is circled in red. The data rows are:

FID	Shape *	STATION	LINE	TI
0	Point	Ashmont	RED	Y
1	Point	Harvard	RED	N
2	Point	Kendall/MIT	RED	N
3	Point	Capen Street	RED	N
4	Point	Tufts Medical Center	ORANGE	N
5	Point	Waban	GREEN	N
6	Point	Kenmore	GREEN	N
7	Point	Arlington	GREEN	N

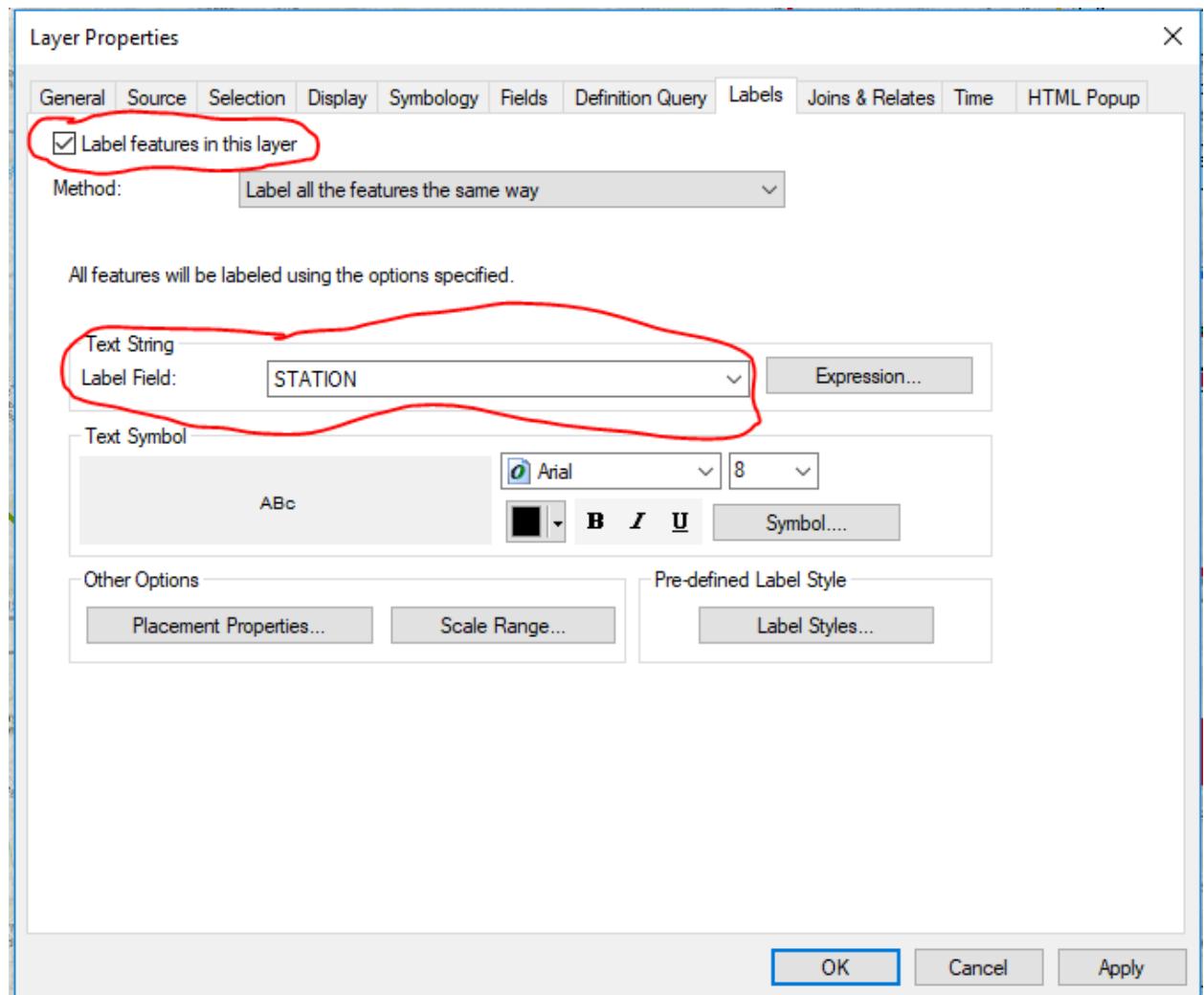
3. We can close the Table. Now we want to right click on the layer and click on “Properties.”



4. Then we will go to the “Labels” tab.



5. First we want to enable the labels, but clicking the “Label features in this layer” check box at the top left. And we want the “Label Field” to be set to “STATION”.



6. Now let's click OK. Now we should see the stations labeled.

