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### Abbreviations

D-click	Double Click
R-click	Right Click
TOC	Table of Content

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### Introduction

The benefit from the use of geographic information system (GIS) software is tremendous and range from managing the transportation in a dense city, to finding and modeling sophisticated environmental problems. GIS is used all over the world to achieve various tasks from managing the environment, and offering better service. It allows the user to carry research, and studies practically everything such as land, climate, environment, natural resources, population, etc.

Chapter 2 introduces the fundamental concepts of GIS, and the major functionality contained in ArcGIS Desktop. You will work with a variety of ArcGIS tools, and you will learn how to create color coded maps, query, and solve a variety of spatial problems.

ArcGIS desktop is a collection of software products for building comprehensive GIS. ArcGIS is the collective name for three products: ArcView, ArcEditor, and ArcInfo. These products have the same interface and share some of their functionality.

GIS is made up of layers or themes that make maps in GIS. You can add as many layers as you want, and the layers may contain features or images.

This section will focus on three components of the most advance ArcGIS desktop: ArcMap, ArcCatalog, and ArcToolbox.

**ArcMap** make maps from the layers of spatial data, choose colors, symbols, query, analyze spatial relationship, and design map layout.

**ArcCatalog** browse spatial data contained on the hard disk, network, or internet, search for spatial data, preview data, create features and metadata.

**ArcToolbox** use many tools to perform different types of analysis ranging from converting spatial data from one format to another, projection data, interpolation, analysis, and many others (you will learn about ArcToolbox in the next chapters).

The lessons in this chapter provide an overview of the basic GIS concepts and standard ArcGIS functions. You'll work with the ArcGIS software and will familiarize yourself with its main components, ArcMap, and ArcCatalog.

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**Electronic Supplementary Material:** The online version of this chapter ([https://doi.org/10.1007/978-3-319-61158-7\\_2](https://doi.org/10.1007/978-3-319-61158-7_2)) contains supplementary material, which is available to authorized users.

## Learning Objectives

A student who completes this module will be able to:

1. Explore a GIS map and get information about map features
2. Preview geographic data and metadata
3. Add data to a map
4. Describe the structure of a GIS map
5. Explain how a GIS represents real-world objects
6. Change the way features are drawn on a map
7. Access feature information in different ways
8. Describe spatial relationships of map features
9. Describe how GIS can be used to solve problems

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## ArcMap and ArcCatalog

Using the ArcMap allows the user to control the whole map, and do changing, modification, and updating, at any time, within a very short period of time. ArcMap makes the map be dynamic, in a way that it is subject to any change, in term of color, symbols, classification, and layout. You can perform and distance measurement, in any unit you desire; regardless the map unit of the map.

You can zoom in and out to see different areas with more or less detail, you can decide what features you want to see and how they are symbolized. But most important is that you can retrieve the database, of the features, displayed on the map.

In this topic, you'll learn some of the concepts to which GIS maps are based. But first, you'll do an exercise to see just how easy they are to use and explore.

The ArcCatalog application organizes and manages all GIS information, such as maps, globes, data sets, models, metadata, and services. It is an application for managing your data in term of copy, delete, review, browse, search, and other functionality.

It includes tools to

1. Browse and find geographic information
2. Record, view, and manage metadata
3. Define, export, and import geodatabase schemas and designs
4. Search and browse GIS data, on local networks and the Web

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## Lesson 1: Working with ArcCatalog and ArcMap

**Scenario 1:** You are new GIS employee at the city of Chico, California, and you have been asked by your superior to do the following:

1. Launch ArcCatalog
2. **Connect** to your directory in ArcCatalog \\Ch02\
3. Create a **thumbnail** for all the layers
4. Use the **search** button on California
5. **Integrate** all the layers into ArcMap
6. **Change** the name of the layers, and give them a proper name
7. **Symbolize** the school
8. Create a **bookmark** for the school in the north of city of Chico
9. Shift your work between **Data View** and **Layout View**


### Connect

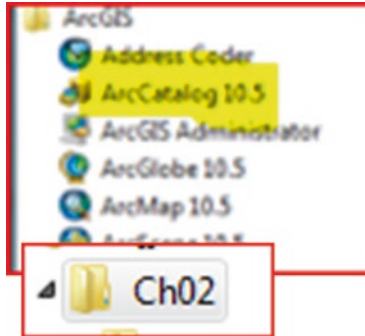
1. Start ArcCatalog

**Note 1:** In Window/Start/All Programs/ArcGIS/ArcCatalog 10.5 **OR**

**Note 2:** R-click ArcCatalog/Send to/Desktop (to create shortcut permanently in desktop)

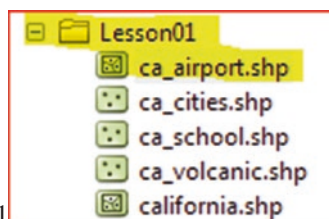
## 2. Connect to your directory in ArcCatalog

- Click “Connect To Folder” button 
- Browse to the following directory (\\Ch02)
- Highlight Ch02 and click “OK”



## Create a Thumbnail

**Thumbnail** allows you to use pictures (images) instead of shapes for variable and tool elements in a model diagram. Thumbnails draw quickly because they are snapshots; the data isn't displayed when you see a thumbnail.

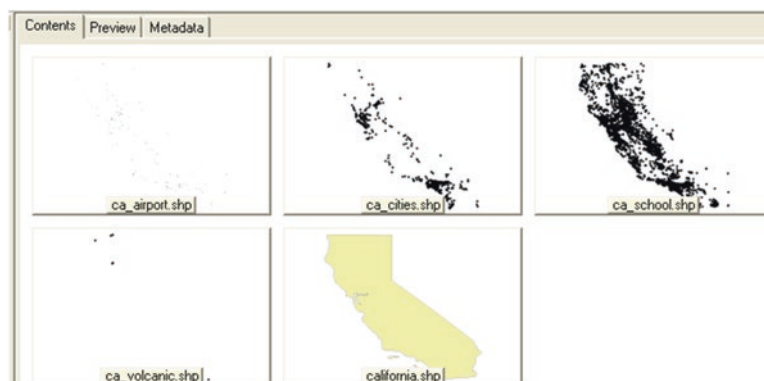


- In the Catalog Tree, click the plus sign to open Q1
- Highlight the file “**ca\_airport.shp**”
- Click “preview tab”



- Click “Create Thumbnail” button  in the Geography Toolbar

- Repeat the previous steps to create thumbnails to the rest of the files
- Highlight the folder (\\Q1)
- Click “Contents” tab to see all the thumbnails



**Note:** make sure you are clicking the Thumbnail button in the Standard toolbar

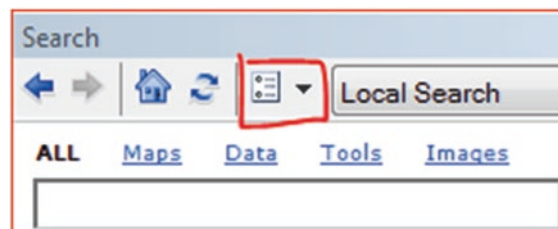


## Use the Search Window

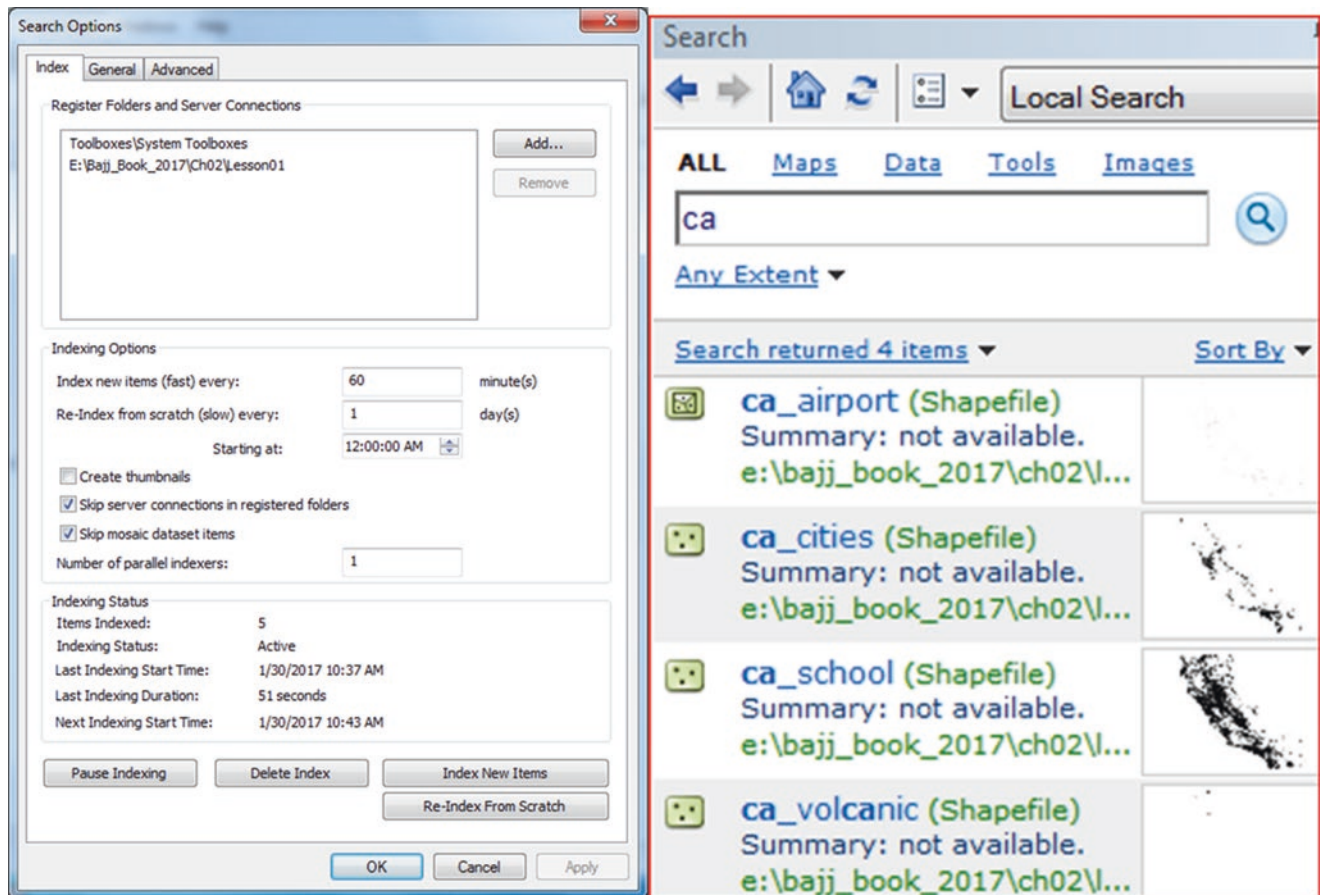
1. Click the “Search” window icon in the Standard toolbar



2. The Search dialog box display
3. Click on the “Search Options” icon on the ArcGIS Search Window



5. The dialog box of “Search Options” display
6. Click Add
7. Browse to the directory \\Ch02\Data\Q1
8. Click the “Index New Items” tab
9. Click Apply/OK when finishing indexing
10. Write in the Local Search the word “Ca” and click search
11. Four files displayed ca\_airport, ca\_cities, ca\_school, and ca\_volcanic



12. Click in the link below the Ca\_airport file this will highlight the Ca\_airport in the table of content of Catalog Tree in the left panel
13. Close the search window

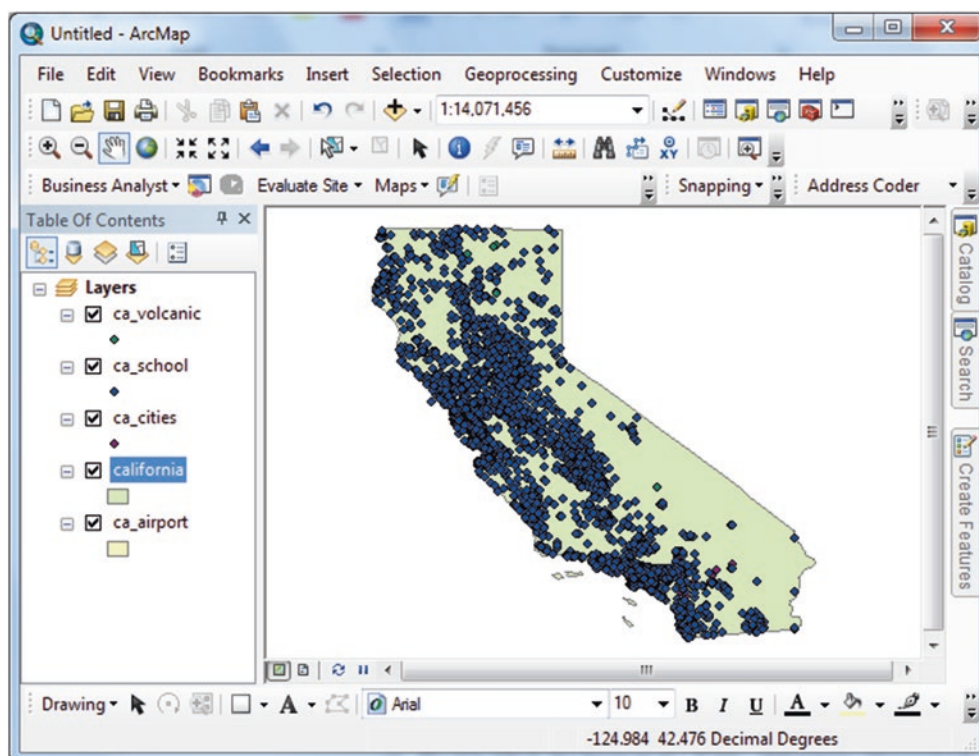
## Working with ArcMap

1. Start ArcMap through the “launch ArcMap” button in Standard toolbar in ArcCatalog



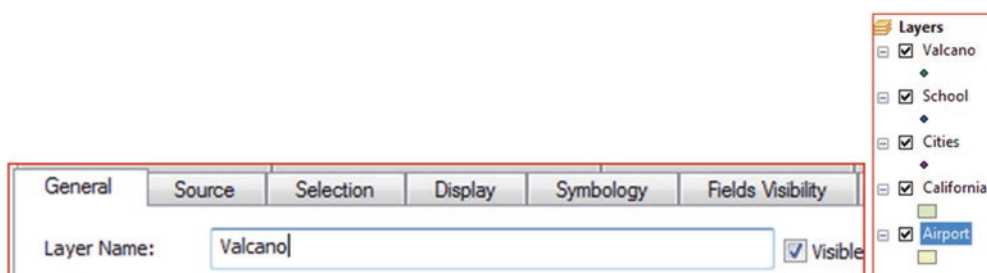
OR

- a. From the window taskbar/Start/All Programs/ArcGIS/ArcMap
2. Minimize the ArcCatalog and ArcMap so you can see both of them
3. Drag the 5-layers one by one (ca\_airport.shp, ca\_cities.shp, ca\_school.shp, ca\_volcanic.shp and california.shp) from ArcCatalog to ArcMap



## Change the Name of Layers

4. D-click “ca\_volcanic” layer in the Table of Contents/General tab/Click on the Layer Name and type “Volcano” OR
5. Click twice on “ca\_volcanic” and rename the file’s name
6. Repeat the previous step and rename all the layers for example “ca\_airport” will be “Airport”, the rest “Cities”, “School”, “California”



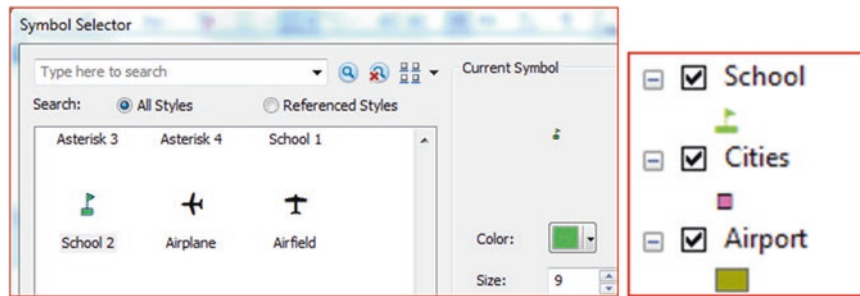
## Symbolize the Layers

Symbolizing means assigning various things to the features, if you have a point feature, you can apply different colors, sizes, and shapes. If you have line feature you can apply width, and color and if you have polygon features you can apply patterns, colors, and make it transparent. Symbolology is also a scale dependent. A city in California may be a polygon on one map if the scale is large such as 1:70,000 or a point on another map, if the scale is small such as 1: 4,000,000. In ArcGIS, the symbols are organized by style, such as Civic, Conservation, Crime Analysis, Environmental, Geology, and others. In addition GIS allow you to create your own symbols. The Symbolology is applied to a field in the attribute table.



ArcGIS allow you to symbolize the feature and then save it as a layer, so when the layer is added to the map the feature is already symbolized the way you saved it. Symbolology is also can be applied to the images. You are going to change the symbol and color of the school and the color of the airport.

- (a) In ArcMap, click on the **School** symbol in the TOC
- (b) The Symbol Selector display, scroll down and chose the **School 2** symbol **OR**
- (c) Type School in the Search window/click search/chose the **School 2**
- (d) Keep the green color and make the size 9
- (e) Click “OK”
- (f) R-click the symbol of the airport and change the color of the Airport to the color of your taste



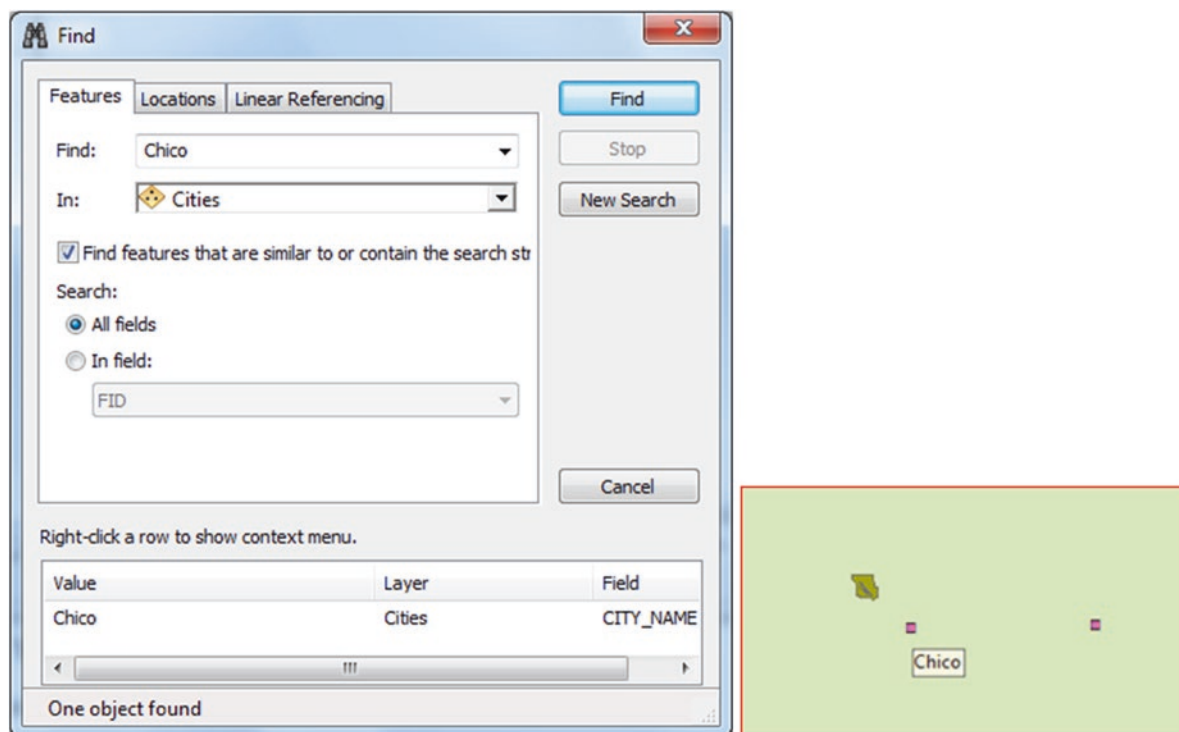
## Find and Create a Bookmark

### Create a Bookmark for the School North of the City of Chico

1. Click the “find” icon in the **Tools** toolbar



2. Under the “feature” tab:
3. Type “Chico” in the “Find” box
4. In the dropdown menu in the “In” select “Cities”
5. Click “Find” button
6. R- Click Chico in the result, select “Zoom To”



7. Close "Find Dialog"
8. R- Click on the "Cities" layer in the TOC/Properties
9. Under the "Display" tab
10. Check the box *"Show Map Tips using the display expression"*

**Note:** Make sure the Field: **CITY\_NAME**

11. Click "OK"
12. In the Tools toolbar click on Select Elements
13. In the map put your Select Element cursor above the city that you have zoomed in



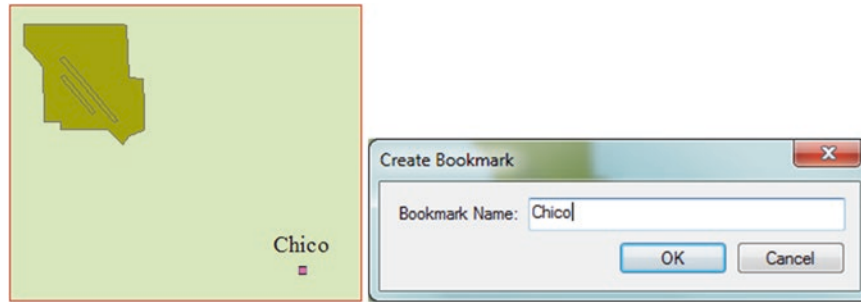
**Result:** The Chico city will display



14. Click the Zoom In  in the **Tools** toolbar and zoom in around city of Chico
15. Go to "Bookmarks" menu, select "Create Bookmark"
16. Give desired name (i.e. "Chico")

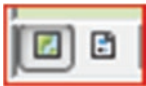


17. Click “OK”



18. On the View menu click “Layout View” OR

19. Shift your work between “Data View” & “Layout View” at the bottom of the map



20. Click Data View

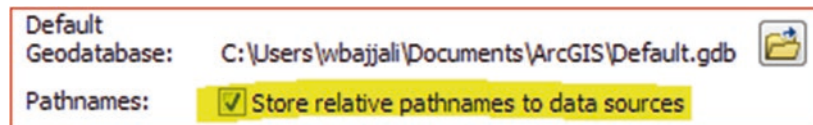
21. Click Full Extent button  at the **Tools** toolbar

22. Click “Bookmarks” and select “**Chico**”

## Using Relative Paths

Relative paths in a map specify the location of the data contained in the map relative to the current location on disk of the **map document** (.mxd file) itself. As relative paths don’t contain drive names, they enable the map, and its associated data, to be moved to any disk drive without the map having to be repaired. If you don’t set the relative path, and you move your map document from one directory, such as (\\C:\\data\\), to another directory (\\K:\\GIS\\), (or another computer), you will encounter a problem when you display your layer data. The layer will still appear in ArcMap TOC with red exclamation mark, but will not display in the Data View. To avoid this issue, it is recommended to set the relative path.

1. Click the File menu/click Map Document Properties
2. Check the option to store relative path names and click **OK** to apply the settings.



## Save Map Document

Save the map document to the result folder

3. File/Save As/browse to \\Ch02\\Result
4. Save it as **Chico.mxd**


**Quiz:** Find Fountain Valley School and Bookmark it

## Lesson 2: Data Management

**Scenario 2:** In this exercise, you are going to work with spatial data from the state of Texas. In the state, there is a pipeline that runs from Lubbock to San Antonio, passing various cities and transporting fresh water. The fresh water is abstracted from a deep groundwater wells. Your duty is to do the following:

1. Open new ArcMap Document and Add data into ArcMap
2. Change the name of layers
3. Change Symbols and Show Map Tip
4. Label the groundwater wells
5. Symbolize the pipeline and rivers
6. Create a layer file

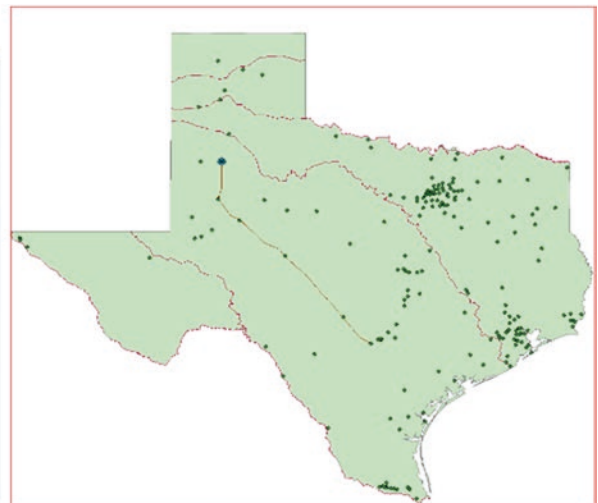
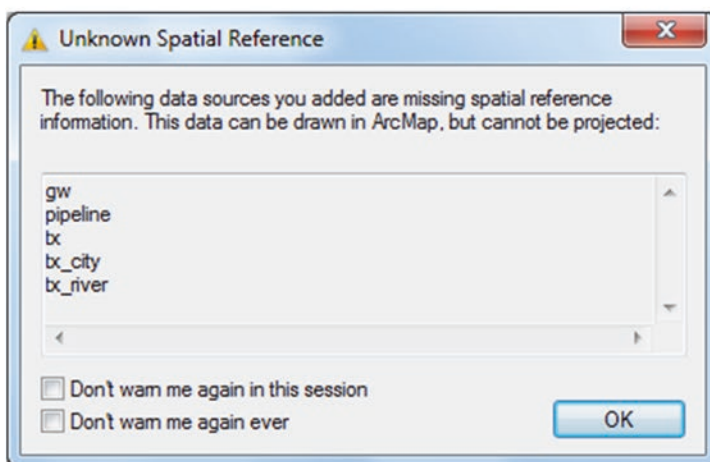
### GIS Approach

1. Start a new ArcMap document by doing the following
2. File/New/accept the default setting/OK
3. A dialog box display asking to “Save Changes to Untitled/No
4. Click “Add data”  in the Standard toolbar
5. Browse to the directory \\Ch02\Data\Q2
6. Use the Shift key, highlight the following files: **gw.shp, pipeline.shp, tx.shp, tx\_city.shp, and tx\_river.shp**
7. Click “Add”
8. A message will be displayed stating “**Unknown Spatial Reference**”

**Note:** this means that the following data sources you added are missing spatial reference information (will be discussed in projection chapter)

9. Click OK

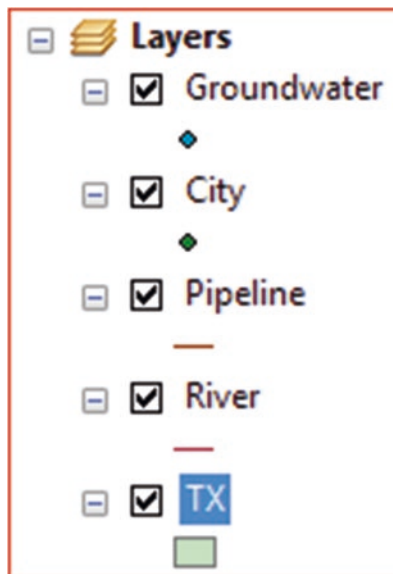
**Result:** the 5-layers will be displayed



### Change Names

Change the name of all layers and give them a proper name i.e. tx\_city is City

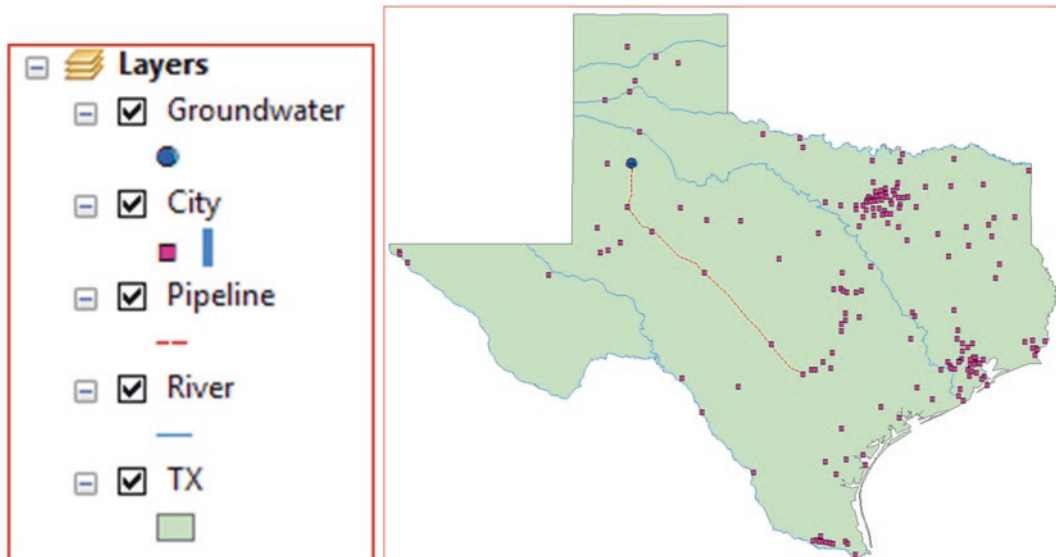
10. R-click on desired file
11. Select “Properties”
12. Under the “General” tab rename the “layer name” as desired Or
13. Click twice on each layer and rename it as desired (see below)



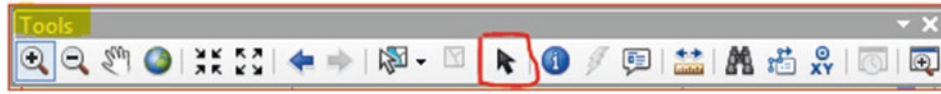
### Change the Symbols of the Layers and Show Map Tip

Change the symbol of some layers and identify city names located along the pipeline using Show Map Tip

1. Click on the **City** symbol in the TOC, select Square 2, Size 7, and the Color to Ginger Pink then click OK
2. Change the symbol and color of the Groundwater into Circle 2, Size 8, and the Color to blue
3. Click the symbol of the Pipeline, type in the Symbol Selector “Pipeline” click search select “*pipeline\_segment\_line*”, then click OK
4. Click the Symbol of the River, select the River Symbol, then click OK



1. Uncheck the “Groundwater” layer in the TOC
2. Zoom In around the Pipeline
3. R-click on the “City” layer/Select “Properties”
4. In the “Display” tab, click the “*Show Map Tips using the display expression*” box and the Field: *NAME*
5. Click “OK”
6. Click on the Select Element icon in the Tools toolbar



7. Place it above each city along the pipeline in order to see the name of the cities

**Result:** Lubbock, Big Spring, San Angelo, Kerrville, and San Antonio

## Label a Layer

There is another way to see the name of the features in the layer by using the labeling. You are going to label the Groundwater layer using the “ID” Field

8. R-Click Groundwater layer in the TOC
9. Select “Zoom To Layer”
10. R-Click “Groundwater” layer/Label Features  
**Result:** The Groundwater wells will be labeled, but not with the ID field.
11. In order to label the Groundwater layer with the ID field, do the following
12. R-Click groundwater layer once again
13. Select “properties”
14. Click the “Labels” tab check the box “label features in this layer”
15. Label Field “ID”
16. Click Symbol
17. Change the Aerial into Time New Roman, Size 12
18. Click “OK” then “OK”



## Create a Bookmark

### Create a Bookmark for the Groundwater Wellfield

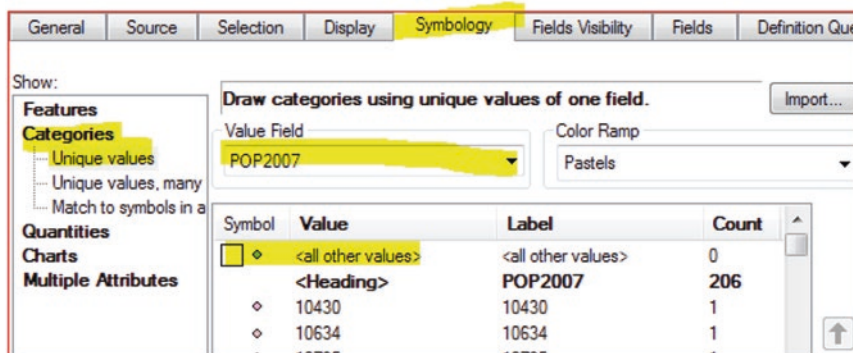
19. Click “Bookmarks” menu, select “Create Bookmark”
20. Give desired name (i.e. “GW”)
21. Click “OK”
22. Click Full Extent
23. Click “Bookmarks” menu select “GW”
24. Click Full Extent

## Classification

Classifying feature is an important part in GIS map making. Symbolizing is based on a field in the attribute table of a feature class. The attribute table of the city’s layer contains a numeric attribute called “POP1990”. You would use this field to symbolize the city layer.

### Classify the City Layer

- a. D-click the “City” layer/Symbology/Categories/
- b. Unique Value
- c. Value Field: **POP2007**
- d. Click “Add All Values”
- e. R-Click Color Ramp/Uncheck Graphic View/Choose Pastels/OK



**QUESTION:** Does this classification make a sense?

**ANSWER:** NO

**Note:** in Chap. 3 you will learn how to perform better symbology and classification

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