

Introduction to ArcGIS Desktop

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September 2011

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Goals of the Exercise

This exercise introduces you to ArcMap and ArcCatalog. You use these applications to create a map of pan evaporation stations in Texas, and to draw a graph of monthly pan evaporation data measured at these stations. You use ArcCatalog to create a new personal geodatabase and import shapefiles to a feature dataset. The relationship between ArcGIS and MS Word and Excel is demonstrated so that you can create graphs in Excel, maps in ArcGIS and place the result in a Word file as a report for this homework. In this way, you link the spatial location of the observation sites, with the time variation of the water observations data at those sites.

Computer and Data Requirements

To carry out this exercise, you need to have a computer, which runs ArcGIS.

















You will be working with the following spatial datasets during this exercise:

1. A polygon shapefile of the counties of Texas, called **Counties**
2. A point shapefile of pan evaporation stations, called **Evap**
3. A polygon shapefile of the state of Texas, called **Texas**

These shapefiles consist of several files (e.g. **evap.dbf**, **evap.shp**, **evap.shx**). You can get them from this zip file: <http://www.ce.utexas.edu/prof/maidment/giswr2011/Ex1/Ex12011Data.zip>

You need to establish a working folder to do the exercise on. This can be in c:\temp, your student directory, or on a memory stick attached to the machine you are working on. To establish a new account at the CE Information Technology Support and Services, go to <http://www.caee.utexas.edu/itss/> and select **LRC User Accounts**. If you don't yet have a regular Login account at the LRC, get a temporary guest login to do the exercise.

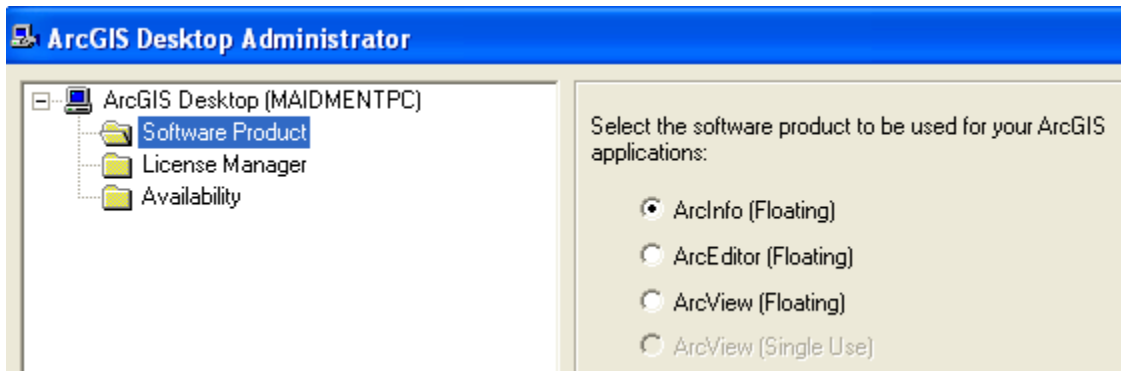
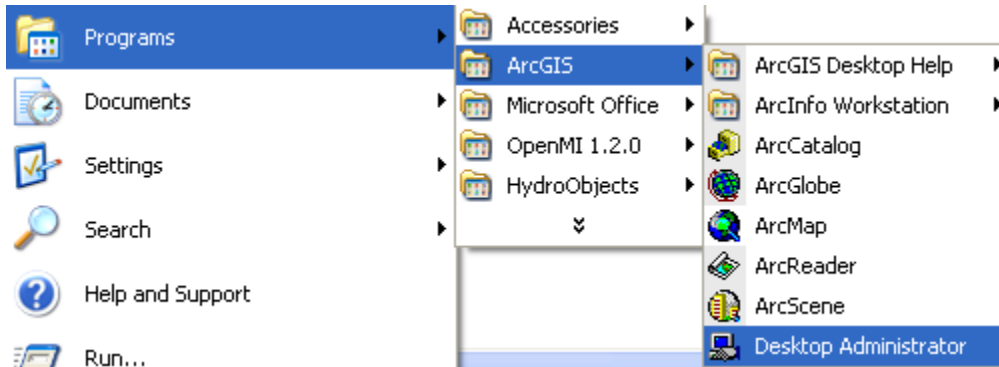
After you have downloaded the zip file **Ex12011.zip** double click on the file and you should see the Winzip, Alladin Stuffit utility, or other zip utility to open the file on your computer (if it doesn't open you'll have to unzip this file on a computer that has a zip utility installed). Extract all files from the zip file to the working folder that you've set up to do this exercise. You should end up with a file list that looks something like this. You may see these data within a sequence of folder names, and if so, click on each folder down through the sequence until you locate the required files.

 counties.dbf	8/31/2011 10:32 PM	DBF File	13 KB
 counties.prj	8/31/2011 10:32 PM	PRJ File	1 KB
 counties.shp	8/31/2011 10:32 PM	SHP File	947 KB
 counties.shp	8/31/2011 10:32 PM	XML Document	9 KB
 counties.shx	8/31/2011 10:32 PM	SHX File	3 KB
 evap.dbf	8/31/2011 10:32 PM	DBF File	26 KB
 evap.prj	8/31/2011 10:32 PM	PRJ File	1 KB
 evap.shp	8/31/2011 10:32 PM	SHP File	2 KB
 evap.shp	8/31/2011 10:32 PM	XML Document	1 KB
 evap.shx	8/31/2011 10:32 PM	SHX File	1 KB
 Texas.dbf	8/31/2011 10:32 PM	DBF File	1 KB
 Texas.prj	8/31/2011 10:32 PM	PRJ File	1 KB
 Texas.sbn	8/31/2011 10:32 PM	SBN File	1 KB
 Texas.sbx	8/31/2011 10:32 PM	SBX File	1 KB
 Texas.shp	8/31/2011 10:32 PM	SHP File	162 KB
 Texas.shx	8/31/2011 10:32 PM	SHX File	1 KB

ArcGIS License Server

This exercise can be executed with any of the license levels within ArcGIS, namely ArcInfo, ArcEditor or ArcView. Each of these license levels provides access to ArcMap and ArcCatalog, which are the ArcGIS interfaces used to do the work. When you invoke ArcMap or ArcCatalog, it is possible that you will get a message saying that all the licenses for ArcInfo are in use on the network, or that you aren't licensed for this application. In that event, you need to switch to another license level of the software with available licenses. To do this, from Windows use **Start/Programs/ArcGIS** to invoke the ArcGIS Desktop Administrator, and select another version. In the LRC, ArcView [Single Use] works best, but

in another lab setting, the ArcView [floating] or ArcEditor [floating] could be the right choice, depending on license availability.



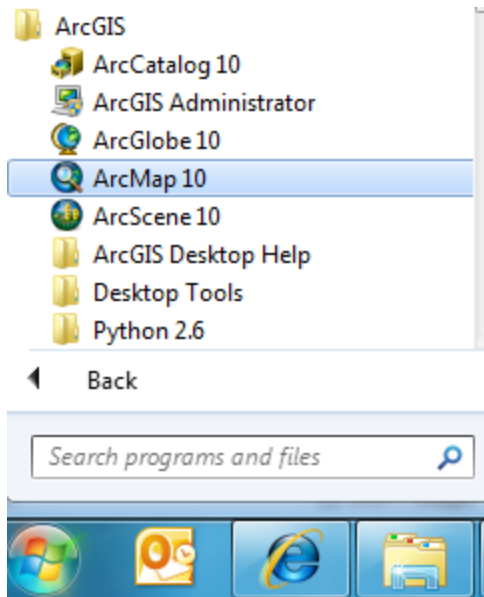
Procedure

Please note that the following procedure is a general outline, which can be followed to complete this lesson. However, you are encouraged to experiment with the program and to be creative.

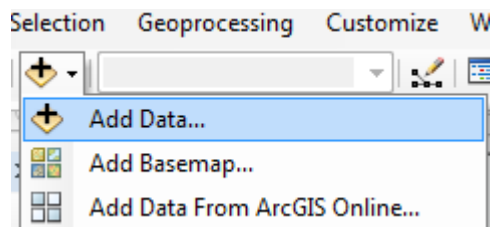
1. Viewing Shapefiles in ArcMap

A *shapefile* is a homogenous collection of simple features that do not contain topological information. A shapefile includes geometric features and their attributes. The attributes are contained in a dBase table, which allows for the joining with a feature based on the attribute key.

Open **ArcMap** and select the **A new empty map** option.



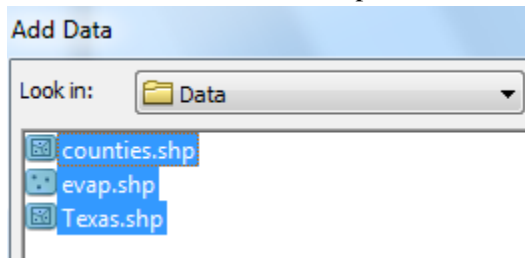
Use the Add Data button to add the data for this exercise to the ArcMap display.



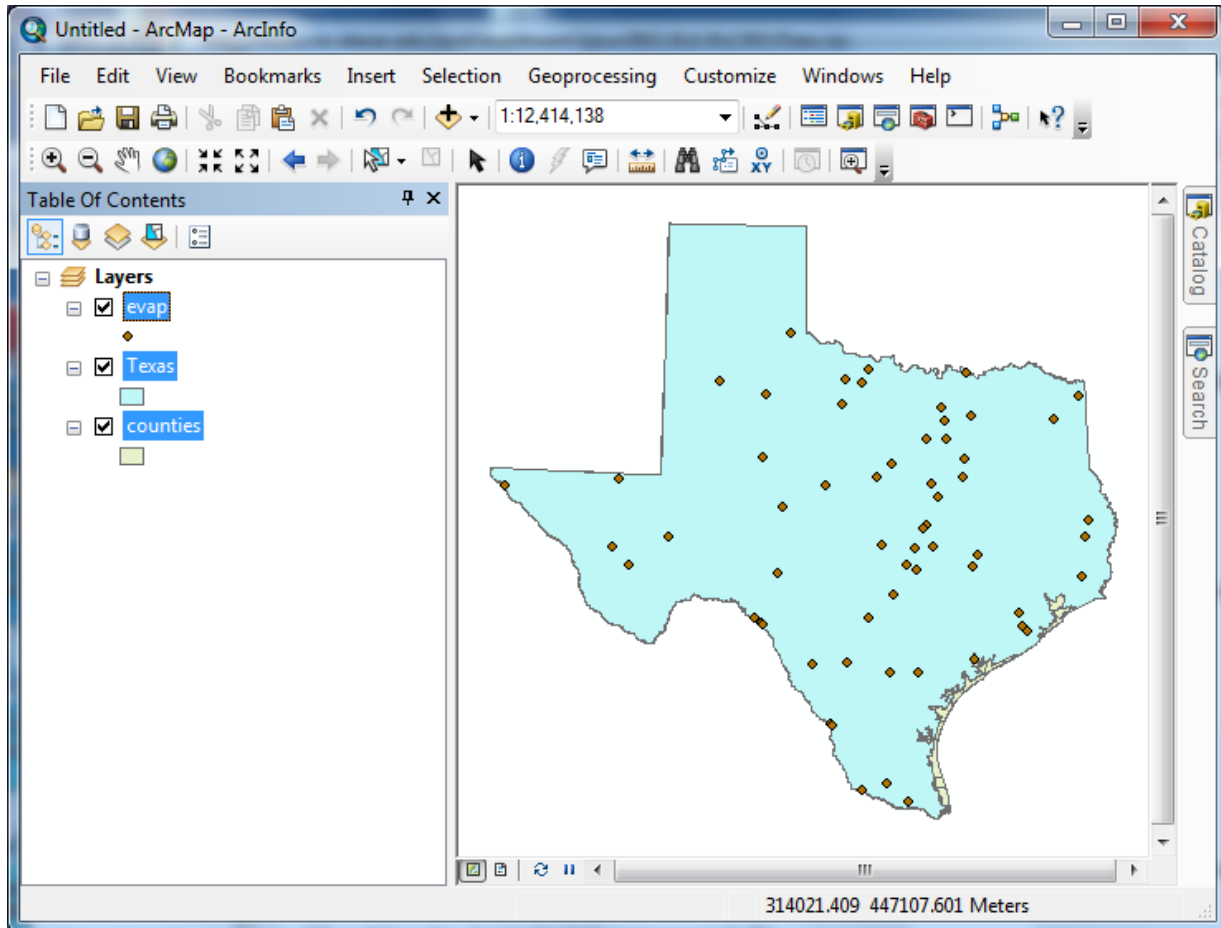
Navigate to the folder, which contains the data, and select all three files at once by using the shift key. Click the Add button to import the data. If you are using a network drive to obtain your files use the “Connect to folder” button to add the network drive to the ones that ArcMap is accessing so you can get to the files.



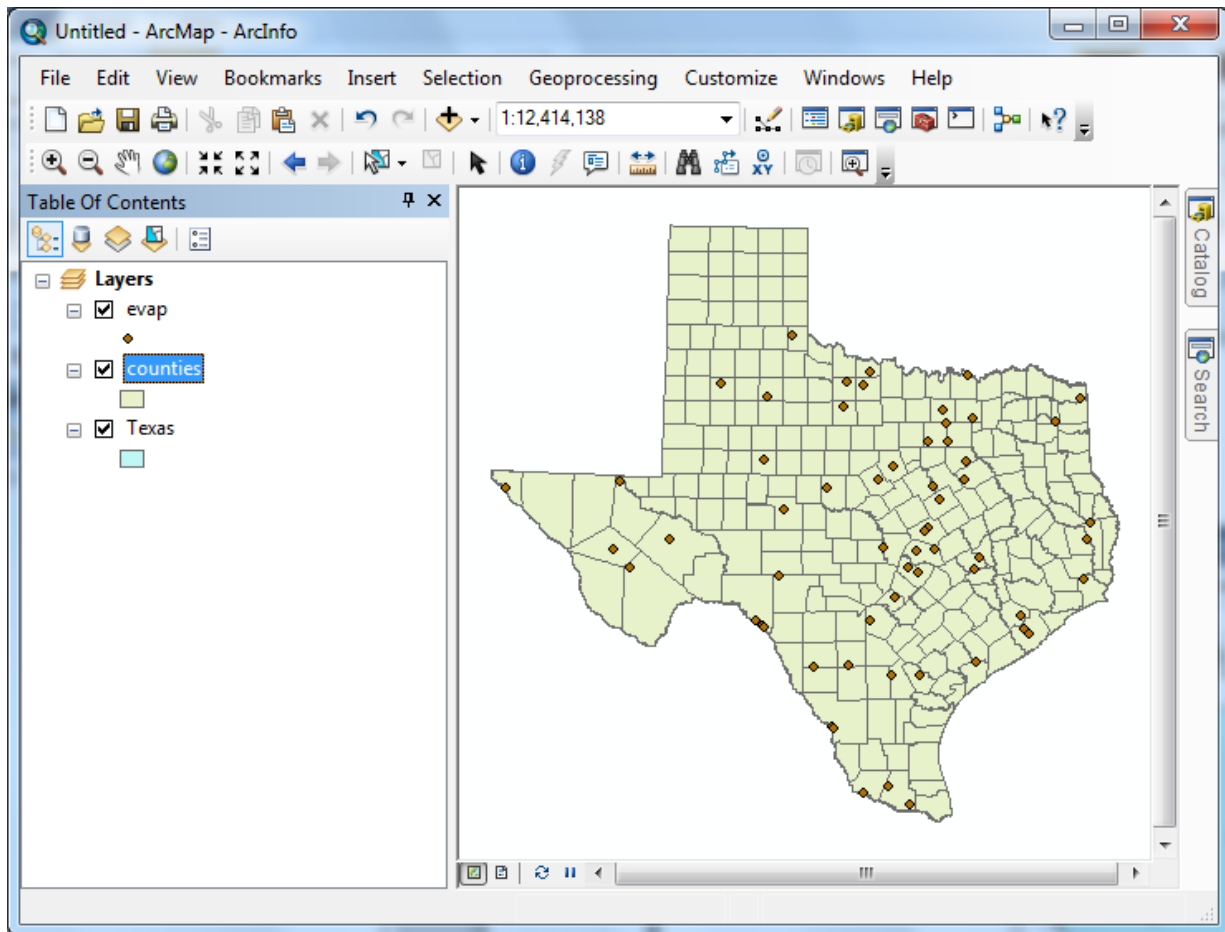
Click on each of the three shape files so that they are highlighted



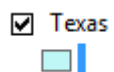
and add them to your ArcMap display.



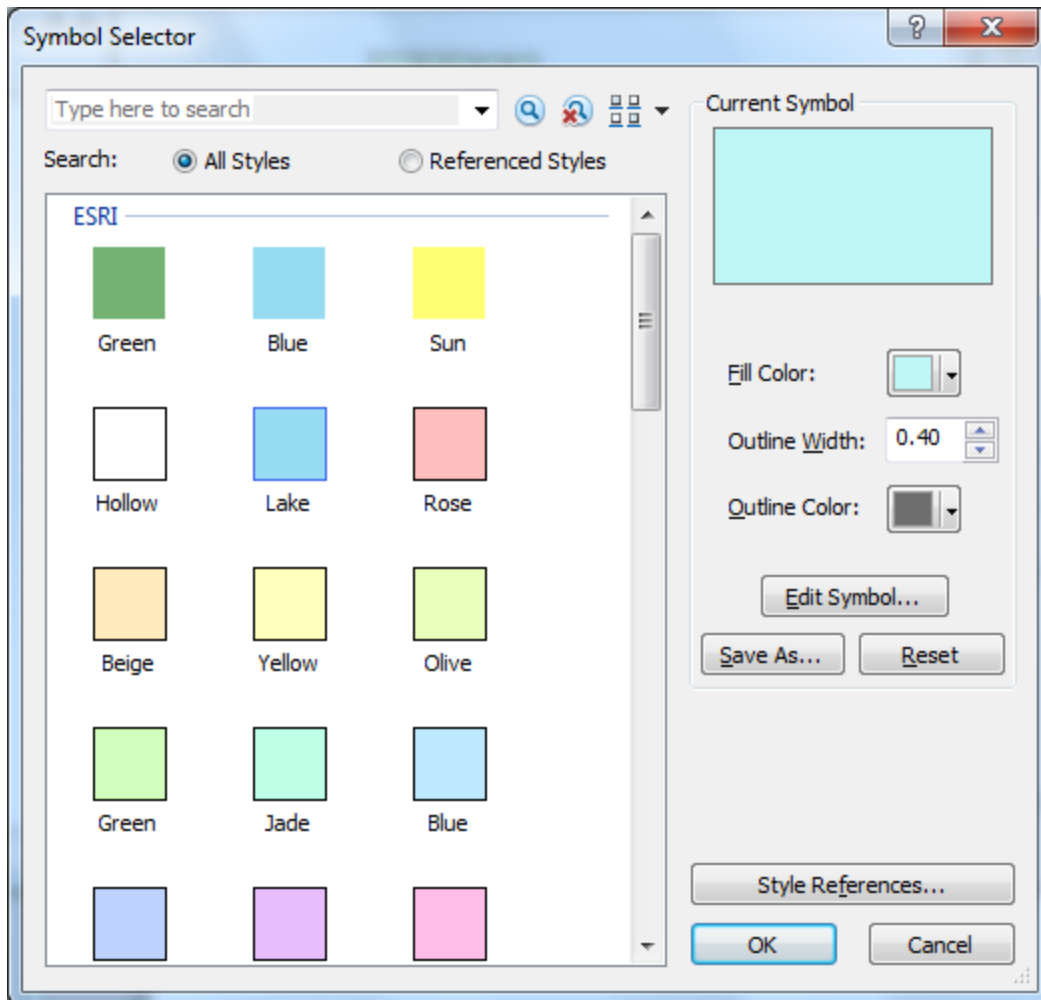
All the themes are highlighted and Texas lies above counties so you cannot see the counties theme. Click in the Table of Contents area below the feature class names so that three themes are no longer highlighted, then click on the counties theme and drag it up so that it is located above the Texas theme. You'll then get a display showing the counties.



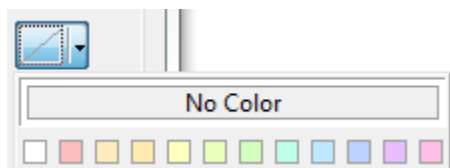
To change the appearance of a map display, you can access the **Symbology** menu just by double clicking on the Symbol



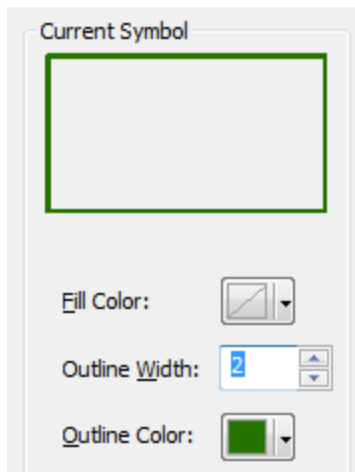
displayed in the ArcMap Layers, and you'll get the **Symbol Selector** window



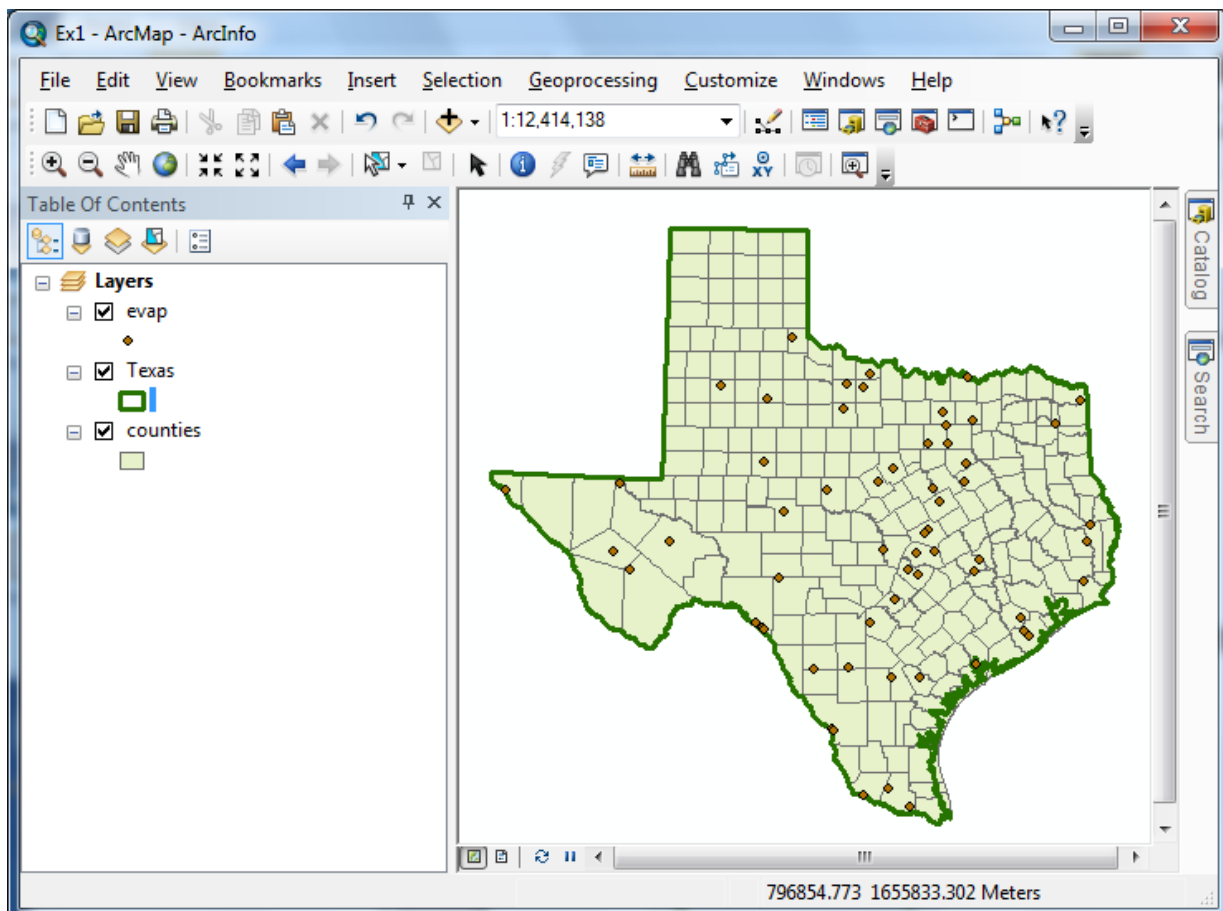
Click on the symbol color box, make your selections for the **Fill Color** and the **Outline Color**, and click OK, twice. You can show the outline of the State of Texas more distinctly by using the **No Color**



symbolology for the Fill Color and then changing the Outline Color to Green and the **Outline Width** to 2.

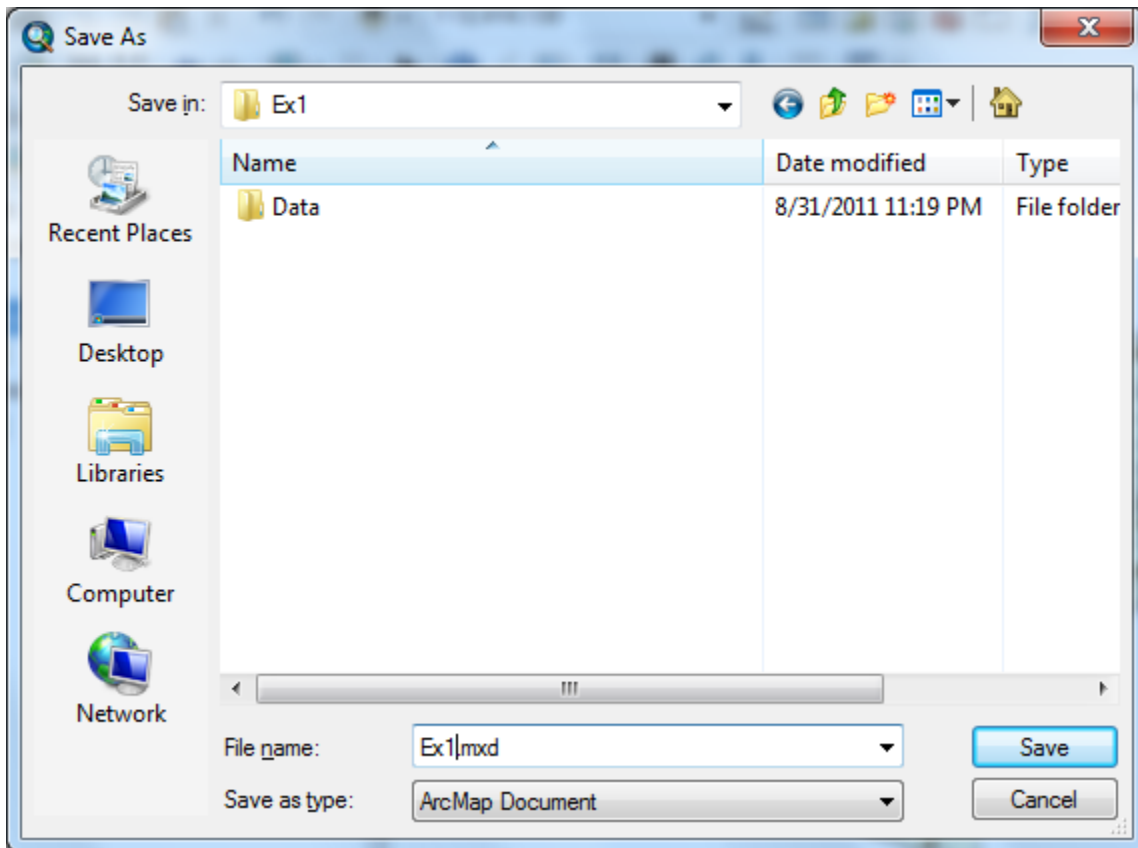


Drag the Texas layer above the Counties layer, and you'll see that the Counties are not obscured as they were before and the State of Texas is highlighted with a nice Green outline! We are green in Texas!



To Save this map display, use **File/Save As** in ArcMap and save the resulting file as **Ex1.mxd**.

Save your work in ArcMap by choosing **File/Save** and, after navigating to your working directory, naming the file **Ex1** (the file will be assigned the extension **mx**d). When you do this, the **Ex1.mxd** file contains the file location of the geodatabase and the symbology you've chosen for the map display. You can shut down Arc Map and then invoke Arc Map again and reload the same map display by clicking on **Ex1.mxd**. Note, however, that if in the mean time you've relocated your data, ArcMap will go back to where you had it at the time the map file was saved.

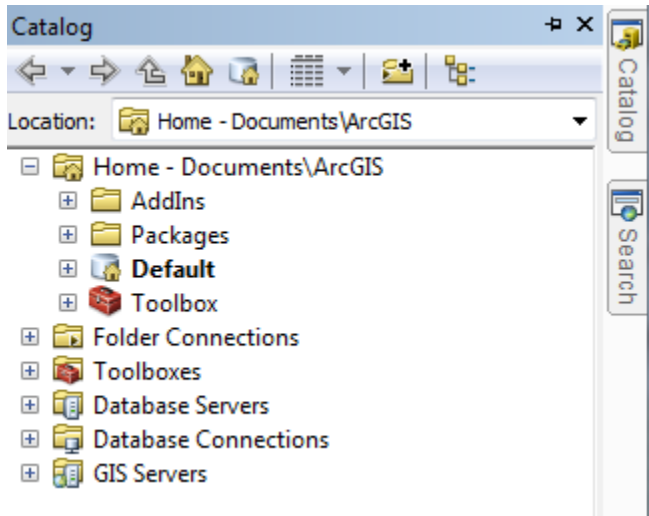


Helpful Tip:

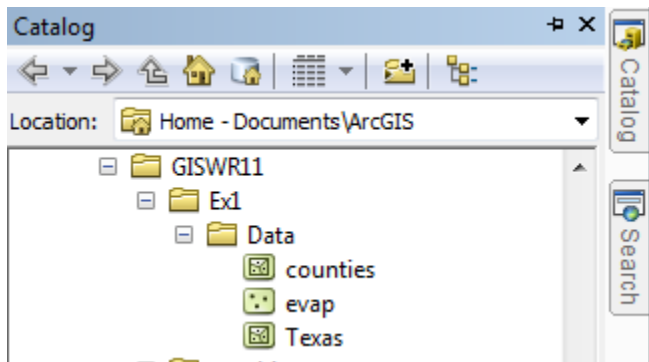
If you open your ArcMap **Ex1.mxd** file later from another location in your file system, you may see a red exclamation points beside your feature classes. If this happens, in ArcMap, right click on the feature class use **Data/RepairData Sources** to relocate the file location where the corresponding data are now stored and your map will display correctly again.

2. Viewing Shapefiles in ArcCatalog

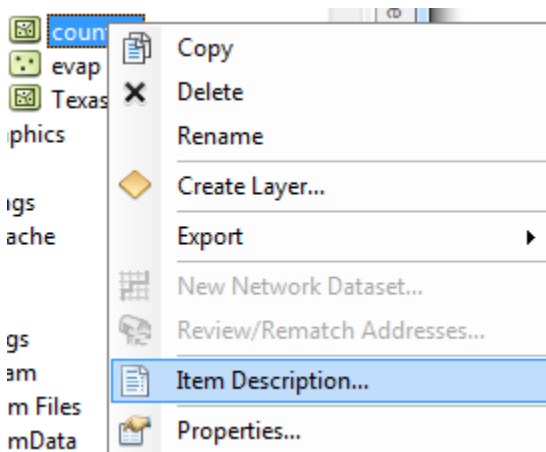
Open **ArcCatalog** by clicking on the Catalog tab on the right hand side of the map display



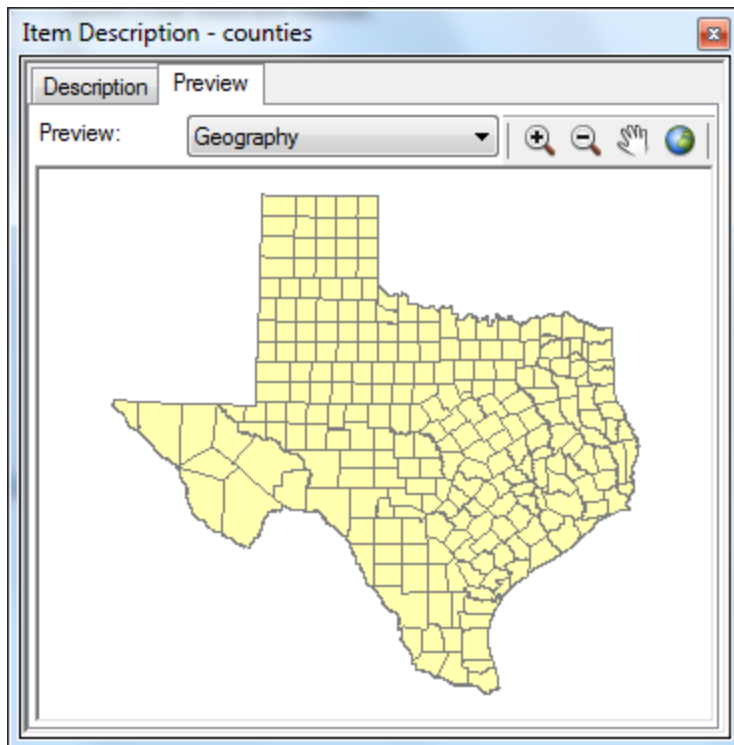
Click on the “Folder Connections” button and navigate to where your data are stored.



If you right click on a data layer, you can obtain an Item Description



Select the **Preview** tab and then **Geography** to see a map of the feature class



And then select the **Table** view

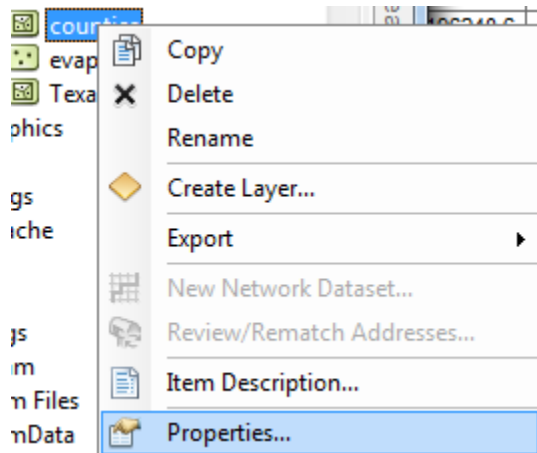
The screenshot shows the same window with the "Preview" dropdown set to "Table". The table displays the following data:

FID	Shape	AREA	PERIMETER	COUNTY_
0	Polygon	3.902182E+09	257113.3	2
1	Polygon	2.39924E+09	195825.4	3
2	Polygon	2.388509E+09	195421.4	4
3	Polygon	2.381337E+09	194963.5	5
4	Polygon	2.415397E+09	196597.4	6
5	Polygon	3.809098E+09	254867.7	7
6	Polygon	2.374503E+09	193469.3	8
7	Polygon	2.325443E+09	192910.9	9
8	Polygon	2.386247E+09	195551.8	10
9	Polygon	2.382076E+09	195185.8	11
10	Polygon	3.882737E+09	257160.5	12
11	Polygon	2.401505E+09	197577.8	13
12	Polygon	2.39338E+09	195627.9	14
13	Polygon	2.414045E+09	196310.0	15

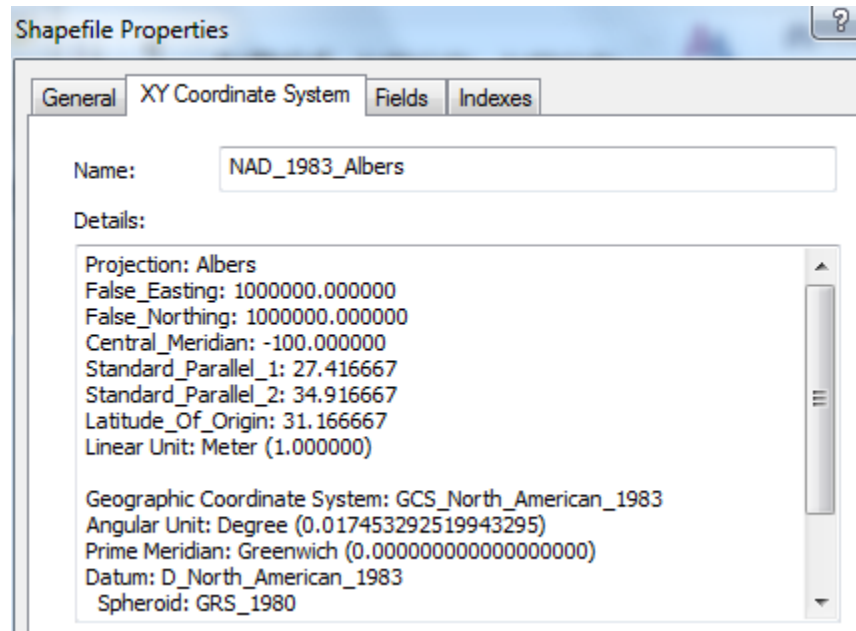
The table has a scrollbar on the right side. At the bottom, there are navigation controls including a list icon, a page number "1", and a total count "(of 264)".

The attributes FID, Shape, Area and Perimeter are standard attributes for ArcGIS feature classes. The units of the area and perimeter are defined from the map units of the feature class.

If you right click on a feature class and then select **Properties**

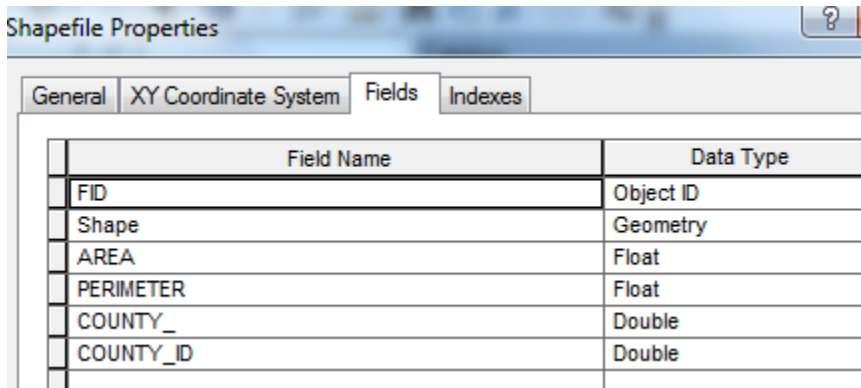


And select **XY Coordinate System** which shows you the parameters of the coordinate system of these data. This provides a rather complicated set of parameters that we'll learn more about later. For the moment, just note that the **Linear Unit: Meter** means that the map units for this feature class are in meters and thus that the area and perimeter values discussed earlier are in square meters and meters, respectively.



If you click on the **Fields** tab, you'll see a formal definition of each attribute field with its **Field Name** and **Data Type**. In this case, **ObjectID** means a special data type that indexes each feature as an object in the GIS, **Geometry** means that the Shape field has geographical coordinates stored in it, and **Float**

and **Double** mean decimal numbers in single or double precision, respectively. There are some other data types such as Short and Long integers, Text and Date types, that we'll encounter later in the course.

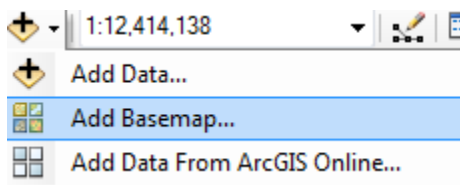


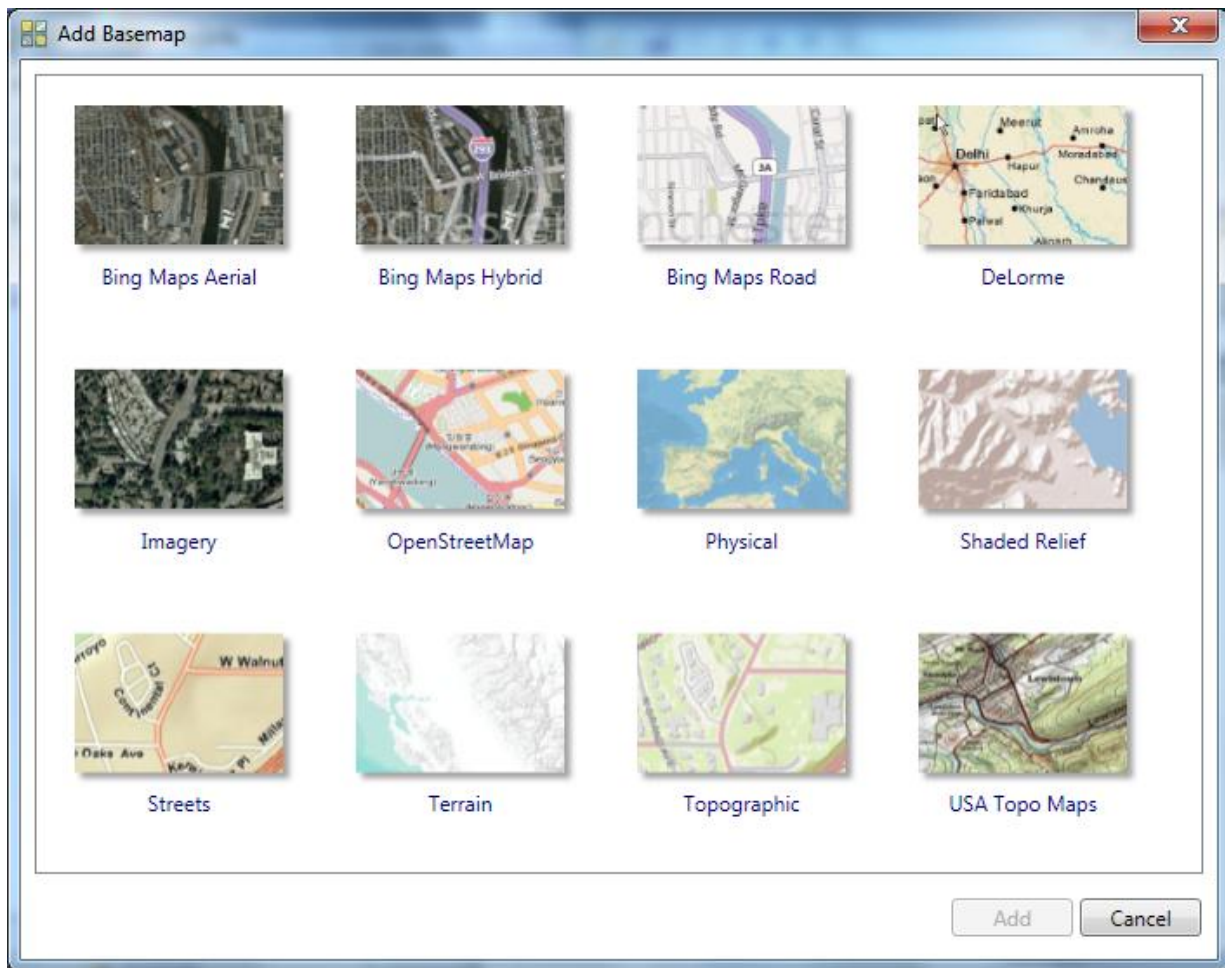
Field Name	Data Type
FID	Object ID
Shape	Geometry
AREA	Float
PERIMETER	Float
COUNTY_	Double
COUNTY_ID	Double

Click on the other two data layers, **Evap** and **Texas** to preview them also.

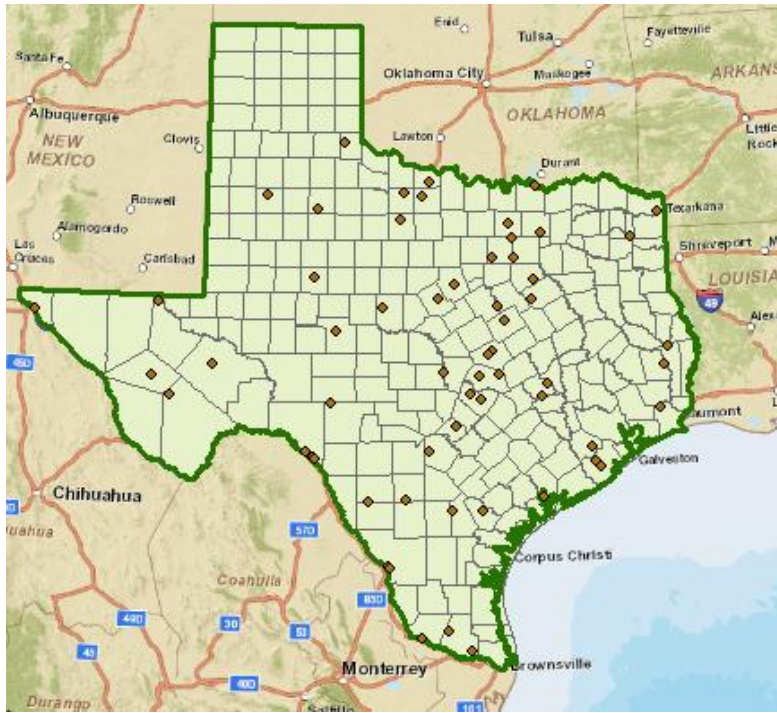
3. Using Base Maps from ArcGIS Online

Up to this point we have just used local GIS data in our display. Let's instead use base maps from the ArcGIS Online. Use **Add Basemap**:

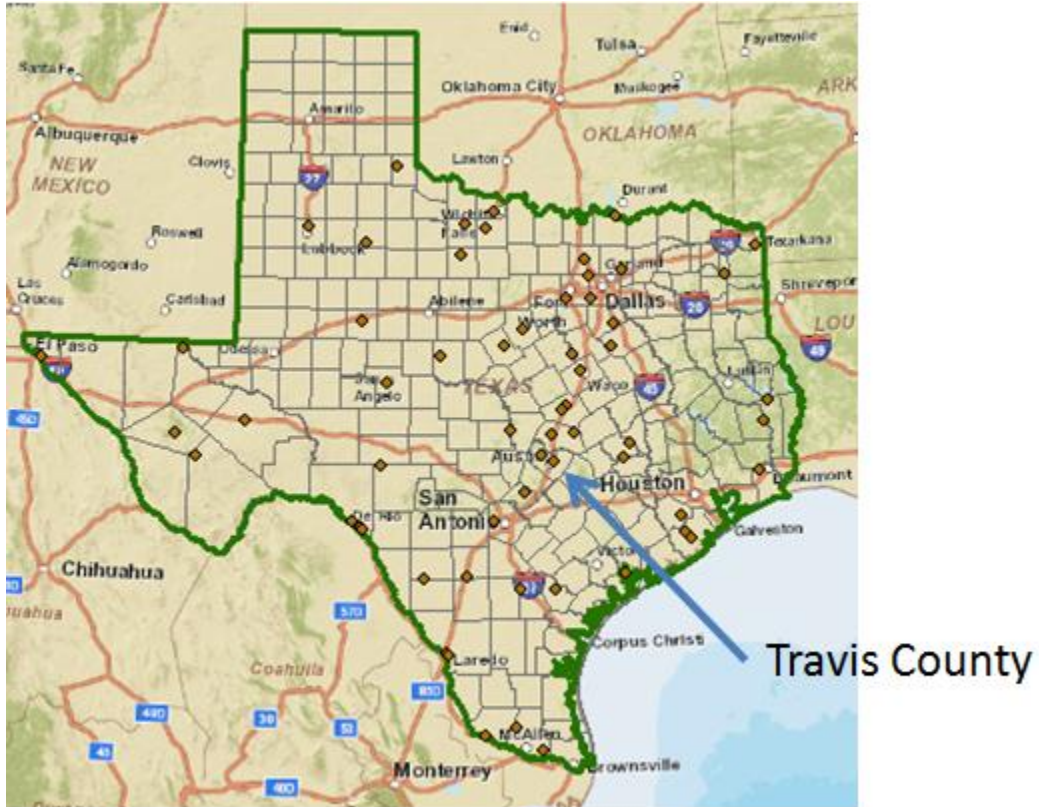




Click on “**Streets**”, in the bottom row of maps. You’ll see a background map appear behind your Texas display. Pretty cool!



Click on the Counties theme and use the Symbol Selector to change the Fill Color to “No Color” so we can see through it to the background map, and the new display appears. Let’s examine Travis County.



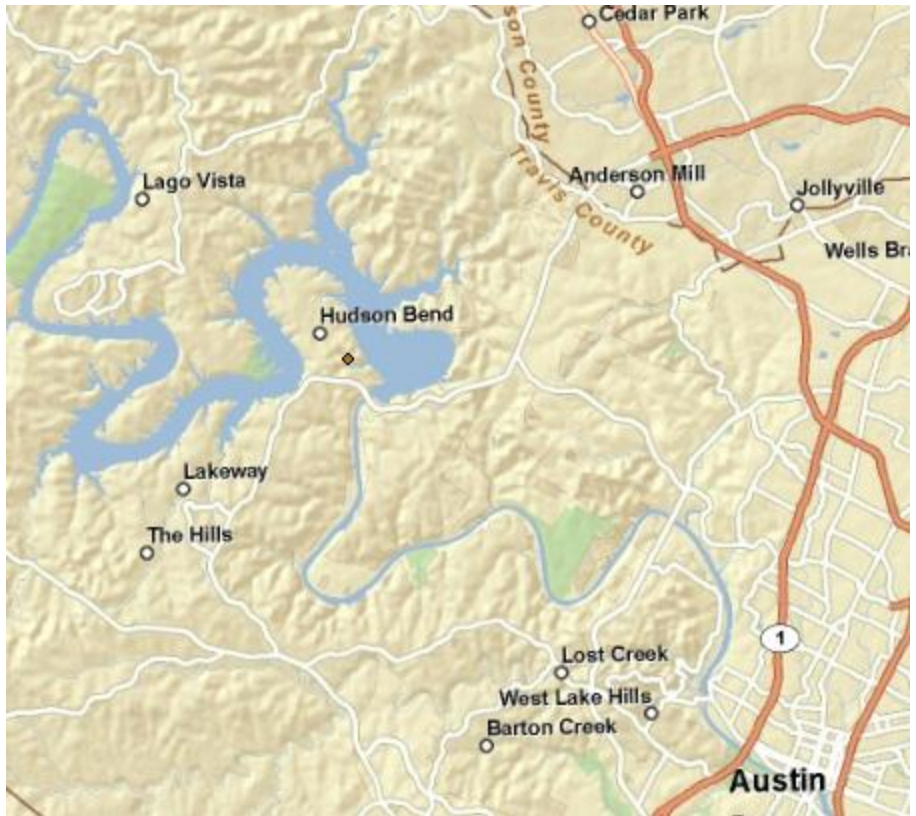
Use the Zoom in button to select a box around Travis County



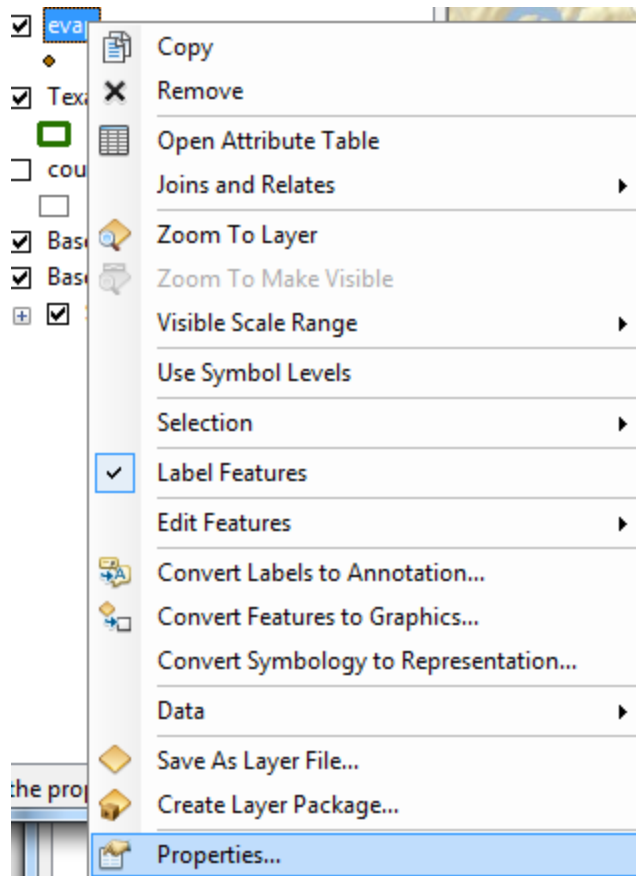
Click the counties layer to turn off the county boundaries since the background map already shows the county boundaries



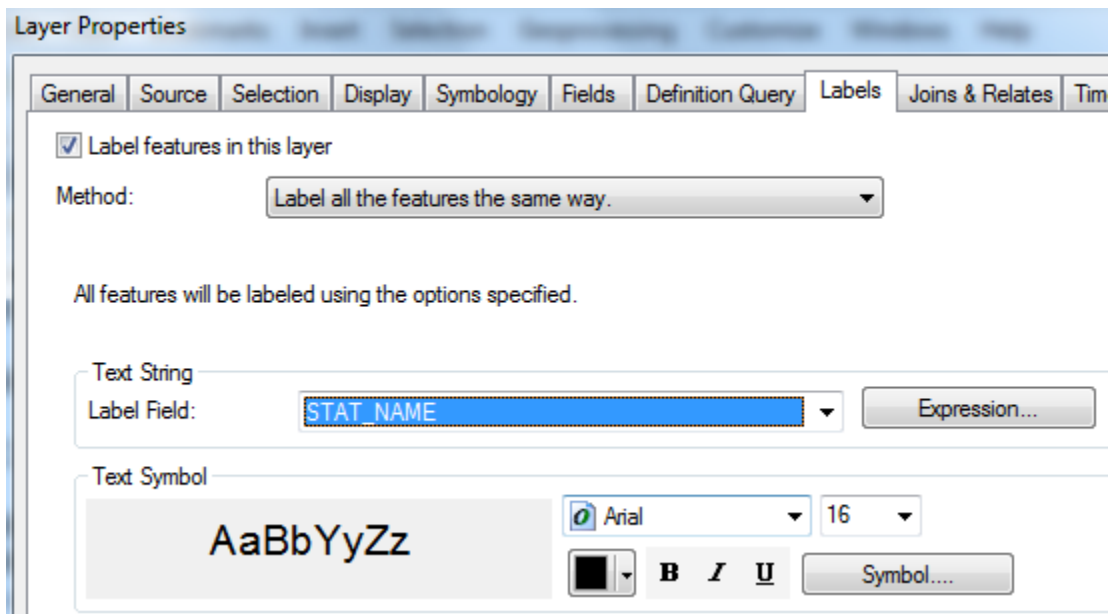
Zoom in to Travis County by Austin in the center of Texas, and let's examine the evaporation site by Lake Travis to the Northwest of the city. Notice how more interesting information appears as you zoom in closer.



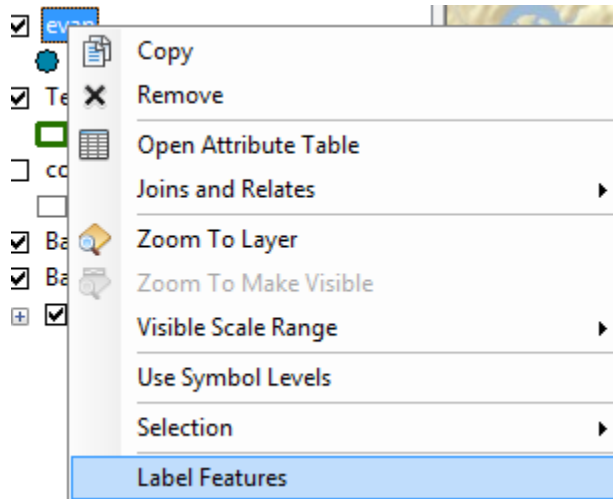
Lets label the sites with their names. Right click on the **Evap** theme and select **Properties** at the bottom of the display that appears.



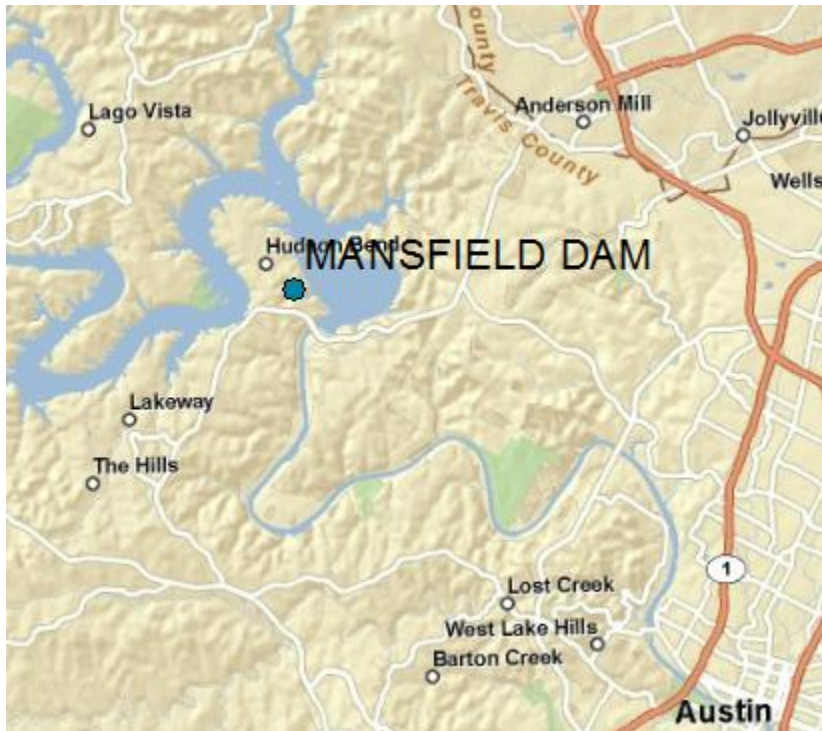
Labels tab and for the **Label Field**, select **STAT_NAME**, and **16** point as the type size. Hit **Apply** and then **Ok**, to close this window.



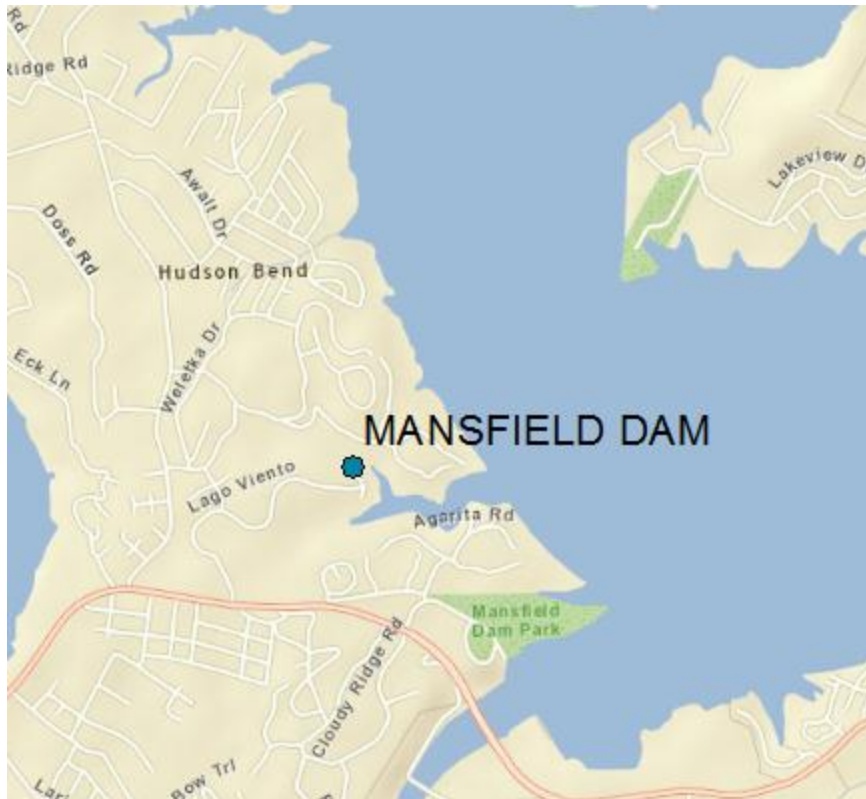
Now, right click on the Evap theme again and select **Label Features**, and you'll see a nice label **Mansfield Dam** appear by the site next to Lake Travis.



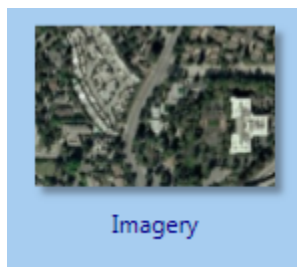
Click on the symbol for the Evap points and use the Symbol Selector to change the size of the points to 8 and the color to Blue. Now we've got a nice map that shows the location of our observation site labeled with its name.



If you zoom in a bit closer, you can see just where the site is located near Lake Travis. Mansfield Dam is the dam that is at the downstream end of Lake Travis. You can even see the access roads you'd use to go to this site.



Now, let's look at some imagery for this location. Proceeding as you did before to get the Street map, use **Add BaseMap**, to add data for **Imagery**



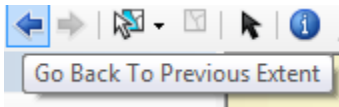
And now you'll see the same information displayed against a background map of orthoimagery, and let's zoom in a bit to see more detail. For the **Evap** theme, I have used the **Properties/Label** to change the color of my site labels from black to blue to make them easier to see against the image background. This is really cool stuff! You can really get a sense of context about where this observation site is located.



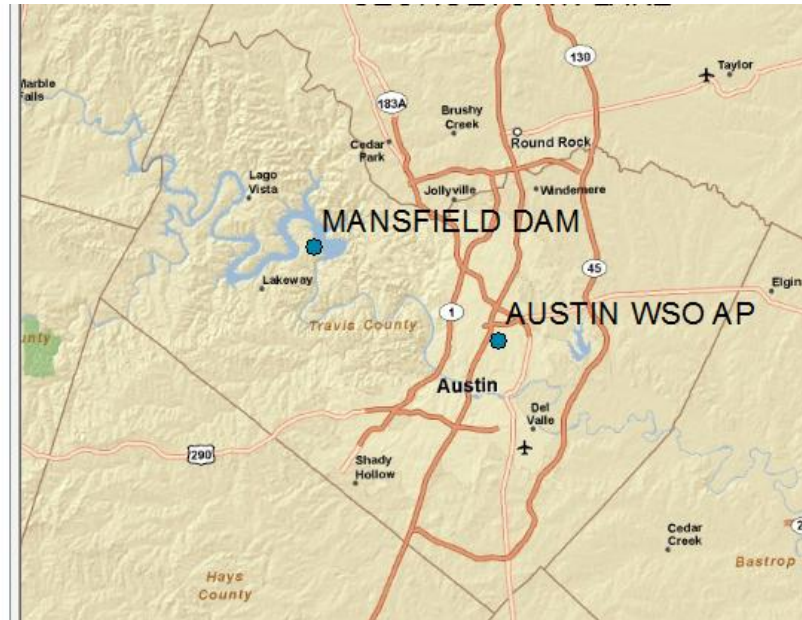
Use **File/Save As** to save this new map display as **Ex1.mxd** so that you can get it back later if you need it.

4. Accessing and Querying Attribute Data

Lets go back to the view we had earlier of Travis County. Use the Go Back to Previous Extent arrow to step back through the views we have just been working on, and turn off the Image basemap so that you can see the Streets basemap again. Change the Label color for the evap sites back to Black.

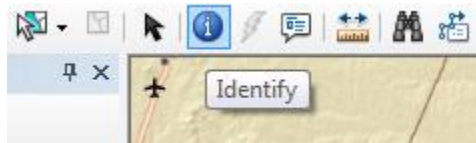


- evap**
- Texas
- counties
- Basemap
 - Boundaries and Places
 - Transportation
 - Imagery
 - Basemap
 - Basemap
 - Streets



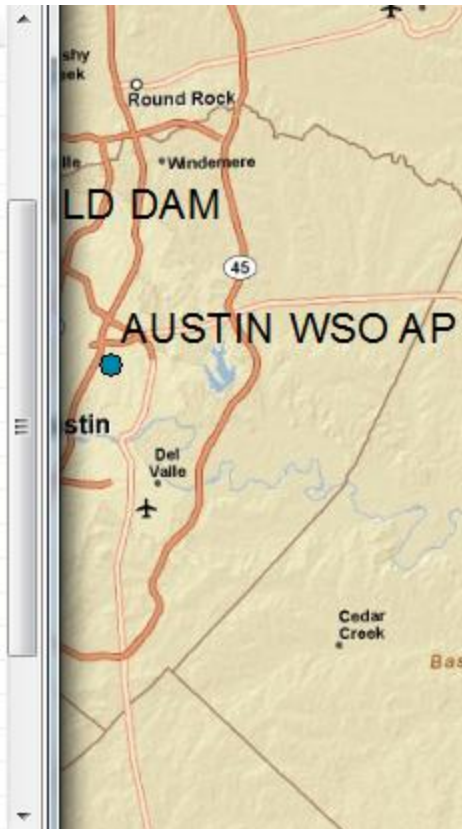
Numerical and text information stored in the fields of the geodatabase tables are called **attributes**. To access attribute data of the feature classes at a specific location:

Click on the **Identify** tool



Highlight the feature class you are interested in the Table of Contents (Evap), and then click on the feature on the map you are interested in. In the **Identify** window that pops up you'll see the attributes of that particular feature. In this instance, what you see is that the data for Austin WSO AP (Weather Service Office at the Airport), cover the range from January 1979 to May 1992, the elevation of the station (Datum) is 600 feet above geodetic datum, the latitude and longitude are 30.3 and 97.7 (these are not very accurate values and should be more precise now with GPS), and the values from JAN_VAL through DEC_VAL are the mean monthly evaporation recorded at this location, in inches, whose annual total is an ANN_VAL of 72.51 inches.

Field	Value
STAT_NAME	AUSTIN WSO AP
STAT_CTY	TRAVIS
DATUM	600
BEG_MTH	1
BEG_YEAR	1979
END_MTH	5
END_YEAR	1992
LATITUDE	30.3
LONGITUDE	97.7
DATA_YEAR	1979
JAN_VAL	3.01
FEB_VAL	3.66
MAR_VAL	5.45
APR_VAL	6.61
MAY_VAL	7.27
JUN_VAL	8.21
JUL_VAL	9.46
AUG_VAL	9.37
SEP_VAL	7.2
OCT_VAL	5.81
NOV_VAL	3.83
DEC_VAL	2.63
ANN_VAL	72.51

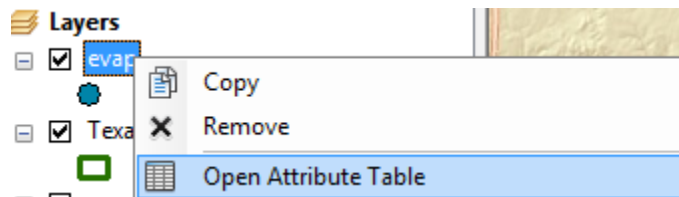


These are pan evaporation data recorded using an instrument like that shown below.

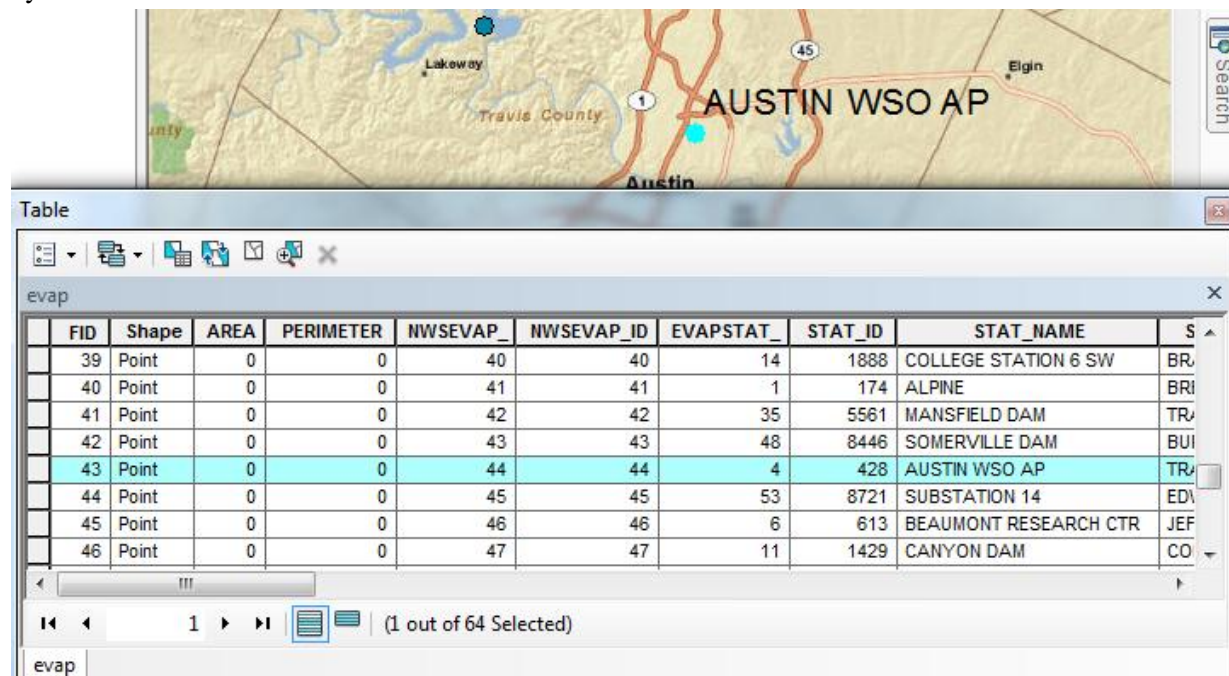


Viewing an Attribute Table

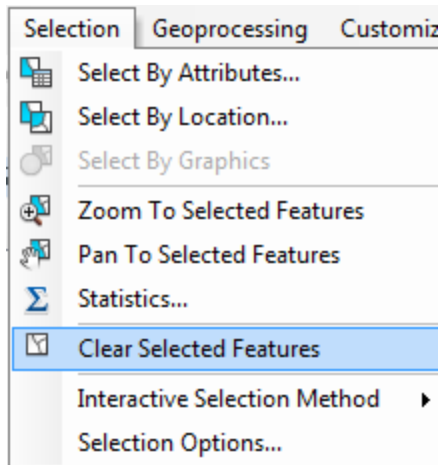
To access attribute data of an entire layer, in **ArcMap**: right click on the **Evap** layer name in the table of contents, and select **Open Attribute Table**:



And if you scroll down the resulting **Table** and click on **FID 43** you'll see the record that contains the attributes of the Austin Airport station that you identified earlier. Click on this to select it, and you'll see the corresponding point selected in the map – this is a key idea of GIS – map features are described by records in attribute tables.



To Clear a Selected feature and select a new one, use: **Selection/Clear Selected Features** in the ArcMap toolbar:



5. Selecting features from a feature class

Selecting features from a feature class involves choosing a subset of all the features in the class for a specific purpose. Feature selection can be made from a map by identifying the geometric shape or from an attribute table by identifying the record. Regardless of how you select an object, both the shape in the map and the record in the attribute table will be selected. Make sure that the Evap theme is highlighted in the Table of Contents and then Click on the **Select Features by Rectangle** tool



If you drag a box over the two evaporation sites in Travis County, you'll see both records highlighted on the map and in the attribute table.

Table

FID	Shape	AREA	PERIMETER	NWSEVAP_	NWSEVAP_ID	EVAPSTAT_	STAT_ID	STAT_NAME	S
39	Point	0	0	40	40	14	1888	COLLEGE STATION 6 SW	BR
40	Point	0	0	41	41	1	174	ALPINE	BRI
41	Point	0	0	42	42	35	5561	MANSFIELD DAM	TR
42	Point	0	0	43	43	48	8446	SOMERVILLE DAM	BUI
43	Point	0	0	44	44	4	428	AUSTIN WSO AP	TR
44	Point	0	0	45	45	53	8721	SUBSTATION 14	ED
45	Point	0	0	46	46	6	613	BEAUMONT RESEARCH CTR	JEF
46	Point	0	0	47	47	11	1429	CANYON DAM	CO

evap (2 out of 64 Selected)

If you Click on Show selected records at the bottom of the table, you'll see just the two records for the selected sites in the attribute table.

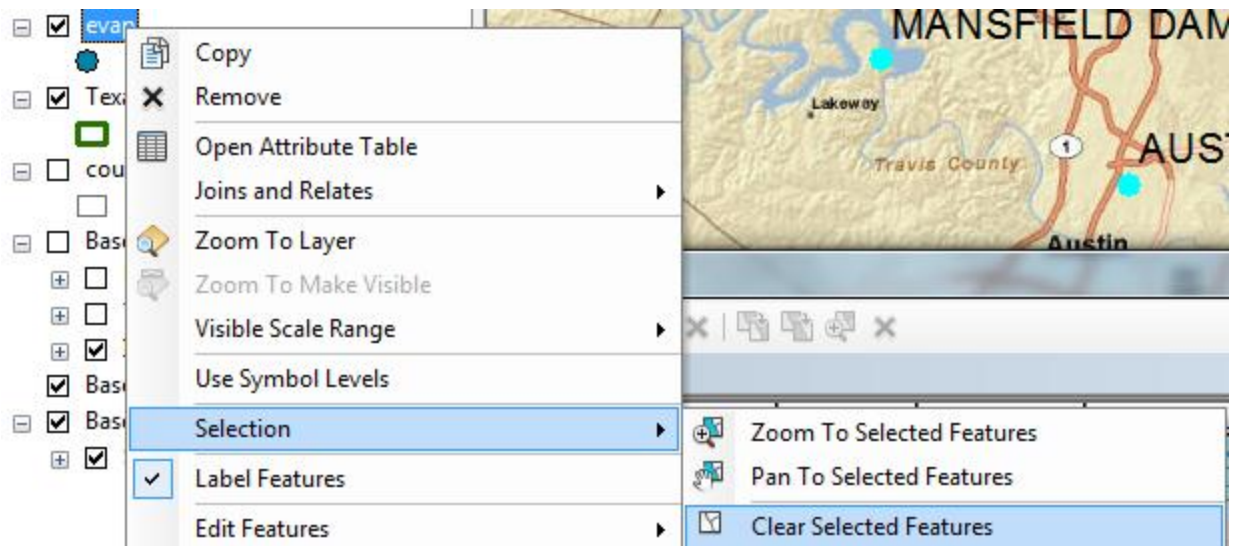
Table

FID	Shape	AREA	PERIMETER	NWSEVAP_	NWSEVAP_ID	EVAPSTAT_	STAT_ID	STAT_NAME
41	Point	0	0	42	42	35	5561	MANSFIELD DAM
43	Point	0	0	44	44	4	428	AUSTIN WSO AP

evap (2 out of 64 Selected)

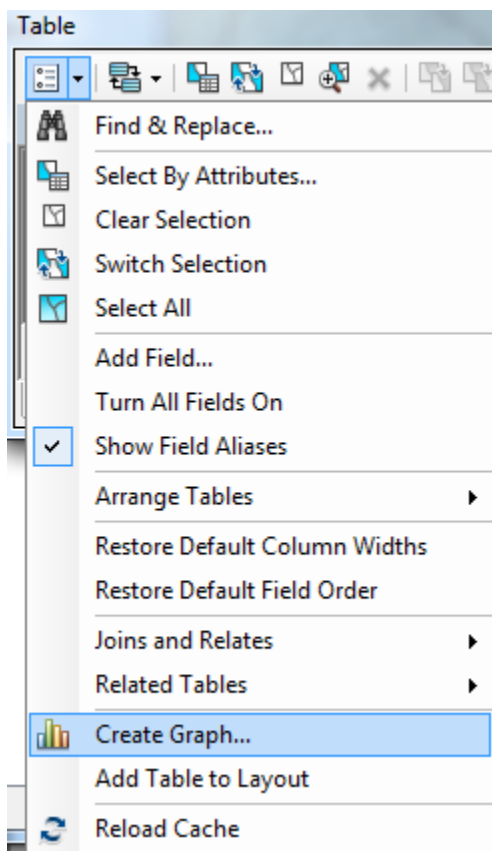
Show selected records

To clear your selection, right click on the layer name, and choose **Selection/Clear Selected Features**.

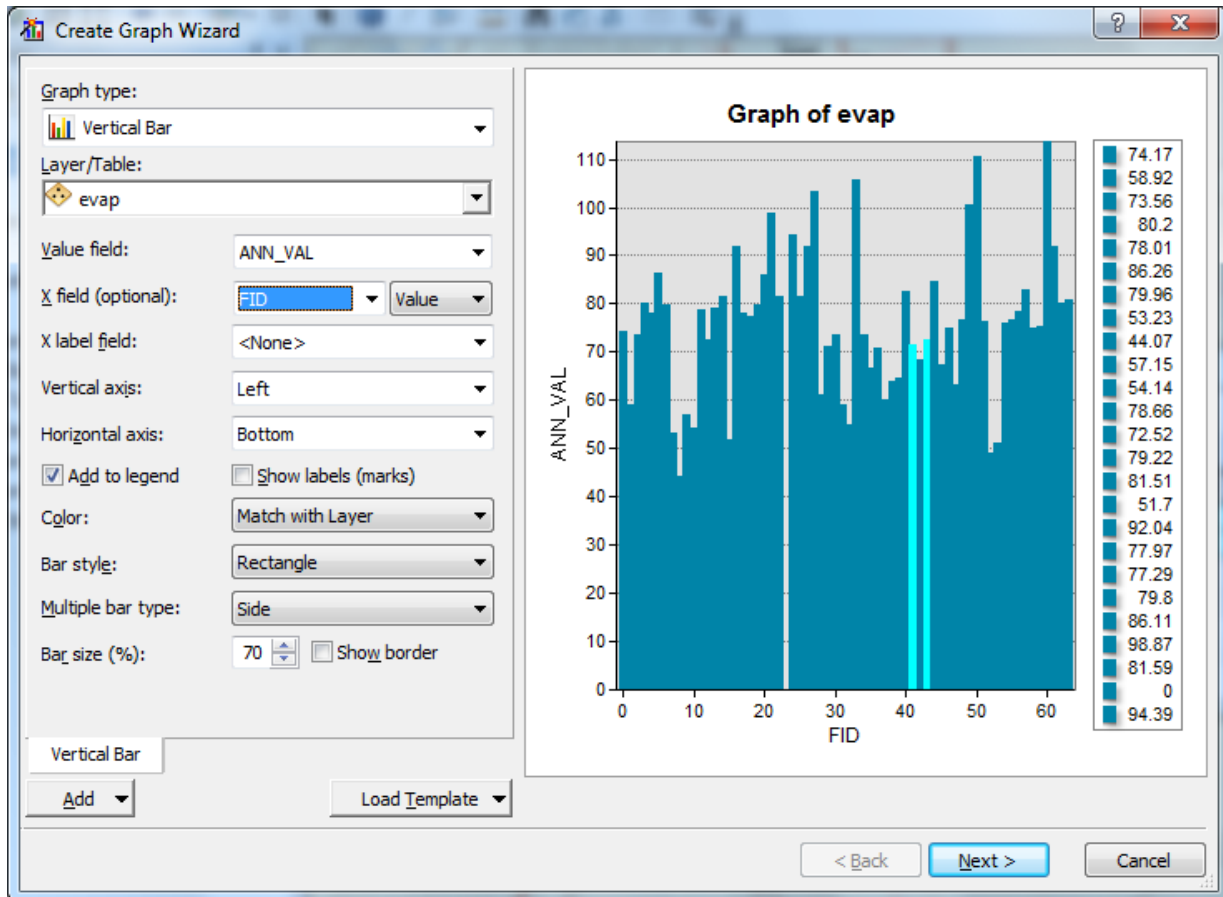


6. Making a Chart

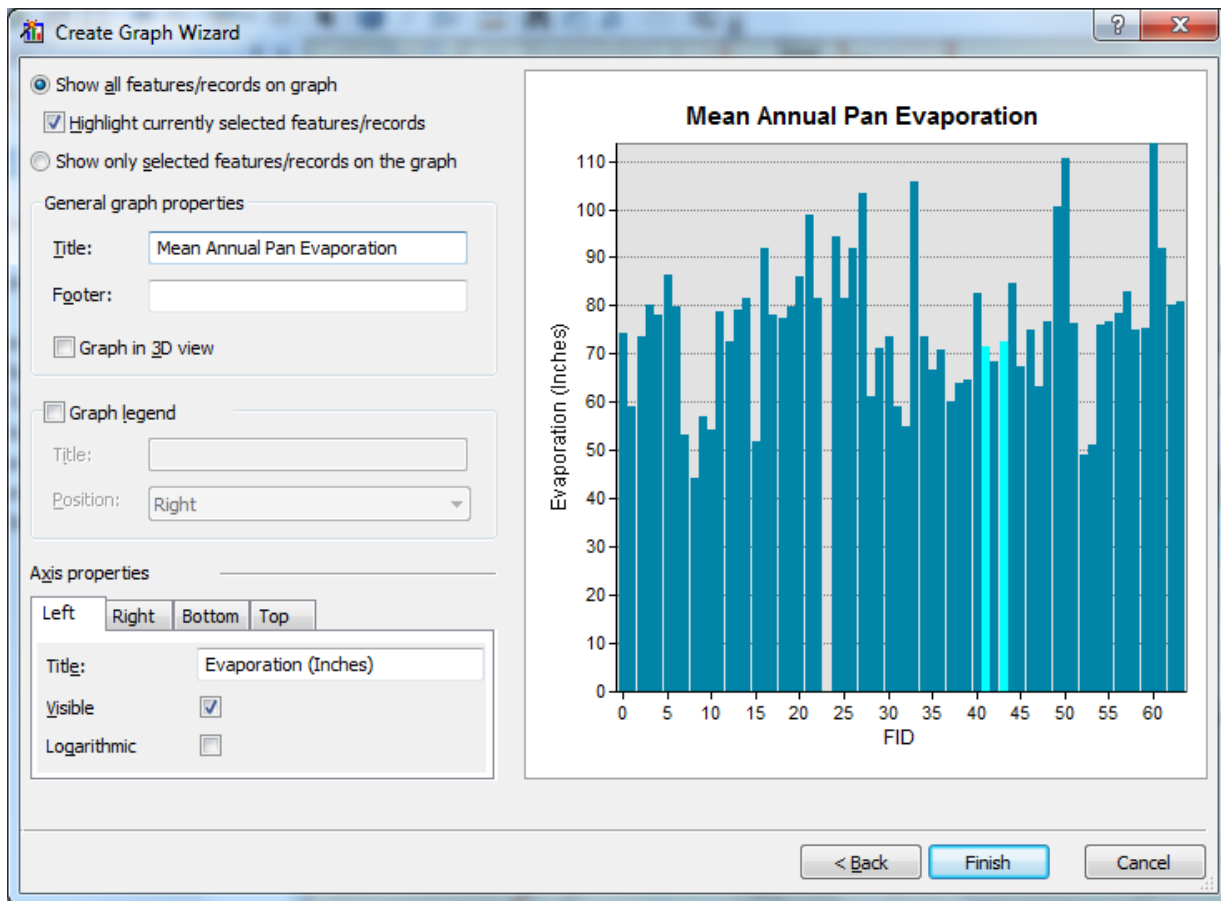
Charts are useful because they allow you to visualize trends in data. ArcMap has chart-making capabilities. We will plot a chart of one or more records selected from an attribute table. Select the two evaporation sites that are located in Travis County. Click on **Table Options** at the top left of the Table and select **Create Graph**.



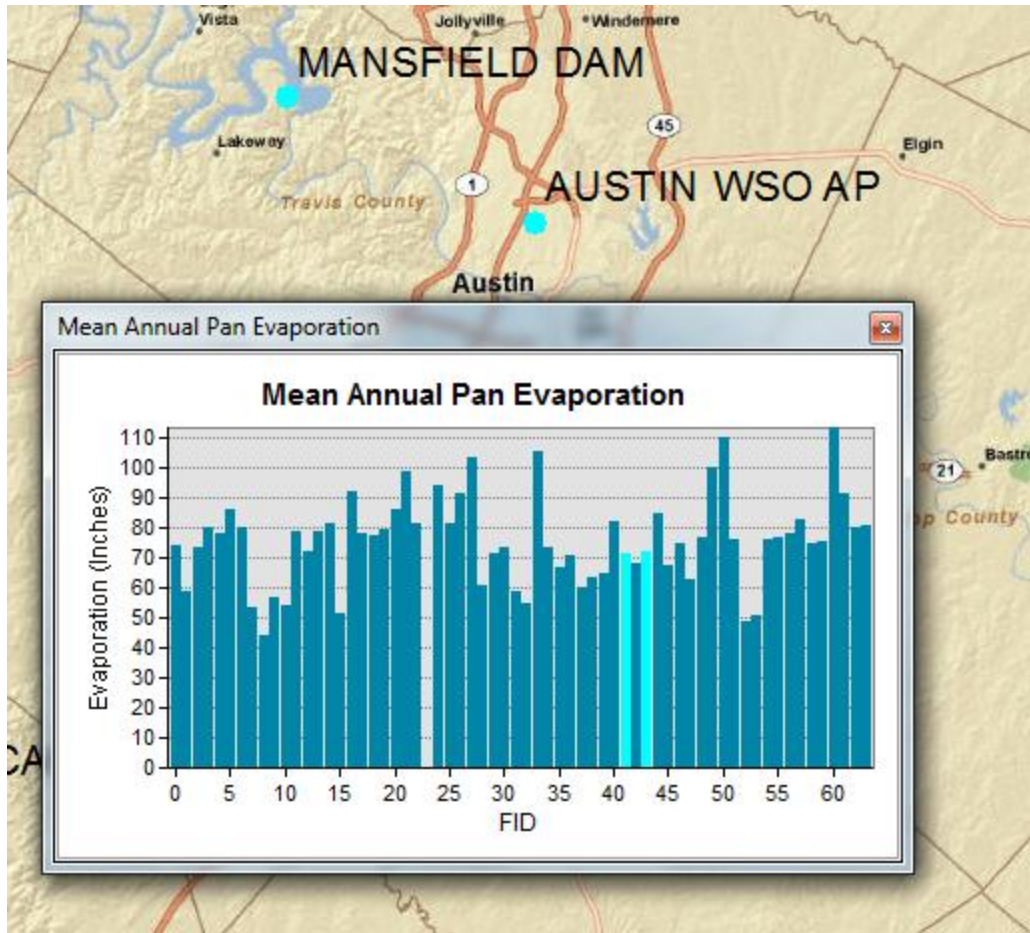
You will be making a Vertical bar chart (the default option). The next screen will allow you to indicate the data to be used in the graph. Here is a graph of the Annual Evaporation (**Ann_Val**) of the two stations plotted against a backdrop of all the stations in Texas, indexed using **FID**:



Hit **Next** and edit the graph properties to make them nicer. Click off to get rid of the legend on the right hand side. Add a title and relabel the vertical axis:



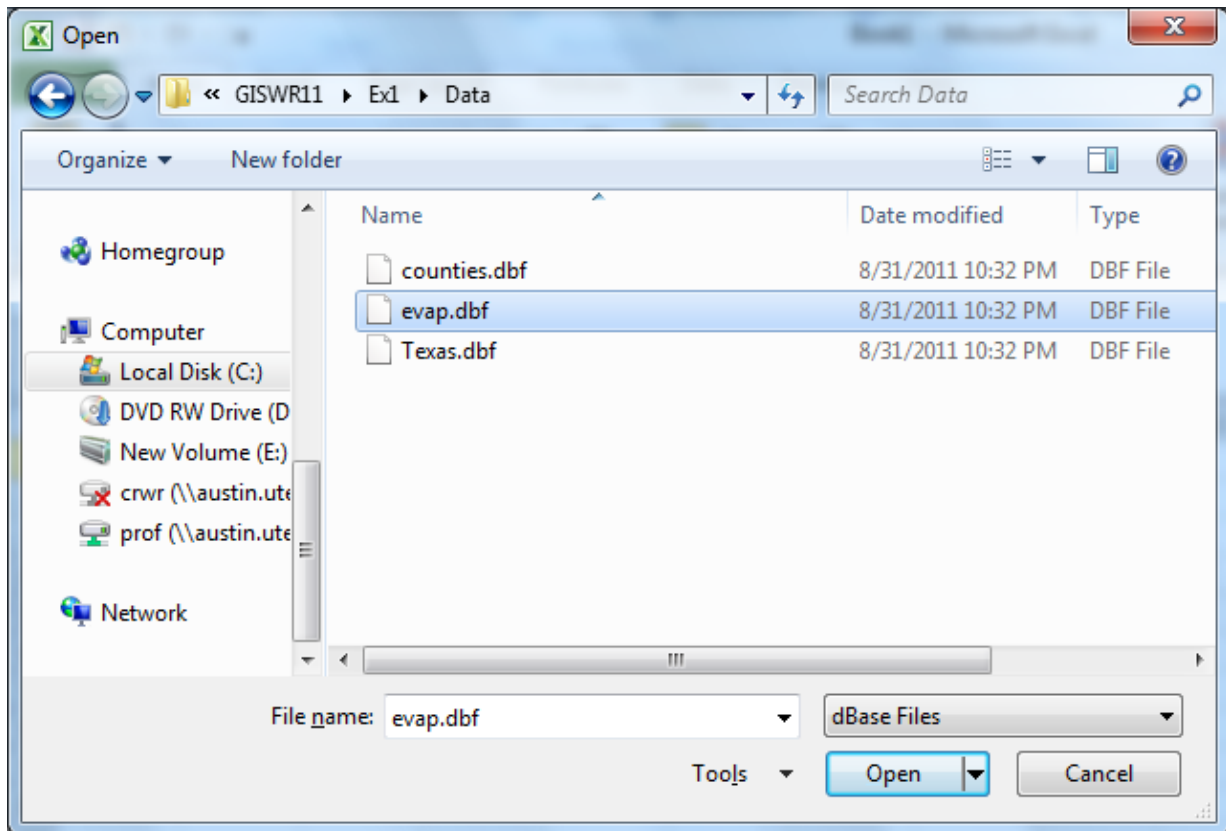
Click Finish, and you've created a graph linked to mapped features in ArcMap. You can get some sense of how the evaporation in Travis County relates to values recorded elsewhere in Texas.



Save your ArcMap document **Ex1.mxd** so that you can retain this display. The graphing options in ArcMap are pretty limited. For example, I wanted to plot the annual pan evaporation against longitude because this would show how evaporation changes from West to East across Texas, but I could not find a way to control the range of the longitude axis, the values started from 0 and all my displayed data was piled up on one side of the graph (longitudes of 90 to 100 West as occur in Texas). This is not to helpful.

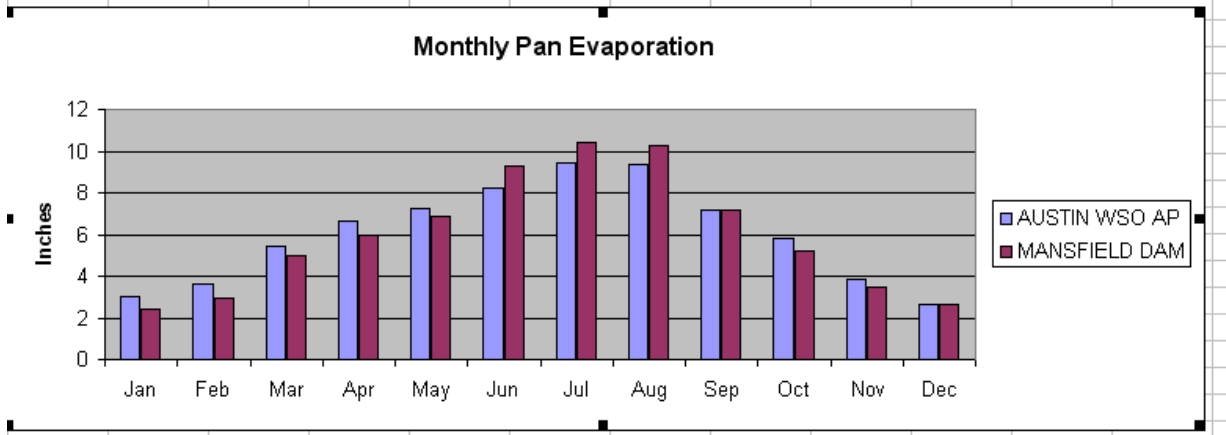
Graphing in Excel

Another graphing option is to make a chart in Excel using the dBase tables given by the evaporation shapefile. Open the evaporation attributes table **evap.dbf** as a table in **Excel**. Use **Files of Type: dBase files** in Excel to focus only on .dbf tables when you open the table.



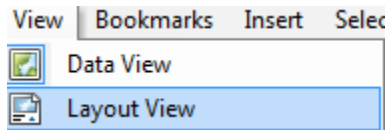
Select the stations you want to plot, copy their records to a new worksheet, delete the columns you don't need there, and then create a chart. Here is an example chart created this way. The column headers have been renamed from Jan_Val to Jan, etc to make the Chart x-axis more attractive to view. The legend has been moved to the top of the chart to allow a wider spacing of the data in the chart. I copied the data for Mansfield Dam and Austin airport into a new spreadsheet to make this chart.


Q	R	S	T	U	V	W	X	Y	Z	AA	AB
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.01	3.66	5.45	6.61	7.27	8.21	9.46	9.37	7.20	5.81	3.83	2.63
2.39	2.91	5.01	5.95	6.89	9.30	10.43	10.23	7.14	5.18	3.48	2.64



7. Creating a Map Layout

To consolidate a map of counties of Texas with evaporation stations with the graph that you created before in a single sheet of paper, in ArcMap: (1) change the format of the display window from **Data View** to **Layout View** by clicking on **View/Layout View**,

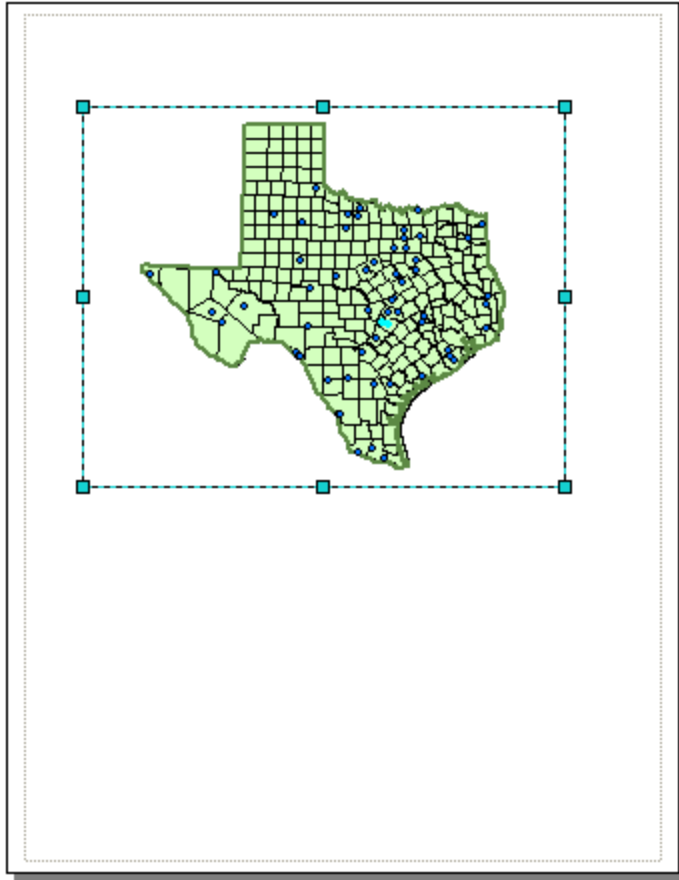


If your Layout doesn't display properly in ArcMap, hit  at the bottom of the map display to refresh it.

Reduce the size of the data frame in the layout (i.e., rectangle where the spatial data is contained) -- to make room for the graph -- by clicking on the graph and moving its handlers. If you have a zoomed in view in Arc Map, you'll get the same image in in the Layout. To move the location of your map, go back to the Data View and use the Pan tool

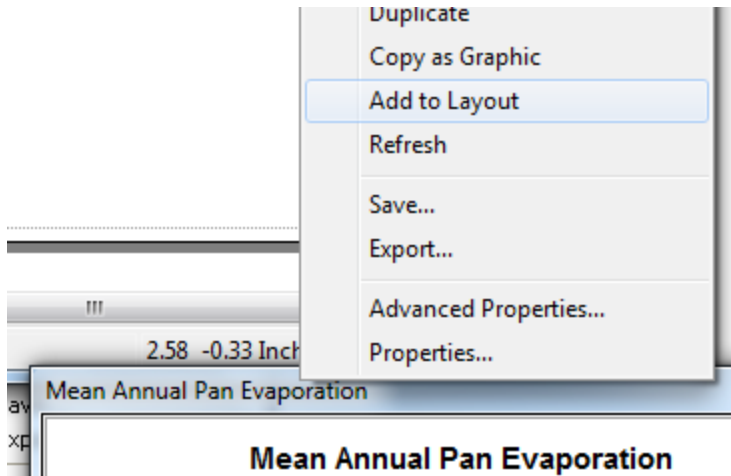


to move your map around. When you switch back to the Layout View the new map location will be displayed.

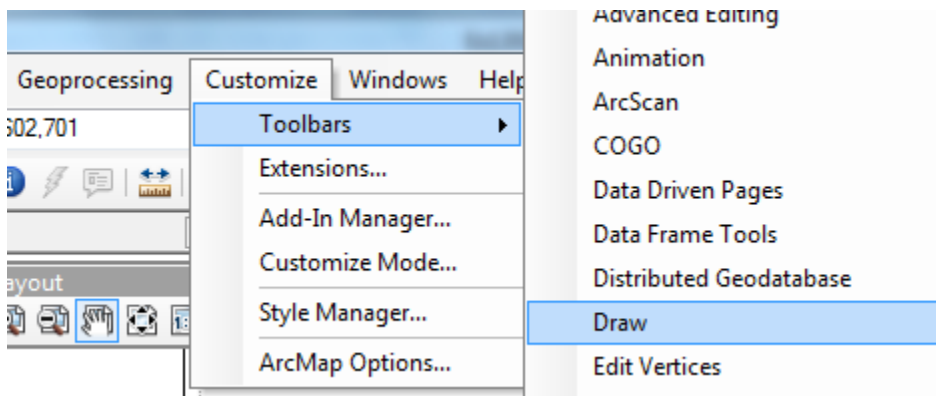



Keep saving your ArcMap document as you proceed through the map making steps so that if you mess up something you can get back the work you've already done.

To insert the ArcMap Chart into the Layout, right-click on the upper blue bar at the top of the Chart and select **Add to Layout**. Move and resize the graph as necessary. If you want to copy your graph from Excel, highlight the graph, and click on **Copy** in Excel, then **Paste** in ArcMap and your graph should appear in the map layout.

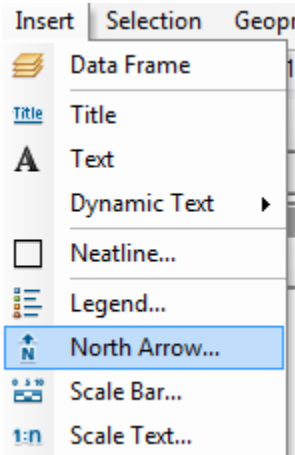


You can draw lines to relate the location of the measurement stations and the data plotted on the graph using the Draw a Line tool from the ArcMap Draw toolbar (to display this Toolbar, use **Customize/Toolbars** and select **Draw**). This draw toolbar works the same in ArcMap as it does in other MS applications. It is important to show some association between the data plotted on the chart and where these data were measured on the map so that you can figure out which data series was measured at what location.

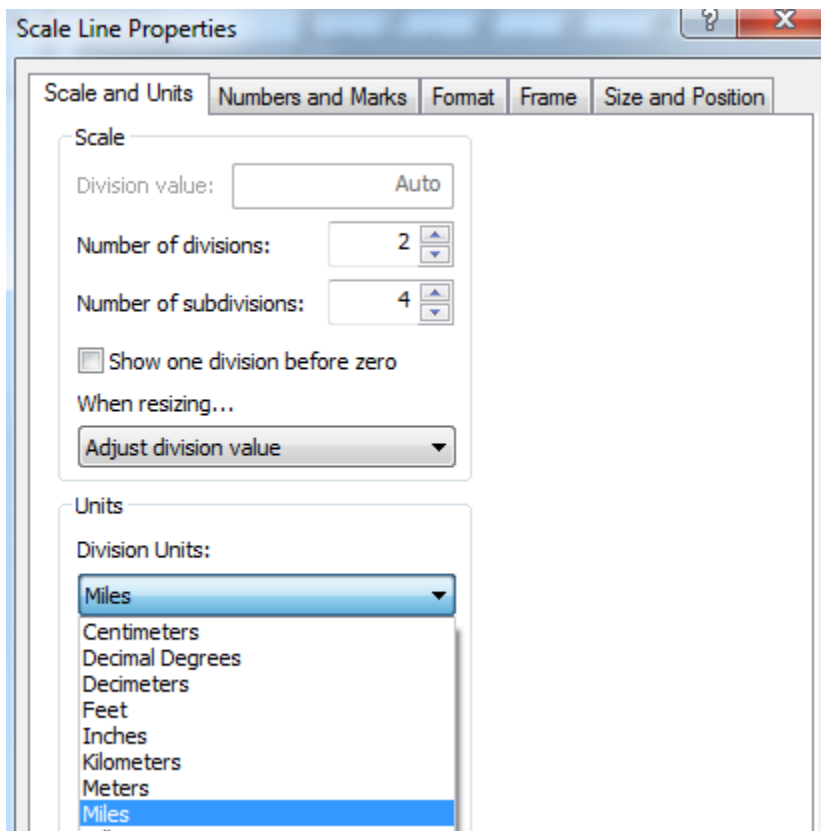


Or you can add text with the text tool  shown next to the line draw tool. The text displays in very small font sizes. Select and click on them, and use **Properties** to resize them. You can also insert a

North Arrow and a Scale Bar by using the **Insert** menu in ArcMap.



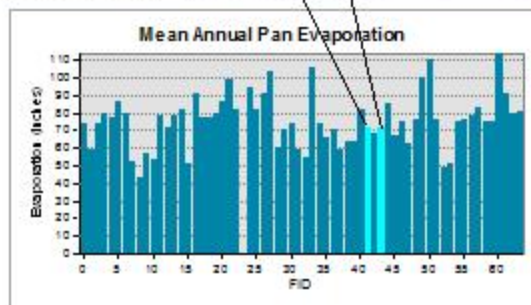
When you put up the scale bar it is in meters because those are the map units used in the data. If you click on the scale bar you can redefine the distance units (I have used miles) and if you expand or contract the scale bar you can show a desired spacing of these distance units.



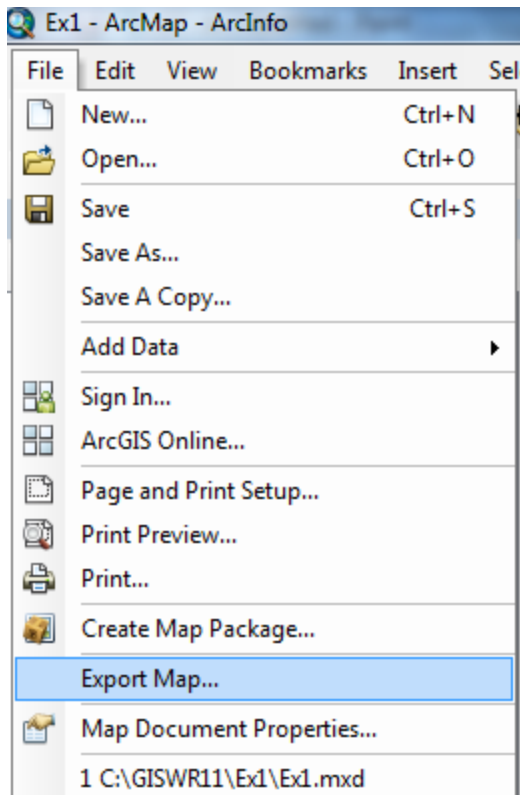
Your map might look like this:

Pan Evaporation in Travis County

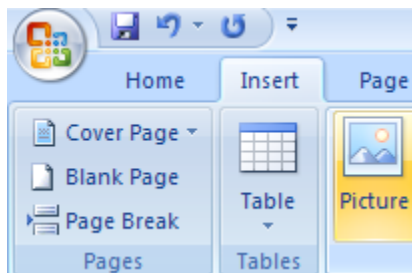
Prepared by David R. Maidment, 1 September 2011



You can export your map from ArcGIS using **File/Export Map** from the ArcMap menu, and you can store this as **Ex1.emf** in your data file. Then you can add it to a Word document using **Insert/Picture/From File** and load this emf file, as shown below. Pretty cool!

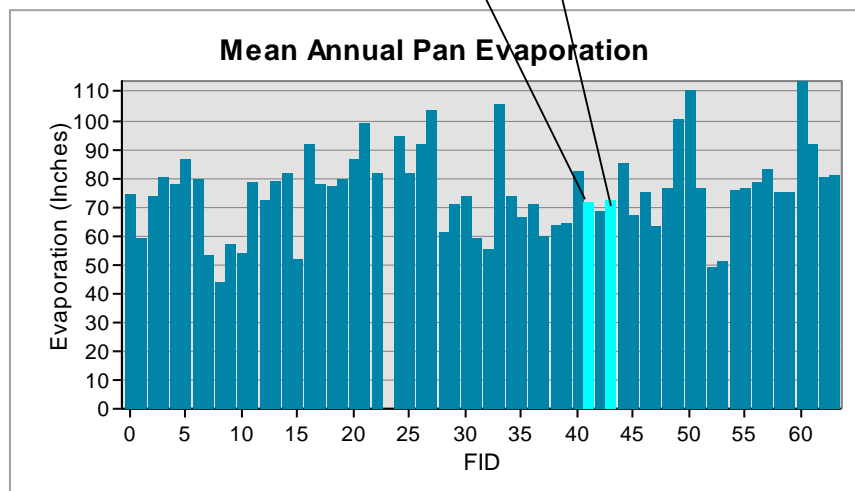
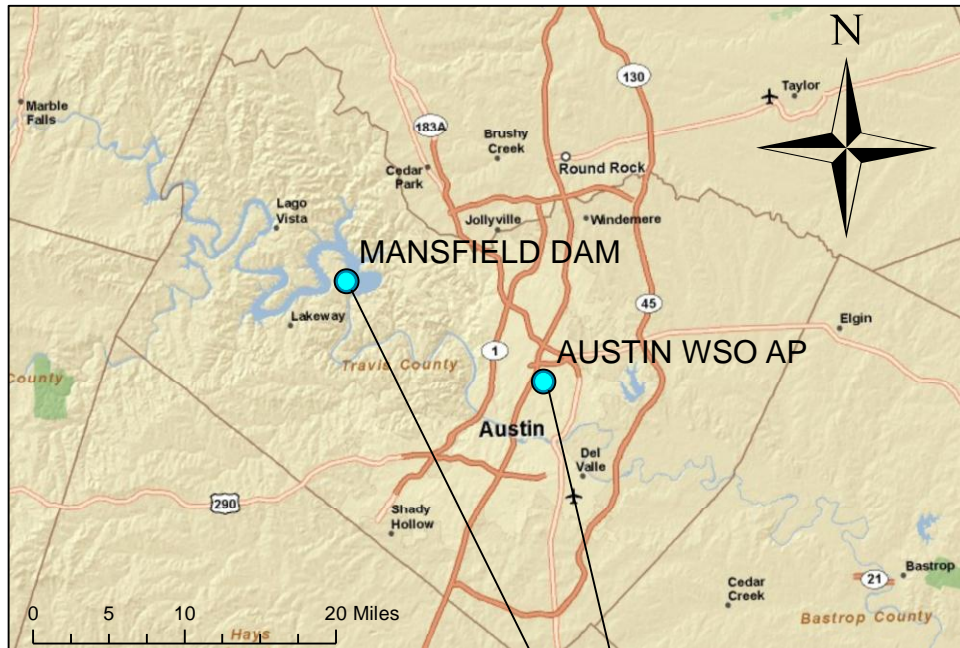


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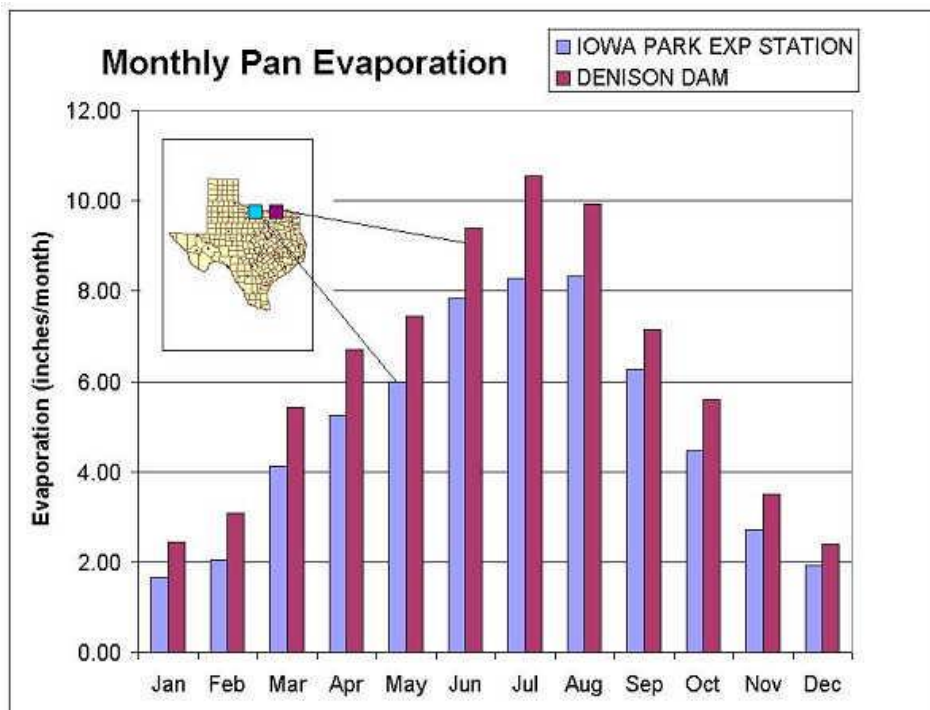


Pan Evaporation in Travis County

Prepared by David R. Maidment, 1 September 2011



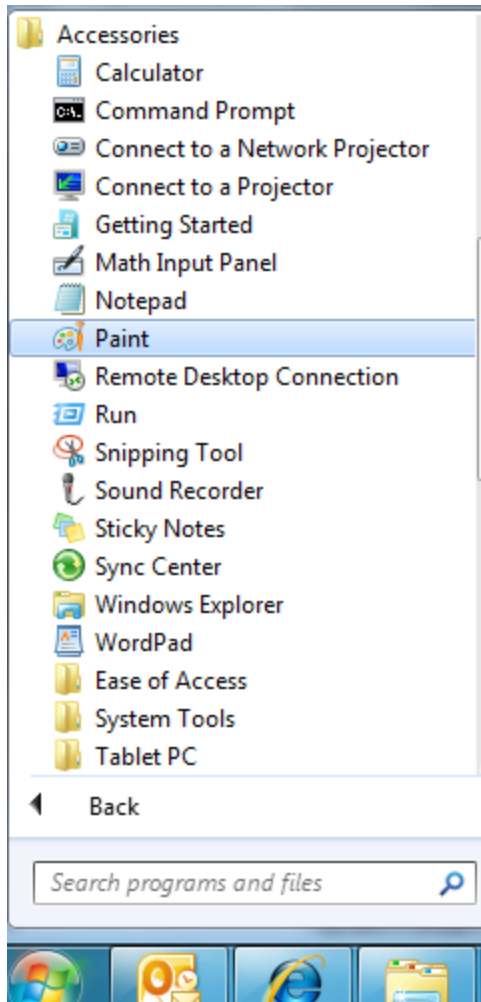
Here's another option: suppose you want to take a chart in Excel and add a map to the Chart to show where the data apply. In the **Map** display (not Layout Display) use **File/Export Map** to create another .emf file, and then in Excel you can use Insert/Picture from File to place this in an Excel graph. You can see that in this map, a nice color association between the symbols on the map and the bars on the chart makes it clear which data series was measured at which location. This chart shows a different pair of evaporation stations that are color code at their geographic locations so you can see how the pattern of evaporation varies geographically.



The manipulations just described transfer objects from one application to another.

Helpful Tip:

A more general procedure is to simply copy the screen to the clipboard and crop out the part that you want, saving it to a file for later use. That is how all the images in this exercise were prepared. To copy any image, hit **Print Screen** on your keyboard (this copies the Screen onto the Clipboard). If you only want to capture the active frame, press **Alt + Print Screen**. This is convenient if you only want to capture an attribute table or graph within ArcMap as opposed to the entire screen, therefore no cropping is necessary. You can open the tool Paint as



And then use **Paste**, **Select** and **Copy** to put the image into Paint, select the part that you want, copy it, and then **Paste** the result into your Word document.

Ok, let's complete the exercise:

To be turned in: An ArcMap map layout in it showing a map of Texas with gages, and linked with a graph showing monthly evaporation data plotted from two gages. In the presentation of information on maps and charts it is important to include sufficient labeling detail so that the information can be clearly and unambiguously interpreted. You should include a scale bar to indicate distance, a north arrow to indicate direction and labels or legends with units wherever they are needed to interpret map or quantitative values.

Lets see some nice cartography!!