Exercise 2: Building a Watershed Base Map

Prepared by David R. Maidment and David G. Tarboton

18 September 2018, Corrected 25 September 2018

Table of Contents

Goals of the Exercise

This exercise is intended for you to build a base data set of geographic information for a watershed using the San Marcos Basin in South Texas as an example. The base dataset comprises watershed boundaries and streams from the National Hydrography Dataset Plus (NHDPlus). In addition, you will create a point Feature Class of stream gage sites by inputting latitude and longitude values for the gages in an Excel table that is added to ArcMap and the geodatabase. You will create a resource in Hydroshare of the San Marcos Basin and use it as a backdrop to download forecasts from the National Water Model.

Computer and Data Requirements

To complete this exercise, you'll need to run ArcGIS Pro version 2.2 from a PC. You will download hydrologic information to do this exercise from HydroShare and other online data sources.

Procedure for the Assignment

Getting Started

We'll begin by getting the input data for Water Resource Region 12, and creating a new, empty geodatabase into which you'll put data for the San Marcos basin, which is a small drainage area within this region.

Open the ArcGIS Online map at: http://arcg.is/1JW0DBm This map is publicly shared so you don't need to login to ArcGIS Online to use it. Click on the **Texas Gulf** region. If there is no response, try another browser.

Then click on **More info**

And scroll down to **Content**

Download the file **NFIEGeo_12.gdb.zip** (127.1MB). If you have trouble locating this file, you can get it directly at:

https://www.hydroshare.org/resource/1d78964652034876b1c190647b21a77d/

Unzip this file and navigate down through the folders to a zipped geodatabase file, and unzip that. Move the geodatabase file to your working directory for this exercise. NFIE stands for National Flood Interoperability Experiment, which was the academic effort that we undertook to establish the prototype for the National Water Model. NFIEGeo is the geospatial database that we created to support this effort, and NFIEGeo_12 is the portion of that geodatabase that covers USGS Water Resources Region 12, the

rivers and streams that drain to the Texas Gulf Coast. **NFIEGeo_12.gdb** is a geodatabase containing this information.
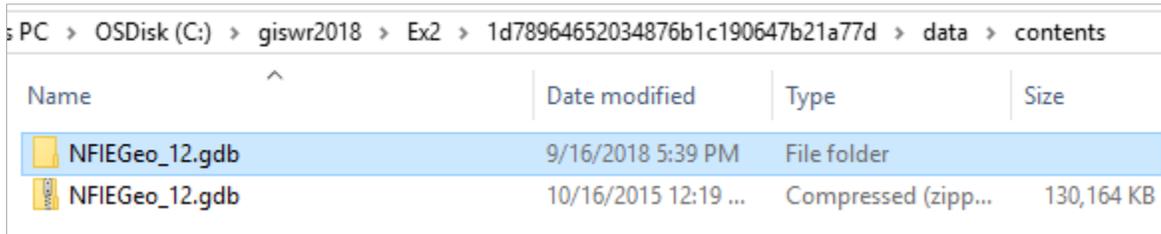

Open ArcGIS Pro and create a new Blank Project for this exercise. I have called this **Exercise2**. It's a good idea to just use one word titles for projects because this is the name of the Geodatabase that you create within the project. In general, ArcGIS likes to have single word titles as the names for things or otherwise you have to interpret spaces and that can be ambiguous.
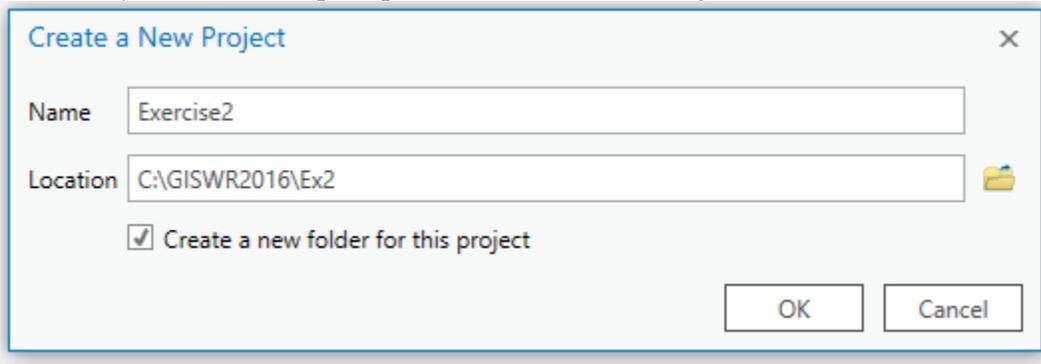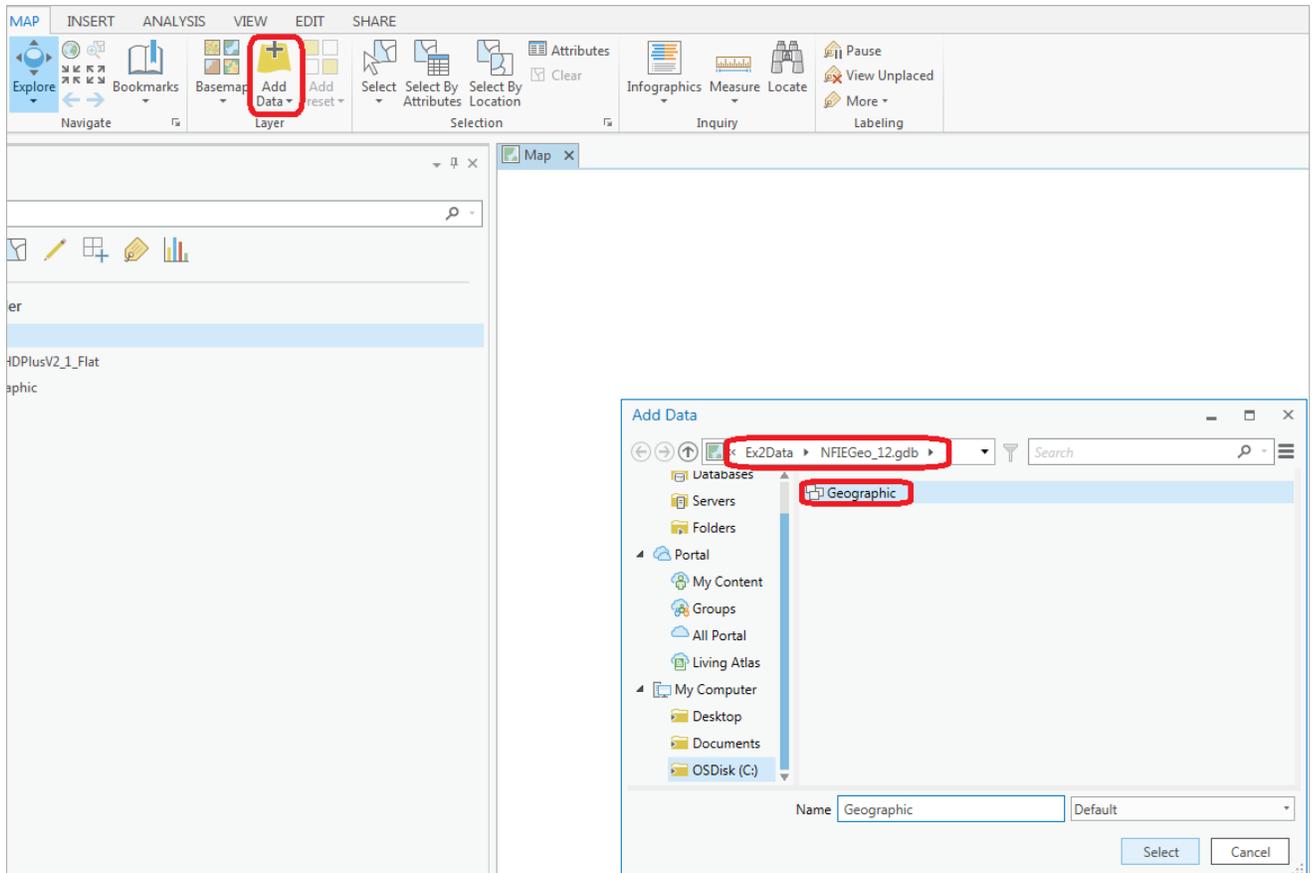

Insert a **New Map** into your view
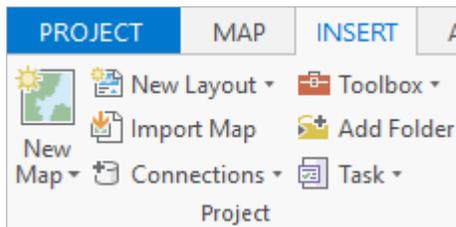
And you'll see a big topographic map of the United States show up.

Add the **NFIEGeo_12** data to the map by using the **Add Data** button and navigating to the Feature Dataset **Geographic**. A feature dataset is a folder that contains feature classes all having the same spatial reference or geographic coordinate system.

This adds all the feature classes in this feature dataset to your map view.
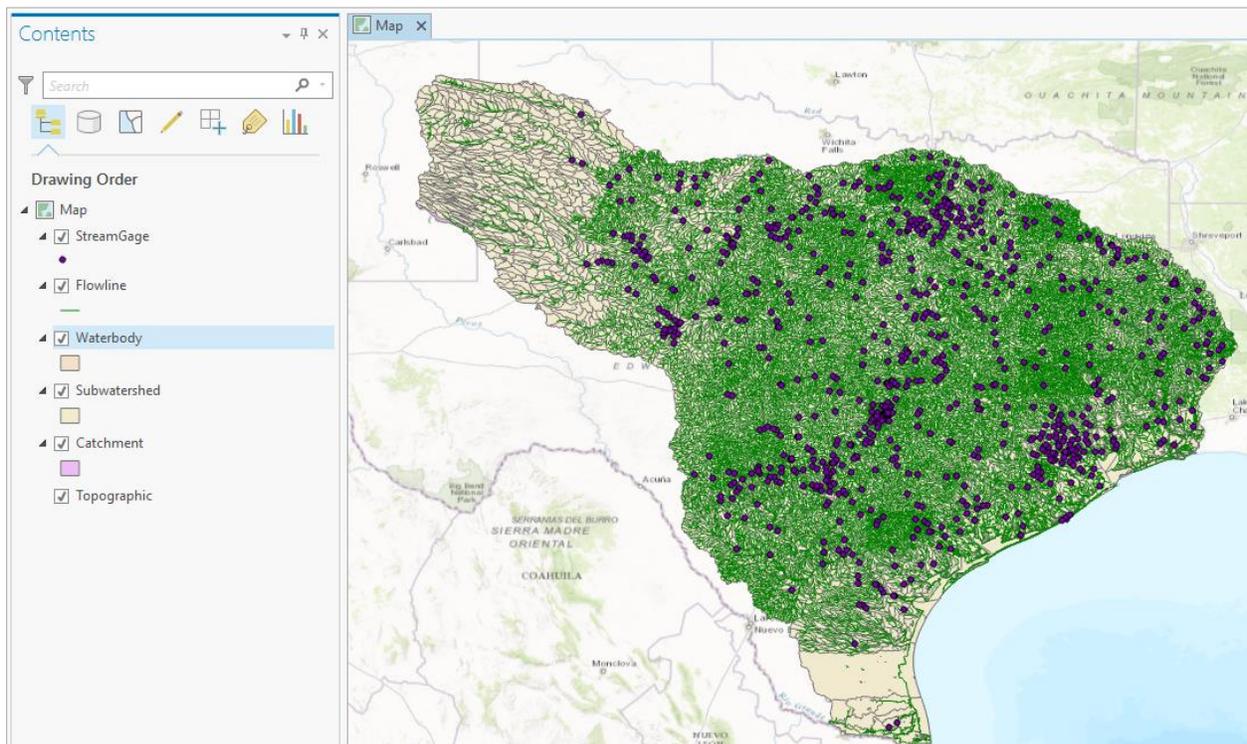
You'll see that there are five feature classes in this **Geographic** feature dataset. Turn off the display of all feature classes except for **Subwatershed** and recolor the Subwatersheds using the HUC_8 attribute using Unique Values. Right Click on the Subwatershed feature class and select **Symbology**
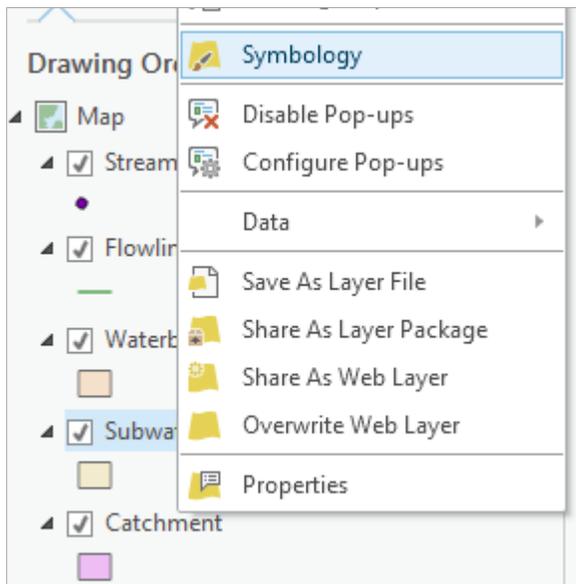
and in the **Symbology** window that opens on the right hand side click on the **Single Symbol** bar and change this to **Unique Values**
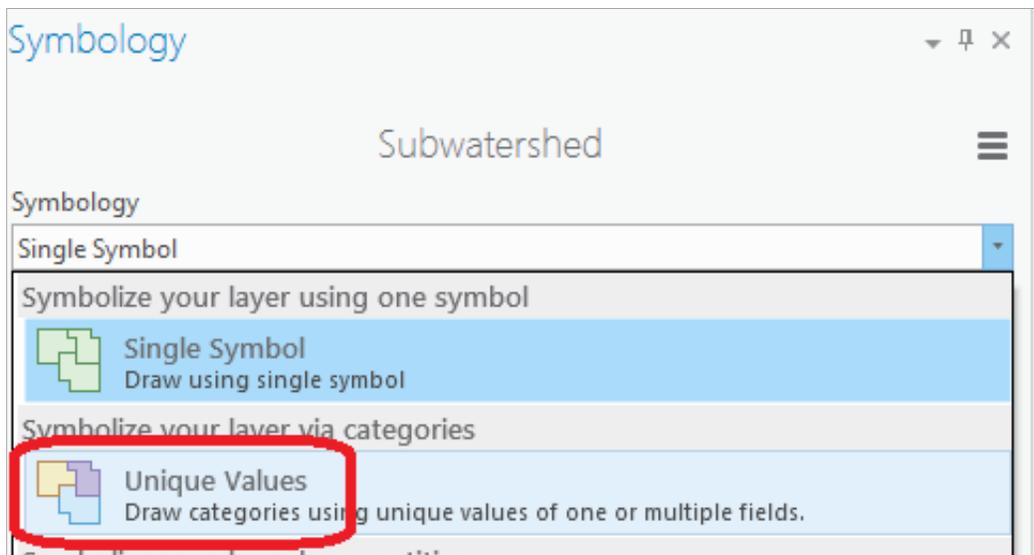

And select **HUC_8** as the Field to be used to display these values
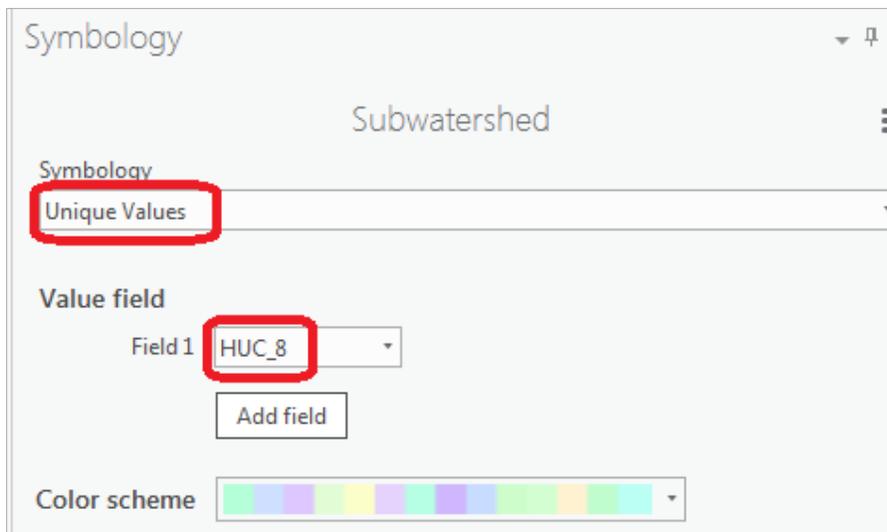
You'll be asked a question as to whether you want more than 100 Unique values, and answer **Yes** to this question.

Your resulting map should look something like this (the colors may be different on your map). The different colors represent HUC8 Subbasins and the outlines are HUC12 Subwatersheds. You can change the default color scheme that you get by clicking on **Color scheme** in the Symbology window and selecting a new one.
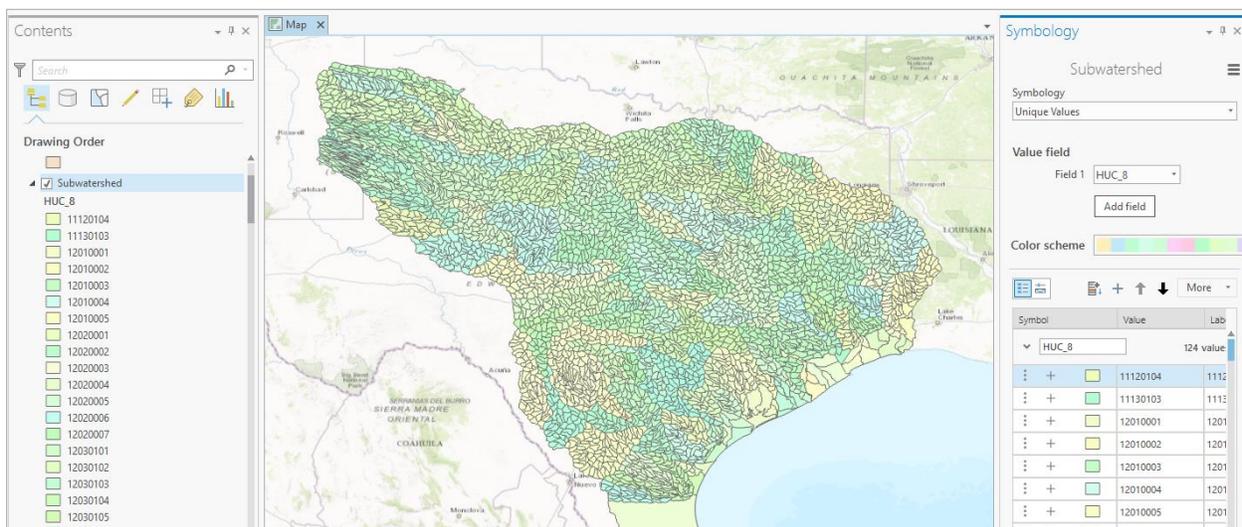

Use **Project/Save** to save the current version of your project so you don't have to recreate this map display again. The project is saved in a file **Exercise2.aprx**, in the folder **Exercise2**.

At the bottom of the Right Pane, click on the **Catalog** tab to open the **Catalog** window

If you open up the Databases section of the Catalog display, you'll see a new Geodatabase already created for you called **Exercise2.gdb**, consistent with the name of the Project that we created when opening ArcGIS Pro.
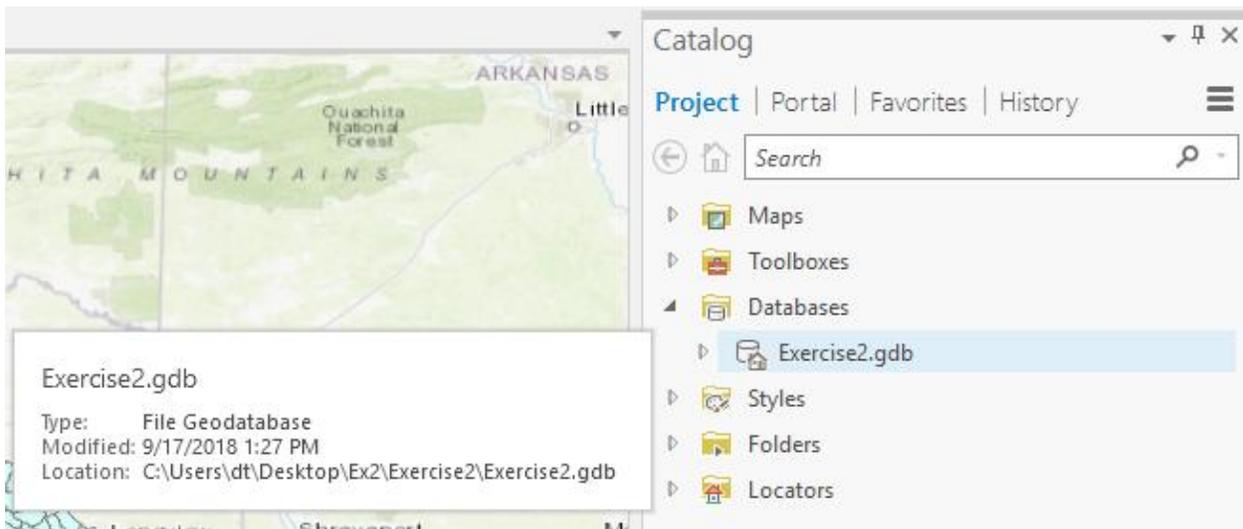

Right click on this **Exercise2.gdb** Geodatabase and create a new **Feature Dataset**.
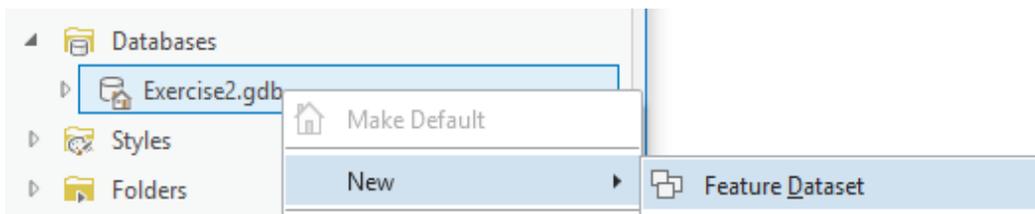

Call this new dataset **SanMarcos** (again, just use one word titles for files) and select the coordinate system for the **Subwatershed** class you are working with. This is a geographic coordinate system defined on the NAD83 datum, or North American Datum of 1983: **GCS_North_American_1983**.
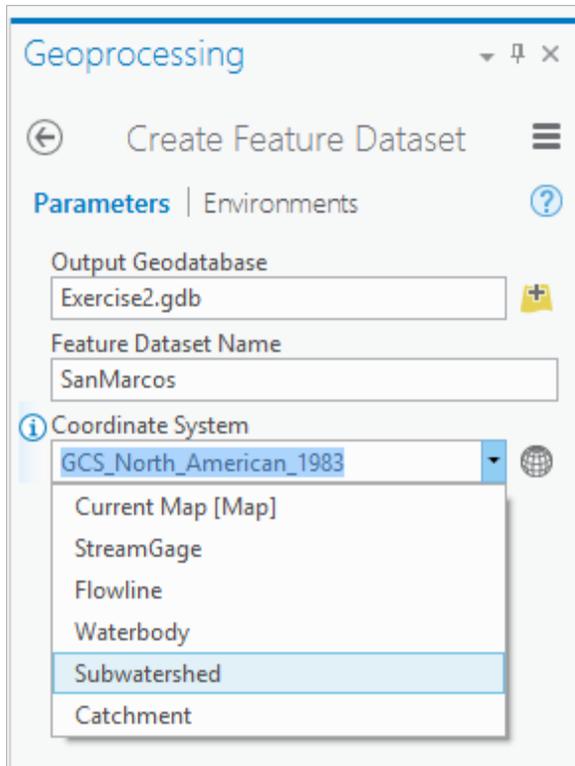
Hit **Run** at the bottom of the tab to execute this action. Notice that you are in a new Tab now called **Geoprocessing**, which indicates that you are creating new information.
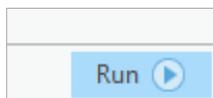

If you go back to the Catalog pane, and expand the Exercise2 geodatabase, you'll see its got a **SanMarcos** feature dataset inside it now, which will hold the data that you create for the San Marcos Basin.
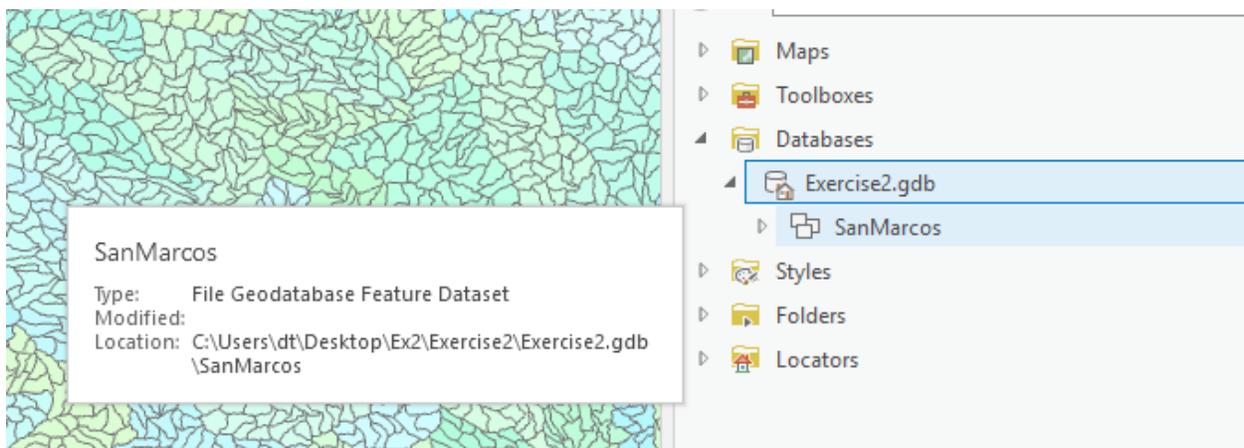
Selecting the Watersheds in the San Marcos Basin

Let's focus on data in the San Marcos basin. The Subwatersheds feature class is a part of the **Watershed Boundary Dataset** of the United States, which subdivides the nation's drainage into a hierarchy of drainage areas. https://www.usgs.gov/core-science-systems/ngp/national-hydrography/watershed-boundary-dataset We want all the HUC12 subwatersheds that lie within the San Marcos subbasin, which has a HUC8 value of 12100203; these are the first 8 digits of the HUC12 identifier. This means that these drainage areas lie within **Region** 12, **Subregion** 10, **Basin** 02 and **Subbasin** 03.

Open the Attribute Table of the Subwatershed feature class by right clicking on the **Subwatershed** in the Map view and selecting **Attribute Table**
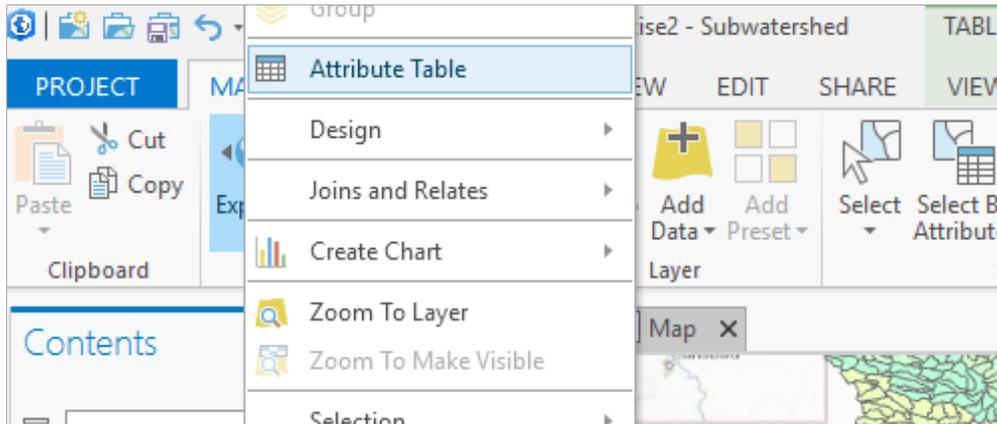

A window like this will open up in your map display.

| OBJECTID_1	Shape	OBJECTID	HUC_8	HUC_10	HUC_12	ACRES	NCONTRB_A	HU_10_GNIS	HU_12_GNIS
1	Polygon	212912	12110208	1211020806	121102080600	105412	0	0	0
2	Polygon	212913	12110208	1211020807	121102080700	83558	0	0	0
3	Polygon	212914	12110208	1211020808	121102080800	178671	0	0	0
4	Polygon	212915	12110208	1211020803	121102080300	289845	0	0	0
5	Polygon	212917	12110208	1211020810	121102081000	175787	0	0	0
6	Polygon	212918	12110208	1211020804	121102080400	229107	0	0	0
7	Polygon	212919	12110208	1211020805	121102080500	227239	0	0	0
8	Polygon	226615	12110208	1211020802	121102080200	177049	0	0	0
9	Polygon	226660	12110208	1211020809	121102080900	232263	0		
10	Polygon	226661	12110208	1211020801	121102080100	109630	0	0	0
11	Polygon	122292	12070104	1207010403	120701040309	23541	0	0	0
12	Polygon	122301	12040202	1204020204	120402020400	156240	0	0	0
13	Polygon	122302	12040104	1204010401	120401040103	17390	0		
14	Polygon	122308	12040104	1204010403	120401040305	13048	0		
15	Polygon	122310	12040104	1204010407	120401040701	26118	0		1374181
16	Polygon	122709	12090402	1209040202	120904020204	40574	0	0	0
17	Polygon	122748	12090401	1209040103	120904010308	45599	0		
18	Polygon	122753	12090402	1209040203	120904020300	160389	0	0	0

Now let's select some records in this table that describe the San Marcos Basin. In the **Table View**, menu at the top choose **Select by Attributes**
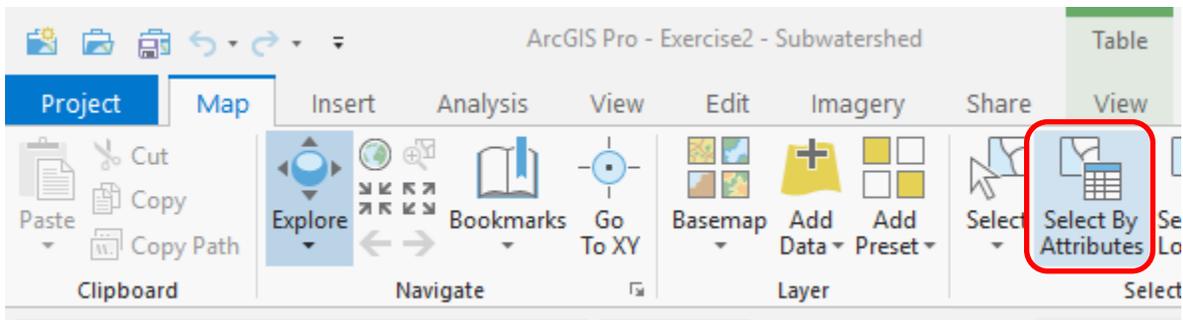
Now construct the query that will identify these records by selecting **Add Clause**
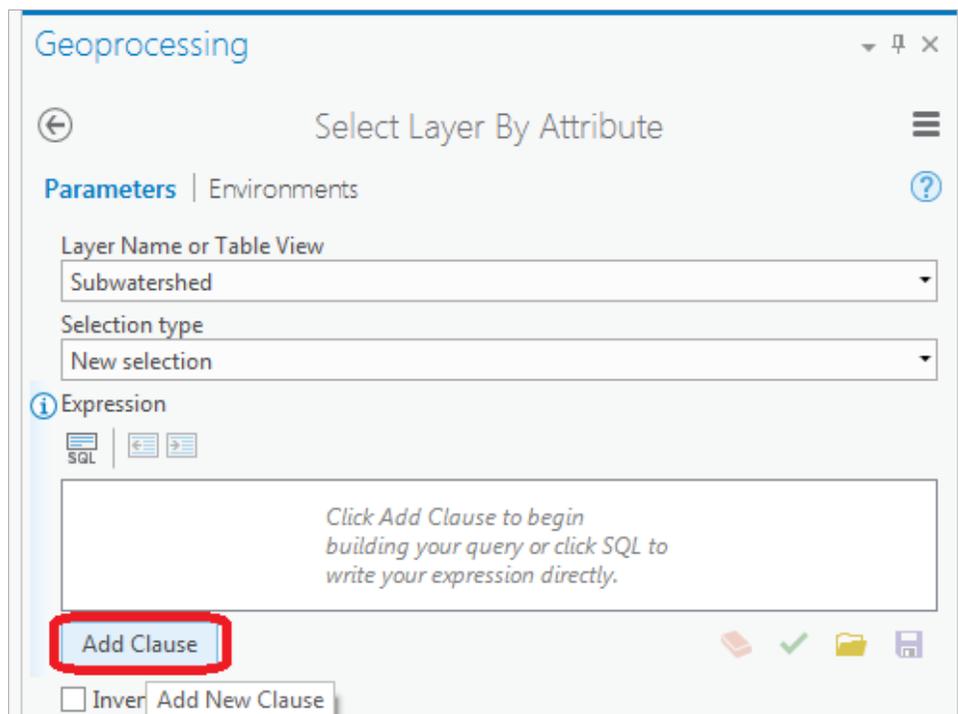

And in the resulting display choose **HUC_8 is Equal to 12100203** using the choices in the boxes available.
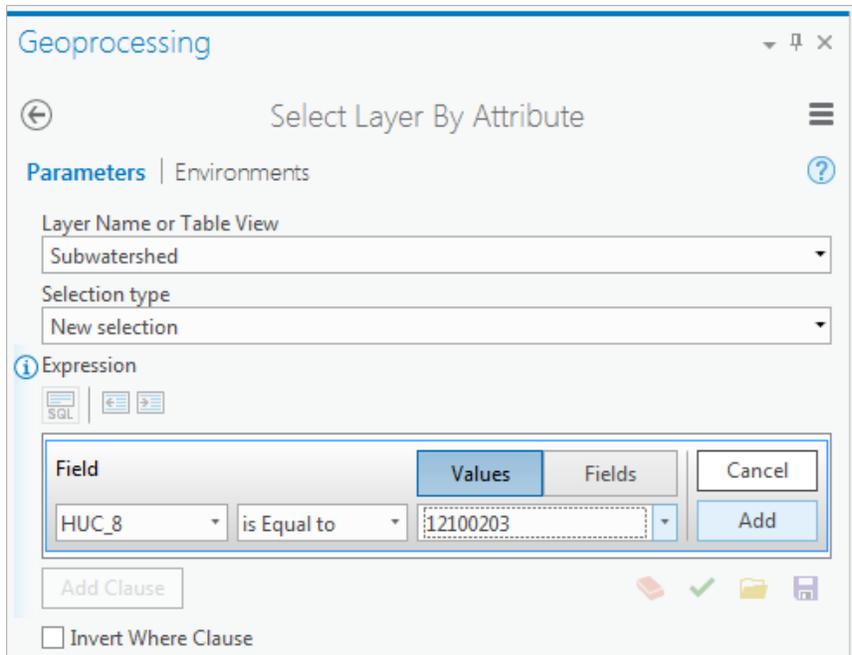
Once your clause is input, hit the **Add** button so that your expression is specified completely. If you don't do this last step, your query will not be actioned and you'll end up selecting all the Subwatersheds.
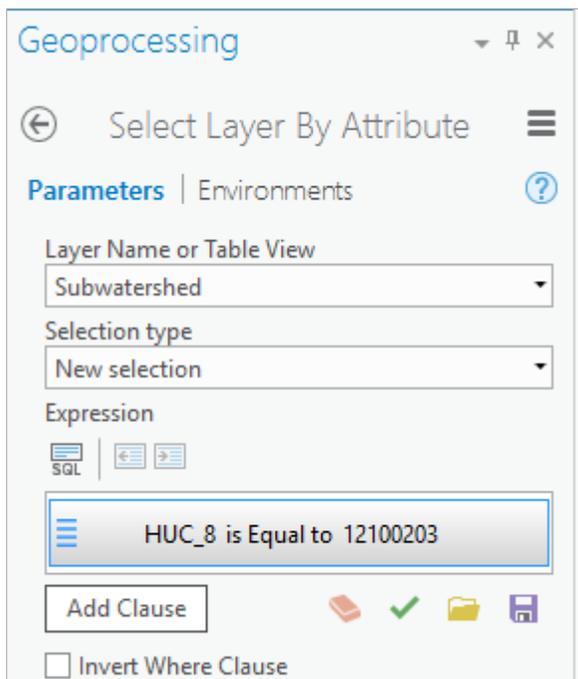

and then hit **Run** at the bottom of the **Geoprocessing** pane to select the San Marcos basin by its HUC_8 identifier. You'll see that this selects 32 of the HUC-12 Subwatersheds that lie within the San Marcos basin (one HUC-8 Subbasin).
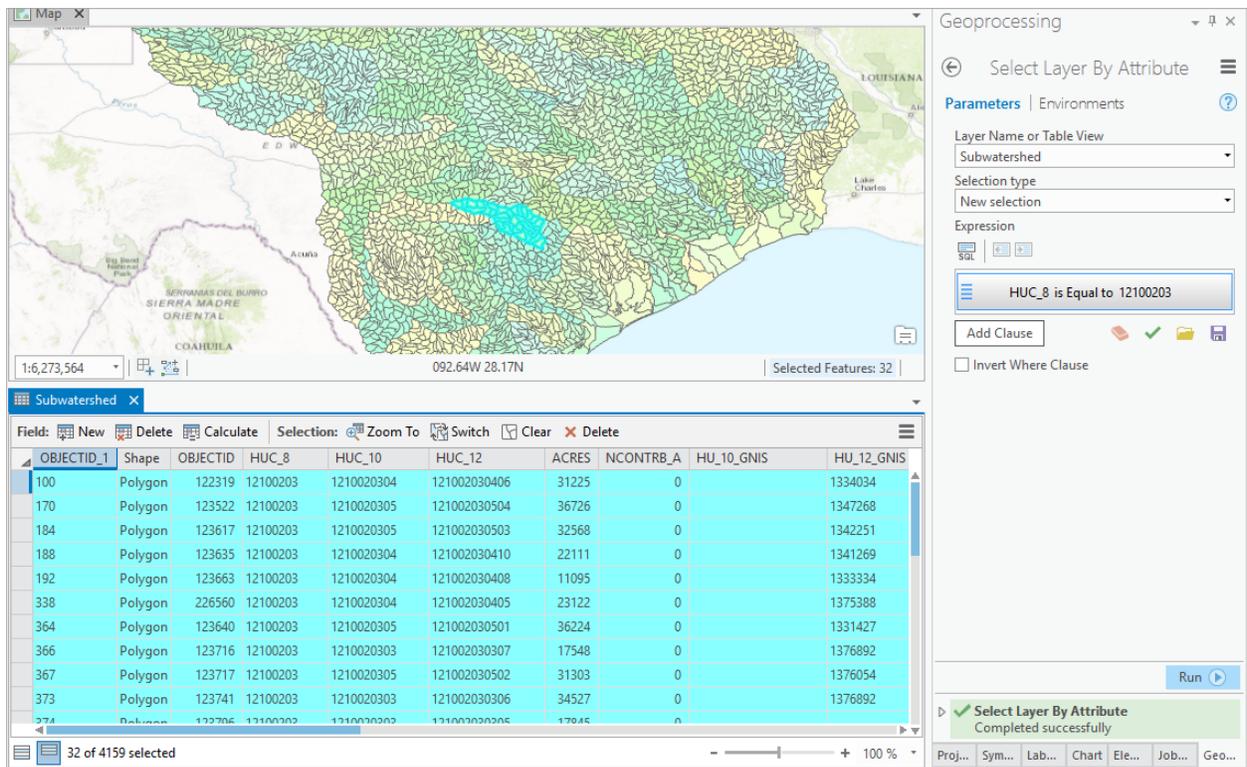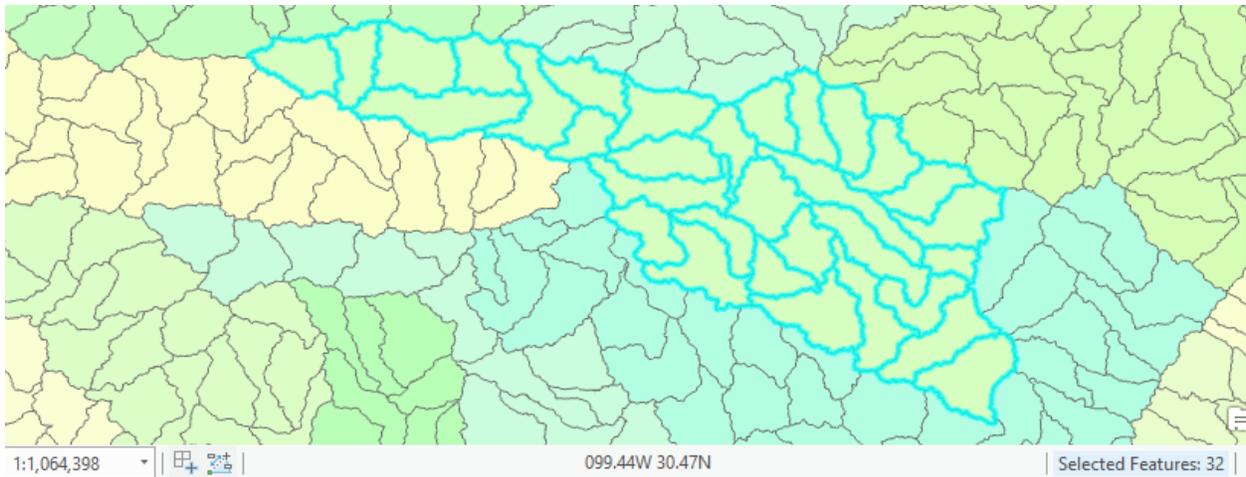
If you hit the **Show Selected Records** button at the bottom of the Table, you'll see the selected records, and also their highlighted images in the map.
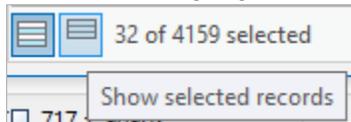

To zoom to this selection, use the **Zoom to Selected Features** button in the map tab.
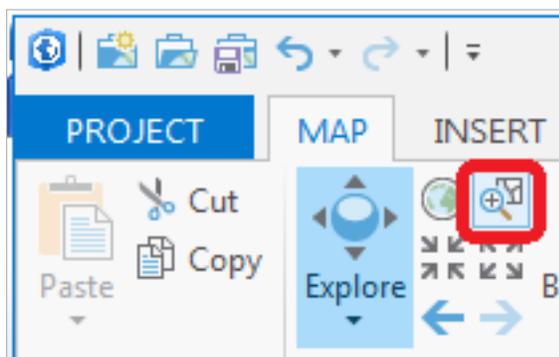

And you'll see a close up view of the San Marcos Subwatersheds.

1:1,064,398   099.44W 30.47N   Selected Features: 32

Close the **Subwatershed** attribute table to get it out of the way. Right Click on the **Subwatershed** layer in the Map Contents (on the left) and select **Data/Export Features** to produce a new Feature Class.
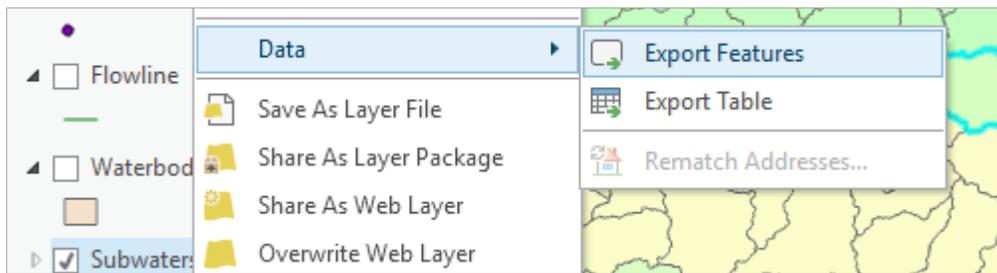

You'll see a Geoprocessing window open with Input Features as Subwatershed and Output Feature Class as Subwatershed_CopyFeatures.
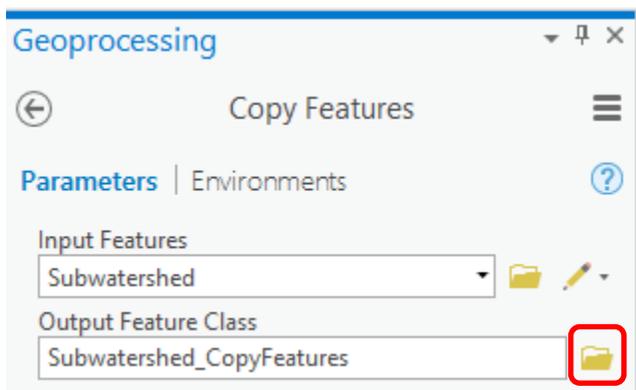

We want to place this output feature class in the SanMarcos feature dataset we created, so click on the Browse 📁 button for the Output Feature Class and navigate to where you have stored the results in **Exercise2.gdb** in the **SanMarcos** feature dataset and call the new feature class **Subwatershed**. Click **Save**.

13
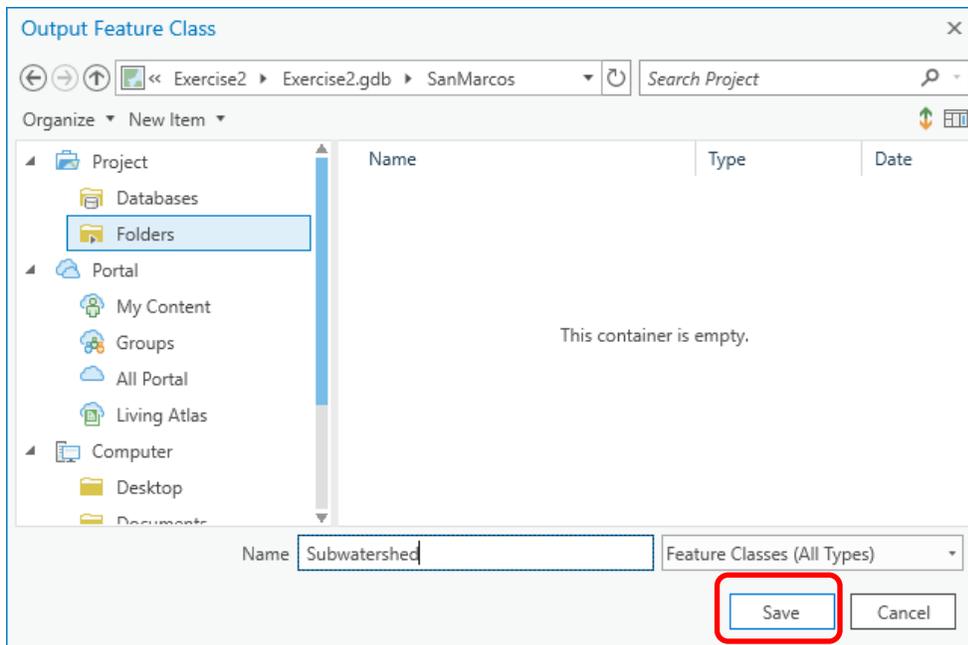
Click **Run** at the bottom of the Geoprocessing pane.
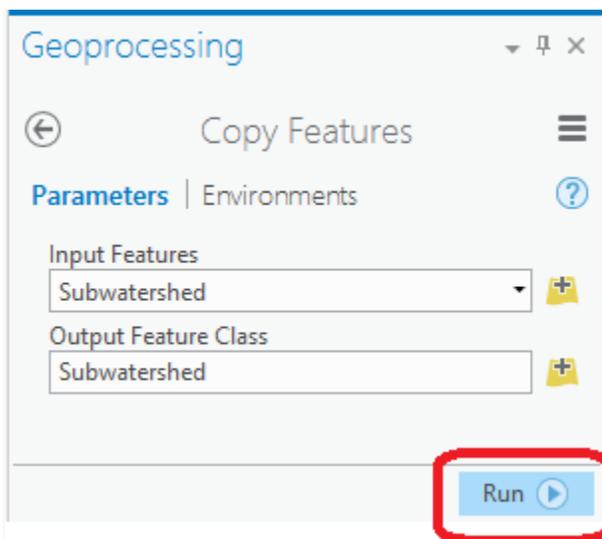

Clear the previous HUC_8 selection with the **Clear** button.
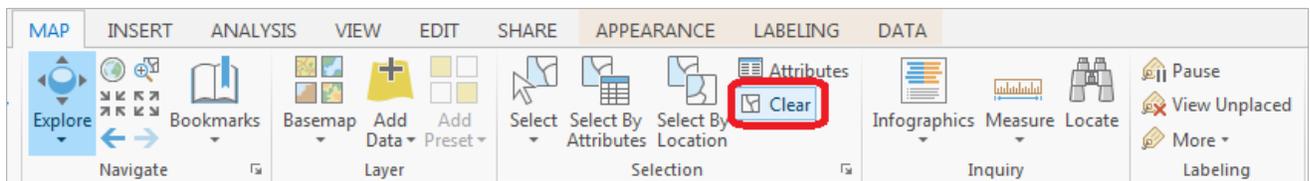
In the **Catalog** pane, you can navigate to the San Marcos feature dataset and you'll see there is now a Subwatershed feature class located there, and that it has been added to the Map view. Turn off the lower Subwatersheds for all of the HUC2 region, and you'll see just the Subwatersheds of the San Marcos

basin. Pretty cool! We've just taken a large dataset and selected from that a smaller dataset of interest for our study.
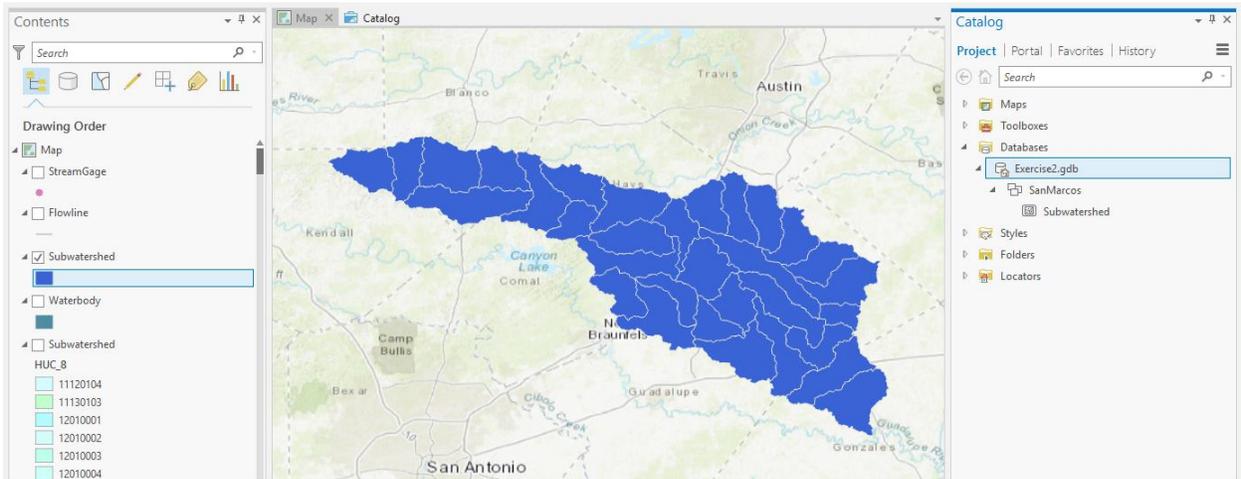

Remove the larger Subwatershed feature class for all of the Region 12 by right clicking on it and selecting **Remove**
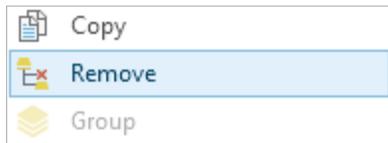
Note that in ArcGIS there is generally a distinction between Remove and Delete. Remove is a safe action that detaches a data set from a document. Delete is a less safe action, it actually deletes the object from disk.
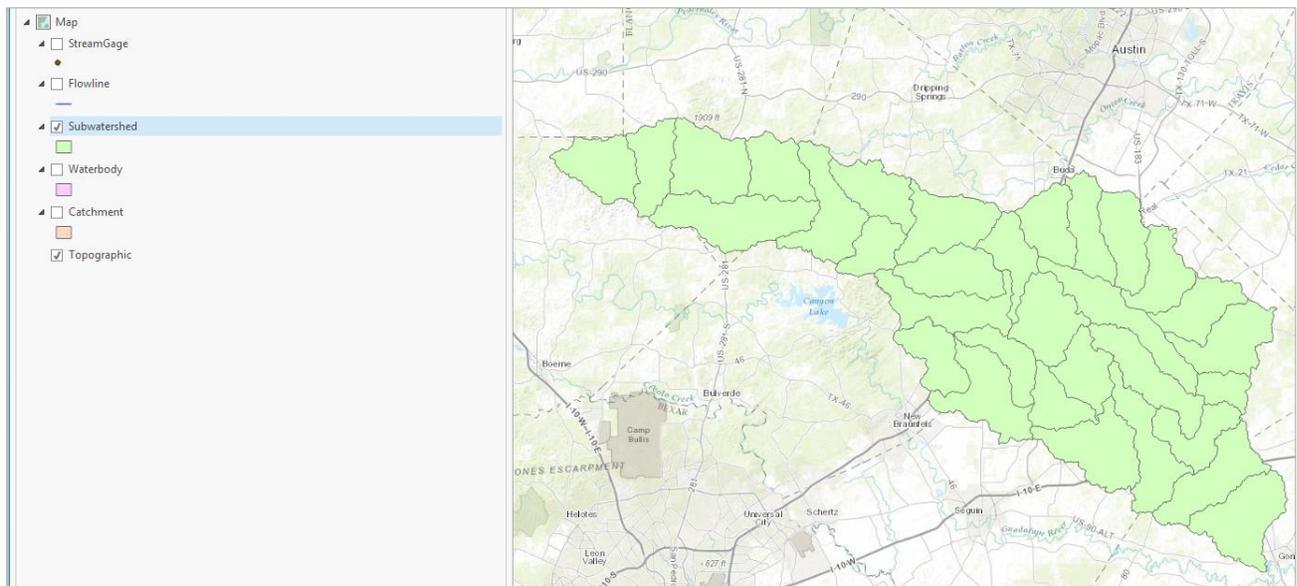

Click on the North-Western subwatershed on the map.
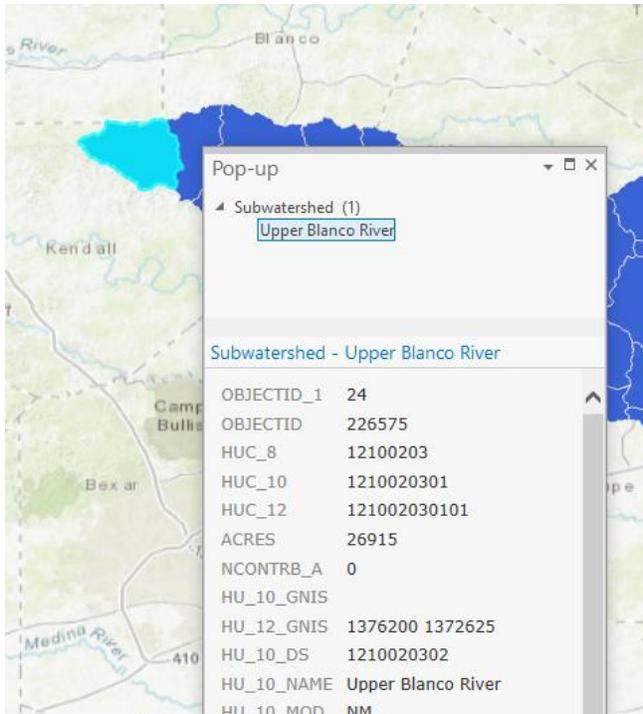
This is HUC_12 number **121002030101**. The position of this in the USGS drainage hierarchy is: **Region** 12, **Subregion** 10, **Basin** 02, **Subbasin** 03, **Watershed** 01, **Subwatershed** 01, thus making the HUC_8 number **12100203** as we used earlier, and the additional subdivision to the HUC_12 level yielding the 32 Subwatersheds in this Subbasin.

Right click on the **Subwatershed** feature class, and select **Symbology**. Select **Unique Values** and use **HUC_10** as the Value Field.
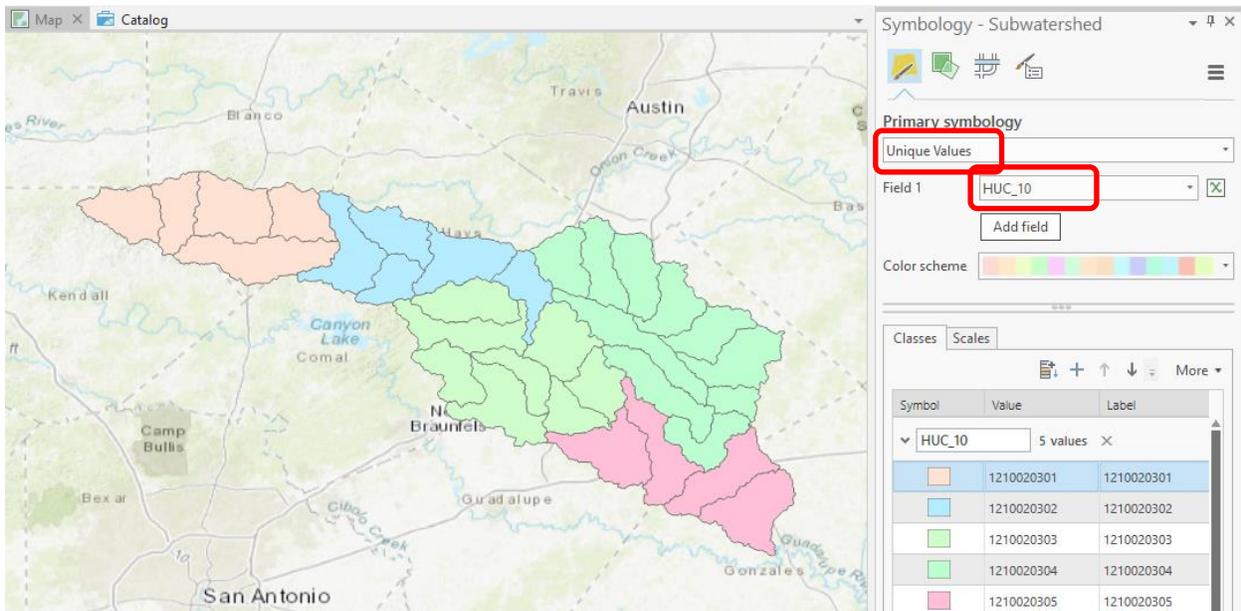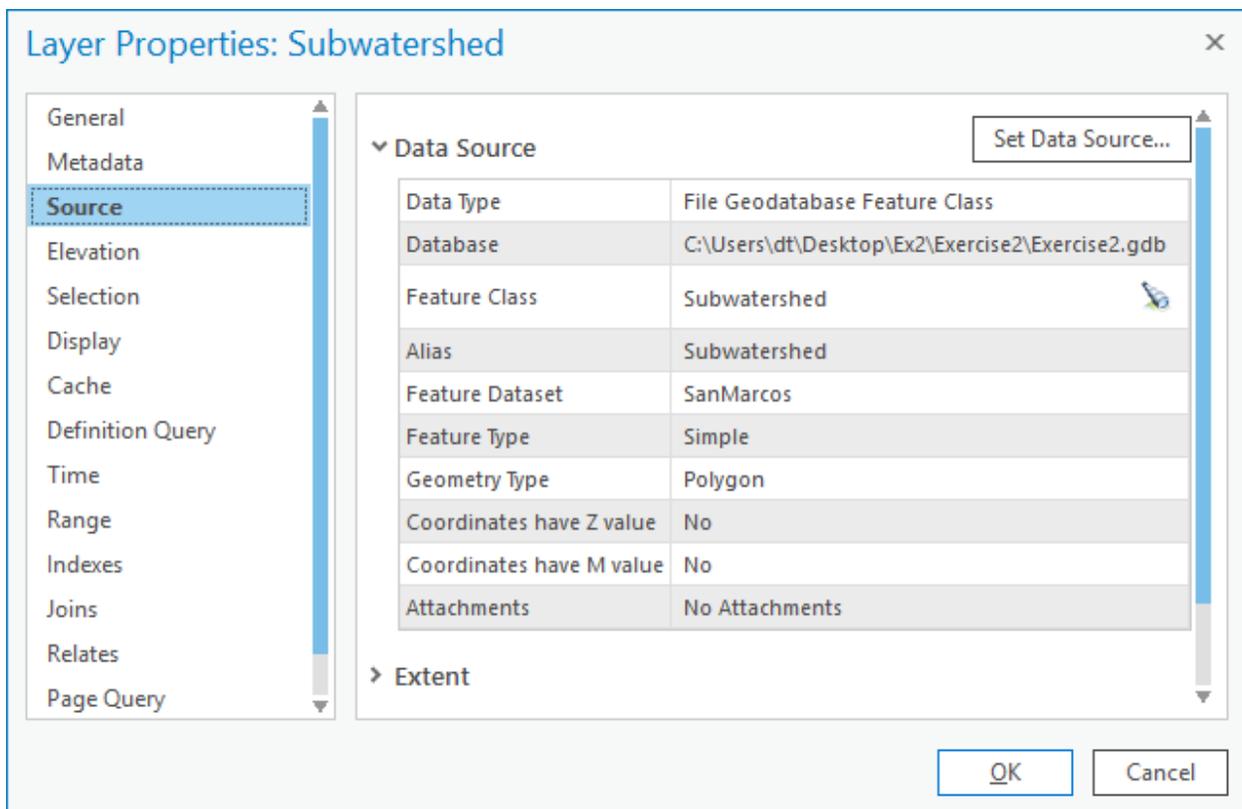

You should get this nicely colored map of the watersheds and subwatersheds of the San Marcos basin.

Notice that the 32 HUC-12 *subwatersheds* have been grouped into five *watersheds* within the San Marcos *subbasin* (I am here using the Watershed Boundary Dataset nomenclature to refer to the drainage area hierarchy in its formal sense).

Use **Project/Save** to update your **Exercise2.aprx** map project with the new information that you've created.

Where is My Stuff?

Right click on **Subwatershed** and select **Properties** and select the **Source** tab. Notice that this Feature Class you created is in the **SanMarcos** Feature Dataset in the **Exercise2.gdb** Geodatabase in the location where you created it. It comprises Simple Features (no topology) that are Polygons (have X and Y values) but have no Z or M values, which deal with elevation and measure, respectively.

Layer Properties: Subwatershed

| General	⌄ Data Source		Set Data Source...
Metadata			
Source	Data Type	File Geodatabase Feature Class	
Elevation	Database	C:\Users\dt\Desktop\Ex2\Exercise2\Exercise2.gdb	
Selection	Feature Class	Subwatershed	
Display	Alias	Subwatershed	
Cache	Feature Dataset	SanMarcos	
Definition Query	Feature Type	Simple	
Time	Geometry Type	Polygon	
Range	Coordinates have Z value	No	
Indexes	Coordinates have M value	No	
Joins	Attachments	No Attachments	
Relates			
Page Query	> Extent		

OK   Cancel

If you look at your Exercise2 folder on disk that was created when you created the project you will see a number of files, including Exercise2.gdb, which is the folder that holds this data in File Geodatabase format.

You do not need to do anything with these files, this is just pointed out to let you know where on disk your stuff is stored. Note that I had Exercise2 inside a folder Ex2 alongside the NFIEGeo_12.gdb. If you need to move these files to another computer (e.g. from the PC lab to a thumb drive) or to a different location on your computer, the integrity of the project will generally be maintained if you move all these files together retaining the relative folder structure .

Creating a San Marcos Basin Boundary

It is useful to have a single polygon for the outline of the San Marcos Basin. Navigate to the **Dissolve (Data Management)** tool in the *Analysis* tab (You have to expand the single line ribbon that you are initially presented with to get the display shown below).
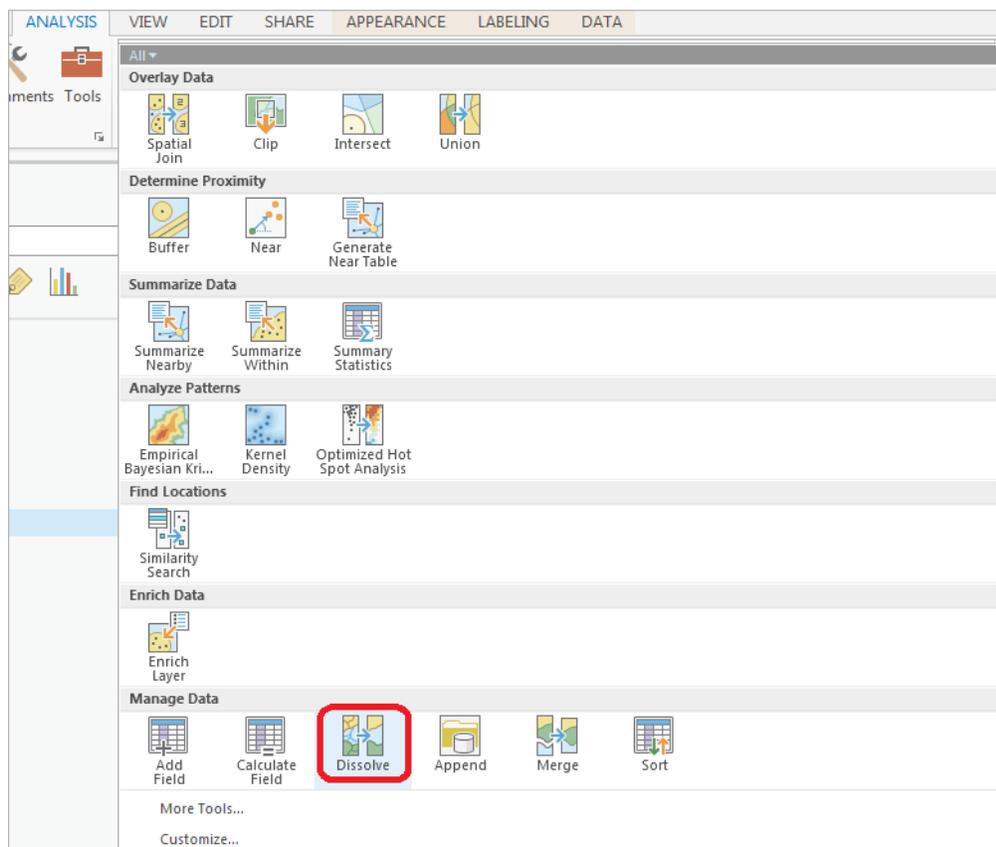
The **Geoprocessing** pane will appear with the **Dissolve** tool selected. You can drag and drop the **Subwatershed** feature class from the Table of Contents into the **Input Features** area of this window. Click on **HUC_8** as your **Dissolve_Field**. This means that all Subwatersheds with the same HUC_8
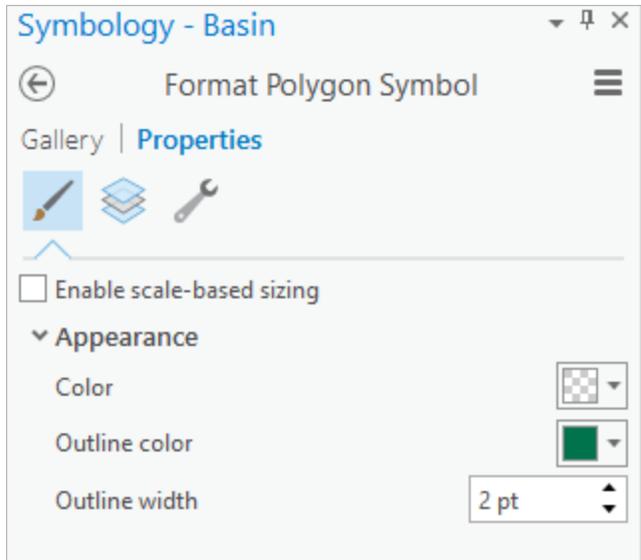
number (12100203) will be merged together. Set the output Feature class to be called **Basin** in your **SanMarcos** feature dataset. Hit **Run** to execute the function.
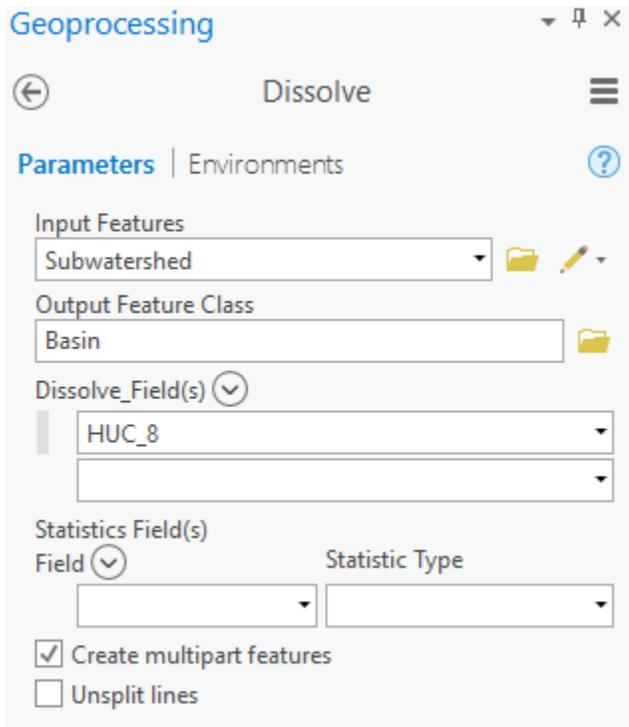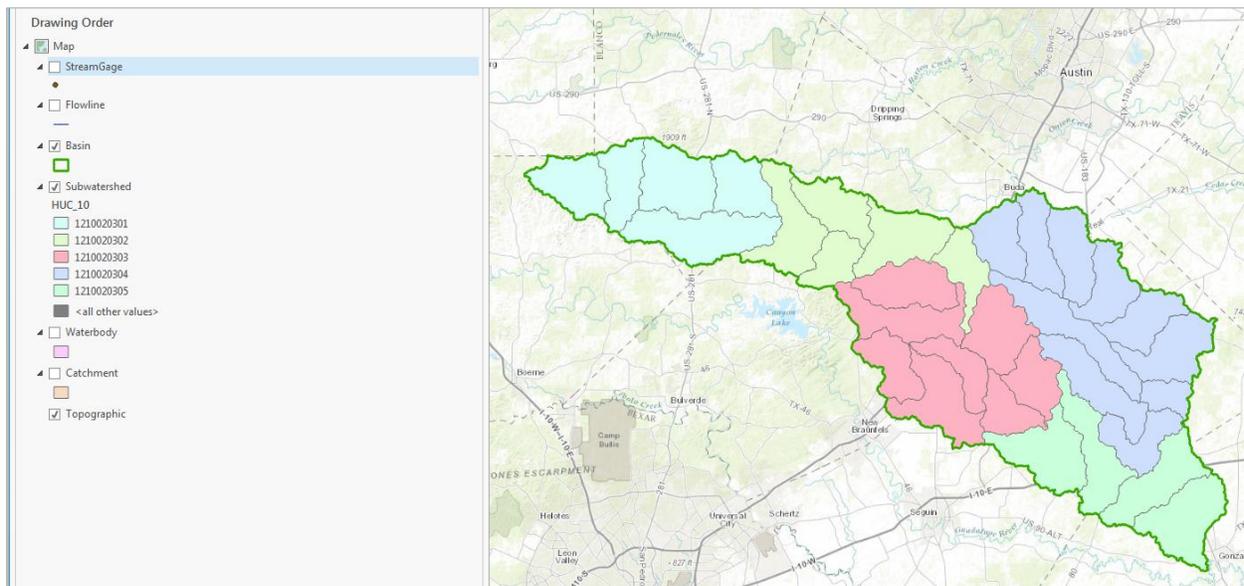

And you'll see a new **Basin** feature class pop up on your map display

Navigate to the **Symbology** and select **No Color** for the shape, Green for the **Outline Color** and 2 for the **Outline Width**.

You will now have a very nice looking map of the San Marcos Basin with its constituent subdrainage areas.


Right click on the **Basin** feature class and open its Attribute Table. Notice that the **Basin** feature class has only one Polygon and it is identified with the HUC_8 = 12100203, which is the 8-digit number all the HUC_12 subwatersheds had in common.

OBJECTID	Shape	HUC_8	Shape_Length	Shape_Area
1	Polygon	12100203	4.405787	0.32871

Use **Project/Save** to save your ArcGIS Pro project. Close the attribute table for the Basin feature class.

Navigate to your **SanMarcos** feature dataset in the **Project** pane. Notice how you've now got the **Watershed** and **Basin** feature classes that you've just created stored inside it.
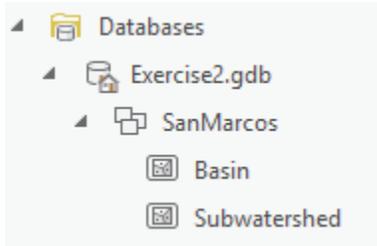

To be turned in: Make a map of the San Marcos basin with its HUC10 and HUC12 watersheds and subwatersheds. Use a layout as you learned in exercise 1. How many HUC10 and HUC12 units exist in the San Marcos Basin? Note that maps that you turn in should be clearly labeled so that they may be unambiguously interpreted with a title, scale, north arrow and appropriate legend information.

# Land Cover Information for the San Marcos Basin

Now, we are going to use some of the online data services to find some land cover properties of the San Marcos basin. Select **Add Data** to the Map
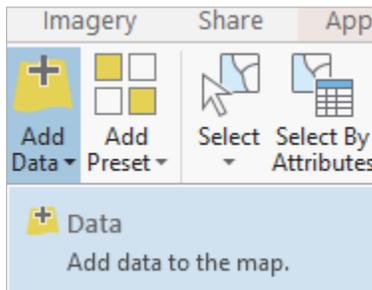

And among the options presented, select **Living Atlas.**
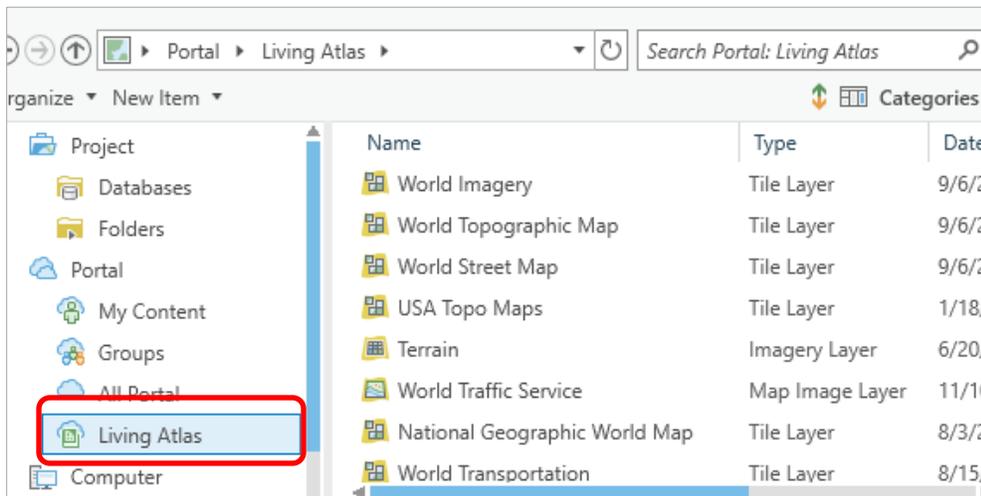
In the **Search Portal: Living Atlas** type in nlcd for National Land Cover Dataset, and among the options presented, select **USA NLCD Land Cover 2011**
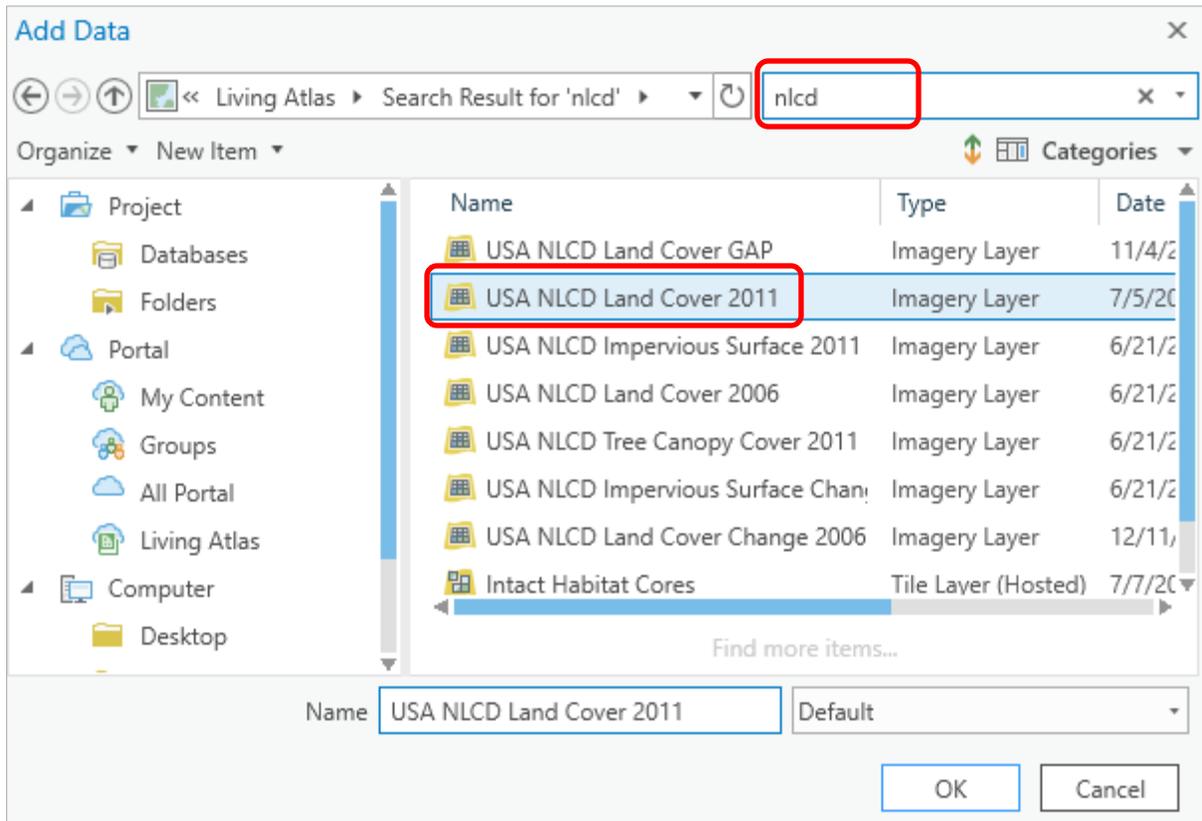

and you'll see it shows up on the map with predetermined color scheme that highlights urban areas in red. In the Table of Contents click off the **Subwatershed** layer, so that you only have the **Basin** displayed over the land cover data. San Antonio is towards the bottom of the map, Austin near the top, and San Marcos lies within the basin. Notice also the profusion of yellow and brown for Agriculture on the right-hand side of the map, to the east of the Balcones escarpment.   Forest areas predominate on the west side of the basin.
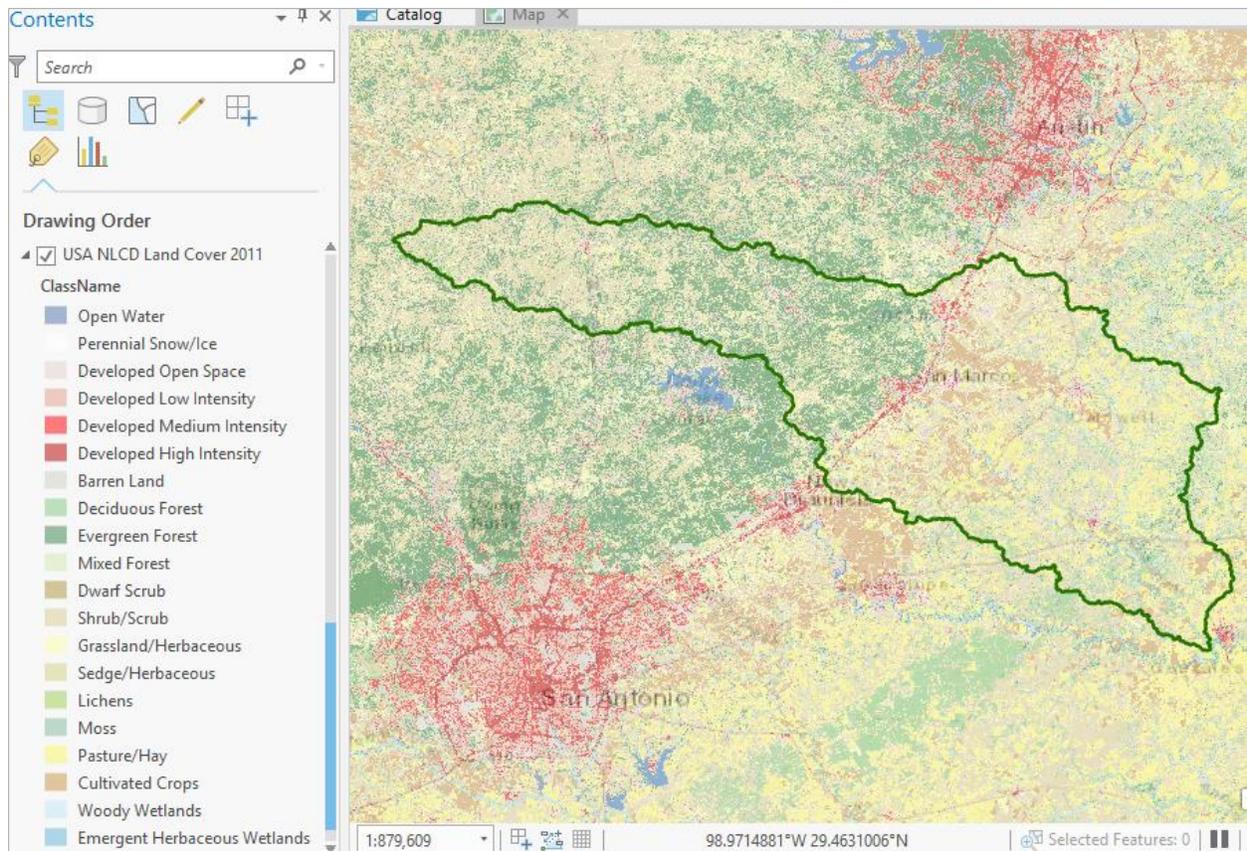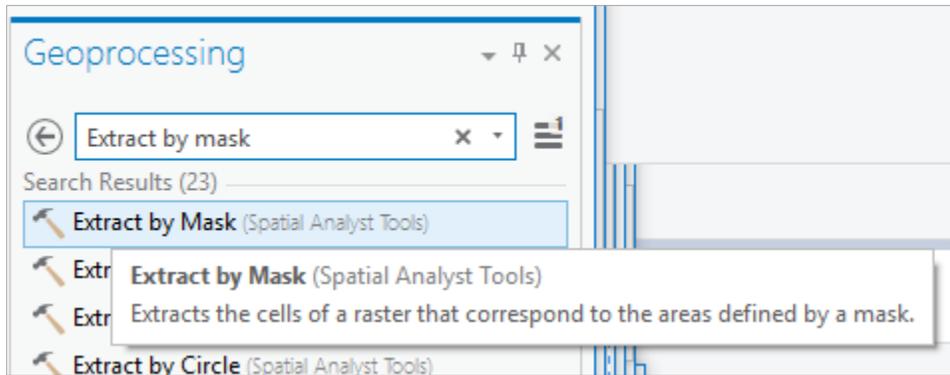
Use **Project/Save** to save the current map display.

In the Geoprocessing pane, in the top right hand corner, select **Open Another Tool**
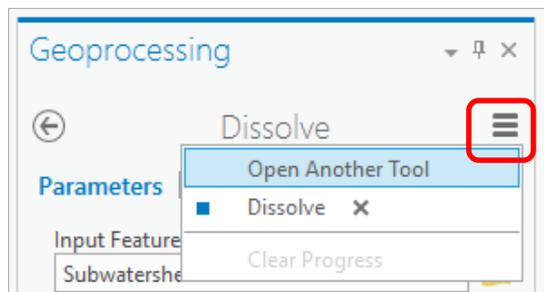

And enter **Extract by Mask** in the Find Tools box.

Click on the **Extract by Mask** (Spatial Analyst Tools) tool, and use **USA NLCD Land Cover 2011** as the Input Raster and **Basin** as the mask data; put the result in the **Exercise2** geodatabase with the name **LandCover**. Be careful to store the Output raster directly inside the Exercise2.gdb, not inside the **SanMarcos** Feature Dataset, which only stores vector feature classes.
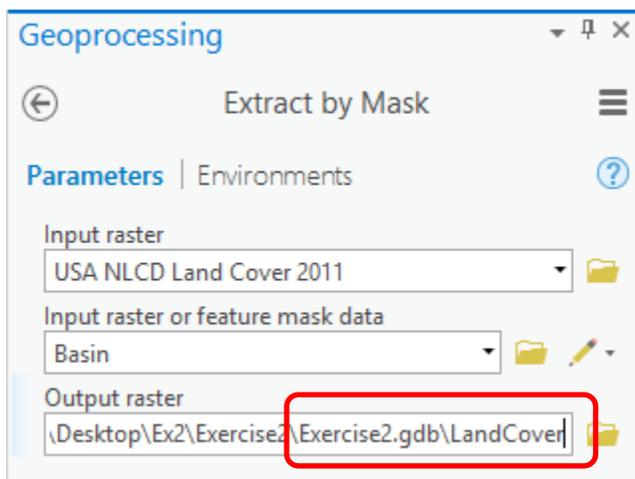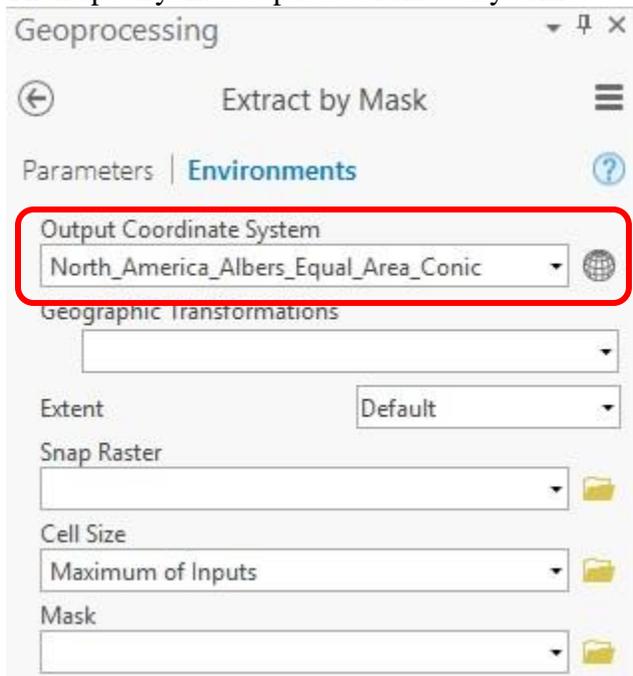

At the Extract by Mask step specify the output Coordinate System to be

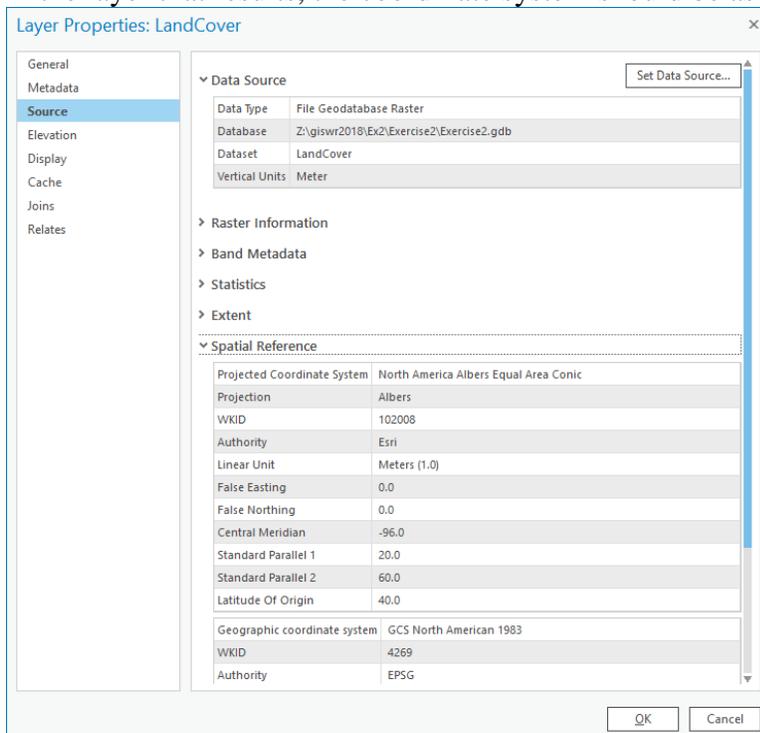**North_America_Albers_Equal_Area.**

After Setting the inputs and outputs, Click on Environments
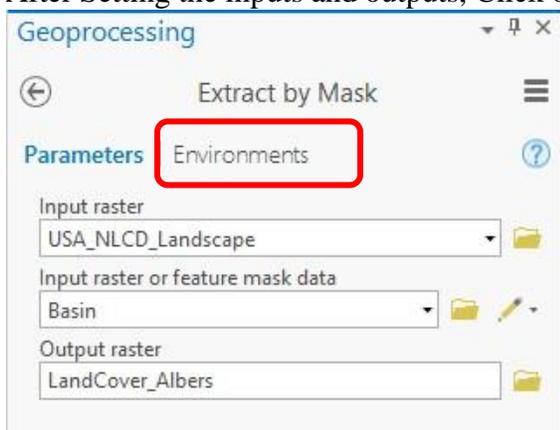
Then specify the Output Coordinate System

In the layer that results, the coordinate system should be as below

Click **Run**.

After a while you'll see the result appear in the Map using the same symbology as the original service. You have now extracted data from the ESRI web service hosted in a cloud somewhere to your local disk. Very cool! Turn off the original NLCD service to highlight your new dataset.
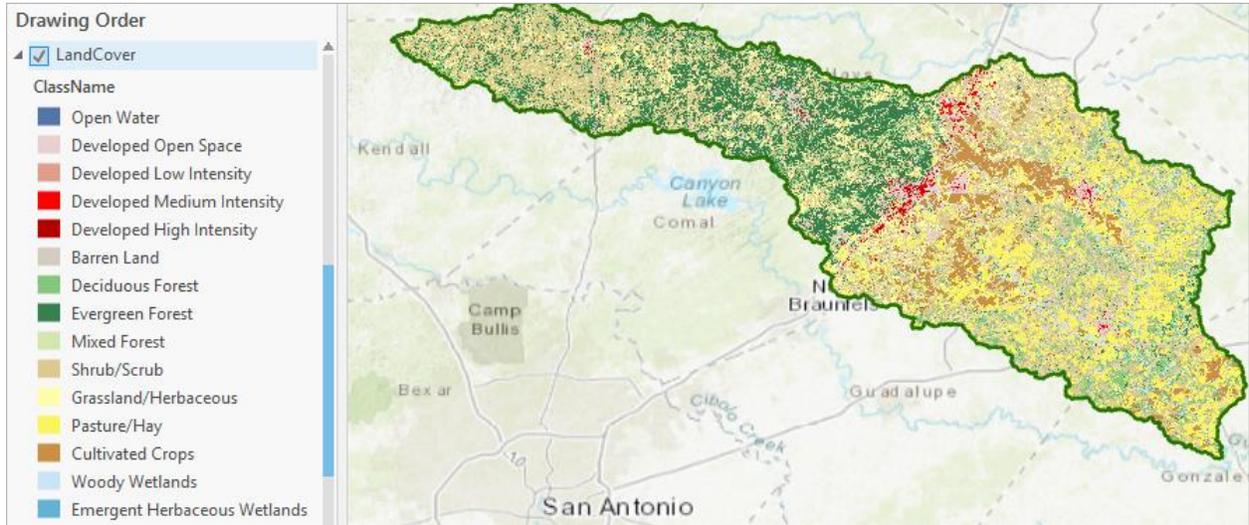
The contrast between the forest to the west of the Balcones fault zone and agriculture to the east is now particularly clear, as are the urban areas lying along the IH-35 corridor between Austin and San Antonio.

If you right click on the LandCover raster and open its **Properties**, and then select **Raster Information**, you'll see it is a raster with approximately 30m x 30m cells (these are derived from 30m Landsat imagery).

This land cover grid is an integer grid with a **Value Attribute Table** (grids with real numbers do not have a VAT). Open the **Attribute Table** and you'll see the land cover classes indicated by **Value**. The **Count** indicates the number of cells having that Value.

OBJECTID	Value	Count	Land Cover	Red	Green	Blue
1	11	17291	Open Water	84	117	168
3	21	298040	Developed Open Spa...	232	209	209
4	22	43192	Developed Low Inten...	226	158	140
5	23	22807	Developed Medium I...	255	0	0
6	24	9685	Developed High Inte...	181	0	0
7	31	9081	Barren Land	210	205	192
8	41	429602	Deciduous Forest	133	199	126
9	42	533130	Evergreen Forest	56	129	78
10	43	32137	Mixed Forest	212	231	176
12	52	1215578	Shrub/Scrub	220	202	143
13	71	460953	Grassland/Herbaceous	253	253	170
17	81	531747	Pasture/Hay	251	246	93
18	82	234645	Cultivated Crops	202	145	70
19	90	70939	Woody Wetlands	200	230	248
20	95	2167	Emergent Herbaceou...	100	179	213

These 20 land cover classes are themselves grouped into 8 main classes.
https://www.mrlc.gov/nlcd11_leg.php

| Main Category	Sub Class Number	Sub Category
Water	11	Open Water
Developed	21	Developed Open Space
	22	Developed Low Intensity
	23	Developed Medium Intensity
	24	Developed High Intensity
Barren	31	Barren Land
Forest	41	Deciduous Forest
	42	Evergreen Forest
	43	Mixed Forest
Shrubland	52	Shrub/Scrub
Herbaceous	71	Grassland/Herbaceous
Planted/Cultivated	81	Pasture/Hay
	82	Cultivated Crops
Wetlands	90	Woody Wetlands
	95	Emergent Herbaceous Wetlands

Let's add these main classes to the Value Attribute Table for Land Cover. In the Table view menu, click on Add to add a Field. Note that you have to have the Table active for this menu to be available.
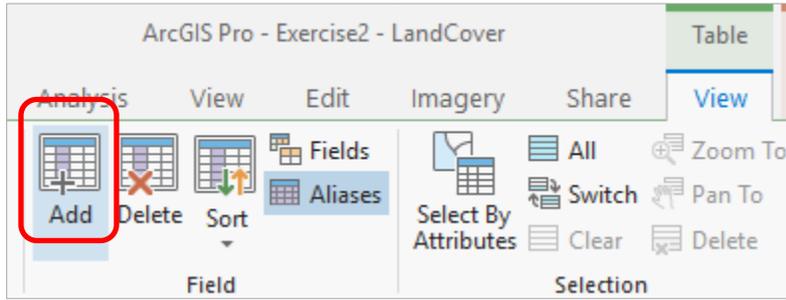
And in the Fields: LandCover table that appears change the **Field Name** from Field to **MainClass** and the **Data Type** to **Text**. Sometimes it takes a few clicks on these field names before they will allow you to edit them.
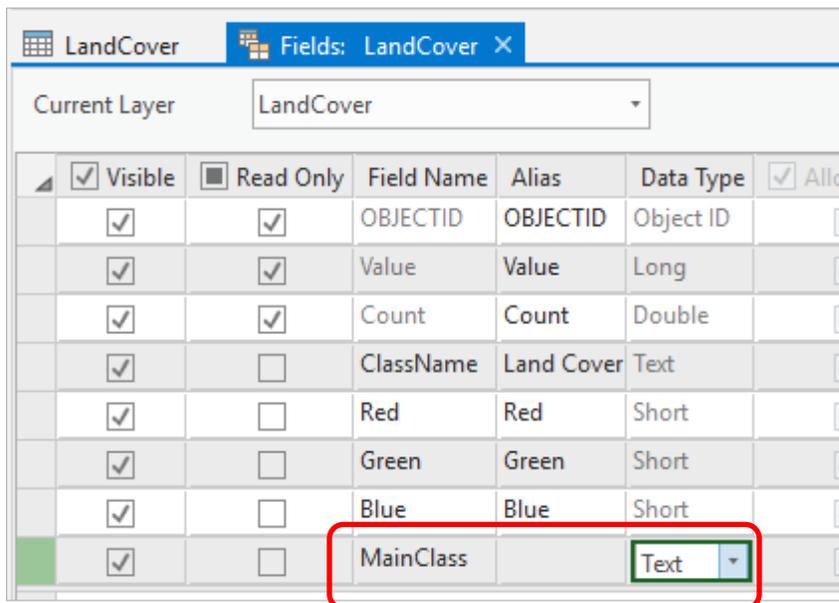

Click **Save** at the top of the display to apply these changes.
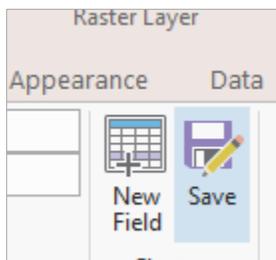
Now, when you return to the LandCover Table, you'll see a new Field called MainClass on the right hand side. Initially all values will be null. Click on each row in this field and add the appropriate MainClass title. I have only partially completed adding these values in the table below. They should all be filled in.

OBJECTID	Value	Count	Land Cover	Red	Green	Blue	MainClass
1	11	17291	Open Water	84	117	168	Water
3	21	298040	Developed Open Spa...	232	209	209	Developed
4	22	43192	Developed Low Inten...	226	158	140	Developed
5	23	22807	Developed Medium I...	255	0	0	Developed
6	24	9685	Developed High Inte...	181	0	0	Developed
7	31	9081	Barren Land	210	205	192	Barren
8	41	429602	Deciduous Forest	133	199	126	Forest
9	42	533130	Evergreen Forest	56	129	78	Forest
10	43	32137	Mixed Forest	212	231	176	<Null>
12	52	1215578	Shrub/Scrub	220	202	143	<Null>
13	71	460953	Grassland/Herbaceous	253	253	170	<Null>
17	81	531747	Pasture/Hay	251	246	93	<Null>
18	82	234645	Cultivated Crops	202	145	70	<Null>
19	90	70939	Woody Wetlands	200	230	248	<Null>
20	95	2167	Emergent Herbaceou...	100	179	213	<Null>

In the Edit tab, select Save to save the new information that you have added to the MainClass field.
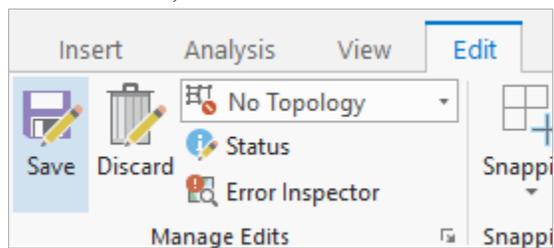
Now, lets summarize the land cover classification according to these main classes.

Right click on **MainClass** field and select **Summarize**.
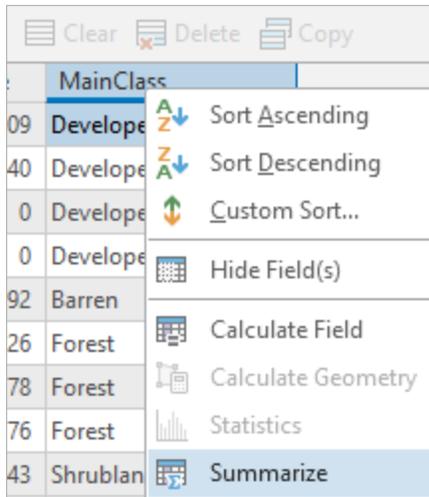
In the **Field** section select **Count** with a Statistic Type **SUM**, then save the result as a table called **LandCoverSummary** in the **Exercise2** geodatabase (not in the SanMarcos feature dataset). Leave the Case field as MainClass. What this action does is to create a new table that sums the count of the cells for all the land cover subcategories in each Main Class
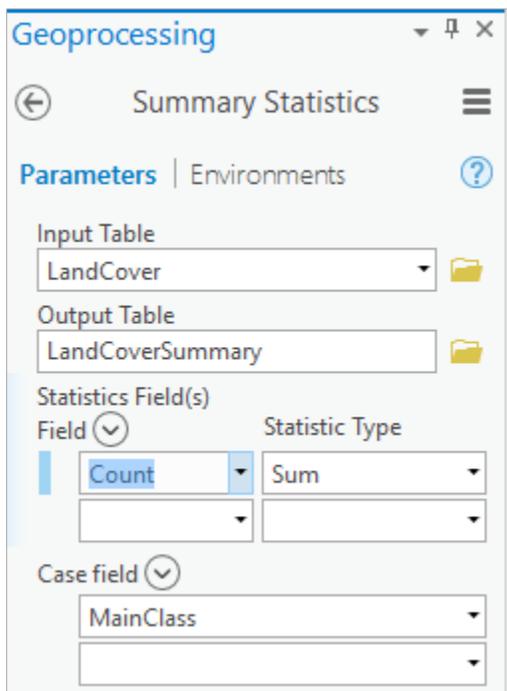

Click **Run**. What this action does is to create a new table that sums for the San Marcos basin the count of the cells for all the land cover subcategories in each Main Class. This table shows up in your Table of Contents at the bottom of the display.

OBJECTID	MainClass	FREQUENCY	SUM_Count
1	Barren	1	9081
2	Developed	4	373724
3	Forest	3	994869
4	Herbaceous	1	460953
5	Planted/Cultivated	2	766392
6	Shrubland	1	1215578
7	Water	1	17291
8	Wetlands	2	73106

If you use the **Catalog** pane to navigate to **Databases**, you'll see that you have a new **LandCoverSummary** table in your geodatabase, along with the **LandCover** raster created earlier:
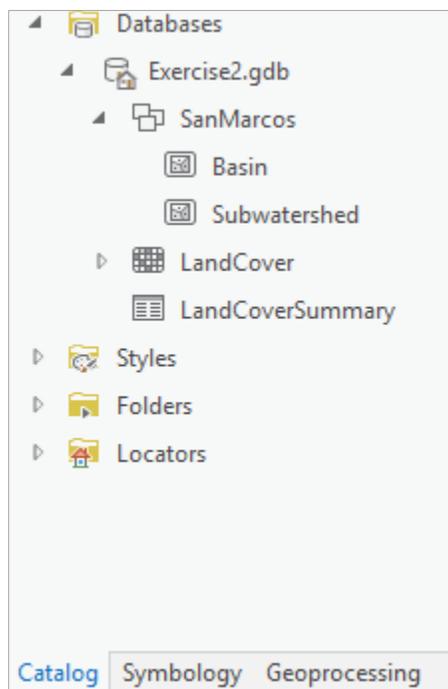
Use **Project/Save** to save your project file.

The **Sum_Count** of the number of grid cells in this table, can be used with cell size (30m) to determine the area in each land cover class.

To be turned in: Make a map of the land cover over the San Marcos Basin. Prepare a table that shows the area (km^2) of each of the main land cover classes and the % of the total basin area that each land cover class represents.

# Obtaining the San Marcos Flowlines and Catchments

Go back to the data from **NFIEGeo_12.gdb** that you downloaded at the beginning of the exercise and focus on the **Flowlines** and **Catchment** layers in to your Map display. Turn off the LandCover distribution. If necessary, reload the Flowlines and Catchment from the geodatabase to the map display. Color your Catchments as "No Color" with a green outline, and your Flowlines as nice blue streams using the same procedure as before of Right Clicking on the feature class name and selecting Symbology from the choices then available to you.
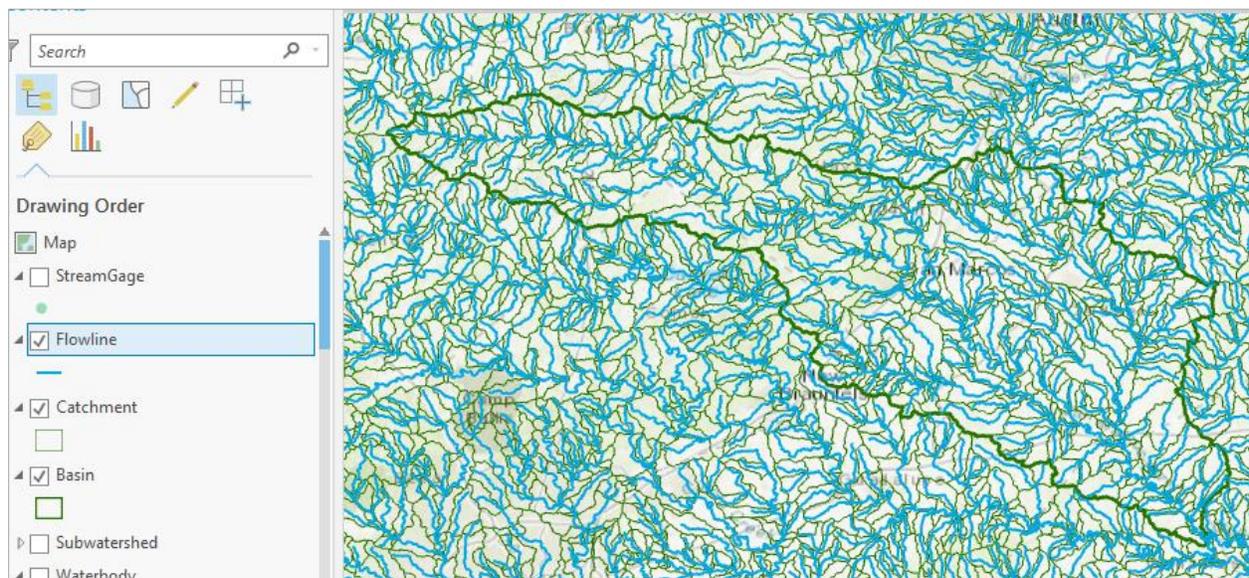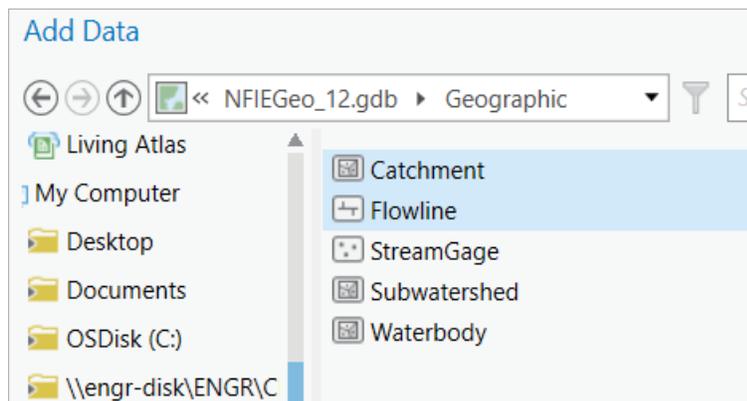

Now, let's select the features from our large dataset that lie within our Basin. Click the **Selection by Location** button on the *Map* tab.
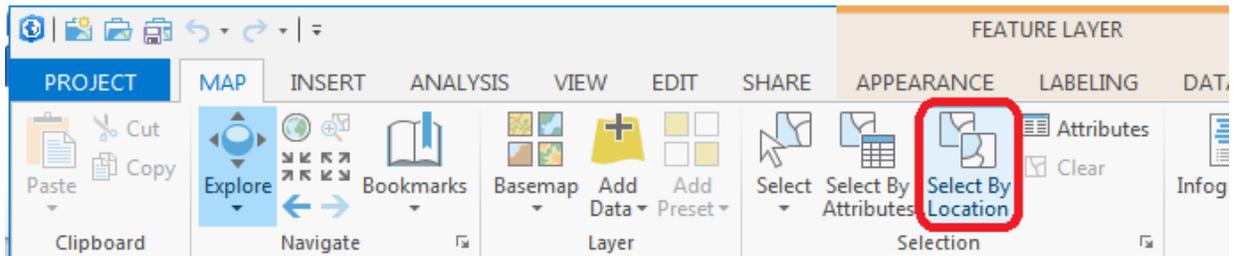
Select the features from the **Flowline** feature class that **Have their center in** the **Basin** and you'll see these flowlines selected as shown below.
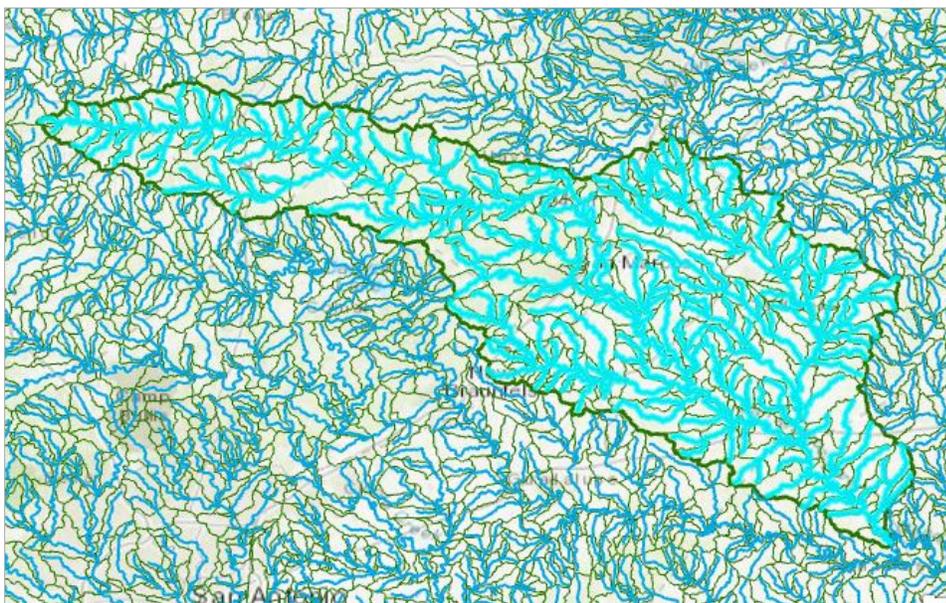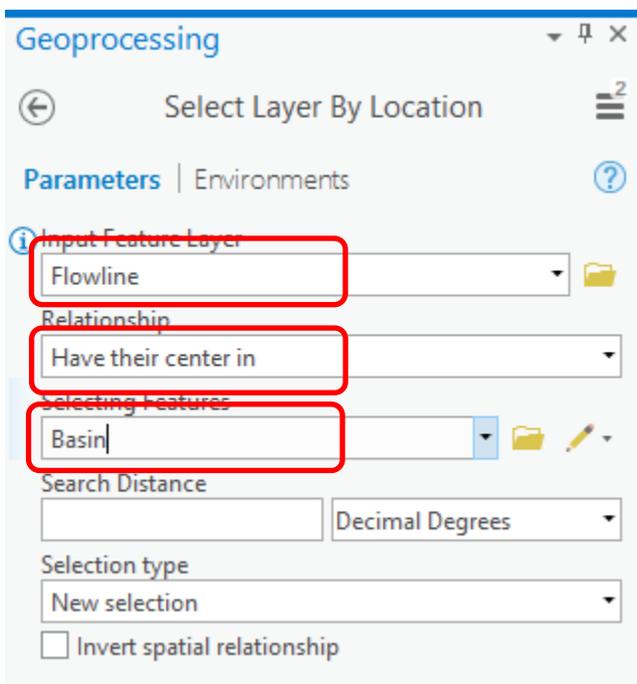
Right click on the **Flowline** feature class and select **Data/Export Data** to Export these selected Flowlines to a feature class called **Flowline** in the SanMarcos geodatabase.
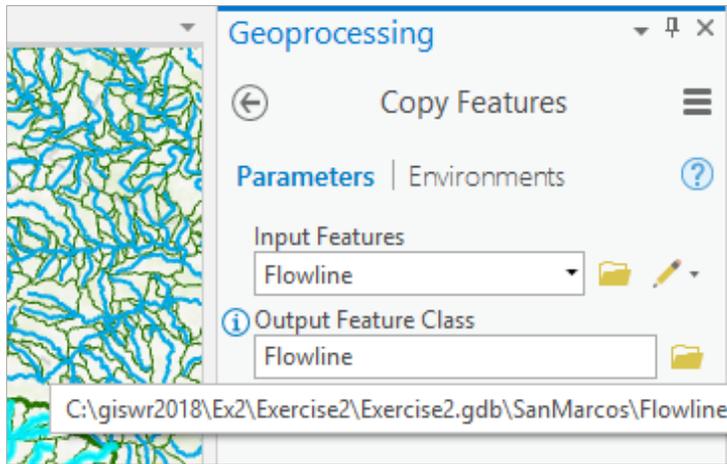

Remove the original **Flowline** feature class for Region 12 from your map display (it is the lower of the two Flowline feature classes in the Table of Contents.

Repeat the same process with **Catchment** as you did for **Flowline:** (1) Use Select by Location to select those catchments having their center in the San Marcos basin; (2) Export those catchments to the San Marcos feature dataset as a new feature class; (3) Remove the larger Region 12 catchment set from the map display and recolor the San Marcos catchments appropriately as a backdrop to your selected flowline set.
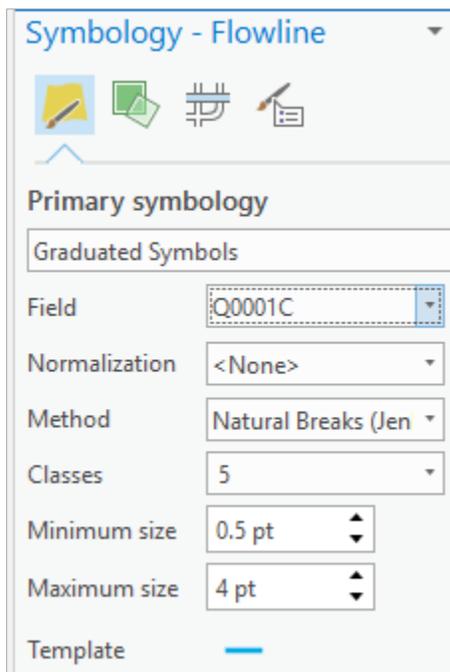

Use **Project/Save** to save your new data display.

This map looks a little bit like spaghetti, so let's recolor the Flowlines according to the Mean Annual Flow (Q0001C attribute). Right click on the **Flowline** feature class and select **Symbology**. Use **Graduated Symbols**
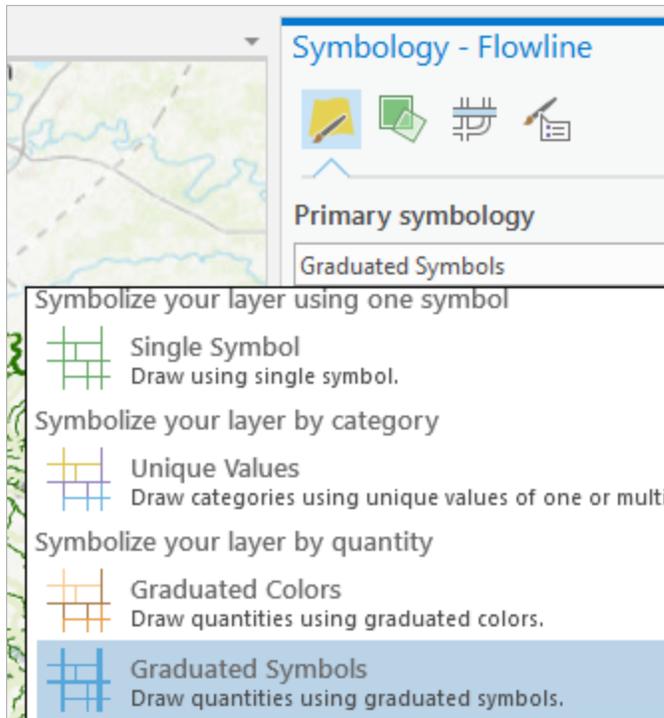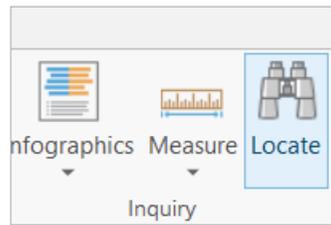
Using **Field Q0001C** (the mean annual flow of each flowline in cubic feet per second)

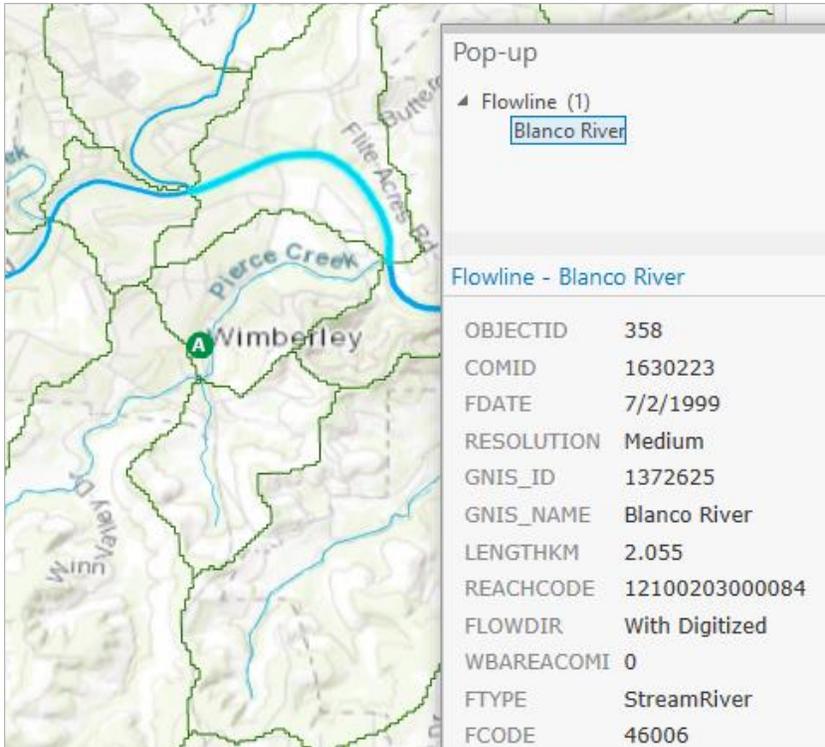and click on **Template** to change the base color to blue.

Turn off the Catchments and you'll get a nice display of the distribution of the streams and rivers in the San Marcos Basin

Use the Locate button in the Map view to locate the town of Wimberley, Texas


Click on the reach of the Blanco River just adjacent to Wimberley:

And you'll see that this reach has a **COMID = 1630223**. If you click on the catchment within which this flowline is located, you'll see that it has a **FeatureID = 1630223**. It is this one to one relationship between the COMID of the Flowline and the FeatureID of the Catchment that connects the river and stream segments with their surrounding local drainage areas in the National Water Model.
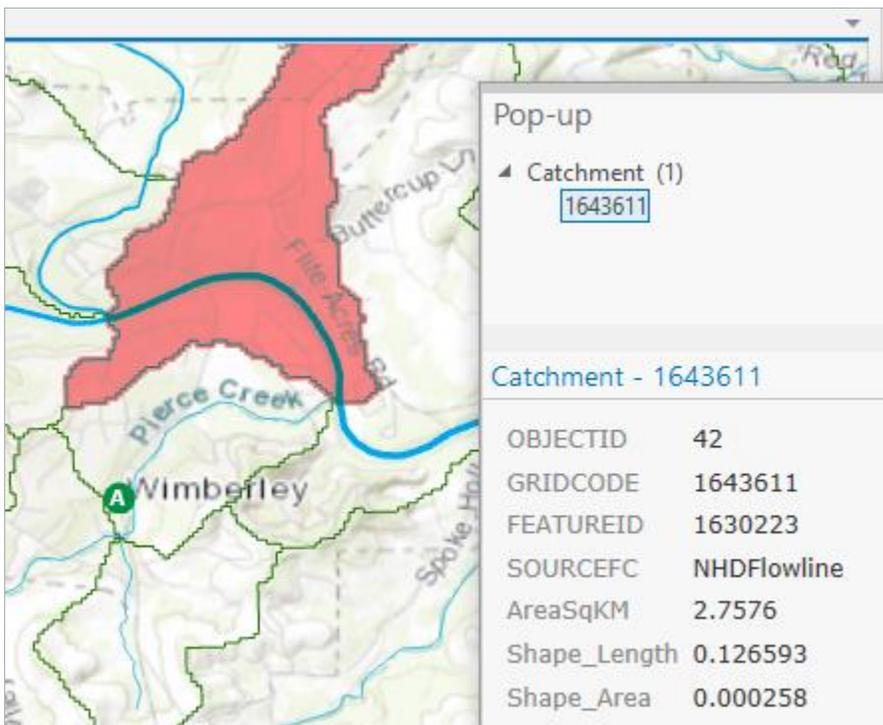
Use **Zoom to Layer** for the **Basin** feature class to get back the original extent of our map.
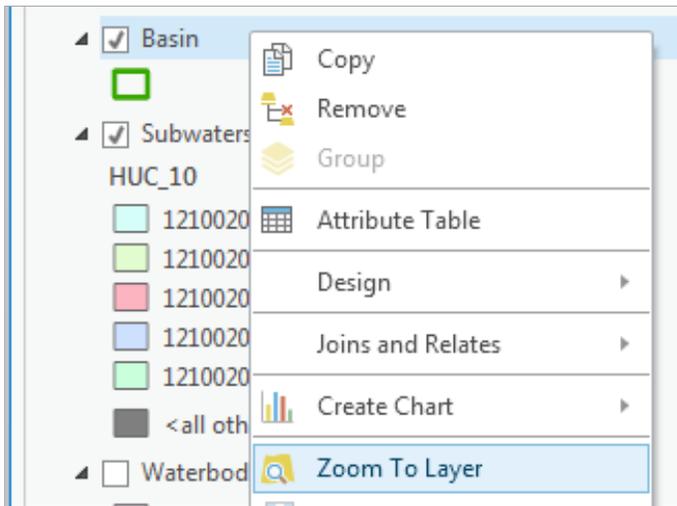
Turn off the Locate panel to eliminate the symbolization of Wimberley.
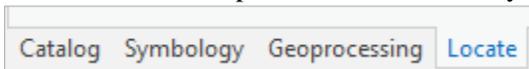
Explore the map and identify where the Blanco River, San Marcos River and Plum Creek are located in the basin.
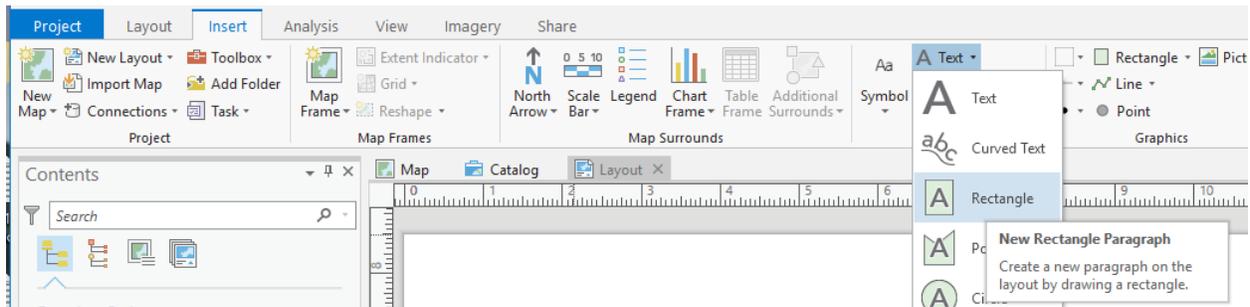
Now let's create a map and do some summarization of watershed attributes. We'll need to create a new Layout with the **New Layout** button in the *Insert* tab. Use 8 ½" x 11" Portrait Letter layout option.
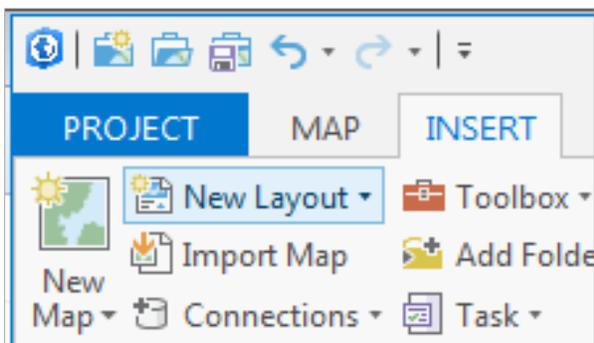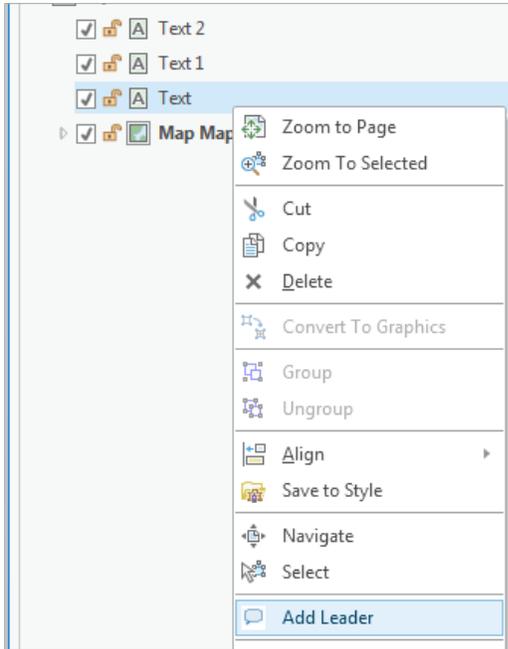

Add your **Map Frame** to the **Layout** (make sure you can see the whole basin),
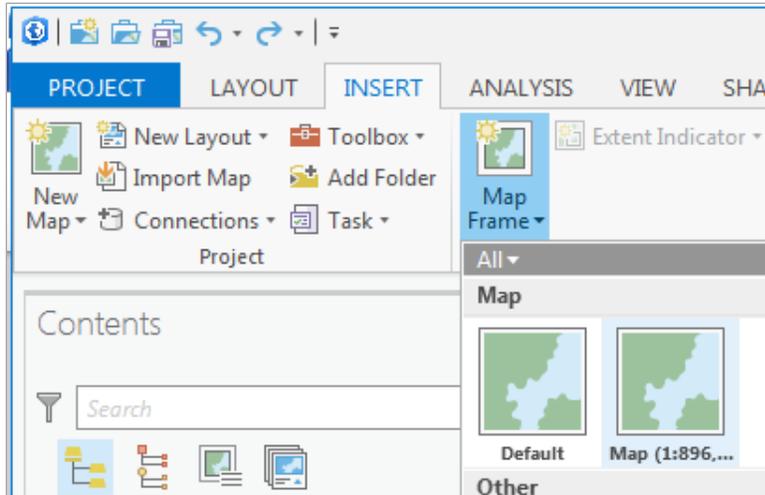
add a **Text Rectangle**,

Add **Plum Creek**, **Blanco River**, and **San Marcos River** Text Rectangles to the **Layout** (click on the tool and then draw a box on the map and type in the river name. Then right-click on each Text Rectangle in the **Contents** pane and select **Add Leader**.

Move the Text Rectangles around and select **Add Leader** again to change the location of the pointer until your map looks something like this:
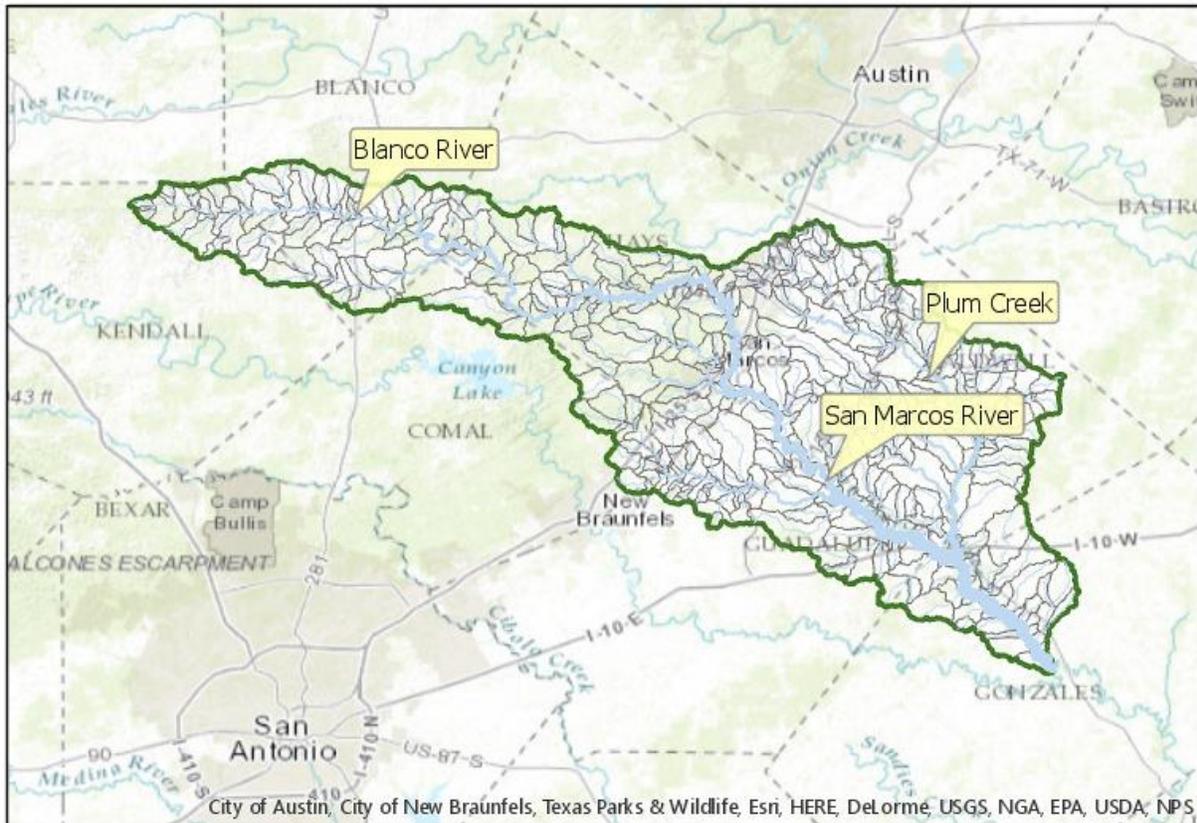
Note that Add Leader repositions the point of the leader, so you need to use trial and error to get the text and leader point the way you want it.

Save your map document as **Ex2_project_flow.aprx** to preserve your layout.

Switch back to the Map tab and open the attribute table for Flowline. Note that there is a field **LENGTHKM** that was obtained from the original data. Use this to compute the average length of flowlines. Right click on the LengthKm feature field and select **Summarize**
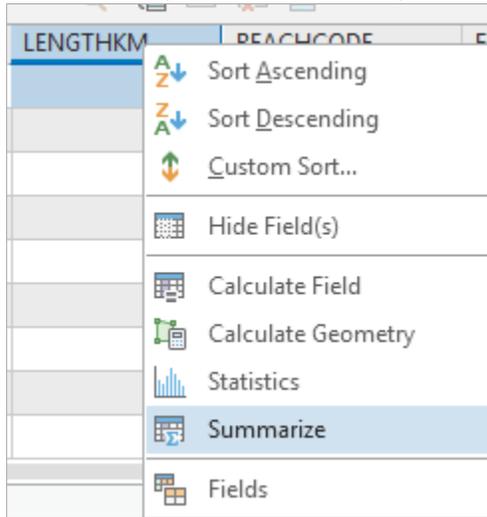
Accept the default value **Flowline_Statistics** as the output table. Use **LengthKm** as the Statistics Field and **Mean** as Statistics Type. Remove **LengthKm** as the **Case field**.
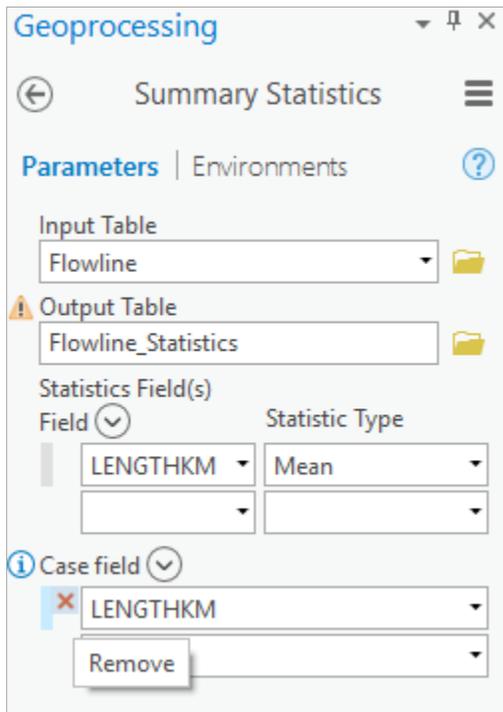
Hit **Run** and you'll see a new table at the bottom of the Table of Contents panel which gives you the number of flowlines and their average length.

The attribute table for Catchment has a field **AreaSqKM** from the original data. Use this field to similarly evaluate the average area of catchments.

Note that the fields Shape_Length and Shape_Area in these tables should not be used for length and area as they are in geographic coordinates so do not account for the curvature of the earth.

To be turned in: Make a map of the San Marcos basin with its labeled rivers. How many Catchments lie within this basin? What is their average area (Sq. Km)? How many Flowlines lie within this basin? What is their average length (Km)?

Creating a Point Feature Class of Stream Gages

Now you are going to build a new Feature Class yourself of stream gage locations in the San Marcos basin. I have extracted information from the USGS site information at
https://waterdata.usgs.gov/tx/nwis/inventory

SiteID	SiteName	Latitude	Longitude	DASqMile	MAFlow
08171000	Blanco Rv at Wimberley, Tx	29º 59' 39"	98º 05' 19"	355	142
08171300	Blanco Rv nr Kyle, Tx	29º 58' 45"	97º 54' 35"	412	165
08172400	Plum Ck at Lockhart, Tx	29º 55' 22"	97º 40' 44"	112	49
08173000	Plum Ck nr Luling, Tx	29º 41' 58"	97º 36' 12"	309	114
08172000	San Marcos Rv at Luling, Tx	29º 39' 58"	97º 39' 02"	838	408
08170500	San Marcos Rv at San Marcos, Tx	29º 53' 20"	97º 56' 02"	48.9	176

(a) **Define a table containing an ID and the long, lat coordinates of the gages**

The coordinate data is in geographic degrees, minutes, & seconds. These values need to be converted to digital degrees, so go ahead and perform that computation for the 6 pairs of longitude and latitude values. This is something that has to be done carefully because any errors in conversions will result in the stations lying well away from the San Marcos basin. I suggest that you prepare an Excel table showing the gage longitude and latitude in degrees, minutes and seconds, convert it to long, lat in decimal degrees:

$$Decimal\ Degrees\ (DD) = Degrees + \frac{Min}{60} + \frac{Seconds}{3600}$$

Remember that West Longitude is negative in decimal degrees. Shown below is a table that I created. **Be sure to format the columns containing the Longitude and Latitude data in decimal degrees (LongDD and LatDD) so that they explicitly have Number format with 4 decimal places using Excel format procedures. Format the column SITEID as Text or it will not retain the leading zero in the SiteID data**. Add the additional information about the USGS SiteID, SiteName, and Mean Annual Flow (MAF). Note the name of the worksheet that you have stored the data in. I have called mine **LatLong.xlsx**

SiteID	SiteName	Latitude	Longitude	LatDeg	LatMin	LatSec	LongDeg	LongMin	LongSec	LatDD	LongDD	DASqMile	MAFlow
08171000	Blanco Rv at Wimberley, Tx	29° 59' 39"	98° 05' 19"	29	59	39	98	5	19	29.9942	-98.0886	355	142
08171300	Blanco Rv nr Kyle, Tx	29° 58' 45"	97° 54' 35"	29	58	45	97	54	35	29.9792	-97.9097	412	165
08172400	Plum Ck at Lockhart, Tx	29° 55' 22"	97° 40' 44"	29	55	22	97	40	44	29.9228	-97.6789	112	49
08173000	Plum Ck nr Luling, Tx	29° 41' 58"	97° 36' 12"	29	41	58	97	36	12	29.6994	-97.6033	309	114
08172000	San Marcos Rv at Luling, Tx	29° 39' 58"	97° 39' 02"	29	39	58	97	39	2	29.6661	-97.6506	838	408
08170500	San Marcos Rv at San Marcos, Tx	29° 53' 20"	97° 56' 02"	29	53	20	97	56	2	29.8889	-97.9339	48.9	176

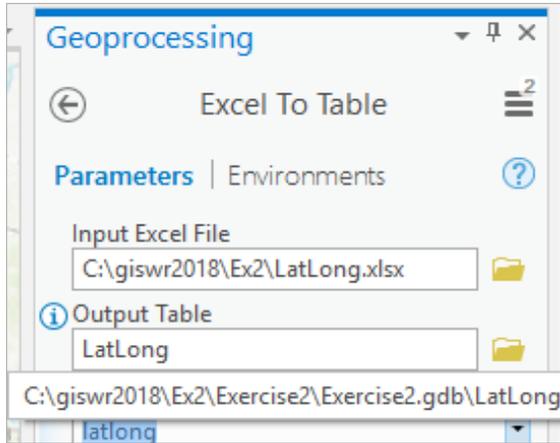**(b) Creating and Projecting a Feature Class of the Gages**

In the Geoprocessing table, click on the bars in the top right corner and **Open Another Tool**

Select **Excel to Table**
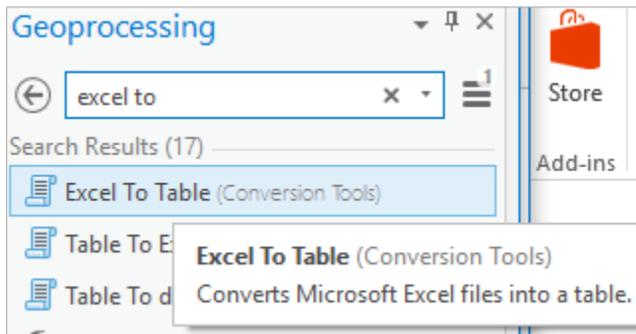
Select the **LatLong.xlsx** as the Input Excel File and name the output file **LatLong.** Notice that it is located within the Exercise2 geodatabase. Select the worksheet within the spreadsheet that contains your data. Mine is called **latlong.**
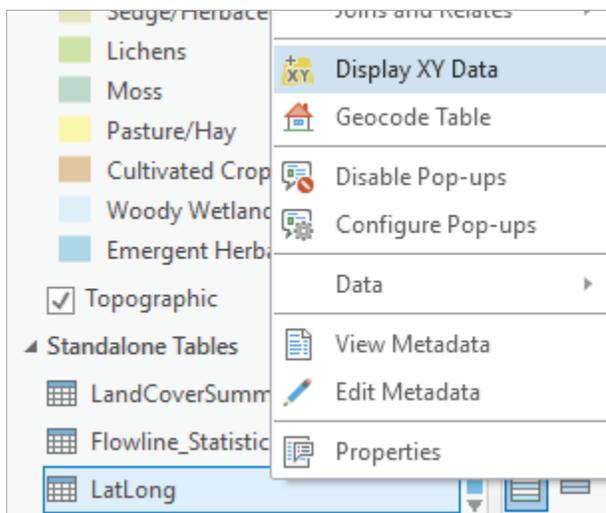
Click **Run**

Now we are going to convert the tabular data in the spreadsheet to points in the ArcGIS Pro display.

Right click on the new table, **LatLong**, and select **Display XY Data**

Set the X Field to **LongDD**, the Y Field to **LatDD**. Note that by default the **GCS_WGS_1984** coordinate system is chosen. This is incorrect for this dataset and must be changed to **GCS_North_American_1983**. Name the Output Feature Class **Gages** and save it in the SanMarcos feature dataset
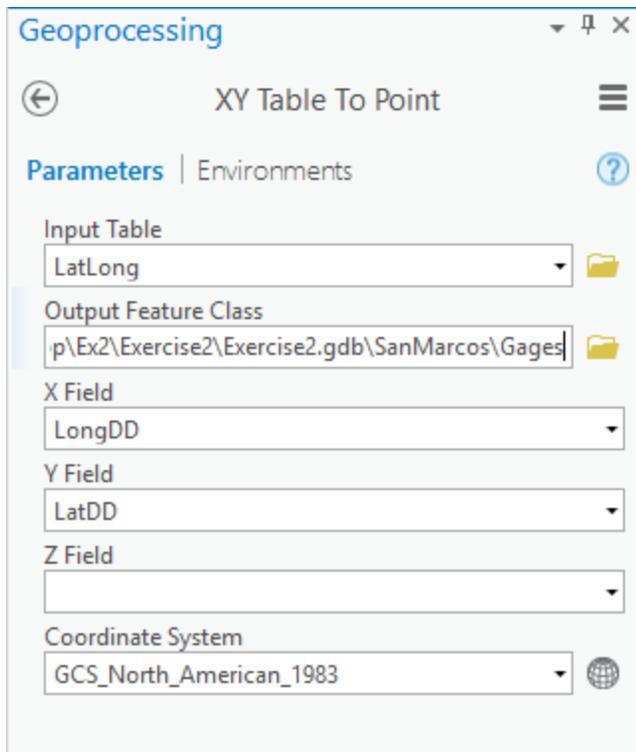
Hit **Run** to create the and voila! Your gage points show up on the map right along the San Marcos River just like they should. Magic! I remember the first time I did this I was really thrilled. This stuff really works. I can create data points myself! If you don't see any points, don't be dismayed. Check back at your spreadsheet to make sure that the correct X field and Y field have been selected as the ones that have your data in decimal degrees.
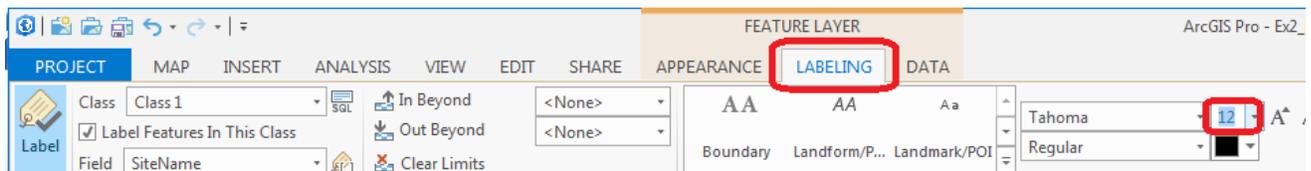
Let's recolor these gages to be nice red dots with 10 point size.

Now let's label the Gages with their Names. Right click on the **Gage** feature class and click on **Label Features**.
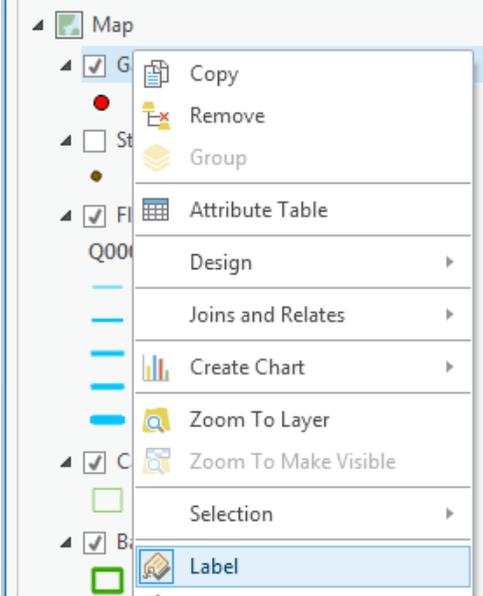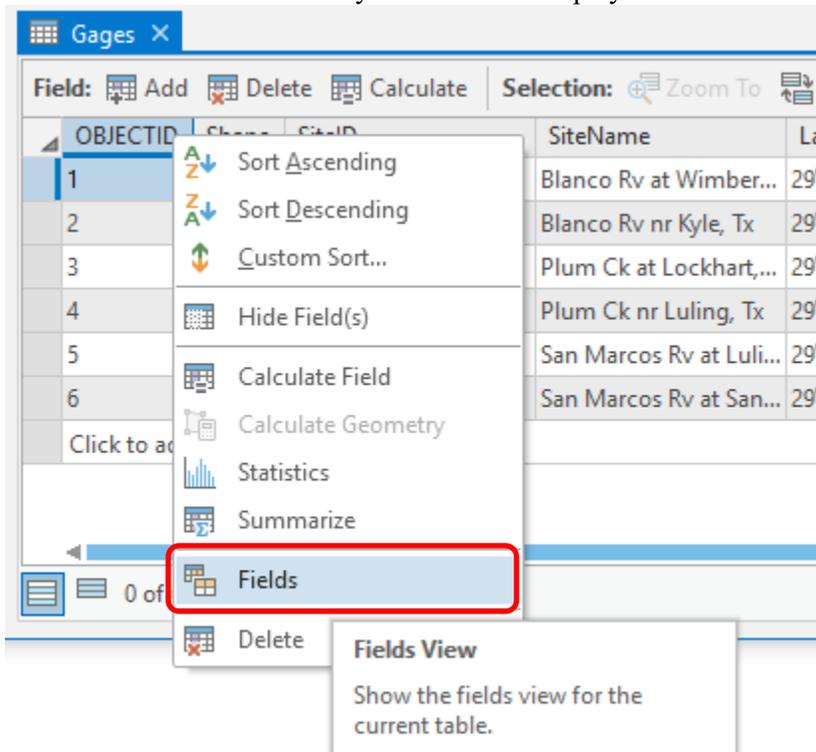

You'll see some labels show up in small lettering. To resize the labels, go to the *Labeling* tab and select 12 point font.
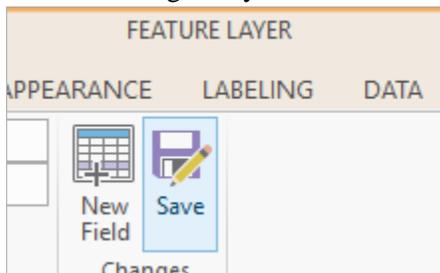
Check your layout (created previously) to make sure that all labels and text boxes show up correctly. If a text box is blocking a gage label, drag the textbox somewhere else.

Open the **Attribute Table** of the **Gages,** and right click in one of the column headers to open the **Fields** view. Turn off the fields that you don't want displayed
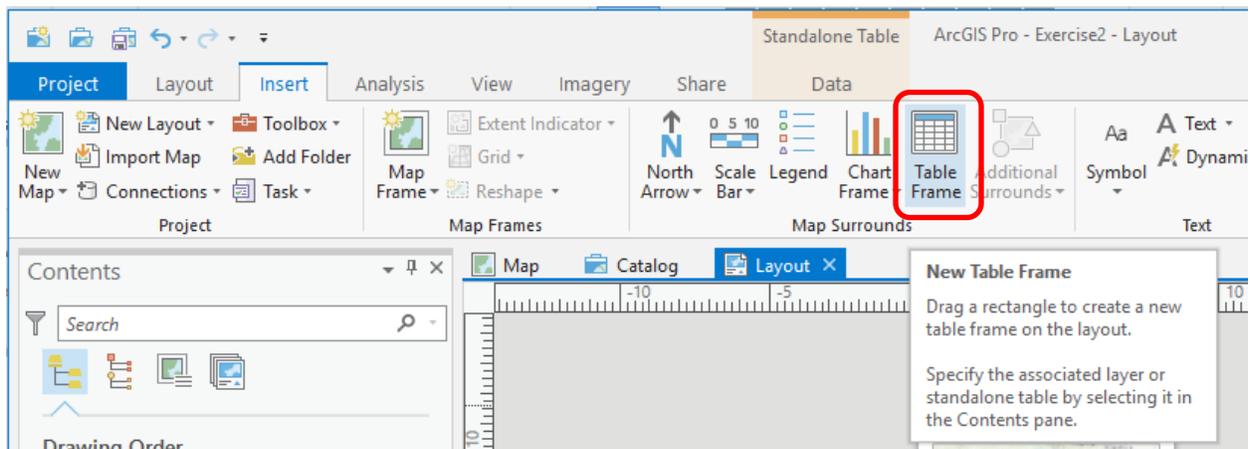
Save the changes to your table view:

To add the table to the layout, in the Contents pane, click the layer you want to use to create the table (**LatLong**), then on the **Insert** tab, in the Map Surrounds group, click **Table Frame** and drag to place your table in the layout.

Make a **Layout** similar that shown below and save your project as **Ex2_projects_gages.aprx**. Be sure to add a title, scale and north arrow to make the content of the map properly described and self explanatory.

48

Note that I had trouble positioning the text leader points. I had to use repeated trial and error moving the text and repeating add leader. Do not worry if you cannot get the text labels just right.


SiteID	SiteName	Latitude	Longitude	Latdeg	LatMin	LatSec	LongDeg	LongMin	LongSec
08171000	Blanco Rv at Wimberley, Tx	29° 59' 39"	98° 05' 19"	29	59	39	98	5	19
08171300	Blanco Rv nr Kyle, Tx	29° 58' 45"	97° 54' 35"	29	58	45	97	54	35
08172400	Plum Ck at Lockhart, Tx	29° 55' 22"	97° 40' 44"	29	55	22	97	40	44
08173000	Plum Ck nr Luling, Tx	29° 41' 58"	97° 36' 12"	29	41	58	97	36	12
08172000	San Marcos Rv at Luling, Tx	29° 39' 58"	97° 39' 02"	29	39	58	97	39	2
08170500	San Marcos Rv at San Marcos, Tx	29° 53' 20"	97° 56' 02"	29	53	20	97	56	2

To be turned in: A layout showing a map and table describing the flow gages in the San Marcos Basin

National Water Model Forecast Data for the Blanco River

Go to http://water.noaa.gov/map, accept the conditions, and zoom in to the **Blanco River near Wimberley** as you have done in ArcGIS Pro. Change the **Basemap** to **Street** so you can pick out Wimberley better. You can select the same NHDPlus reach, with Reach ID **1630223** in the National Water Model map viewer.
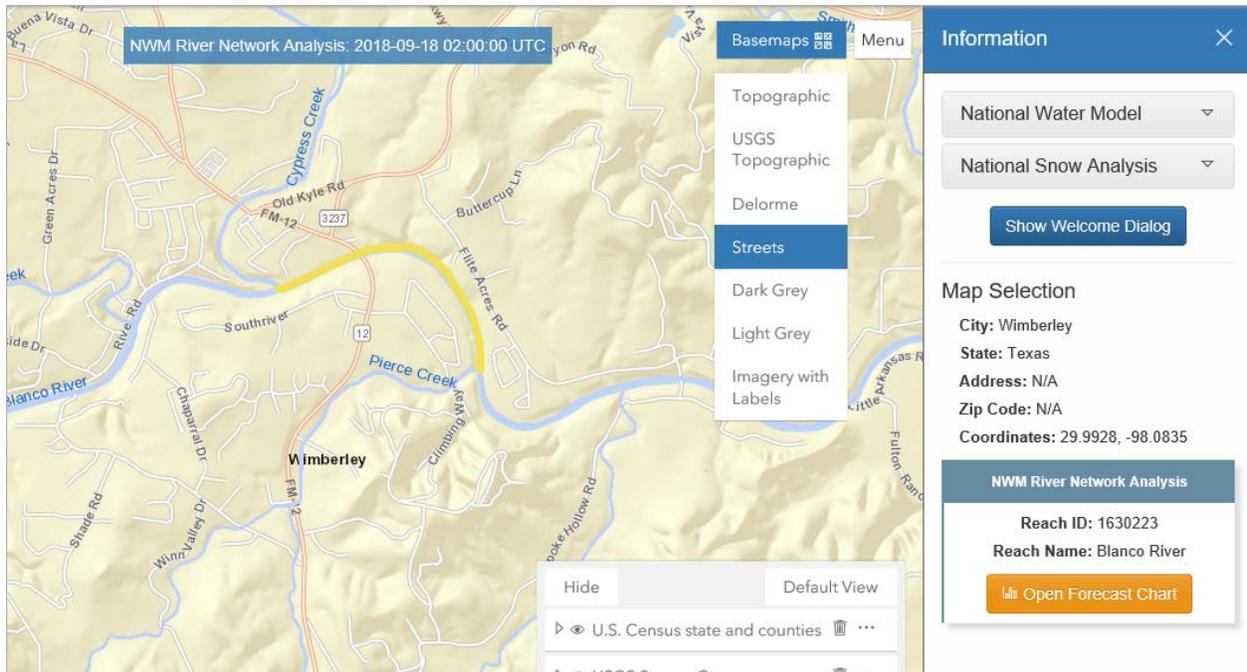
Use Open Forecast Chart to get the forecast data for the Analysis and Short Range models. Click on the **Medium Range** model and select **Rebuild** to see a further outlook 10 days ahead. Looks like we are on the downside of the runoff from recent rainfall and we expect lower flows in the near future. If the title on your chart doesn't look right, hit **QuickView** to recreate it. *[Note that I found that forecast charts did not work well in the Firefox browser, so if this does not work for you, try another browser, e.g. Chrome]*
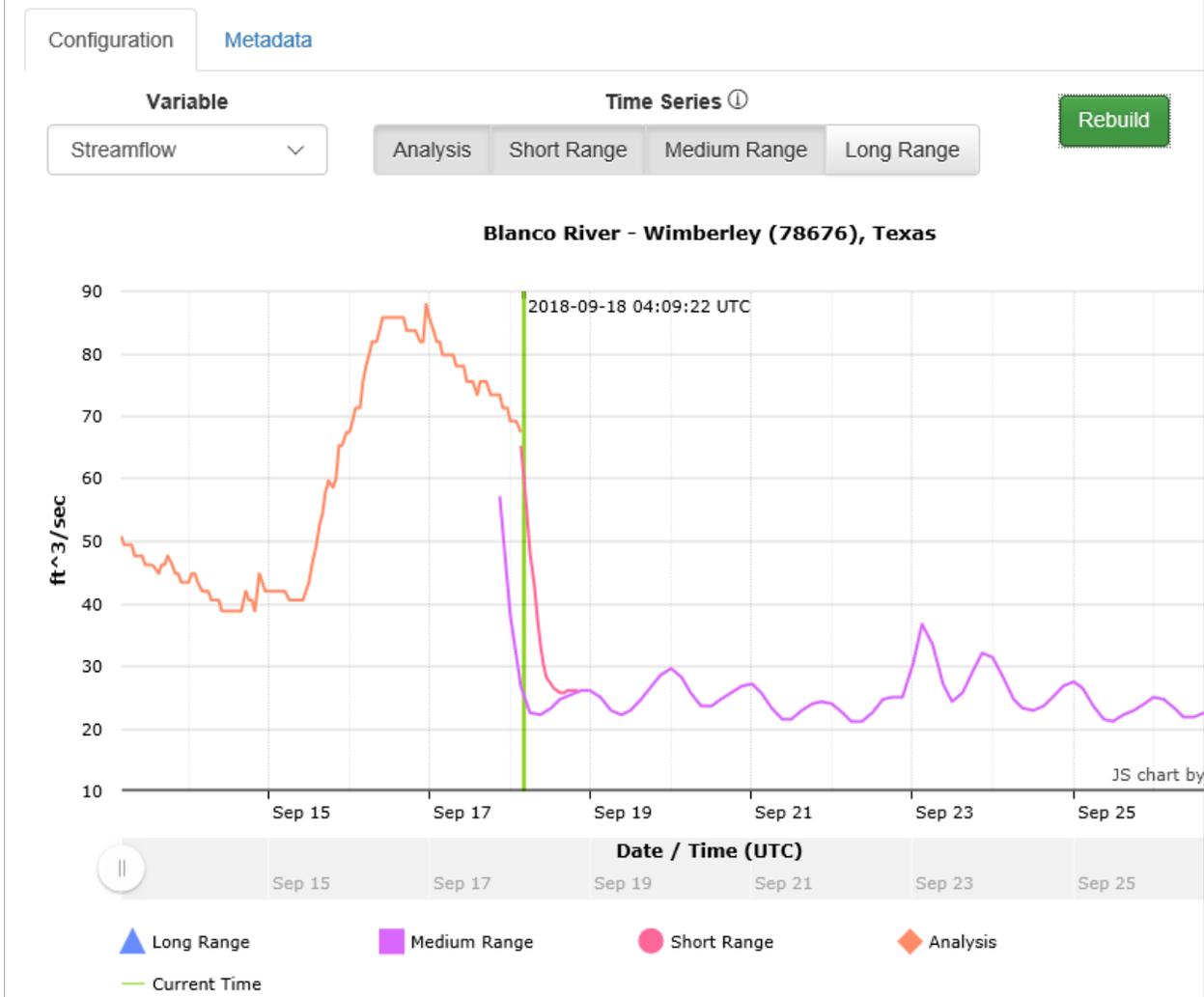
Pan the map to the south east (bottom right) and click on the most downstream stream segment in the San Marcos Basin (COMID 1632017)
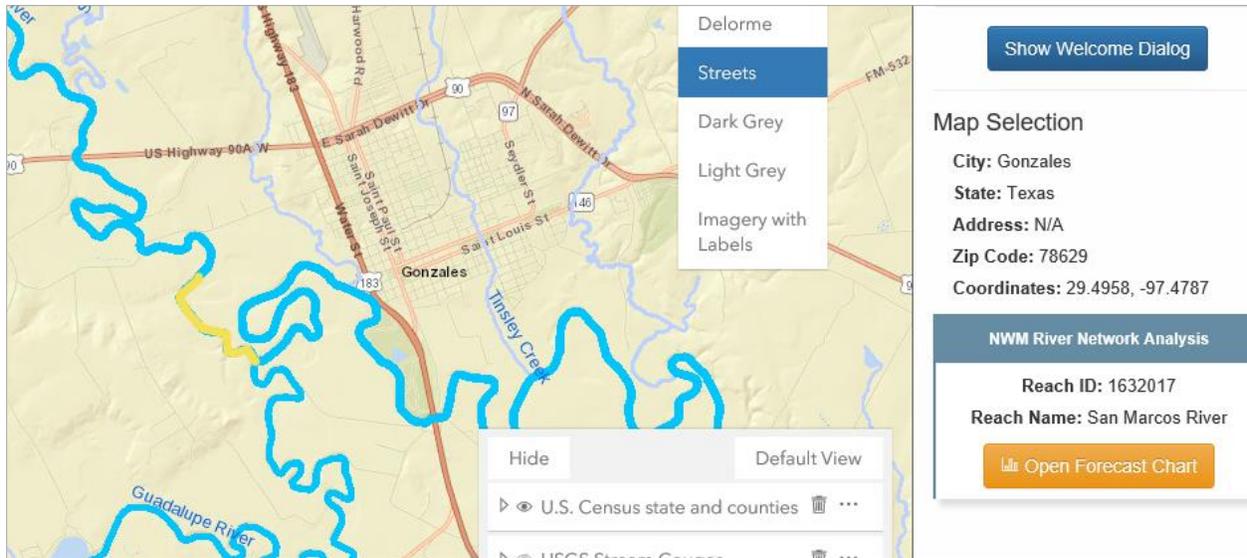
Obtain a streamflow forecast for this location also.

San Marcos River - Gonzales (78629), Texas

To be turned in: Screen captures of your National Water Model forecasts of the Blanco River at Wimberley and the San Marcos River. What is the approximate ratio of the forecast flows at the two locations? How does this compare to the ratio of their drainage areas? Use the attribute TotDASqKM on the Flowline feature class to find the drainage areas of these two flowlines.

Ok, you're done!

_____

Summary of Items to be Turned in:

1. *Make a map of the San Marcos basin with its HUC10 and HUC12 watersheds and subwatersheds. Use a layout as you learned in exercise 1. How many HUC10 and HUC12 units exist in the San Marcos Basin? Note that maps that you turn in should be clearly labeled so that they may be unambiguously interpreted with a title, scale, north arrow and appropriate legend information.*
2. *Make a map of the land cover over the San Marcos Basin. Prepare a table that shows the area (km^2) of each of the main land cover classes and the % of the total basin area that each land cover class represents.*
3. *Make a map of the San Marcos basin with its labeled rivers. How many Catchments lie within this basin? What is their average area (Sq. Km)? How many Flowlines lie within this basin? What is their average length (Km)*
4. *A layout showing a map and table describing the flow gages in the San Marcos Basin*
5. *Screen captures of your National Water Model forecasts of the Blanco River at Wimberley and the San Marcos River. What is the approximate ratio of the forecast flows at the two locations? How does this compare to the ratio of their drainage areas? Use the attribute TotDASqKM on the Flowline feature class to find the drainage areas of these two flowlines.*