



# Using ArcMap™

*GIS by ESRI™*

Michael Minami

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#### DATA CREDITS

*Quick-Start Tutorial Data:* Wilson, North Carolina.

*Population Density—Conterminous United States Map:* U.S. Department of Census.

*The African Landscape Map: Major Habitat Types—*Conservation Science Program, WWF-US; Rainfall—ArcAtlas™, ESRI, Redlands, California;

Population data from EROS Data Center USGS/UNEP.

*Amazonia Map:* Conservation International.

*Forest Buffer Zone—100 Meters Map:* U.S. Forest Service (Tongass Region).

*Horn of Africa Map:* Basemap data from ArcWorld™ (1:3M), ESRI, Redlands, California; DEM and Hillshade from EROS Data Center USGS/UNEP.

*Mexico Population Density Map:* ESRI Data & Maps CDs, ESRI, Redlands, California.

*Health Care in the United States Map:* Population data from U.S. Department of Census; Health Service Areas from the trustees of Dartmouth College; Service Providers data from Healthcare Financing Administration.

*Clark County Land Use Map:* Clark County Office, Washington State.

*Southeast Asia Population Distribution Map:* ArcWorld (1:3M), ESRI, Redlands, California.

*Global 200—World's Biologically Outstanding Ecoregions Map:* Ecoregions data from Conservation Science Program, WWF-US; Country boundaries from ArcWorld (1:3M), ESRI, Redlands, California.

*Australia Map:* Major Habitat Types data from Conservation Science Program, WWF-US; Basemap from ArcWorld (1:3M), ESRI, Redlands, California.

*New Hampshire Telecom Map:* Geographic Data Technology, Inc.

*Redlands Image:* Courtesy of Emerge, a division of TASC.

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# Getting started

## Section 1



# Welcome to ArcMap

# 1

## IN THIS CHAPTER

- Visualizing information
- Working geographically
- Showing relationships
- Solving problems
- Creating and updating data
- Presenting results
- Developing mapping applications
- Tips on learning ArcMap

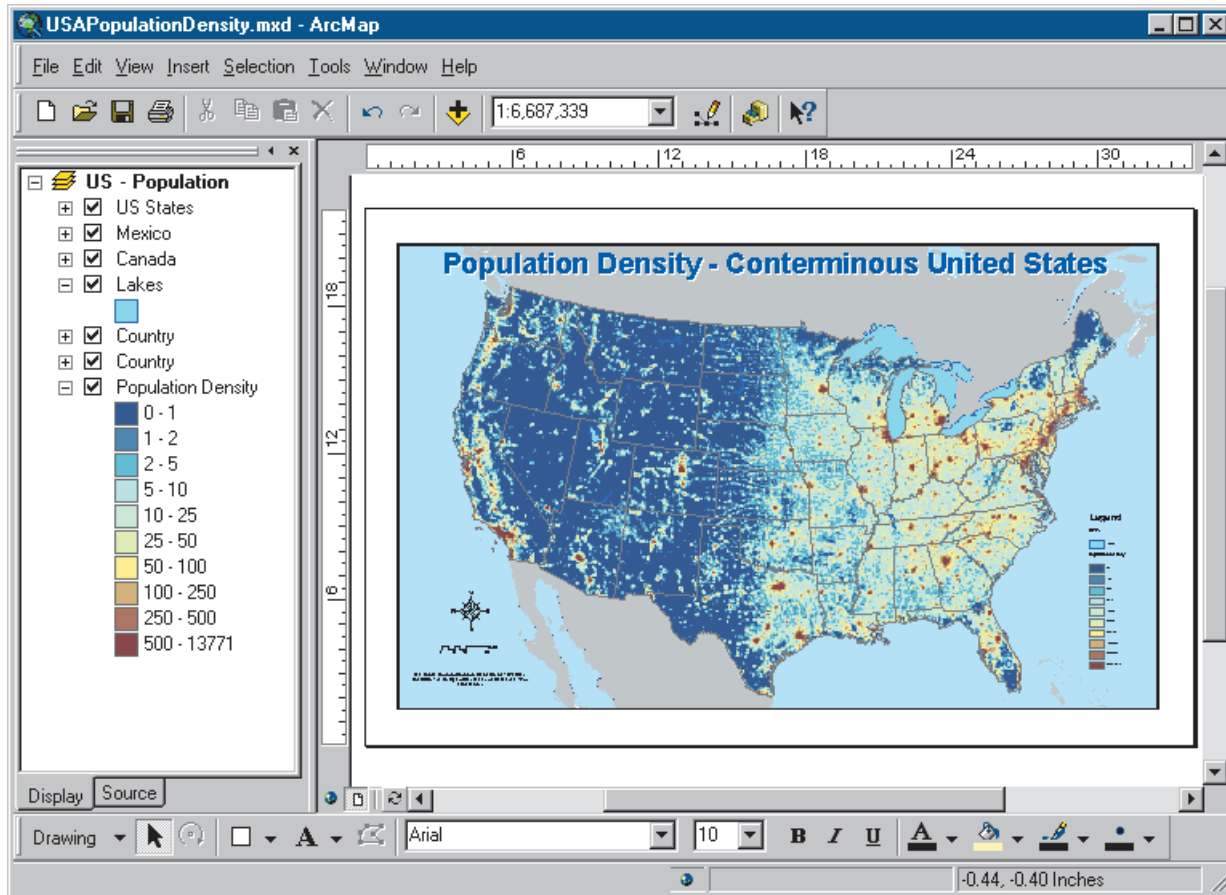
Welcome to ArcMap™, the premier ESRI® software for desktop geographic information systems (GIS) and mapping. ArcMap gives you the power to:

- **Visualize.** In no time you'll be working with your data geographically: seeing patterns you couldn't see before, revealing hidden trends and distributions, and gaining new insights.
- **Create.** It's easy to create maps to convey your message. ArcMap provides all the tools you need to put your data on a map and display it in an effective manner.
- **Solve.** Working geographically lets you answer questions such as "Where is...?", "How much...?", and "What if...?". Understanding these relationships will help you make better decisions.
- **Present.** Showing the results of your work is easy. You can make great-looking publication-quality maps and create interactive displays that link charts, tables, drawings, photographs, and other elements to your data. You'll find that communicating geographically is a powerful way to inform and motivate others.
- **Develop.** The ArcMap customization environment lets you tailor the interface to suit your needs or the needs of your organization, build new tools to automate your work, and develop standalone applications based on ArcMap mapping components.

The next few pages show you some of the things you can do with ArcMap. As you start making your own maps, you'll discover even more.

# Visualizing information

Sometimes just looking at a map will tell you what you want to know. Maps not only tell you where things are, but also what's special about them. This population map shows you where people live in the United States. From it, you can easily see where the major metropolitan areas are located.



*Do you live in a populated area? Areas drawn with dark blue have a lower population density than areas drawn with yellow and brown.*

# Working geographically

Maps are not static displays; they're interactive. You can browse a map—taking a closer look at a particular area—and point at features to find out more about them.

The screenshot shows the ArcMap interface with the following components:

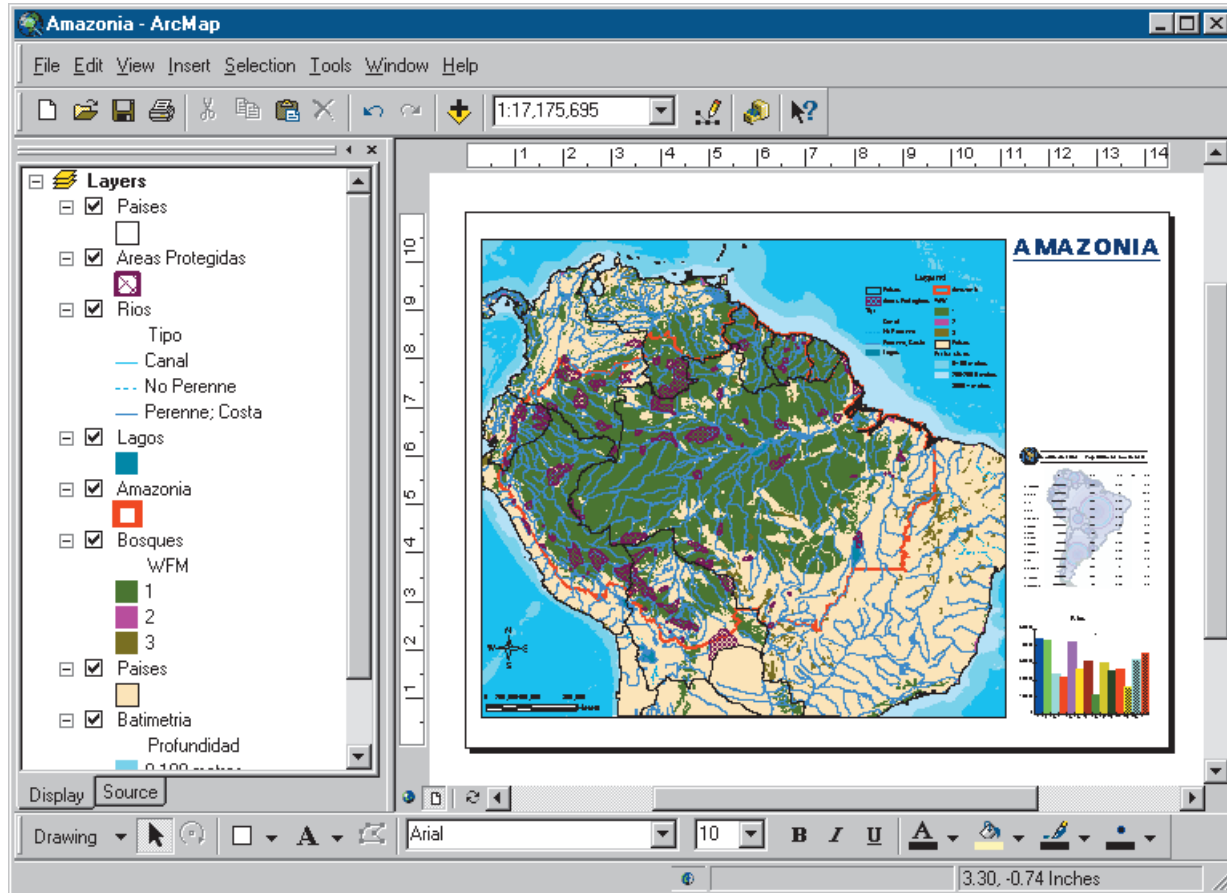
- Title Bar:** AfricaThematic.mxd - ArcMap
- Menu Bar:** File Edit View Insert Selection Tools Window Help
- Toolbars:** Standard, Navigation, and a scale bar showing 1:99,635,055.
- Legend:** Shows layers for World Country, Africa - MHT, Africa - Countries, and Major Habitat Types. The Major Habitat Types legend includes categories like Lakes, Deserts and xeric shr, Flooded grasslands, Mangroves, Mediterranean scrub, Montane grasslands, Temperate coniferous, Tropical and subtropical, and World Country.
- Main Map Area:** Titled "The African Landscape", it displays three maps of Africa:
  - Major Habitat Types:** A map showing different ecological zones across the continent.
  - Rainfall:** A map showing precipitation levels across Africa.
  - Population:** A map showing population density across Africa.
- Identify Results Window:** Shows the results of a query on the "Major Habitat Types" layer. The location is [0.213315 25.445558].

Field	Value
AREA	410.506989
PERIMETER	283.471436
AFRICA_ECO#	176
AFRICA_ECO-ID	79
ECOREG_OLD	92
ECO_CODE	98
ECO_SYM	24
ECOREGION	Sahara Desert

*Get a regional perspective by zooming in. Want to know more about a particular area? Just point at it.*

# Showing relationships

You can show relationships between features by opening tables and creating charts, then adding these elements to the map.

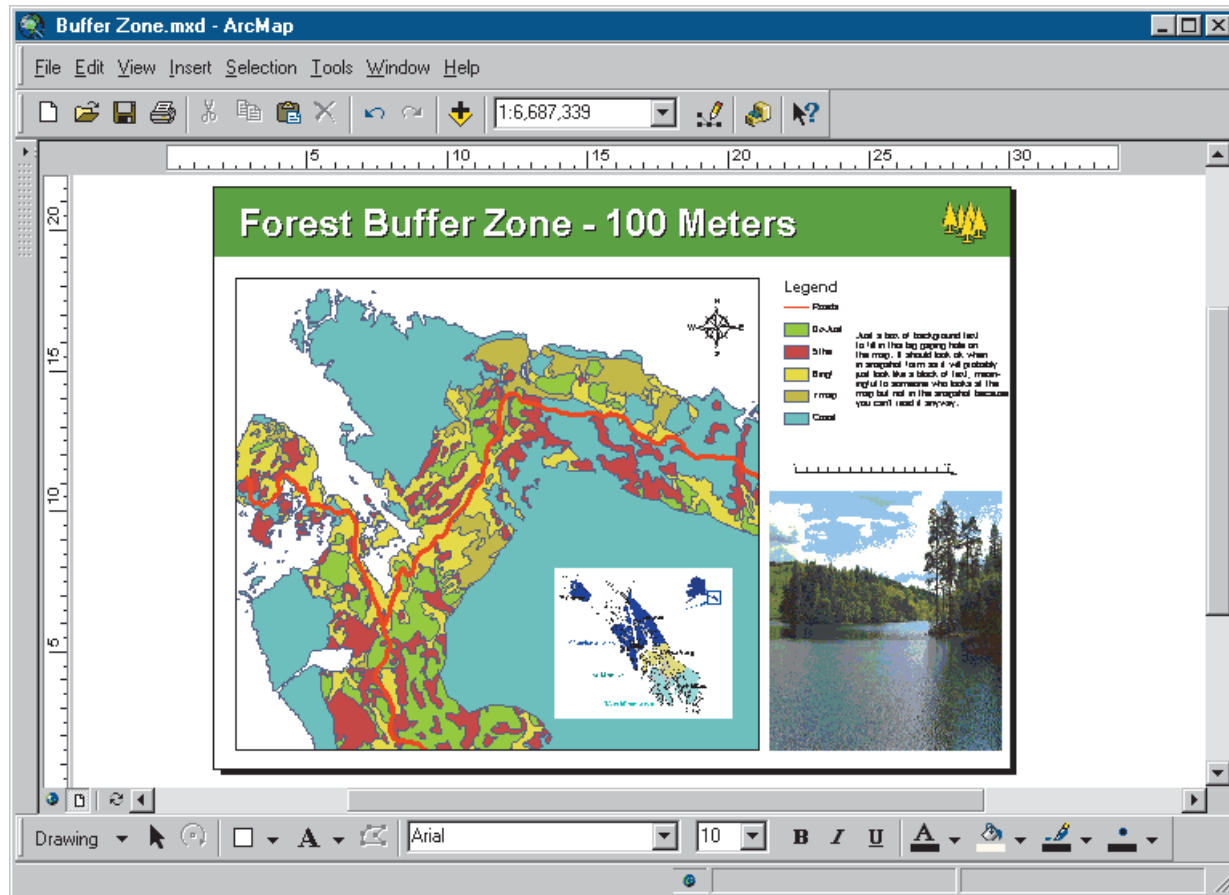


*Charts and tables complement the map because they quickly summarize information that would otherwise take more time to understand.*



# Solving problems

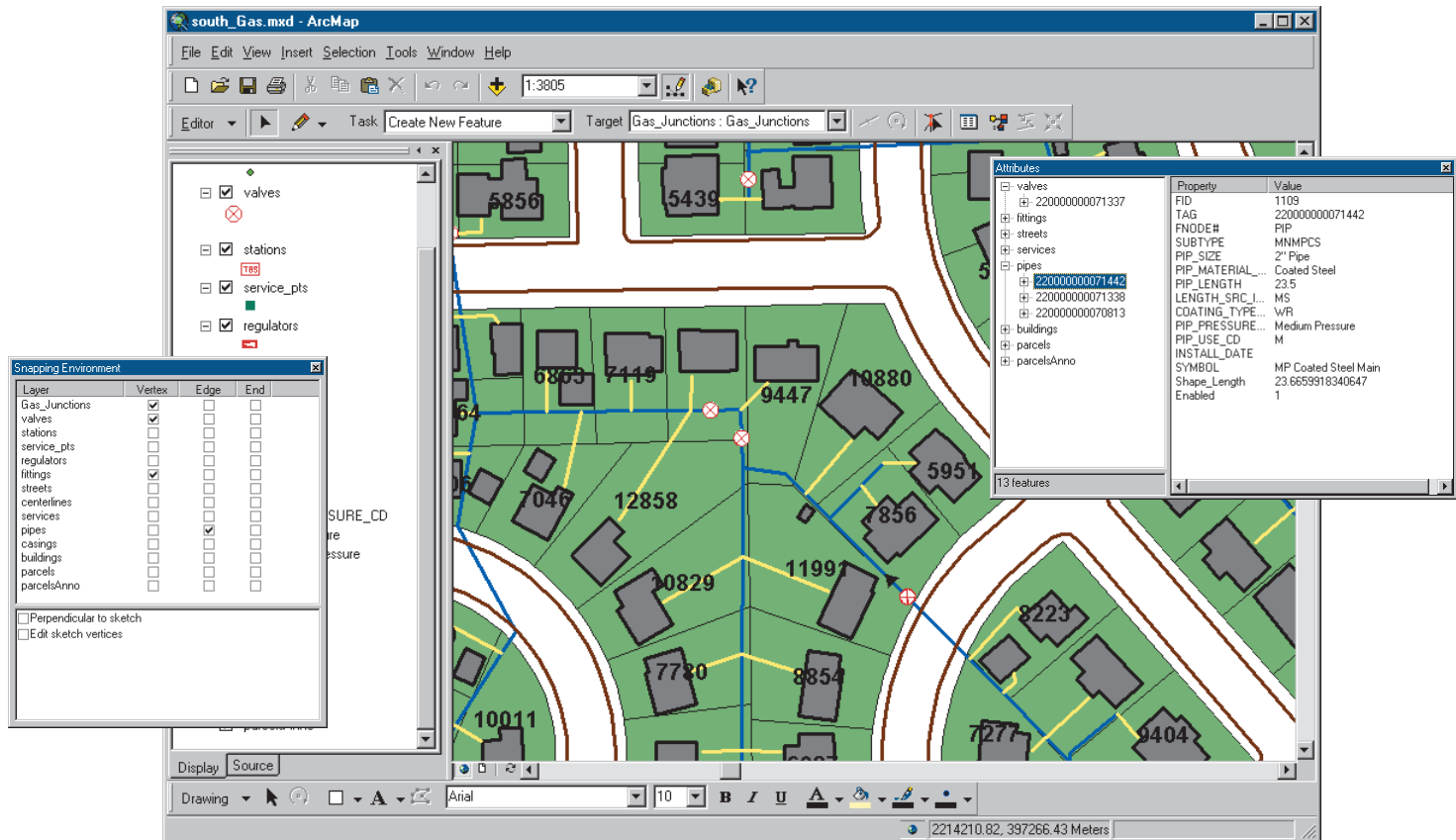
You can search a map for features that meet particular criteria—for instance, find features by name, proximity, or characteristic.



*Finding forest habitats within 100 meters of roads aids in assessing environmental impact.*

# Creating and updating data

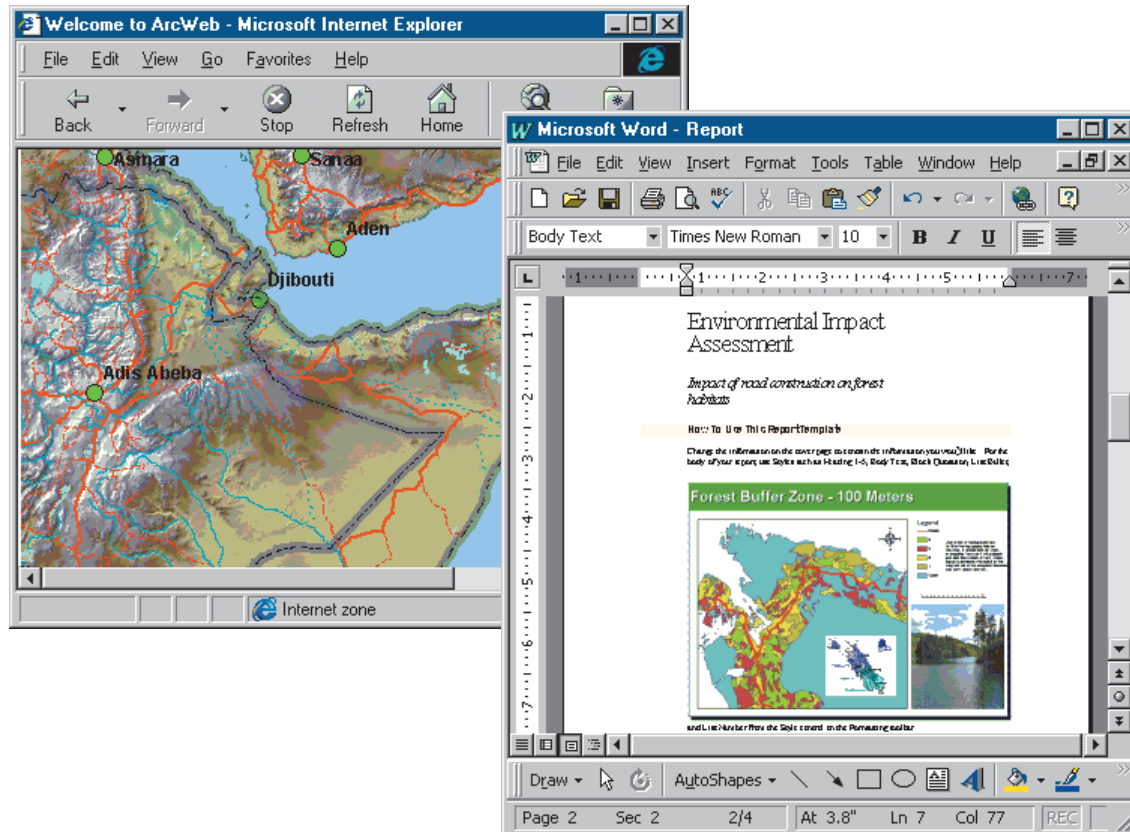
You can keep your data current with the latest information from the field. ArcMap has integrated editing tools to help you update data or create new data.



*As a city grows, so too does its parcel database. ArcMap lets you edit both the geometry and attributes of features.*

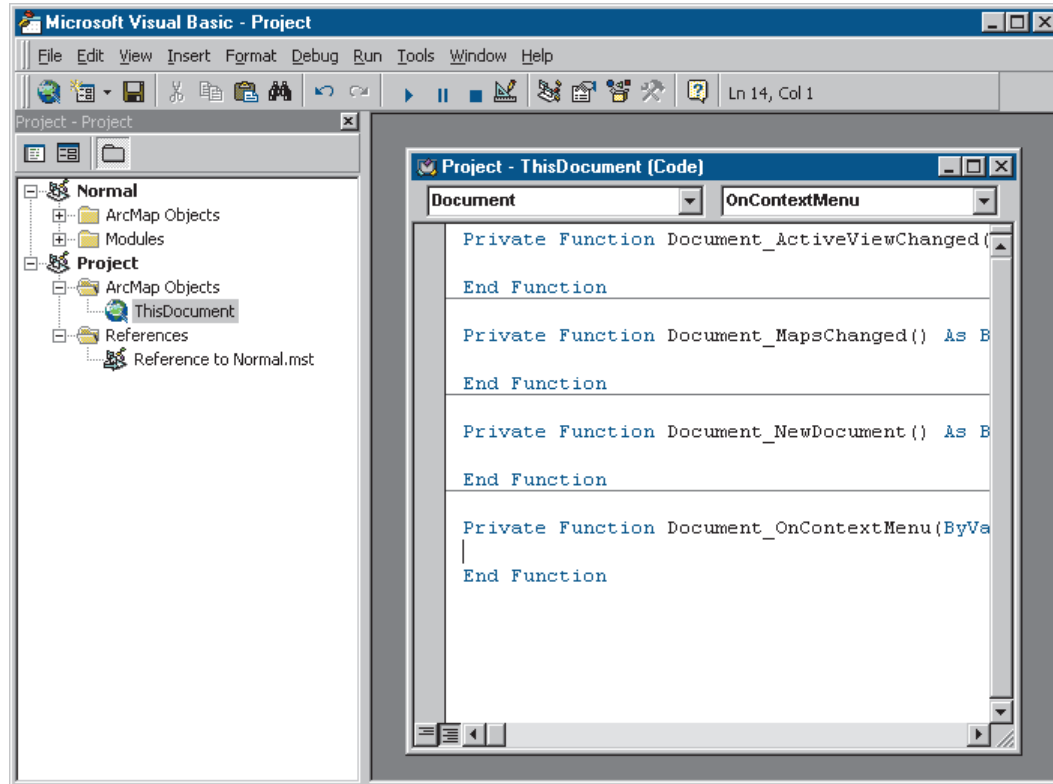
# Presenting results

You can create high-quality maps and present them to others. Embed maps in reports, publish them on the Web, export them to standard formats, or print them out to hang on the wall.



## Developing mapping applications

You can develop custom mapping applications. Customize the out-of-the-box capabilities of ArcMap using the built-in Visual Basic® for Applications (VBA) programming environment or your favorite programming language. With ArcMap, you can customize the interface to suit your needs, write macros to automate work, or use ArcMap components to embed mapping capabilities into other software you create.



*Automate your work with macros.*

## Tips on learning ArcMap

If you're new to GIS and mapping, remember that you don't have to learn everything about ArcMap to get immediate results. Begin learning ArcMap by reading Chapter 2, 'Quick-start tutorial'.

This chapter shows you how quickly and easily you can make a map and gain insights into the steps you'll use to create your own. ArcMap comes with the data used in the tutorial, so you can follow along step by step at your computer. You can also read the tutorial without using your computer.

If you prefer to jump right in and experiment on your own, take a look at some of the maps distributed with ArcMap. Try browsing a map, changing symbols, and adding your own data.

When you're ready to build your own maps, you'll find that ArcMap comes with useful data you can use directly or as basemap data for your own data. If you don't find what you need, more data is available from ESRI, from other organizations, and from the Internet. ArcMap also comes with lots of predefined symbols, North arrows, and scale bars to make building maps easier.

### Finding answers to questions

Like most people, your goal is to complete your tasks while investing a minimum amount of time and effort on learning how to use software. You want intuitive, easy-to-use software that gives you immediate results without having to read pages of documentation. However, when you do have a question, you want the answer quickly so you can complete your task. That's what this book is all about—getting you the answers you need when you need them.

This book describes the mapping tasks—from basic to advanced—that you'll perform with ArcMap. Although you can read this book from start to finish, you'll likely use it more as a reference. When you want to know how to do a particular task, such as saving a map, just look it up in the table of contents or

index. What you'll find is a concise, step-by-step description of how to complete the task. Some chapters also include detailed information that you can read if you want to learn more about the concepts behind the tasks. You may also refer to the glossary in this book if you come across any unfamiliar GIS terms or need to refresh your memory.

### Getting help on your computer

In addition to this book, the ArcMap online Help system is a valuable resource for learning how to use the software. To learn how to use Help, see 'Getting help' in Chapter 3 of this book.

### Learning about ArcMap extensions

ArcMap extensions are add-on programs that provide specialized GIS functionality. Extensions that come with ArcMap are covered in this book.

### Contacting ESRI

If you need to contact ESRI for technical support, see the product registration and support card you received with ArcMap or refer to 'Getting technical support' in the online Help system's 'Getting more help' section.

You can also visit ESRI on the Web at [www.esri.com](http://www.esri.com) for more information on ArcMap and ArcInfo™.

### ESRI education solutions

ESRI provides educational opportunities related to geographic information science, GIS applications, and technology. You can choose among instructor-led courses, Web-based courses, and self-study workbooks to find education solutions that fit your learning style and pocketbook. For more information, visit [www.esri.com/education](http://www.esri.com/education) on the Web.



# Quick-start tutorial

# 2

## IN THIS CHAPTER

- **Exercise 1: Exploring your data**
- **Exercise 2: Working with geographic features**
- **Exercise 3: Working with tables**
- **Exercise 4: Editing features**
- **Exercise 5: Working with map elements**

The best way to learn ArcMap is to try it yourself. This tutorial guides you through some basic ArcMap skills as you create and print a set of maps for a county that is planning to expand its airport.

Residents of the county have identified several issues they are concerned about. These include noise affecting schools and houses near the airport and increased traffic along major roads. In this tutorial, you'll first create and print a map showing schools near the airport. Then you'll place this map—along with two other maps that show land use surrounding the airport and population density for the county—on a wall-sized poster for display.

In the tutorial, you'll learn how to:

- Display map features.
- Add data to your map.
- Edit geographic data.
- Work with data tables.
- Query and select geographic features.
- Create a summary chart.
- Lay out and print a map.

There are five exercises. Each exercise takes between 30 and 45 minutes to complete. You can work through the entire tutorial or complete each lesson one at a time.

## Exercise 1: Exploring your data

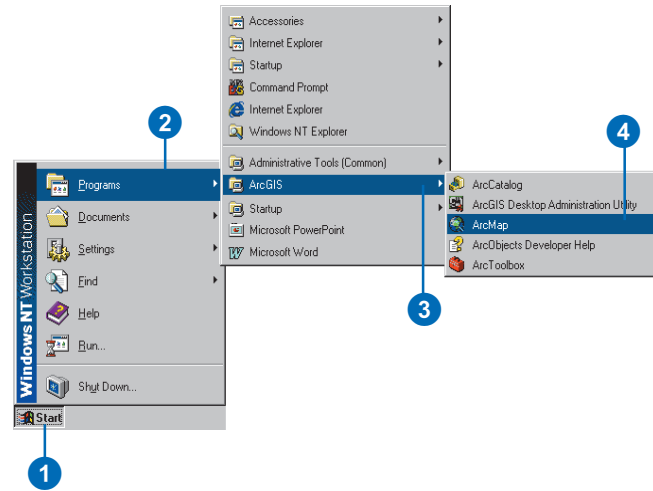
In this exercise, you'll create a map showing locations of schools near the airport along with a noise contour to see which schools may be affected by noise from the airport. The noise contour is based on the 65 Community Noise Equivalency Level (CNEL), which indicates areas experiencing more than 65 decibels of noise, averaged over a 24-hour period. In many cases, buildings within the 65 CNEL will need soundproofing or other mitigation measures.

The exercises in this chapter use the tutorial data distributed with ArcMap. The default install location of the data is C:\ArcGIS\ArcTutor\Map. The exercises require that you have write access to this data. If you don't, you'll need to copy the data to a location that you do have write access to.

### Starting ArcMap

ArcMap lets you explore your geographic data and create maps for display.

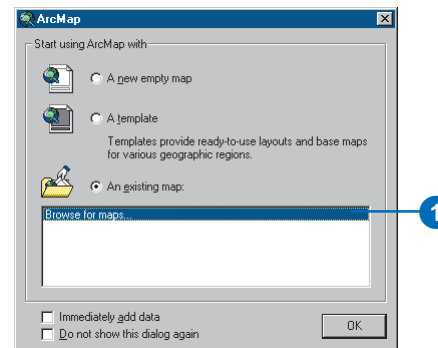
1. Click the Start button on the Windows taskbar.
2. Point to Programs.
3. Point to ArcGIS.
4. Click ArcMap.



### Opening an existing map document

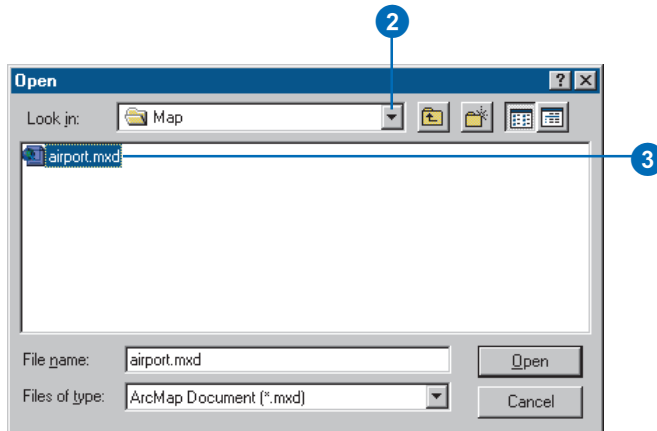
The first time you start ArcMap, the Startup dialog box appears. The Startup dialog box offers you several options for starting your ArcMap session. For this exercise, you want to open an existing map document.

1. Double-click Browse for maps.





- In the dialog box, click the Look in dropdown arrow, and navigate to the Map folder on the local drive where you installed the tutorial data (the default installation path is C:\ArcGIS\ArcTutor\Map).



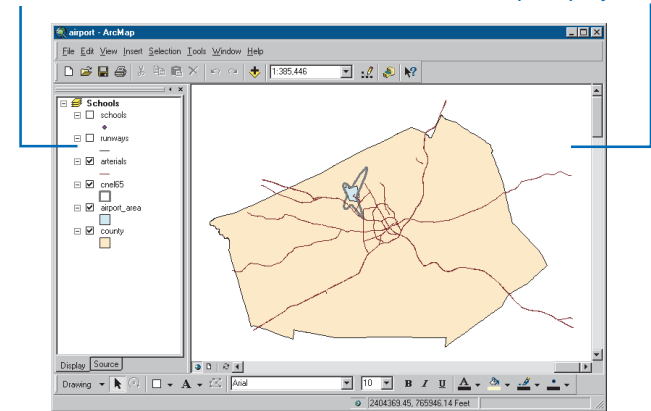
- Double-click `airport.mxd`. ArcMap opens the map.

ArcMap stores a map as a map document so you can redisplay it, modify it, or share it with other ArcMap users. The map document doesn't store the actual data, but rather references the data stored on disk along with information about how it should be displayed. The map document also stores other information about the map such as its size and the map elements it includes (title, scale bar, and so on).

To the left of the ArcMap display window is the *table of contents*, showing you which geographic *layers* are available to display. To the right is the map display area.

Table of contents

Map display area



This particular map contains the following layers in a *data frame* called Schools:

schools	locations of elementary, middle, high, and private schools
runways	location of airport runways
arterials	major roads
cnel65	the noise contour
airport_area	the proposed airport expansion zone
county	the county boundary

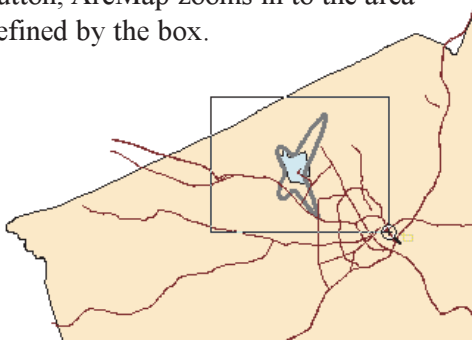
The map currently displays the arterials, noise contour, airport area, and county boundary. Their boxes are checked in the table of contents.

## Moving around the map

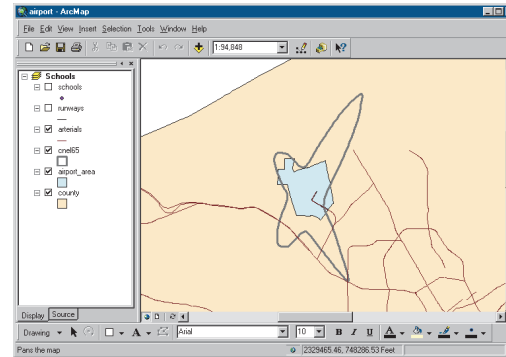
The Tools toolbar lets you move around the map and query the features on the map. Place your pointer over each icon (without clicking) to see a description of each.



1. Using the Zoom In tool, draw a box around the noise contour to zoom in. Place the pointer on the upper-left part of the contour, press the mouse button, and hold it down while dragging to the lower-right. You'll see the box drawn on the screen. When you release the mouse button, ArcMap zooms in to the area defined by the box.

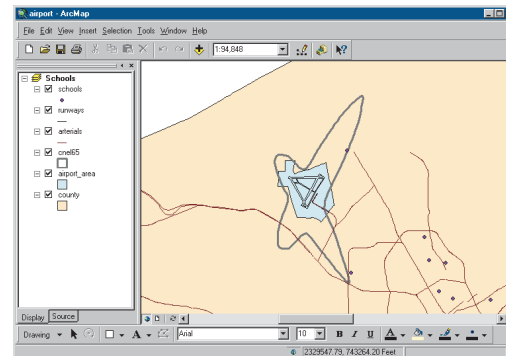


2. If necessary, use the Pan tool (the hand) on the Tools toolbar to reposition the map so the noise contour is in the center of the display area (hold the mouse button down while dragging in the direction you want to move the features, then release the button).



## Displaying a layer

The table of contents lets you turn layers on and off in the display. To display a layer, check the box next to its name. To turn it off, uncheck it. Display the schools and runways by checking their boxes in the table of contents. For more information, see Chapter 5, 'Managing layers'.



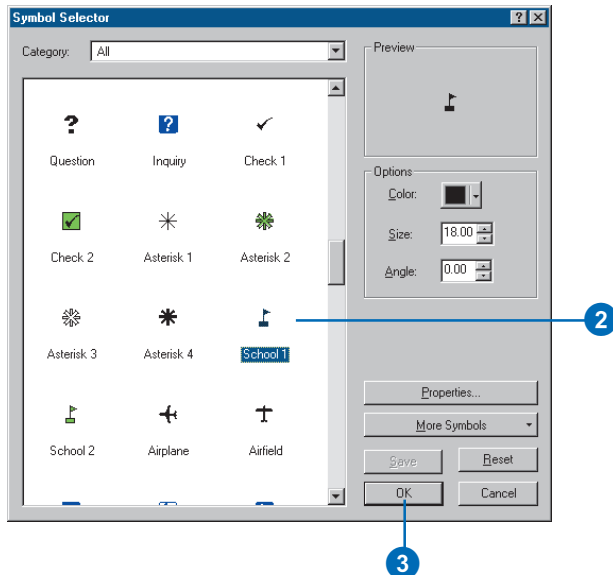
## Changing the display symbol

ArcMap lets you change the colors and symbols you use to display features. You'll change the symbols for schools from a dot to a standard symbol used for schools on many maps.

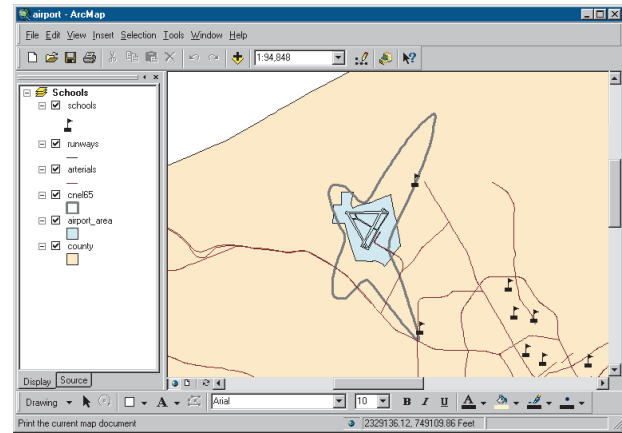
1. Click the dot symbol in the table of contents to display the Symbol Selector window.



2. Scroll down until you find the School 1 symbol. Click it.



3. Click OK. The schools are drawn with the new symbol.

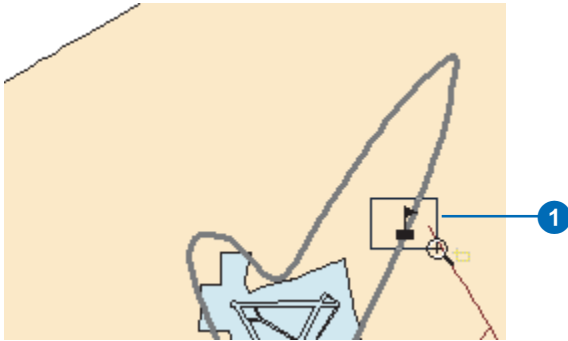


You can also open the symbol dialog by right-clicking the layer name, choosing Properties from the menu that appears, and clicking the Symbology tab. To simply change the color of a symbol, right-click the symbol in the table of contents to display the color palette. For more information on changing display symbols, see Chapter 6, 'Symbolizing your data'.

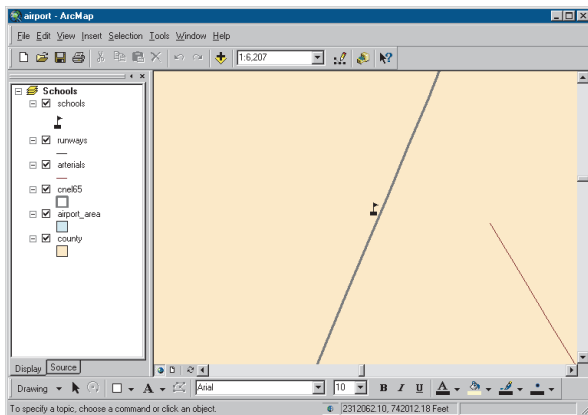
## Identifying a feature

There is one school that may be within the noise contour around the airport.

1. Using the Zoom In tool, draw a box around the school to zoom in.



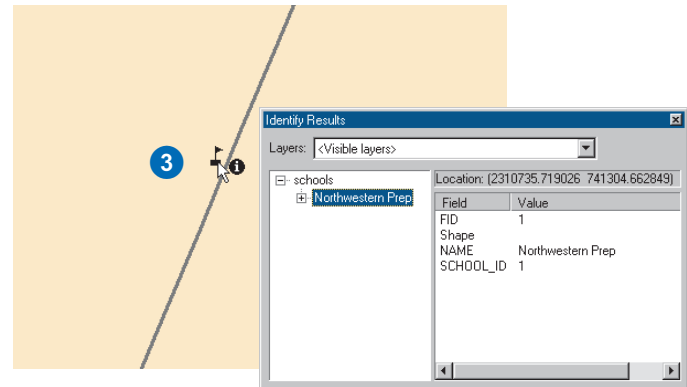
You can see that the school is indeed within the noise contour.



2. Click the Identify tool on the Tools toolbar.

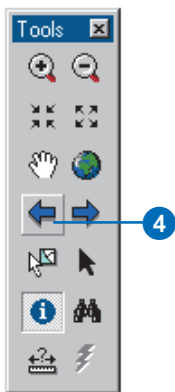


3. Move the mouse pointer over the school and click. The name of the school (Northwestern Prep) is listed in the Identify Results window. Notice that only the features in the topmost layer are identified. You can also identify features in other layers by choosing the specific layers you want to identify by clicking the Layers dropdown arrow in the dialog box.



Close the Identify Results window.

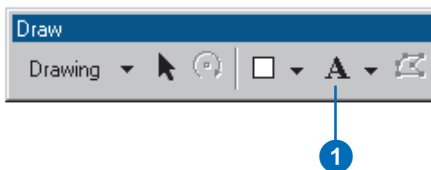
- Click the Back button on the Tools toolbar to return to your previous view.



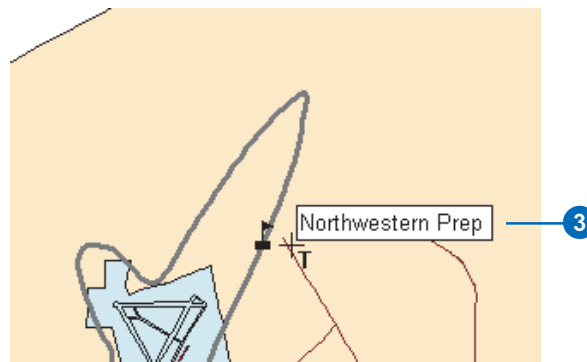
## Adding graphics

You can add text and other graphics to your display using the Draw toolbar at the bottom of the ArcMap window.

- Click the New Text button. The pointer changes to a crosshair with a T.



- Move the mouse pointer near the school you identified and click.
- In the text box that appears, type “Northwestern Prep” and press Enter.



A blue dotted line surrounds the text, indicating it is currently selected. You can drag the text to a new position by clicking and holding down the mouse button while dragging the text and then releasing the button.



- When you’re finished positioning the text near the school, click outside the text box to unselect it.

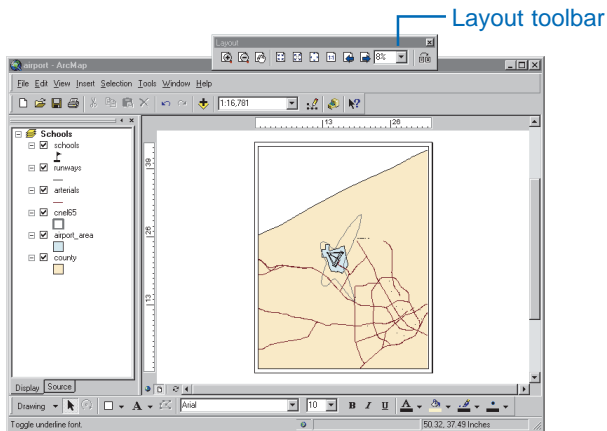
For more information on working with text, see Chapter 7, ‘Labeling maps with text and graphics’.

## Laying out a map

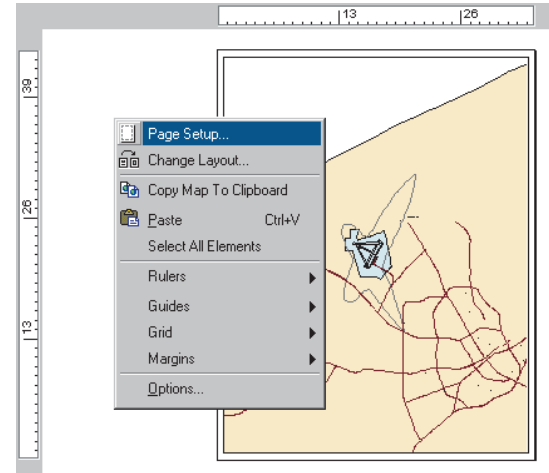
ArcMap lets you work in data view or layout view. Data view focuses on a single data frame. Use data view when exploring or editing your data. Layout view shows you how the map page looks. Use layout view when composing and printing a map for display. You can also explore and edit your data in layout view if you want. All the tools and options available in data view are also available in layout view.

You can change the size and orientation of the page in layout view. In this case, you'll create a 16-by-12 inch map with a landscape orientation.

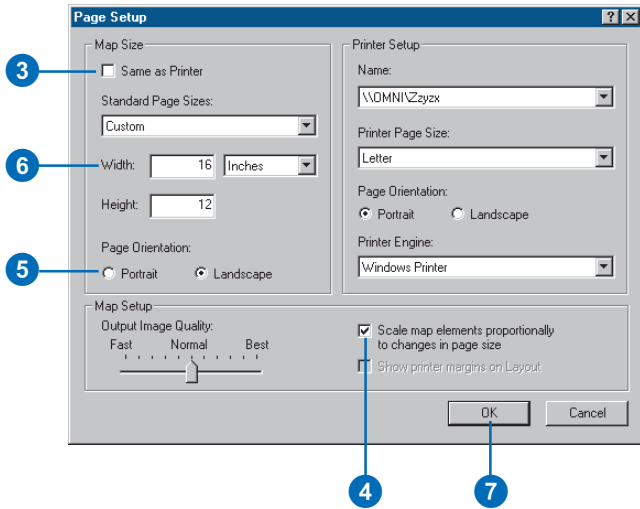
1. Click the View menu and click Layout view. The Layout toolbar appears, and the display changes to show the page layout with rulers along the side.



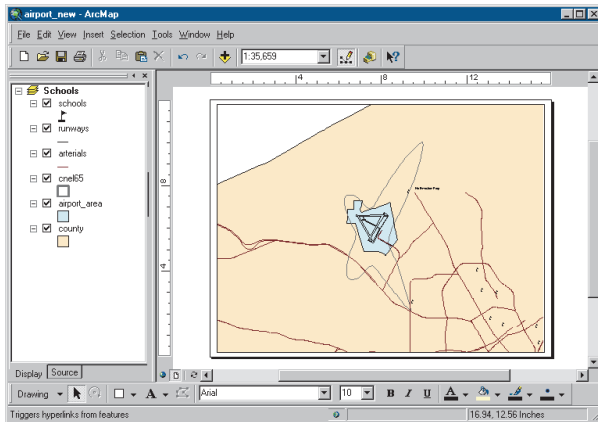
2. Right-click anywhere on the layout background and click Page Setup. You can also access Page Setup from the File menu.



3. Make sure the Same as Printer box is not checked—otherwise, the page size will default to be the same as your printer. (If your printer does not print larger sizes, you can scale the map down when you print it, as you'll see later in this exercise.)
4. Check Scale map elements proportionally to changes in page size. That way, the data will be rescaled to fit the page.
5. Set the Map Size Page Orientation to Landscape.
6. Set the page width to 16 and the height to 12 inches (just click in each box and type over the existing values).



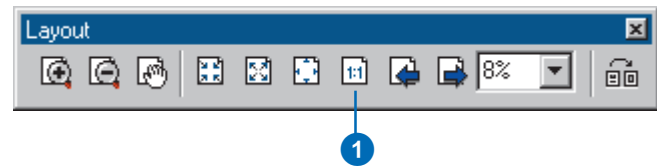
7. Click OK. The page display and rulers change to reflect the new size and orientation.



## Zooming in on the page

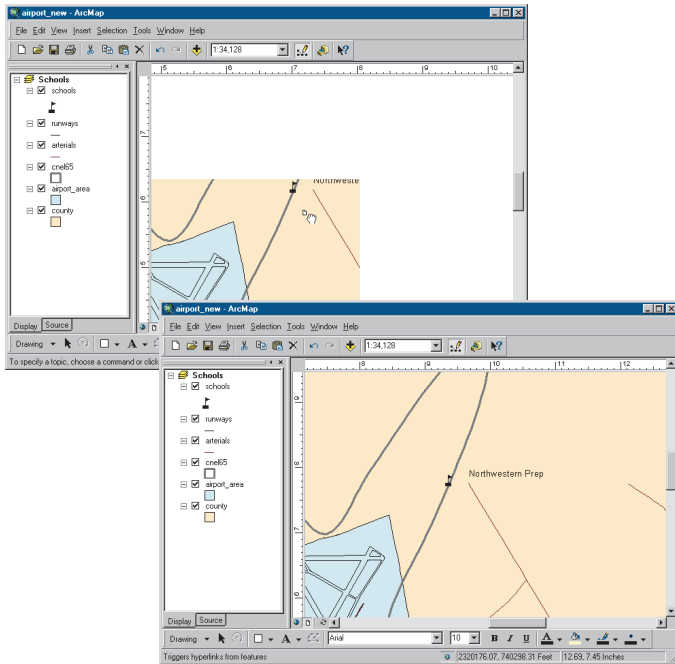
The Layout toolbar controls your view of the scale and position of the whole map (as opposed to the data layers on the map). By default, the map size is set so you can see all of it. But at this scale it's hard to see the school name.

1. Click Zoom to 100% on the Layout toolbar. The page is displayed at the actual printed size so you can see the detail.

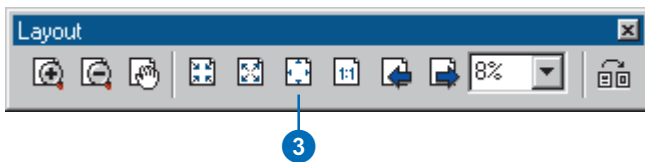


2. Click the Pan button on the Layout toolbar and drag the map to the lower left so you can see the name of the school.





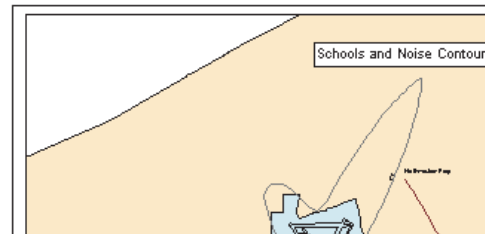
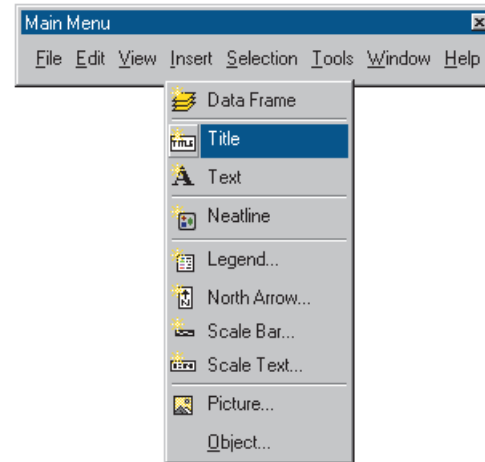
3. Click the Zoom Whole Page button on the Layout toolbar to see the entire page again.



## Inserting map elements

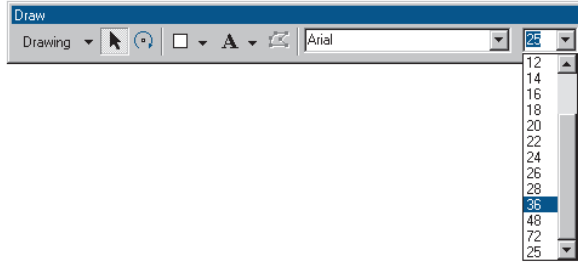
ArcMap makes it easy to add titles, legends, North arrows, and scale bars to your map.

1. Click Insert on the Main menu and click Title. In the box that appears, type the title for your map, “Schools and Noise Contour”, and press Enter.

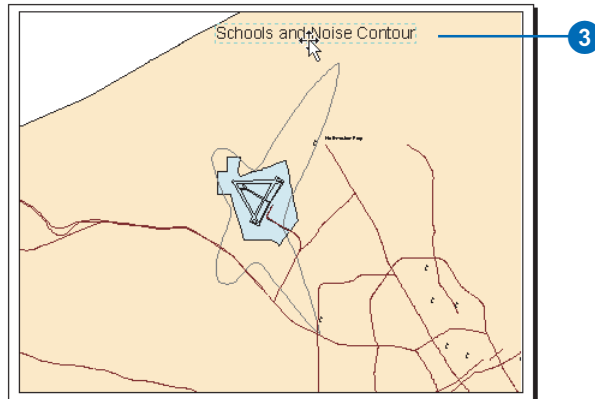




2. On the Draw toolbar at the bottom of the window, click the Text Size dropdown arrow and click 36 to change the title to 36 points.

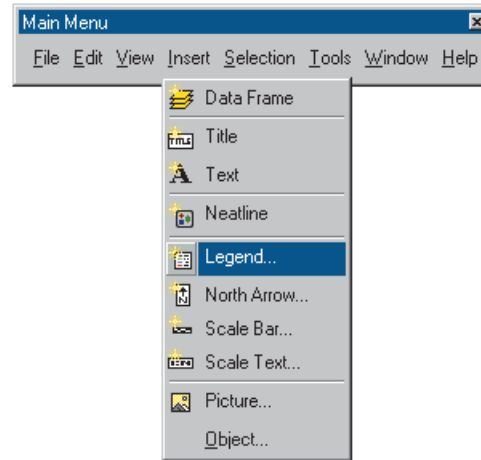


3. Click on the title and drag it so it's centered at the top of the map.



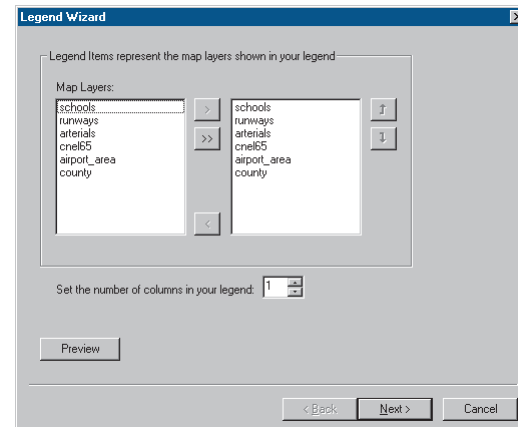
The Draw toolbar lets you add and change the format (font, size, color, and so on) of text and graphic elements—such as boxes, callout lines, or circles—on your map.

4. Click Insert and click Legend.



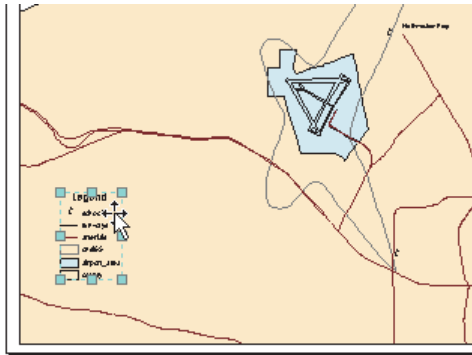
The Legend Wizard appears.

5. Click Next several times to step through the wizard accepting the default legend parameters. Click Finish when done.

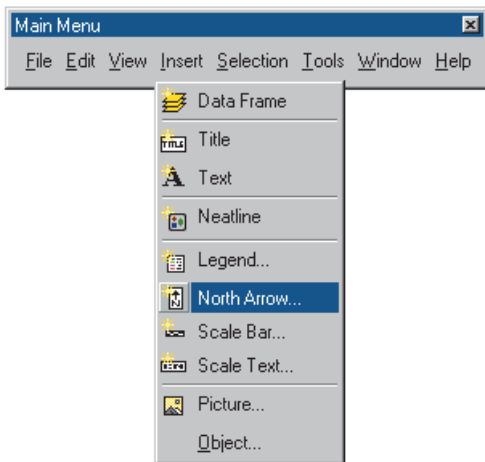


By default, ArcMap scales the legend to the page and includes all the layers that are currently displayed. You can modify the legend by right-clicking it and choosing Properties from the menu that appears. For now, just use the default legend.

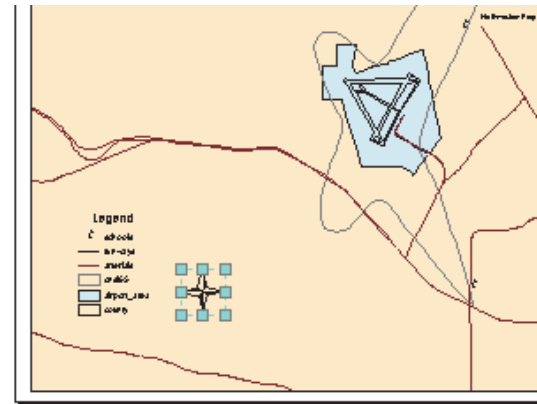
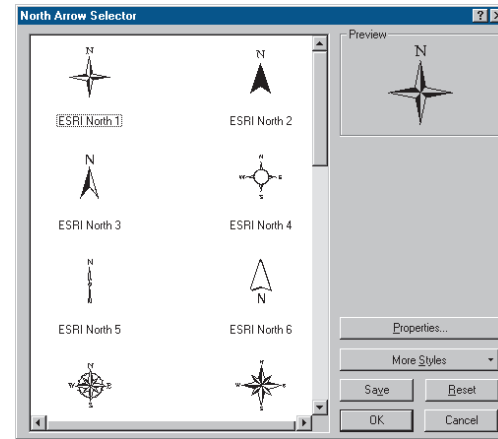
- Click and drag the legend to the lower-left corner of the map.



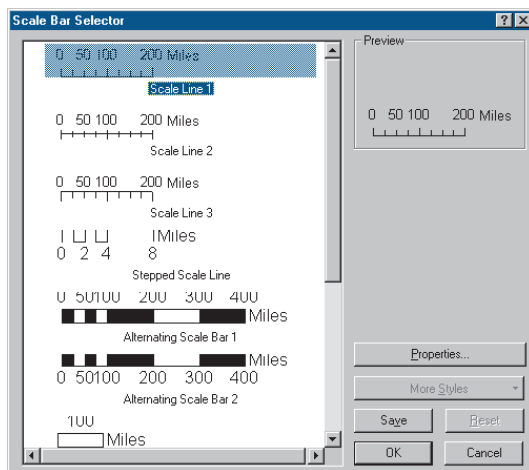
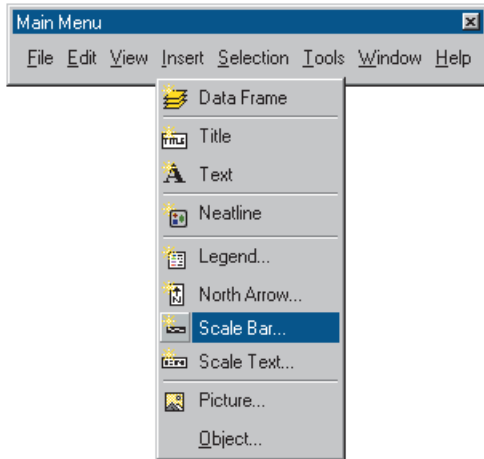
- Click Insert and click North Arrow. The North Arrow Selector window appears.



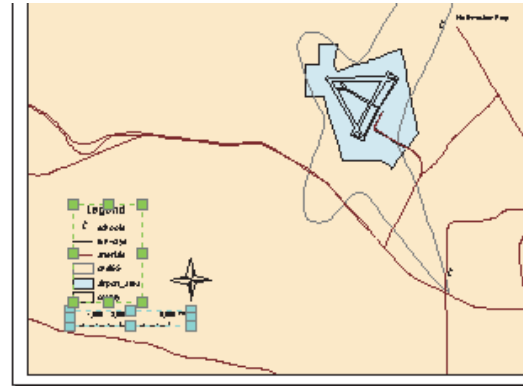
- Click ESRI North 1 and click OK. Click and drag the North arrow so it is to the right of the legend.



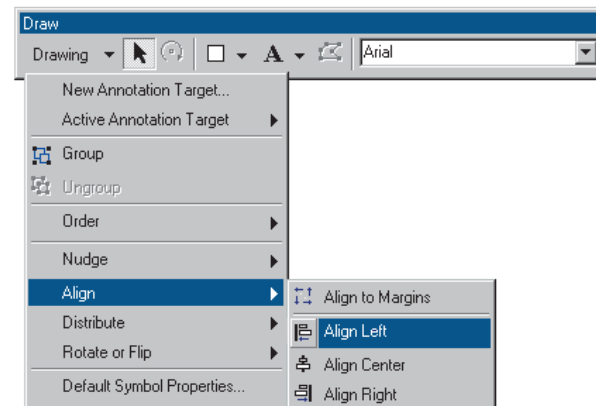
- Now insert a scale bar from the Insert menu. Click Scale Line 1 in the Scale Bar Selector window and click OK.

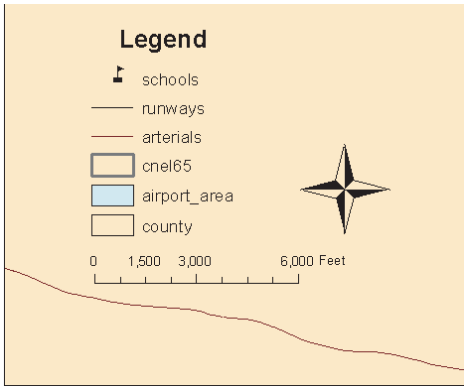


- Click and drag the scale bar under the legend and North arrow.
- Click the legend to select it, then click the scale bar while holding down the Shift key to select it as well.



- Click Drawing on the Draw toolbar, point to Align, and click Align Left from the menu that appears. The scale bar is now aligned with the left side of the legend.

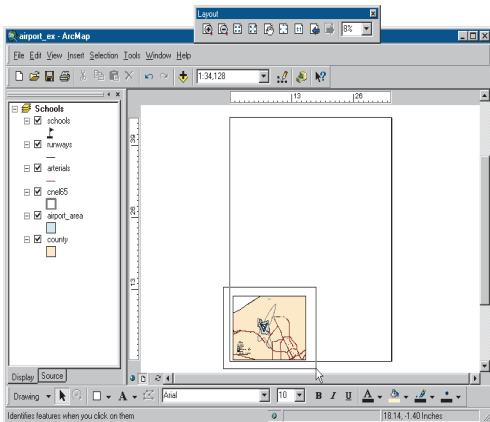




## Printing a map

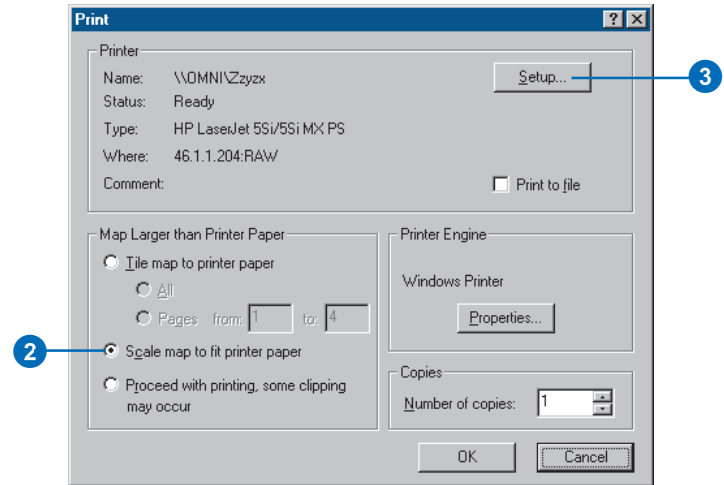
At this point, your first map is finished. If you have a printer connected to your computer, you can print the map.

1. Click File and click Print.



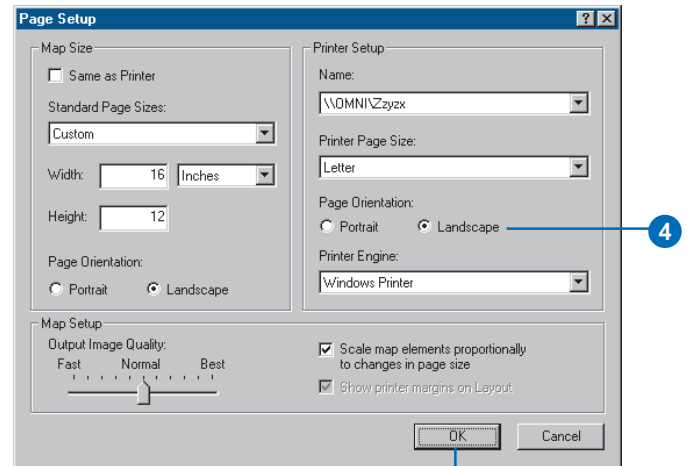
2. If the map (which is 16 by 12 inches) is larger than your printer paper, click Scale map to fit printer paper.

3. Click Setup.

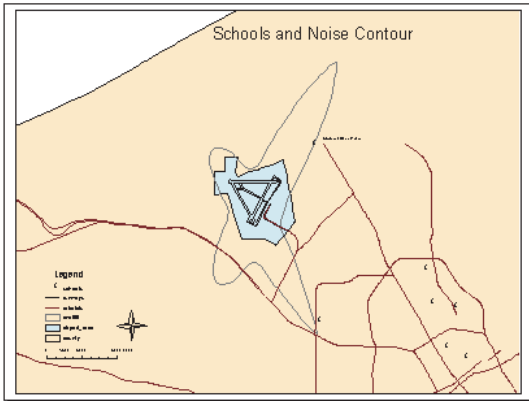


4. Click Landscape on the Printer Setup panel.

5. Click OK to close the Page Setup window.



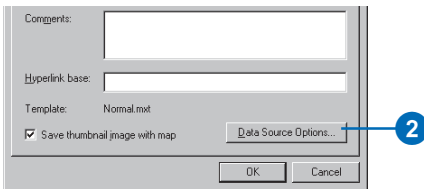
6. Click OK on the Print window to print your map.



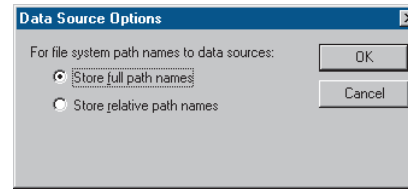
## Saving a map

Save your map in the folder with the tutorial data. First, though, specify that ArcMap use the full pathname of the location of the data on your system (the airport map was created using relative pathnames so ArcMap would find and display the data after the ArcTutor\Map folder was copied to your system).

1. Click File and click Map Properties.
2. Click Data Source Options on the Properties dialog box.



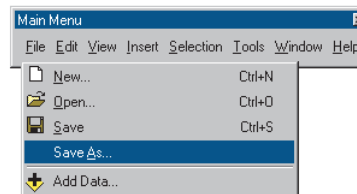
3. Click Store full path names and click OK.



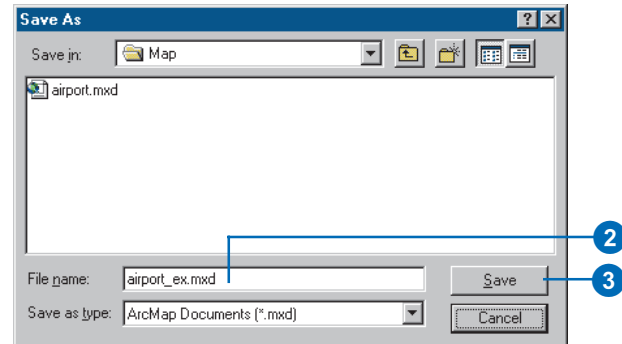
4. Click OK on the Map Properties dialog box.

Now save a copy of your map. You'll use this copy in the subsequent exercises.

1. Click File and click Save As.



2. In the File name box, type airport\_ex.
3. Click Save.



You can continue on with the tutorial or stop and complete it at a later time.

## Exercise 2: Working with geographic features

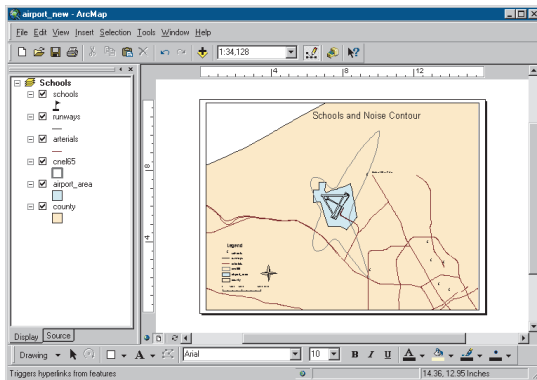
In this exercise, you'll map the amount of each land use type within the noise contour. You'll add data to your map, draw features based on an attribute, select specific features, and summarize them in a chart.

If necessary, start ArcMap, navigate to the folder where you saved the map from Exercise 1 (airport\_ex), and open the map.

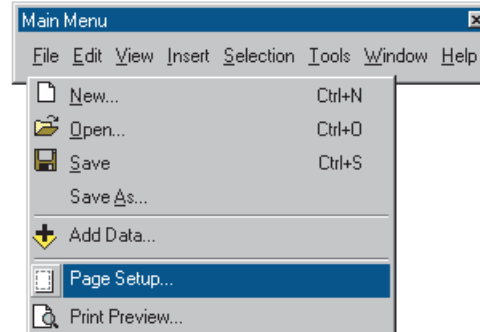
### Changing the page layout

First, you'll create the map layout by changing the page size and orientation.

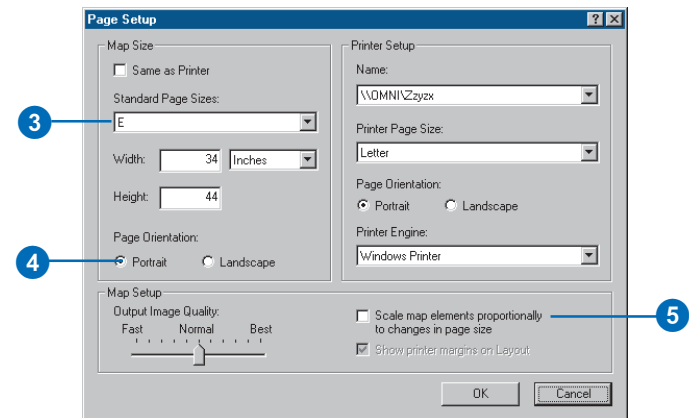
1. Make sure you're in layout view (click the View menu and click Layout View).



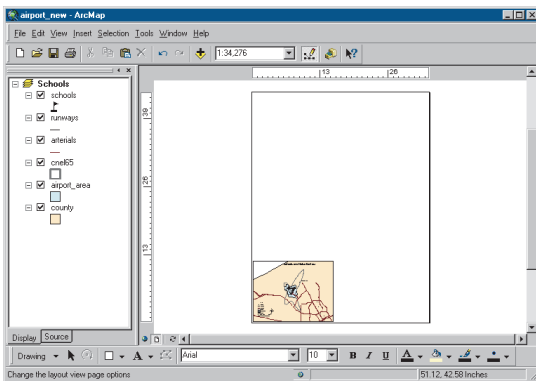
2. Click File and click Page Setup.



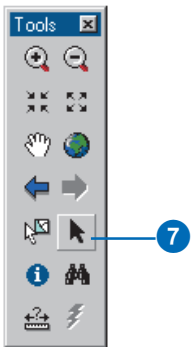
3. Click the Standard Page Sizes dropdown arrow and click E. That sets the width and height to a standard E-size page.
4. Click Portrait on the Map Size panel.
5. Uncheck Scale map elements proportionally to changes in page size (this way, the existing map of schools will remain the same size, rather than being scaled up to fit the page).



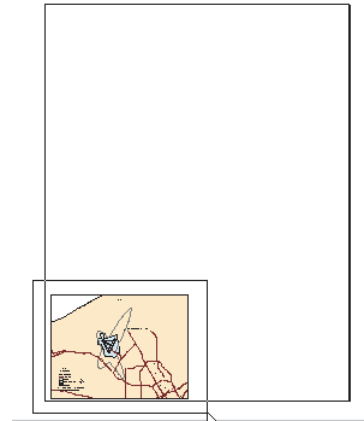
- Click OK. The page size changes, and the existing map is displayed in the lower-left corner.



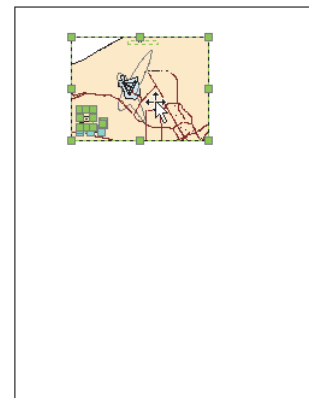
- Click the Select Graphics button on the Tools toolbar.



- Click and drag a box around the elements to select them.



- Click and drag the group of elements to the upper portion of the page.

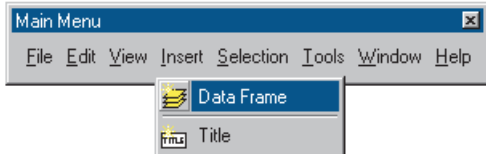


For more information on page layout, see Chapter 8, 'Laying out and printing maps'.

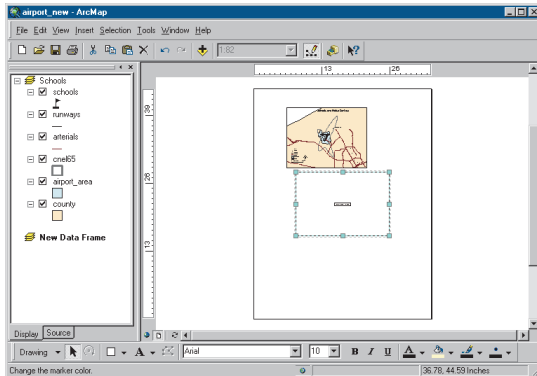
## Creating a new data frame

A data frame is a way of grouping a set of layers you want to display together. Now you'll add a new data frame to show land use.

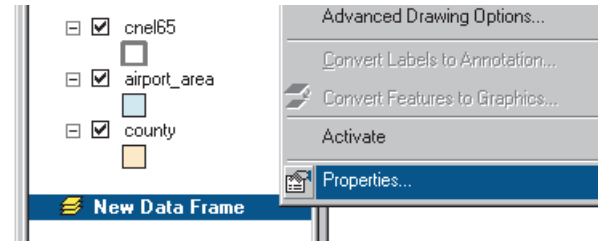
1. Click Insert and click Data Frame.



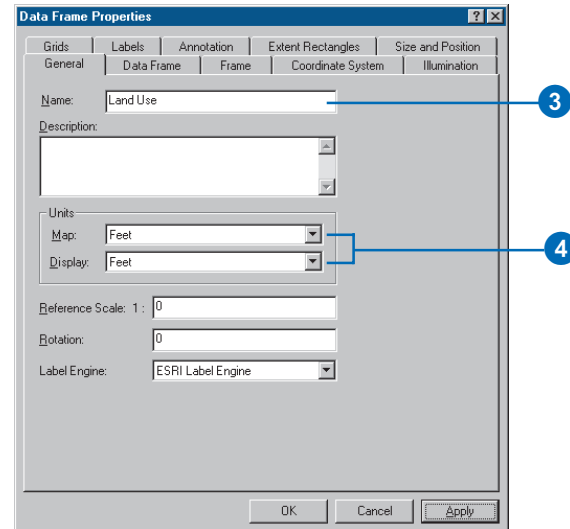
The frame appears on the layout and is listed in the table of contents.



2. Right-click New Data Frame in the table of contents and click Properties.

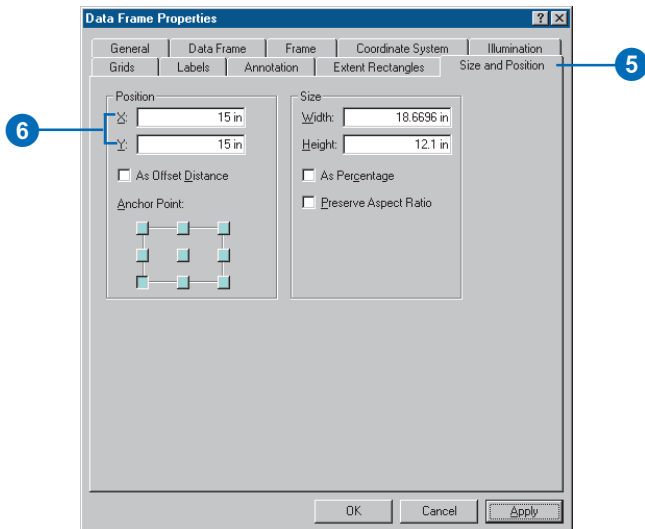


3. Click the General tab, highlight the existing text in the Name text box, and type Land Use.
4. Click the Units dropdown arrows and set the Map and Display units to feet.





- Click the Size and Position tab.
- Set the X position to 15 and the Y position to 15 by typing in the text boxes. This sets how far the lower-left corner of the data frame is, in inches, from the lower-left corner of the page. (You can specify X,Y position for another location on the data frame by clicking the appropriate box on the diagram.)

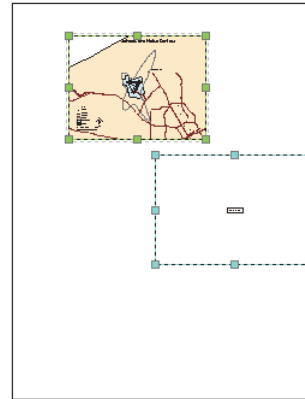


You can specify the position of any object on the page—the data frame itself, text, legends, and so on—either by selecting and dragging them or by setting the X and Y position explicitly.

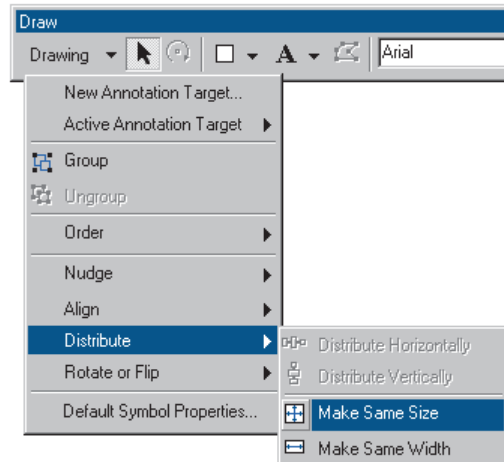
- Click OK. The data frame is repositioned.

The data frame is highlighted with a blue square, and its name is bold in the table of contents, indicating it is the frame you're currently working with.

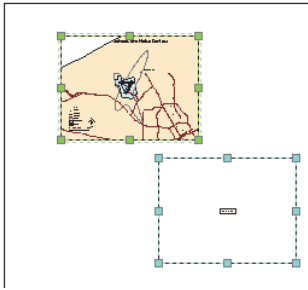
- Hold down the Shift key and click the top data frame on the page so both frames are selected.



- Click Drawing on the Draw toolbar, point to Distribute, and click Make Same Size.



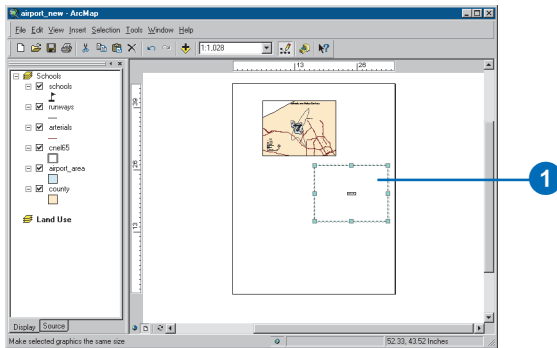
Both data frames are now the same size.



### Adding a data layer

You'll map land use based on a code for each land parcel. First, add the parcels layer to the data frame.

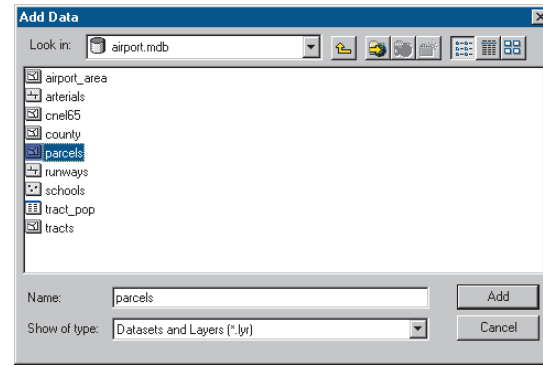
1. Click the Land Use data frame on the page, so that only it is selected.



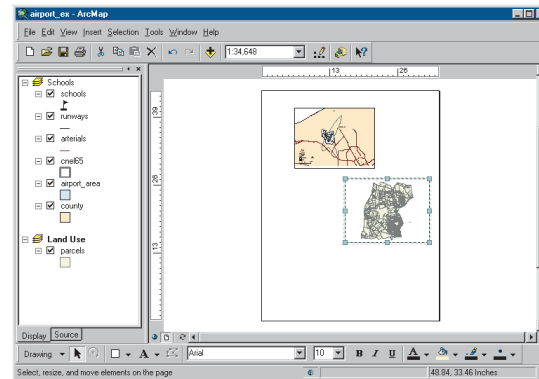
2. Click the Add Data button on the Standard toolbar.



3. Navigate to the Map folder on the local drive where you installed the tutorial data (the default installation path is C:\ArcGIS\ArcTutor\Map).
4. Double-click the airport geodatabase, airport.mdb.
5. Click the parcels layer and click Add.



The data layer is added to the table of contents and displays in the layout (the parcels may be a different color on your map).

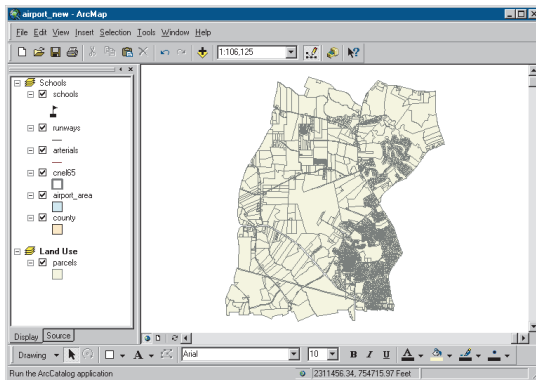
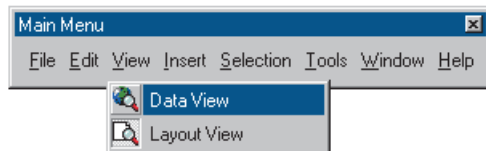


All the data used in this tutorial is stored in a geodatabase. ArcMap also lets you work with ArcInfo coverages, shapefiles, image files, and many other data formats. For more about geodatabases and other data formats, see *Using ArcCatalog*.

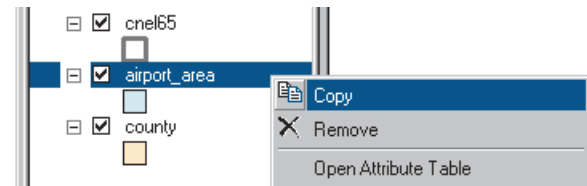
## Copying a layer

You'll want to display the noise contour and airport area with the parcels. You can copy them from the Schools data frame. First, though, switch back to data view.

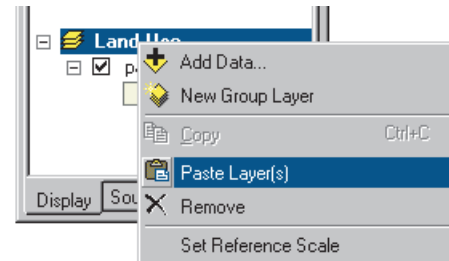
1. Click the View menu and click Data View. Now you're looking at only the area covered by the parcels, rather than at the entire map.



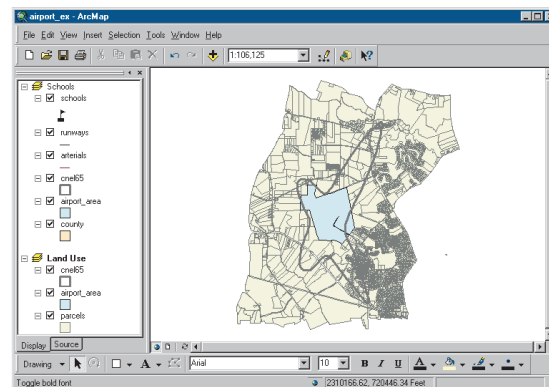
2. Right-click the airport\_area layer under the Schools data frame and click Copy.



3. Right-click the Land Use data frame name and click Paste Layer(s).



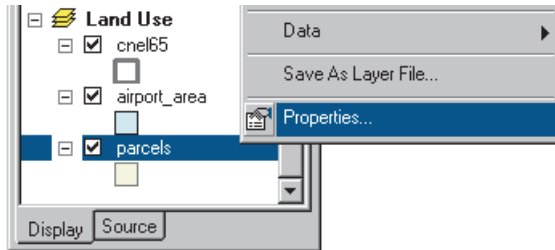
4. Copy the cnel65 layer the same way.



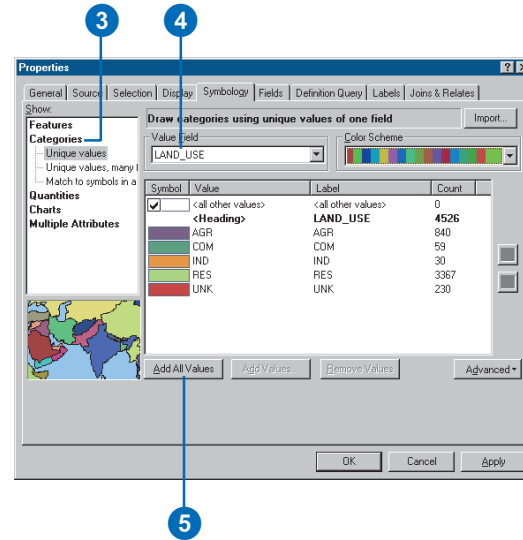
## Displaying features by category

By default, all the parcels are drawn using the same symbol when you add them. You can also draw them based on an attribute (in this case, type of land use).

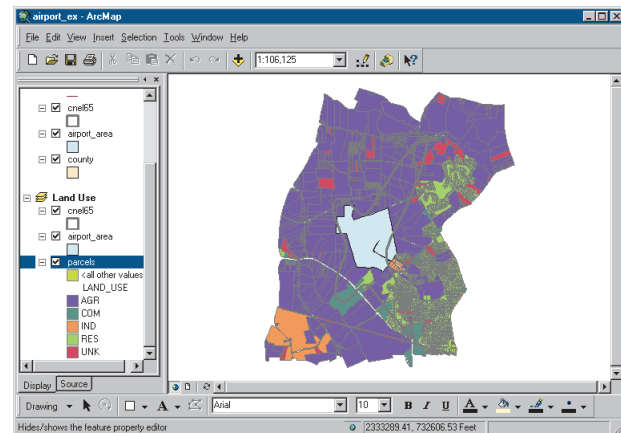
1. Right-click parcels in the table of contents and click Properties.



2. Click the Symbology tab. All parcels are currently drawn using the same symbol (the same solid fill color).
3. Click Categories in the Show box. Unique values is automatically highlighted.
4. Click the Value Field dropdown arrow and click LAND\_USE as the field to use to shade the parcels.
5. Click Add All Values. A unique color is assigned to each land use type.



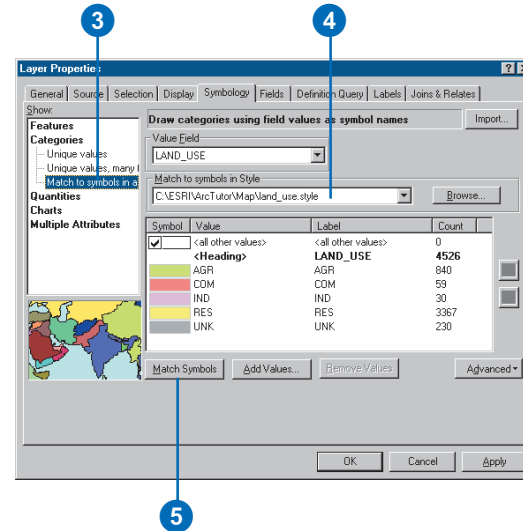
6. Click OK. The parcels are now drawn based on their land use type.



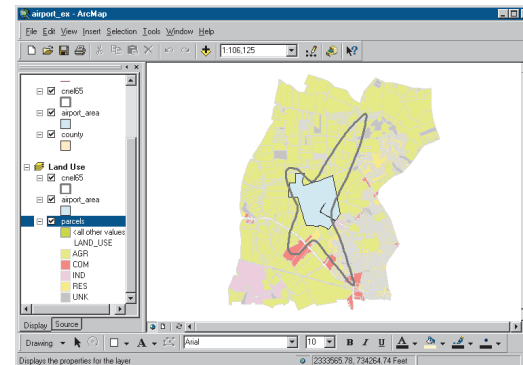
## Using a style

ArcMap uses a random set of symbols to draw the land use types (although you can change the color scheme). You can change an individual color by double-clicking it and specifying a new color in the Symbol Selector, or you can specify a *style* to use predefined colors and symbols (a style is a set of symbols stored in ArcMap, often specific to an application or industry). ArcMap provides some standard styles. You can also create your own. You'll use a land use style created for this tutorial.

1. Right-click parcels in the table of contents and click Properties.
2. Click the Symbology tab.
3. Under Categories in the Show window, click Match to symbols in a style.
4. Click the Browse button and navigate to the Map folder on the local drive where you installed the tutorial data (the default installation path is C:\ArcGIS\ArcTutor\Map). Click the land\_use style and click Open.
5. Click Match Symbols.



6. Click OK. The parcels will now be drawn using colors defined in the style.

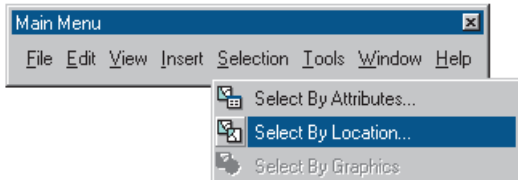


For more information on symbolizing and displaying features, see Chapter 6, 'Symbolizing your data'.

## Selecting features geographically

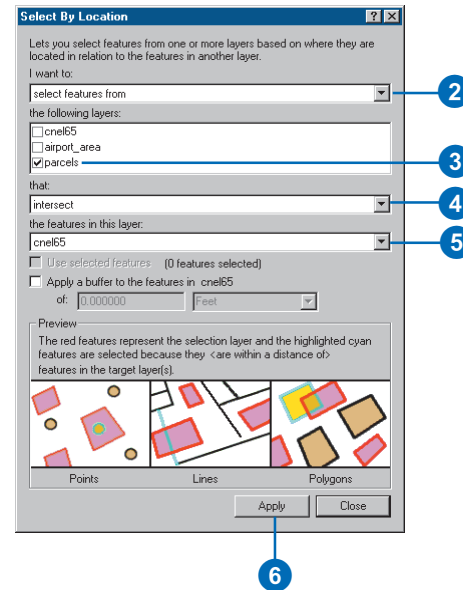
To find out how much of each land use is within the noise contour, select only those parcels within the contour.

1. Click Selection and click Select By Location.

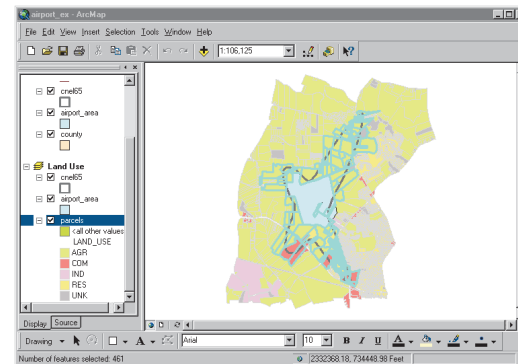


The Select By Location dialog box guides you through creating a geographic query.

2. In the first box, click the dropdown arrow and click select features from.
3. In the second box, check parcels as the layer to select features from.
4. Click the dropdown arrow for the third box and click intersect. This will select those features in parcels that intersect the features of cnel65.
5. In the last box, click the dropdown arrow and click cnel65 as the layer to select by.
6. Click Apply. The selected parcels are outlined in a thick line.



7. Close the Selection window. Notice that any parcel even partially inside the contour is included.

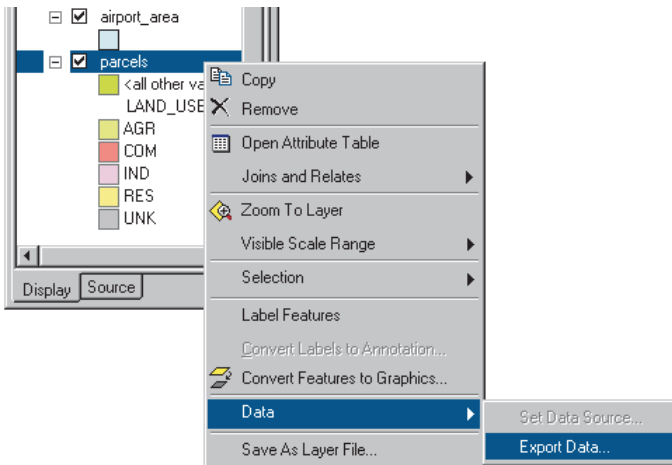


For more on selection, see Chapter 13, 'Querying maps'.

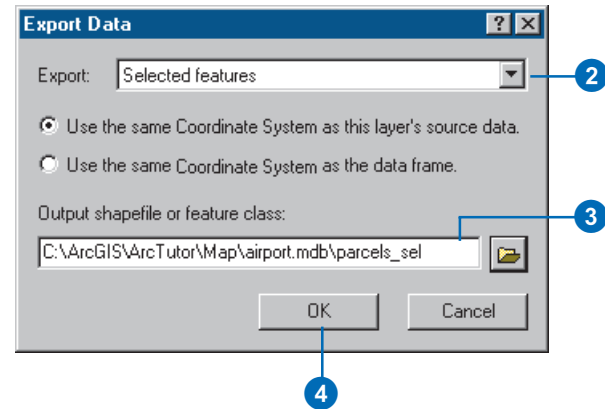
## Exporting a layer

To find out how many parcels and how much land area of each land use type are within the noise contour, you'll create a new feature class and run statistics on its data table.

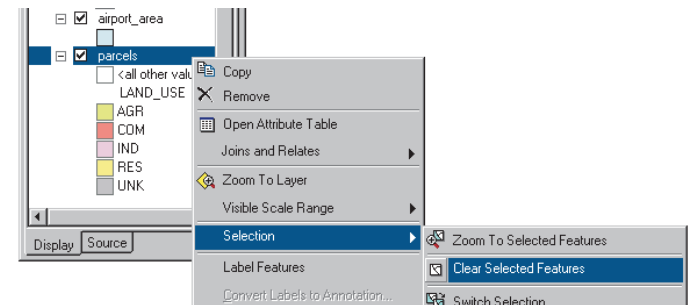
1. Right-click parcels in the table of contents, point to Data, then click Export Data.



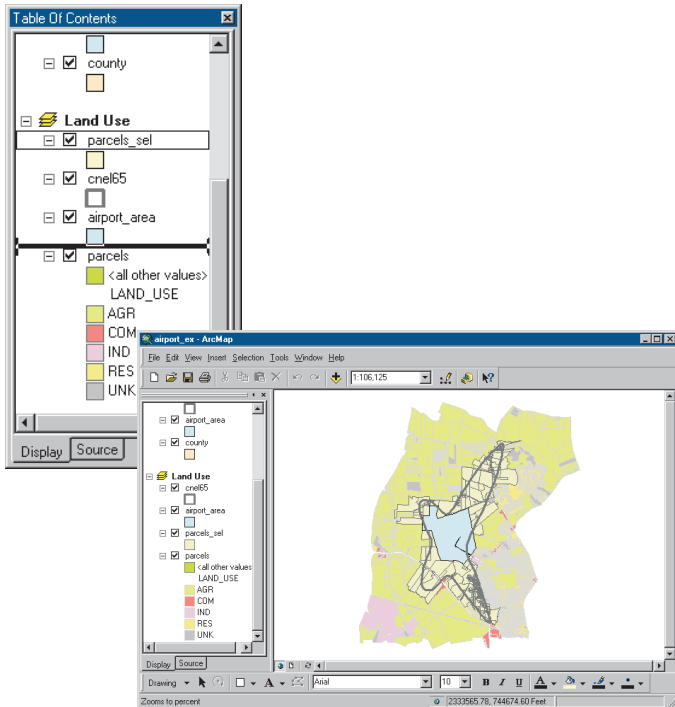
2. In the Export Data dialog box, click the Export dropdown arrow and click Selected features (to export only the selected parcels).
3. Save the selected features in the airport geodatabase as a feature class called parcels\_sel. Type the path as shown below, substituting the install location of the tutorial data on your system. (The default installation path for the geodatabase is C:\ArcGIS\ArcTutor\Map\airport.mdb.)



4. Click OK. ArcMap exports the parcels to a new feature class in the airport geodatabase.
5. Click Yes when prompted to add the exported data as a new layer on the map. The new layer contains only the selected parcels.
6. Right-click the original parcels layer, point to Selection, then click Clear Selected Features.



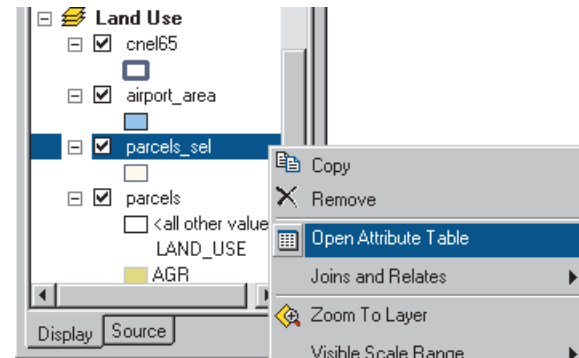
- The new layer is displayed on top of the other layers. To see the noise contour and airport area, click parcels\_sel in the table of contents and drag it down until the bar is above parcels. Then, release the mouse button.



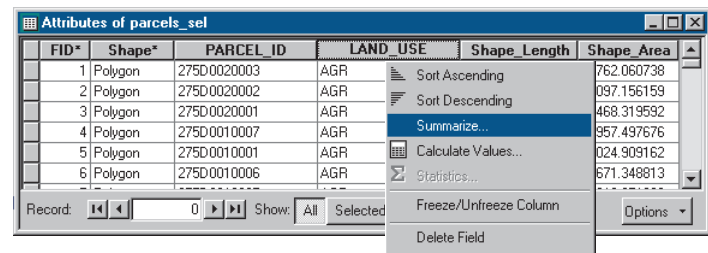
## Creating summary statistics

ArcMap includes tools for statistical analysis. You'll create a table to summarize the number of parcels of each land use type within the noise contour and the total area of each type.

- In the table of contents, right-click the parcels\_sel layer and click Open Attribute Table.



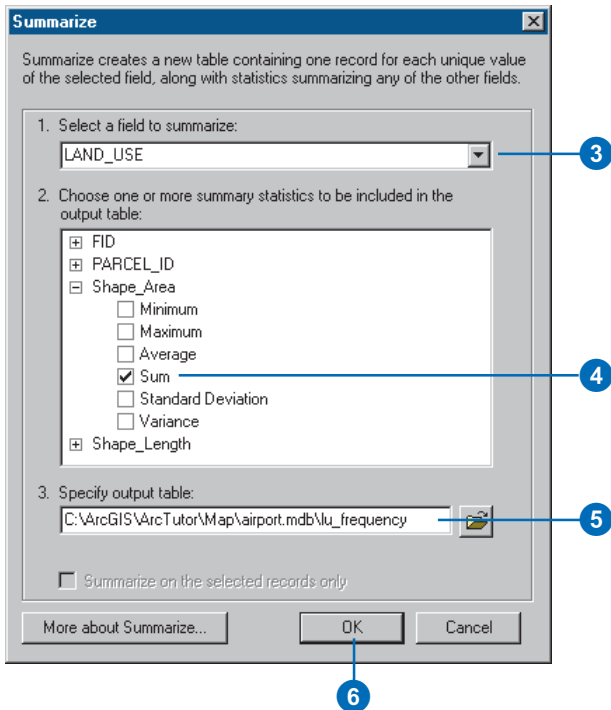
- Right-click the LAND\_USE field header and click Summarize.





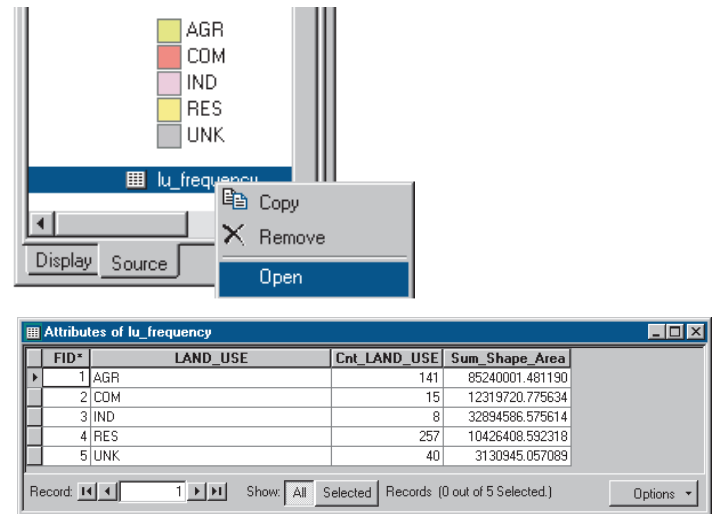
3. Make sure the field to summarize is LAND\_USE.
4. Click the plus sign next to Shape\_Area to expand it. Check Sum to summarize the area by land use type.
5. Create the output table in the airport geodatabase and name it lu\_frequency.
6. Click OK. ArcMap creates a new table with a record for each land use type showing the number of parcels of that type and the total land area (in square feet).
7. Click Yes when prompted to add the resulting table to the map.

## Opening a table



You may have noticed that when the table is added to the map, the table of contents switches from the Display tab to the Source tab (at the bottom of the table of contents). The Source tab shows the location of all data in the table of contents; this is useful when editing data in ArcMap because it shows you which layers are in the same workspace. (When you edit in ArcMap, you edit an entire workspace; that is, all the layers in the workspace are available for editing.) The Source tab also lists all tables. Tables don't show up when the Display tab is selected since a table is not a geographic feature that gets displayed on the map.

1. Right-click lu\_frequency in the table of contents and click Open. You can see the number of parcels and the total area (in square feet) of each land use type.

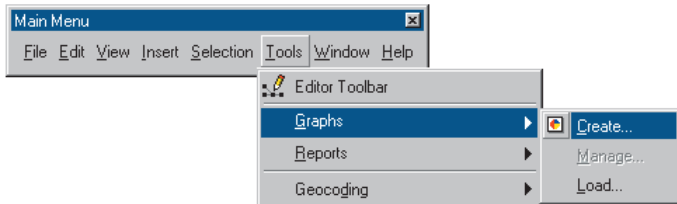


2. Close the table window.

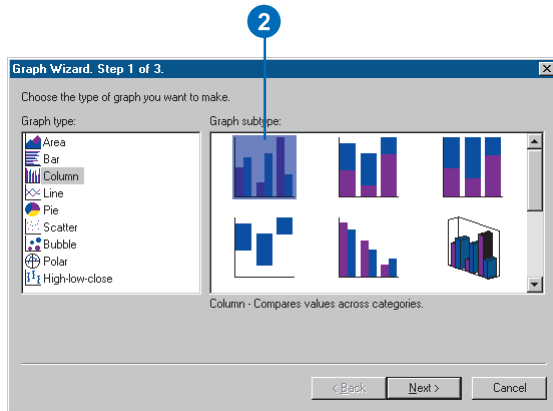
## Making a graph

Next you'll create a column graph showing the number of parcels of each land use type.

1. Click the Tools menu, point to Graphs, and click Create. The Graph Wizard appears.

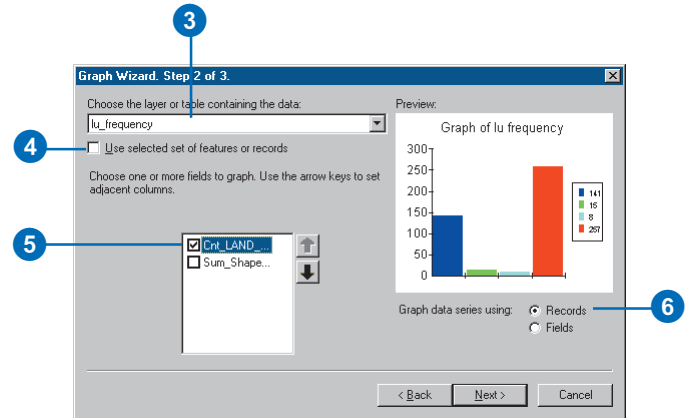


2. On the Graph Wizard dialog box, click the Column graph and click Next.

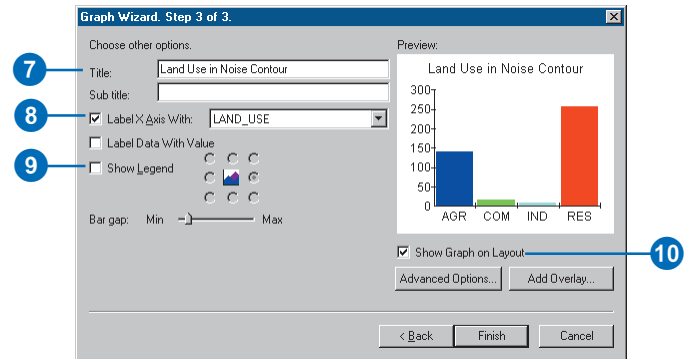


3. Click lu\_frequency as the table containing the data to graph.
4. Make sure that Use selected set of features or records is not checked.
5. Check the field Cnt\_LAND\_USE as the field to graph.

6. Click Graph data series using records and click Next.

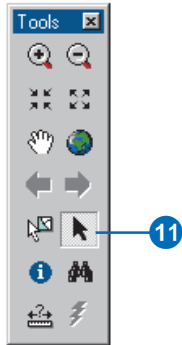


7. Type in Land Use in Noise Contour as the title.
8. Check Label X Axis With and click LAND\_USE as the labeling field.
9. Uncheck Show Legend.
10. Check Show Graph on Layout and click Finish.

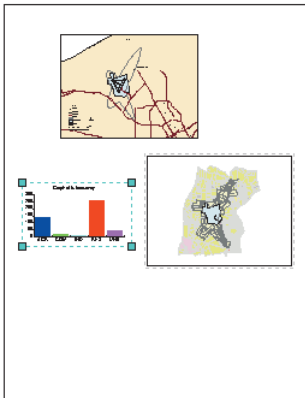


The graph appears on the layout. You can see that most of the parcels are residential.

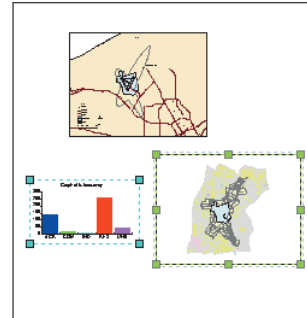
11. Click the Select Graphics button on the Tools toolbar.



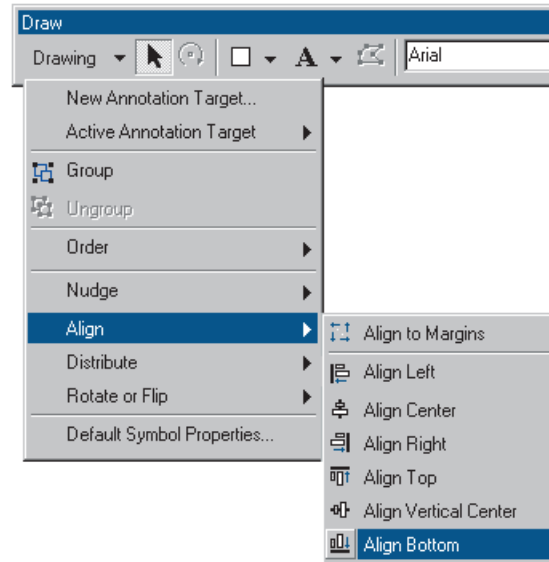
12. Click and drag the graph to the left of the parcel map.



13. With the graph still selected, hold down the Shift key and click the land use map so both are selected.



14. Click the Drawing dropdown arrow on the Draw toolbar, point to Align, and click Align Bottom to line up the graph and map.



You can stop here or continue on with the next exercise. Save your work by clicking Save on the File menu.

## Exercise 3: Working with tables

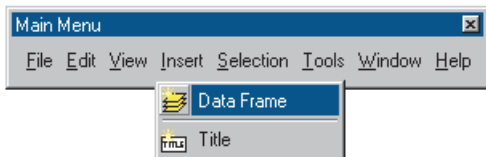
In this exercise, you'll map population density for the county. A population density map shows where people are concentrated. First, you'll add population data for each census tract. Then you'll calculate population density for each tract and map it.

If necessary, start ArcMap, navigate to the folder where you saved the map from Exercise 2 (airport\_ex), and open the map.

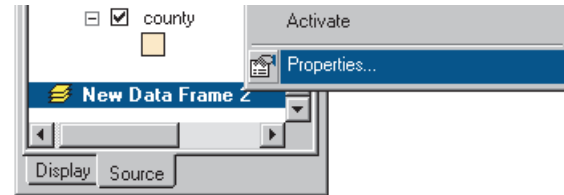
### Creating a new data frame

As with the land use map, you'll start by creating a new data frame to display the data.

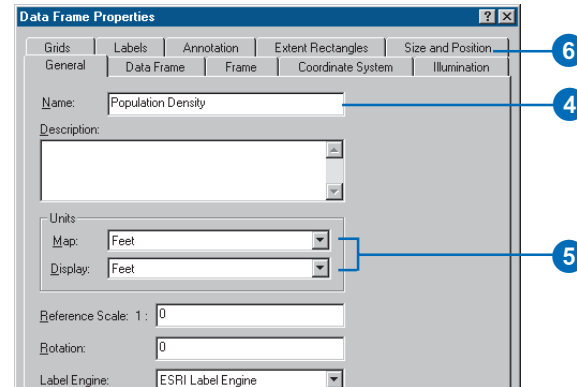
1. Switch to Layout view, if necessary (click View and click Layout View).
2. Click Insert and click Data Frame.



3. In the table of contents, right-click New Data Frame 2 and click Properties.

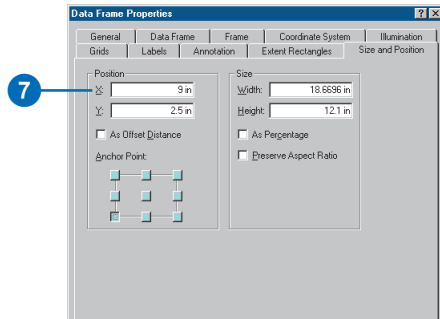


4. Click the General tab and type Population Density in the Name text box.
5. Click the Units dropdown arrows and set the Map and Display units to feet.



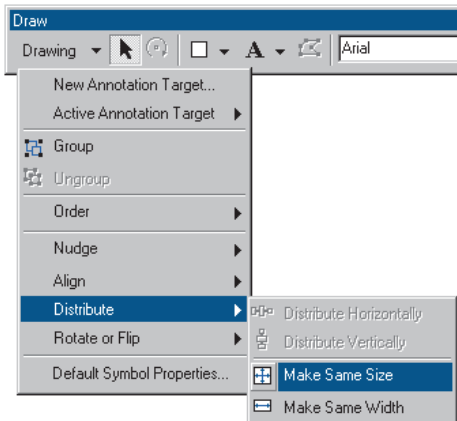
6. Click the Size and Position tab.

- Set the X position to 9 and the Y position to 2.5.
- Click OK.

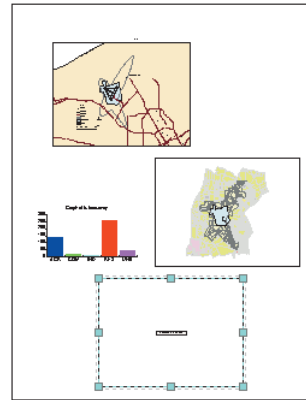


- Hold down the Shift key and click the middle data frame (Land Use) on the page so both frames are selected.
- Click Drawing on the Draw toolbar, point to Distribute, and click Make Same Size.

The data frames are now the same size.



- Click the Population Density data frame on the page so it is the only one selected.



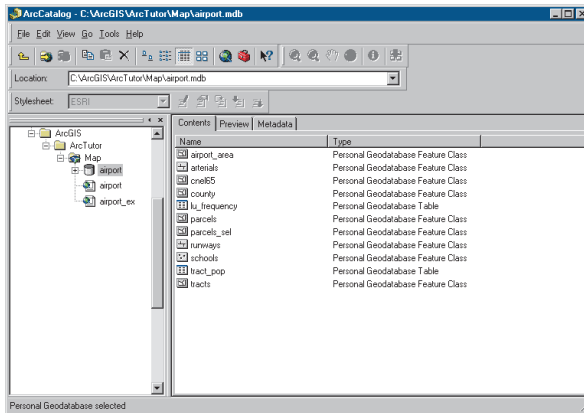
## Adding data from ArcCatalog

You'll add the layers you need by dragging them from ArcCatalog™.

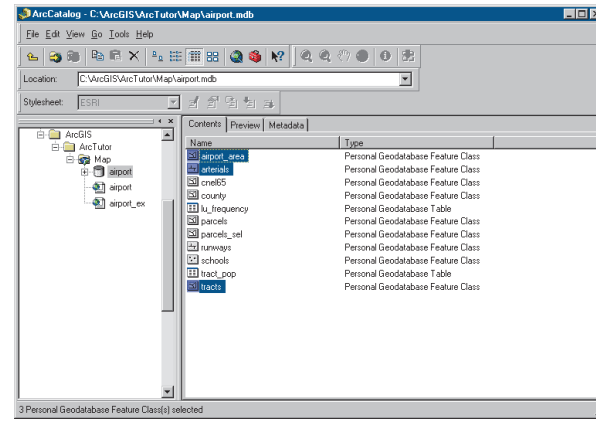
- Start ArcCatalog by clicking the ArcCatalog button on the Standard toolbar in ArcMap. Position the ArcCatalog and ArcMap windows so ArcMap is visible behind the ArcCatalog window.



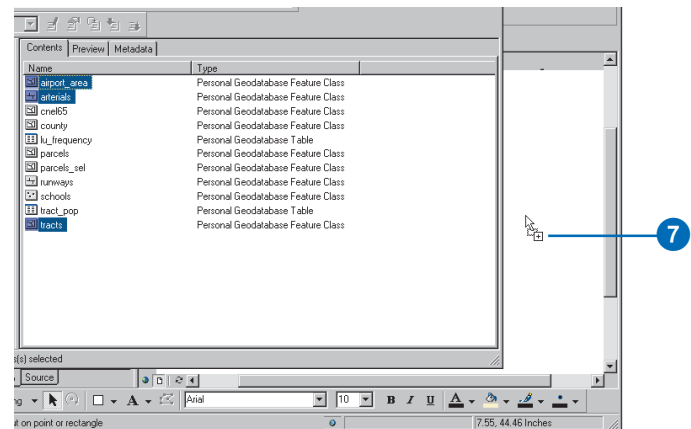
- In ArcCatalog, navigate to the Map folder on the local drive where you installed the tutorial data (the default installation path is C:\ArcGIS\ArcTutor\Map).
- Click the plus sign next to the Map folder to list the contents.
- Click the airport geodatabase icon to display the contents in the right-hand panel.



- In the right-hand panel, click arterials.
- Hold down the Ctrl key and click tracts and airport\_area to select them as well. The layers are highlighted as you select them.



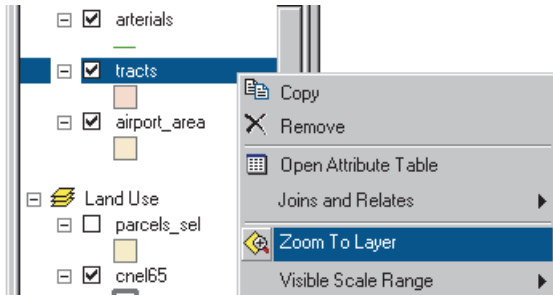
- Point to arterials, hold down the left mouse button, and drag the pointer over the ArcMap layout view (anywhere is fine).



- Release the mouse button. All three layers are added to the new data frame.

9. Close ArcCatalog.

10. Right-click tracts in the ArcMap table of contents and click Zoom To Layer. The map redraws to show all the tracts and centers them in the data frame.



### Adding tabular data

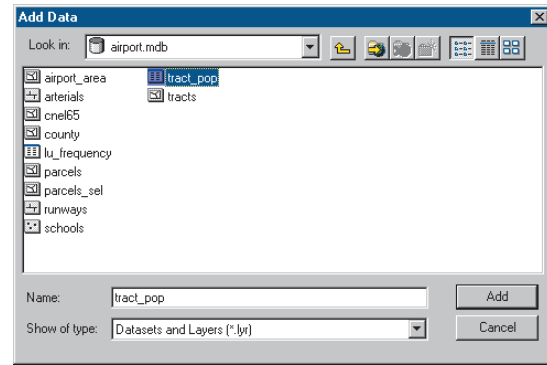
You also need to add the table containing the population data to your data frame.

1. In ArcMap, click the Add Data button.



2. Navigate to the Map folder on the local drive where you installed the tutorial data (the default installation path is C:\ArcGIS\ArcTutor\Map) and double-click the airport geodatabase.

3. Click tract\_pop (the icon looks like a table).

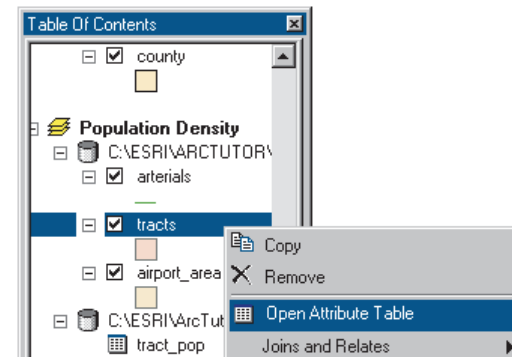


4. Click Add. The table is added to the Population density data frame in the table of contents. ArcMap activates the Source tab so you can access the table.

### Joining tables

The next step is to join the table containing the population data to the census tract data table. You'll do this using the census tract ID as the common field.

1. Right-click tracts in the table of contents and click Open Attribute Table to see the existing attributes including the census tract ID.



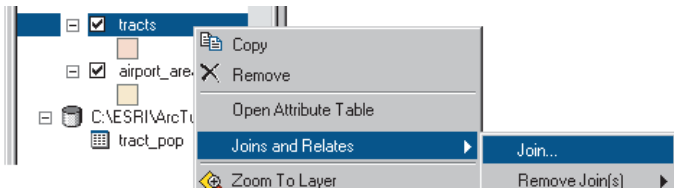
FID	Shape	Shape_Length	Shape_Area	TRACT_ID
1	Polygon	23359.0646179392	29501864.0718	100
2	Polygon	20350.8213216268	17906796.4727	200
3	Polygon	19764.5068628924	17038547.9629	300
4	Polygon	71734.650763681	182638877.306	400
5	Polygon	41535.3888513427	101159098.343	500
6	Polygon	61452.6622484381	183391558.187	600
7	Polygon	91262.7436119726	292795476.836	700
8	Polygon	18980.4140028922	17437646.7340	801
9	Polygon	108657.097454915	452483831.055	802

Now right-click tract\_pop and click Open. The table contains the TRACT\_ID field and the population of each tract.

Rowid*	TRACT_ID	POPULATION
1	100	4231
2	200	1683
3	300	2580
4	400	6012
5	500	7046
6	600	5170
7	700	6203
8	801	2914
9	802	3295
10	900	9999

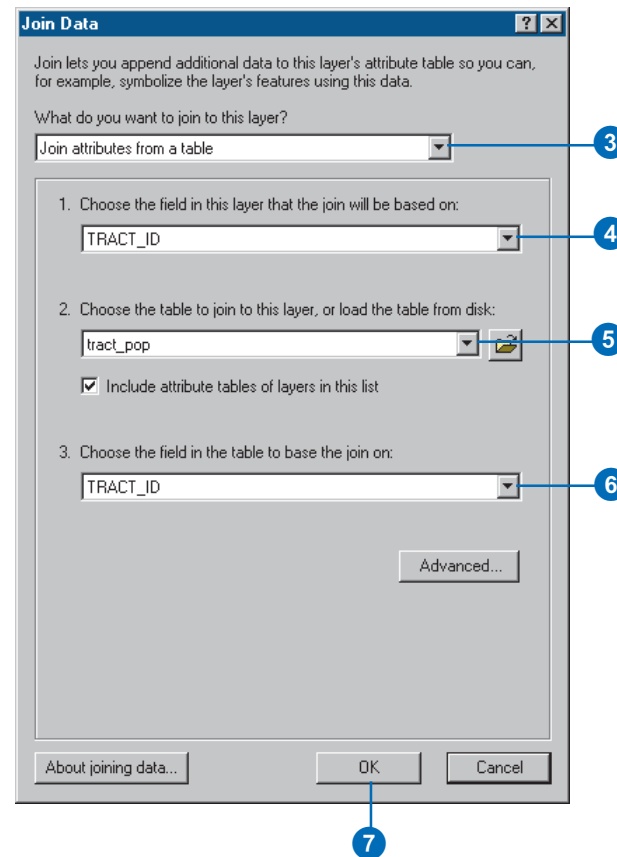
Close the tables before proceeding with the join.

2. Right-click tracts in the table of contents again, point to Joins and Relates, and click Join.



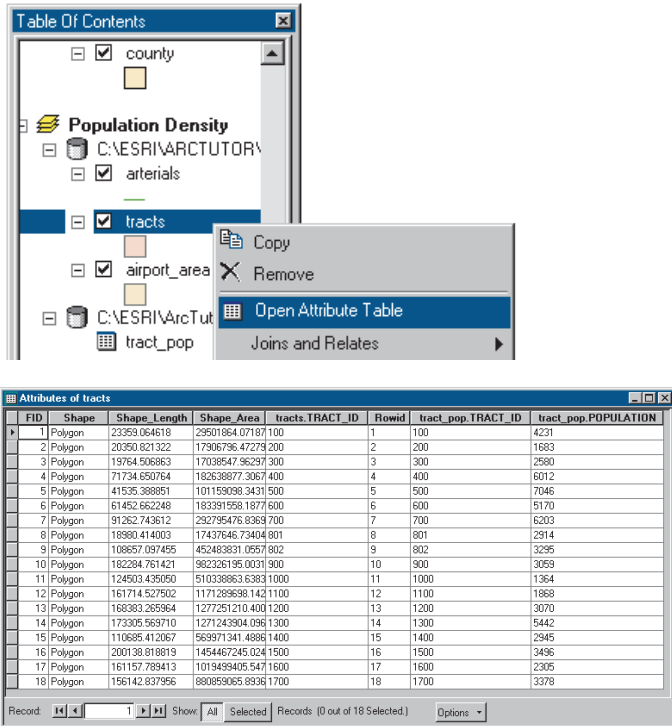
3. Click the dropdown arrow in the first text box and click Join attributes from a table.

4. Click the dropdown arrow in the next text box, scroll down, and click TRACT\_ID as the field in the layer to base the join on.
5. Click the dropdown arrow in the next text box and click tract\_pop as the table to join to the layer.
6. In the next text box, click TRACT\_ID as the field in the table to base the join on.
7. Click OK to join the table to the layer.





- Right-click tracts and click Open Attribute Table. The population value has been added to each tract.

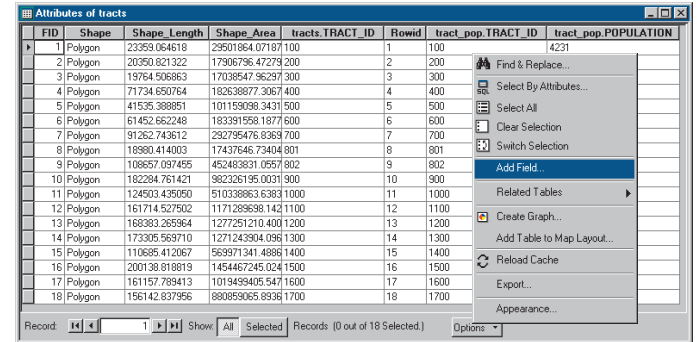


### Adding a field to an attribute table

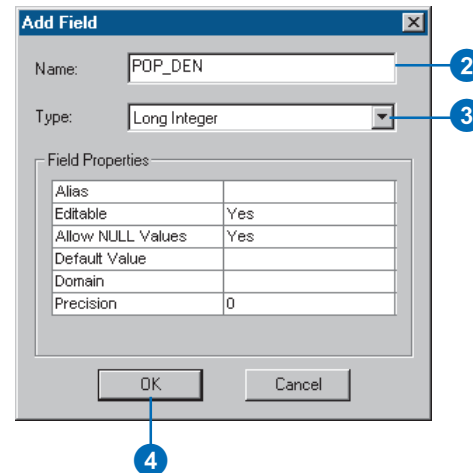
In order to map population density, you'll need to add a new field to the tracts layer. You'll use this field to store the population density of each tract.

- Click the Options button at the bottom of the attributes of tracts window and click Add Field.

If a message appears indicating the table is in use by another user, make sure you closed ArcCatalog.



- In the Add Field dialog box, Type POP\_DEN as the field name.
- Click the Type dropdown arrow and click Long Integer.
- Click OK.

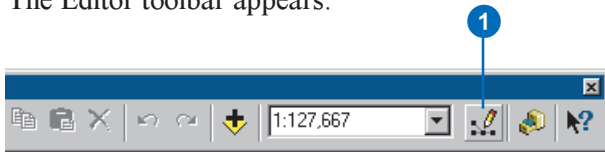


You should see the new field added to the attribute table.

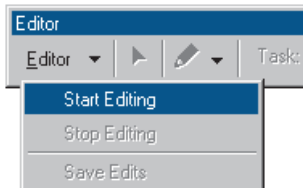
## Calculating attribute values

You'll calculate the population density for each tract by dividing the population by the area of each tract; this will give you the number of people per square mile. To do this, you'll use the editing functions of ArcMap to edit the census tract attributes (in Exercise 4 you'll edit the geometry of a feature).

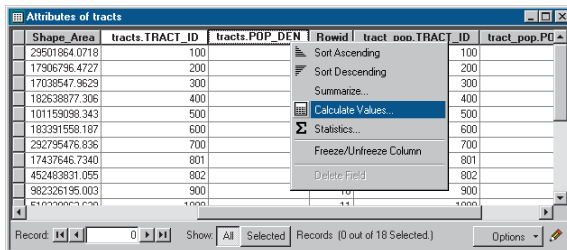
1. Click the Editor Toolbar button on the Standard toolbar. The Editor toolbar appears.



2. Click Editor and click Start Editing.



3. Right-click tracts.POP\_DEN and click Calculate Values. The Field Calculator appears.

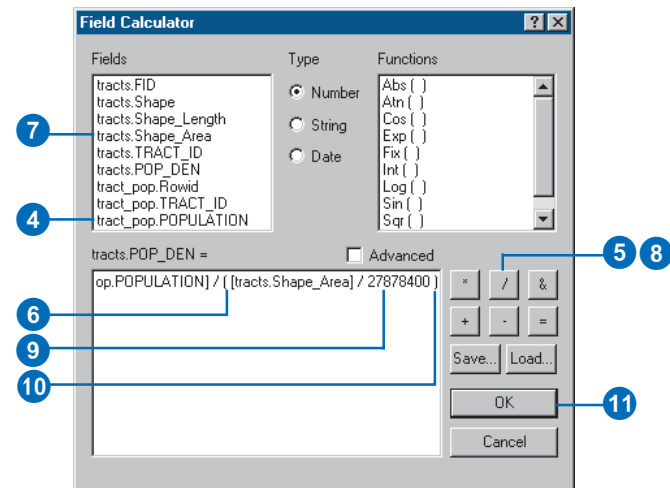


The first part of the formula is entered for you: tracts.POP\_DEN = . The full formula will look like this:

tracts.POP\_DEN = [tracts\_pop.POPULATION] / ([tracts.Shape\_Area] / 27878400).

Dividing the area by 27,878,400 converts the area of each tract, stored in square feet, to square miles. You can type the formula right into the box or use the buttons on the dialog. In this exercise, you'll use both.

4. Click tracts\_pop.POPULATION in the Fields list.
5. Click the division symbol.
6. Type a space and a left parenthesis from the keyboard.
7. Click tracts.Shape\_Area from the field list.
8. Click the division symbol.
9. Type a space and type 27878400.
10. Type a space and a right parenthesis from the keyboard.
11. Click OK.



When the dialog box closes, you can see the population density values for each tract in people per square mile in the table.

FID	Shape	Shape_Length	Shape_Area	tracts.TRACT_ID	tracts.POP_DEN	tr
1	Polygon	23359.064618	29501864.07187	100	3998	1
2	Polygon	20350.821322	17906796.47279	200	2620	2
3	Polygon	19764.506863	17038547.96297	300	4221	3
4	Polygon	71734.650764	182638877.3067	400	918	4
5	Polygon	41535.388851	101159098.3431	500	1942	5
6	Polygon	61452.662248	183391558.1877	600	786	6
7	Polygon	91262.743612	292795476.8369	700	591	7
8	Polygon	18980.414003	17437646.73404	801	4659	8
9	Polygon	108657.097455	452483831.0557	802	203	9
10	Polygon	182284.761421	982326195.0031	900	87	10
11	Polygon	124503.435050	510338863.6383	1000	75	11
12	Polygon	161714.527502	1171289698.142	1100	44	12
13	Polygon	168383.265964	1277251210.400	1200	67	13
14	Polygon	173305.569710	1271243904.096	1300	119	14
15	Polygon	110685.412067	569971341.4886	1400	144	15
16	Polygon	200138.818819	1454467245.024	1500	67	16
17	Polygon	161157.789413	1013499405.547	1600	63	17
18	Polygon	156142.837956	880859065.8936	1700	107	18



12. Click the Editor menu on the Editor toolbar and click Stop Editing.

13. Click Yes when prompted to save your edits.

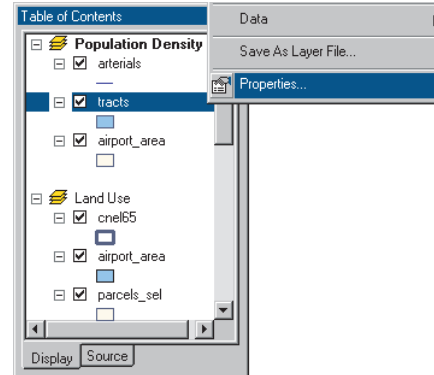
14. Close the Editor toolbar and close the attribute table.

For more information on adding and calculating attributes, see Chapter 10, ‘Working with tables’.

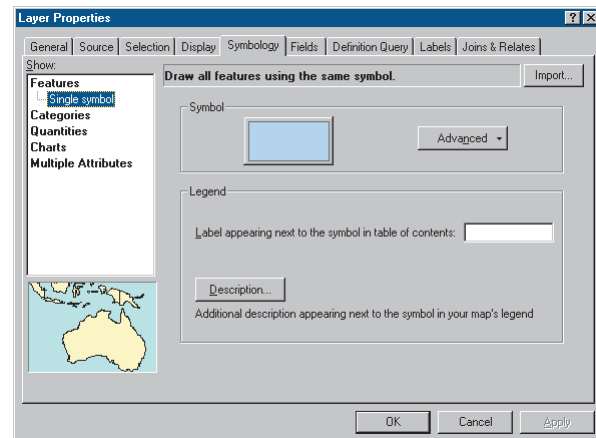
## Classifying features by quantity

You can now map the tracts based on their population density values to see where people are concentrated in relation to the airport and to major roads.

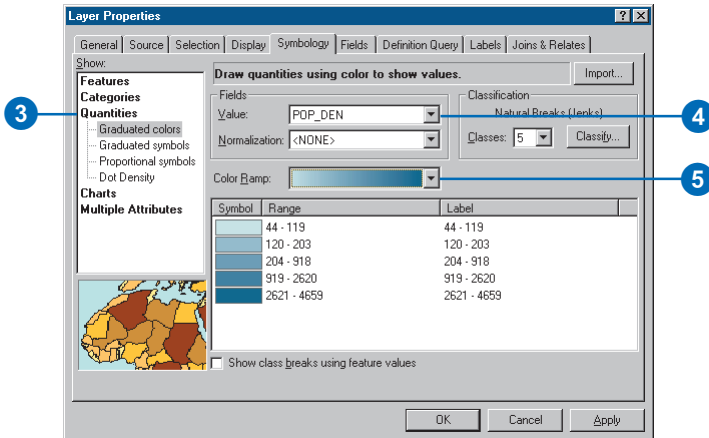
1. Right-click tracts in the table of contents and click Properties.



2. Click the Symbology tab. All tracts are currently drawn using the same symbol (the same solid fill color).



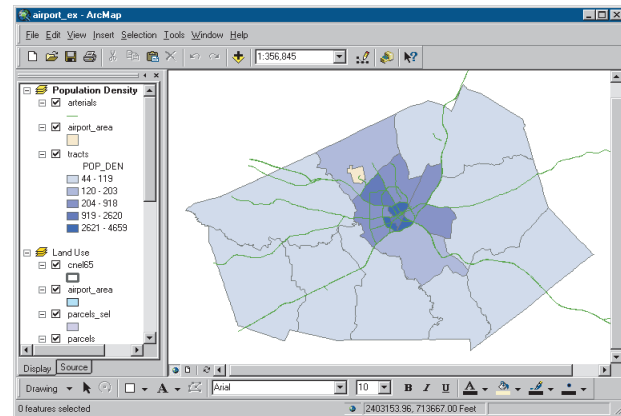
3. Click Quantities in the Show box. Graduated colors is automatically highlighted.
4. Click the Value dropdown arrow and click tracts.POP\_DEN as the field to use to shade the tracts.
5. Click the Color Ramp dropdown arrow and click the blue color ramp.



ArcMap chooses a classification scheme and the number of classes for you. You can modify these by clicking the Classify button in the Layer Properties dialog box. For now, just use the default classification.

6. Click OK.
7. Click the Display tab at the bottom of the table of contents.
8. Click arterials in the table of contents and drag it to the top. Click airport\_area and drag it so it is just below arterials. Now these layers draw on top of the tracts.

9. Switch to data view to get a closer look at the tracts. Click View and click Data View.



For more on classifying and displaying data, see Chapter 6, ‘Symbolizing your data’.

You’ve now completed Exercise 3. You can continue on with the next exercise or continue at a later time. Be sure to save your map (click the File menu and click Save).

## Exercise 4: Editing features

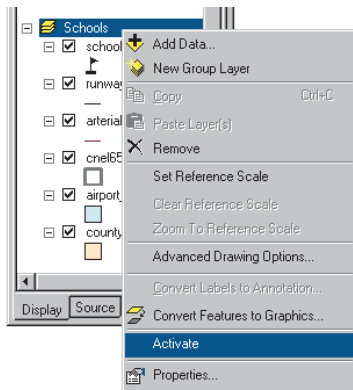
You can use ArcMap to edit your data as well as create maps. In this exercise you'll extend the airport road to create a new loop road joining up with an existing arterial road. This exercise is a very brief introduction to editing, which is covered in much more detail in *Editing in ArcMap*.

If necessary, start ArcMap, navigate to the folder where you saved the map from Exercise 3 (airport\_ex), and open the map.

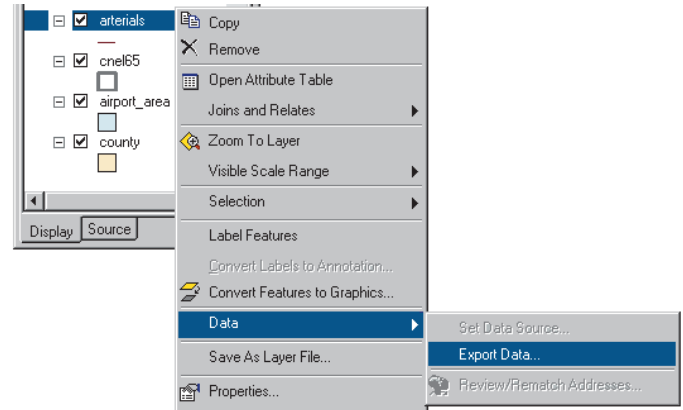
### Exporting data

You'll be working with the schools data frame. First, make a copy of the arterials data. That way, in case you need to, you can start over again with the original data.

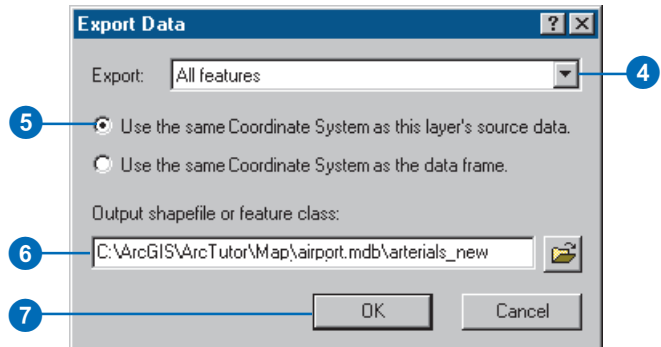
1. Switch to Data view (click the View menu and click Data view).
2. Right-click the Schools data frame in the table of contents and click Activate.



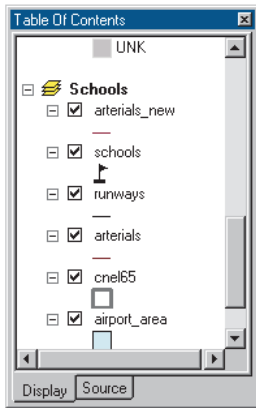
3. Right-click arterials, point to Data, and click Export Data.



4. Click the Export dropdown arrow and click All features.
5. Click Use the same Coordinate System as this layer's source data.
6. Save the new feature class as arterials\_new in the airport geodatabase (the default installation path is C:\ArcGIS\ArcTutor\Map\airport.mdb).



- Click OK to export the data.
- Click Yes when prompted to add the layer to the map.

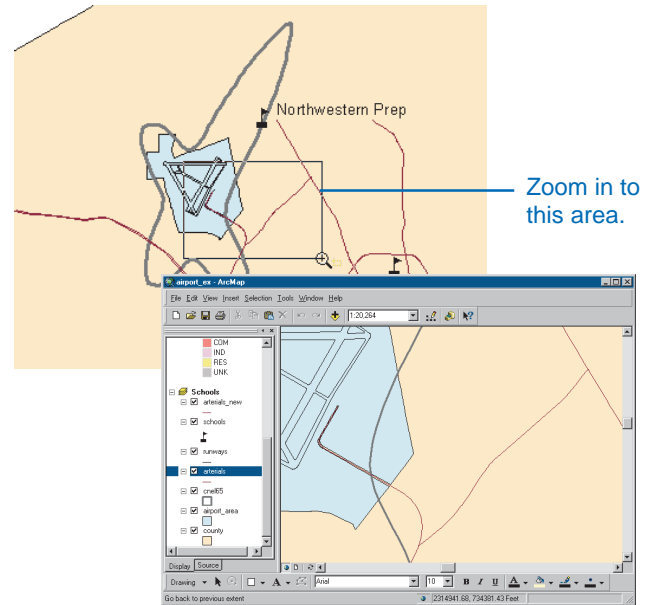


Using Export makes a copy of the data itself. If you'd chosen Copy from the menu, you'd be copying the layer, which is only a pointer to the underlying data and information about how the data is displayed.

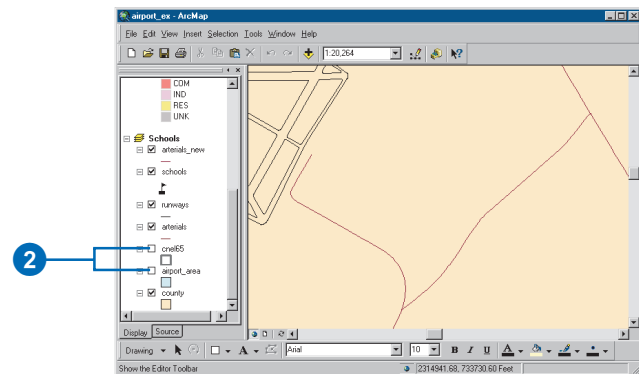
## Creating a new feature

You edit features in ArcMap using the Editor toolbar. All the layers in a workspace are available for editing within the same editing session. You specify which layer (the "target") new features will be added to.

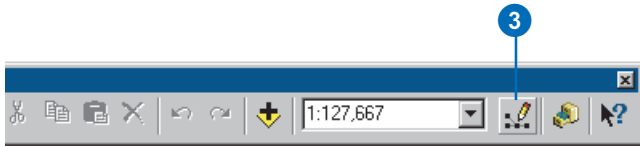
- Click the Zoom In button on the Tools toolbar and zoom in to the area around the existing road and the road you're adding.



- Turn off the cnel65 and airport\_area layers by unchecking the boxes next to them in the table of contents so you can more easily see the existing roads.



- Click the Editor Toolbar button to display the Editor toolbar.



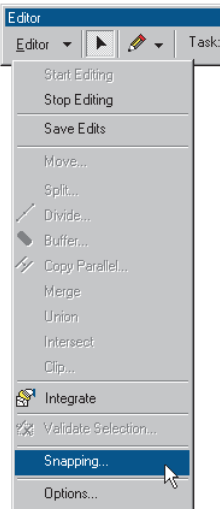
- Click the Editor menu and click Start Editing.



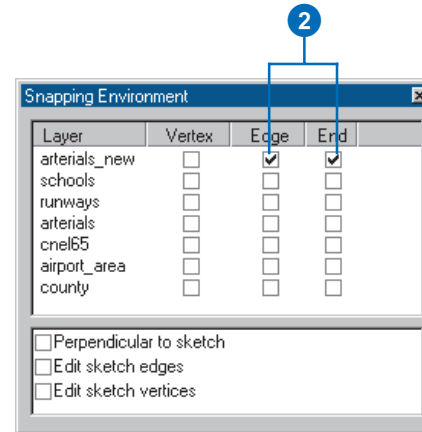
## Setting snapping

Snapping lets you specify that new features connect to or align with existing features.

- Click Editor and click Snapping.



- Check the boxes for Edge and End for arterials\_new. This specifies that the new line you draw in the arterials\_new dataset will snap to existing lines (edges) and endpoints of existing lines.



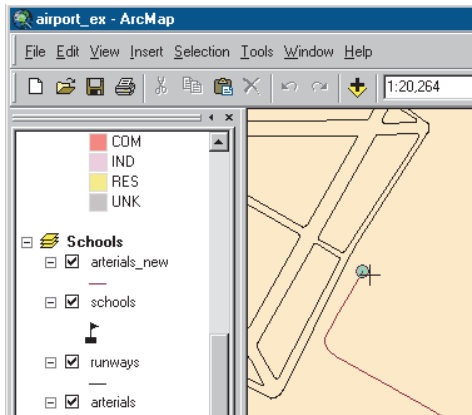
- Close the Snapping Environment dialog box.

## Digitizing a feature

- Click the Target dropdown arrow and click arterials\_new : arterials\_new as the feature class you want to create new features in.
- Click the Sketch tool on the Editor toolbar.

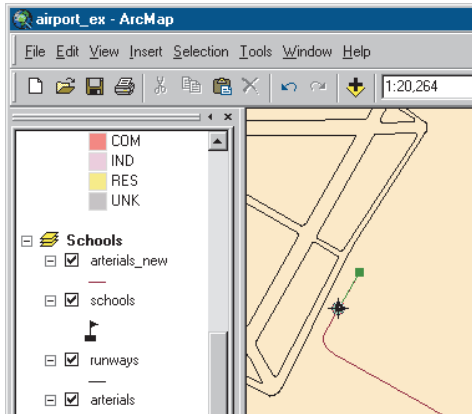


- The pointer changes to a crosshair with a circle. Move the mouse pointer over the end of the existing road—the circle snaps to the end.

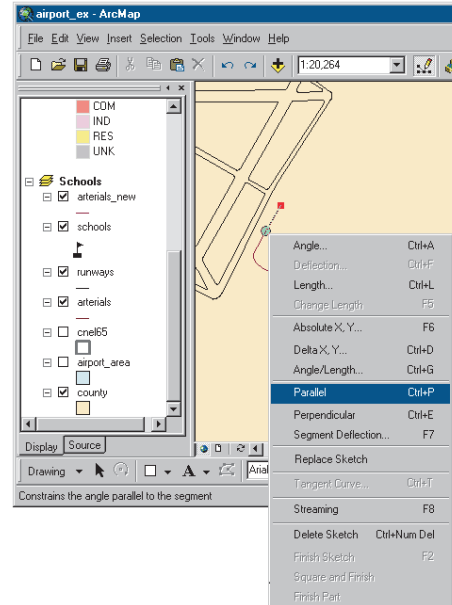


4. Click to start the new road.

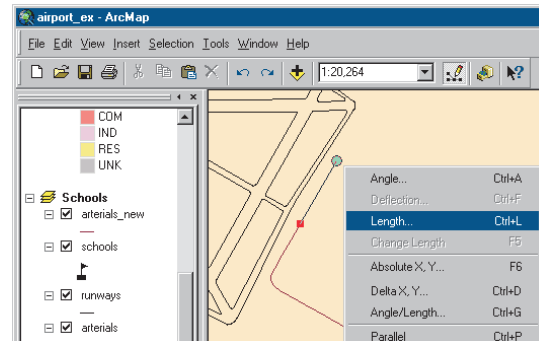
5. Move the mouse pointer back over the existing road and right-click to display the context menu.



6. Click Parallel.

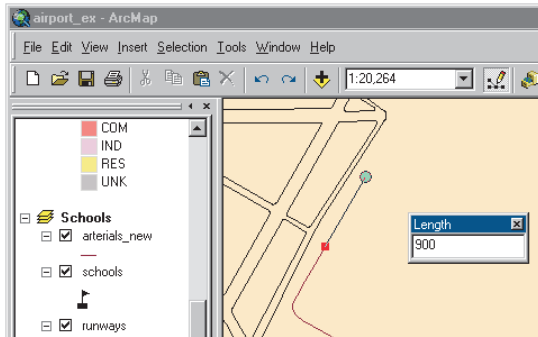


7. Move the mouse pointer in the direction you want the new road to go (up and to the right). Right-click and click Length.

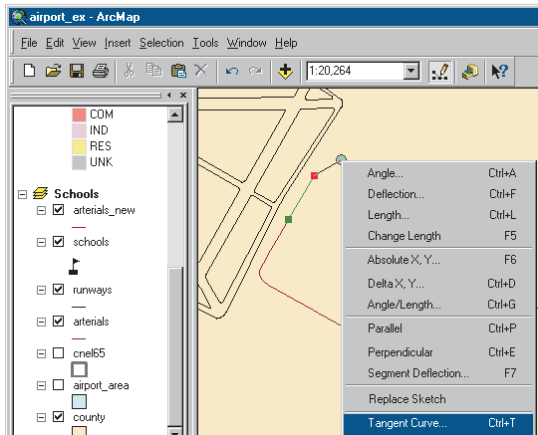




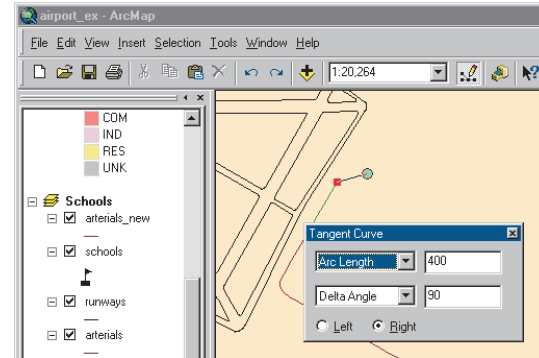
8. Type 900 (feet) and press Enter. ArcMap places a vertex at the correct location.



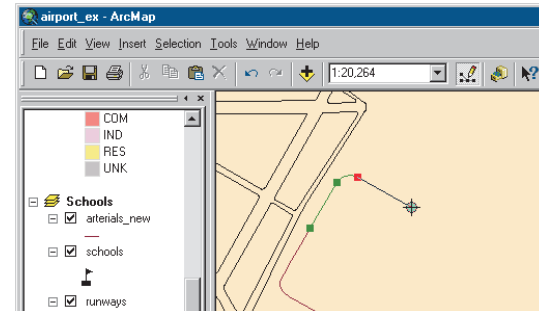
9. Right-click again and click Tangent Curve.



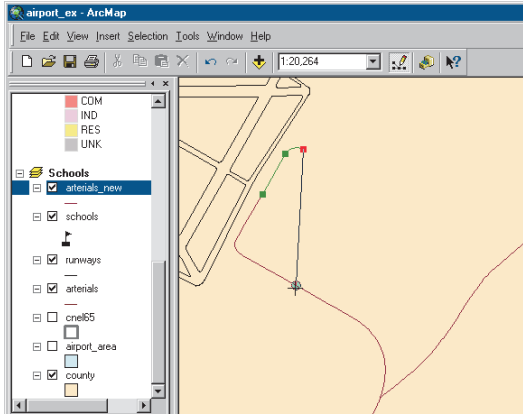
10. Click the dropdown arrow in the upper box and click Arc Length. Click in the box to the right and enter a length of 400 (feet). In the lower box, click the dropdown arrow and click Delta Angle. Click in the box to the right and type 90 (degrees). Click the button next to Right, if necessary. Then press Enter.



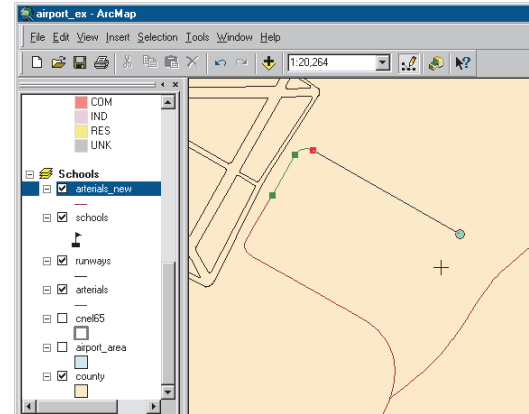
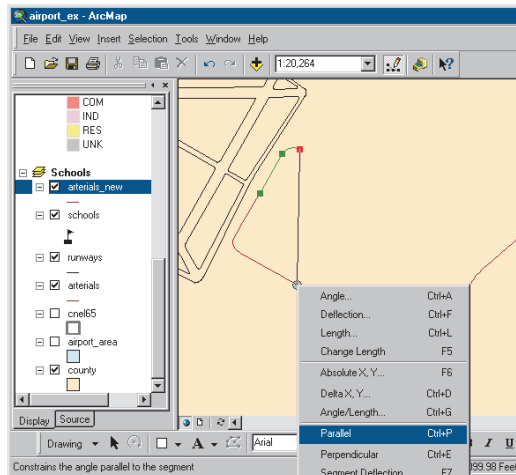
ArcMap draws the curve.



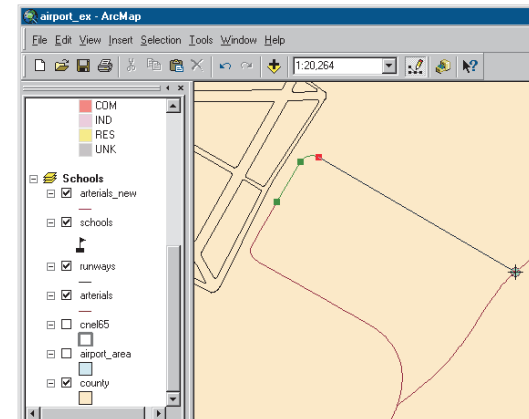
11. Move the mouse pointer so it snaps to the existing road, but don't click the mouse. You want the next segment of the new road to be parallel to the existing road.



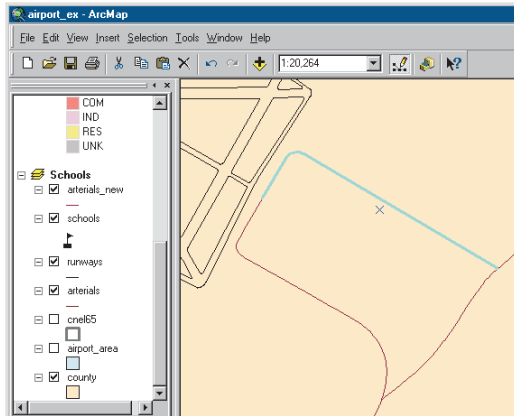
12. Right-click and click Parallel. The line is constrained to be parallel to the existing road.



13. To finish the road, move the mouse pointer over the road you want the new road to intersect and make sure the circle snaps to it. Double-click the left mouse button to end the line.



The new road is highlighted in a thick blue line.



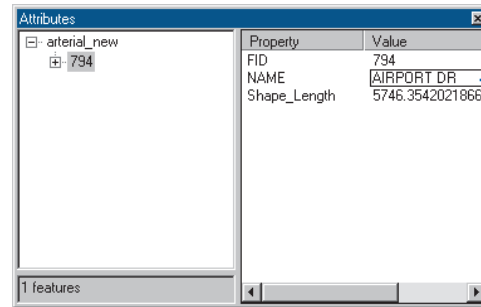
### Adding attributes to new features

You can also add the name of the new road.

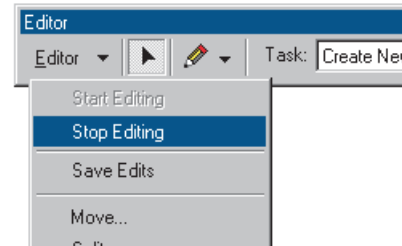
1. Click the Attributes button on the Editor toolbar.



2. Click next to NAME on the list of attributes, type AIRPORT DR, and press Enter.

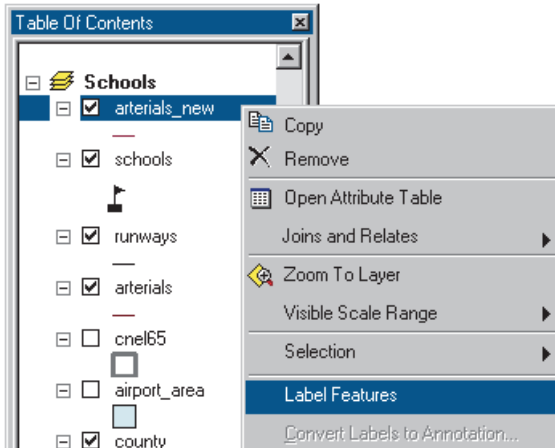


3. Close the Attributes window.
4. Click the Editor menu and click Stop Editing. Click Yes when prompted to save your edits.



5. Close the Editor toolbar.

- Right-click `arterials_new` in the table of contents and click Label Features. The road you added is labeled with its name.



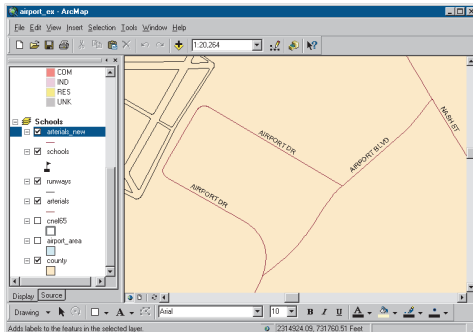
- Switch to Layout view (click the View menu and click Layout view). You can see that the road has been added to your map.
- You zoomed in for editing (when you switched to data view), so type 1:28,000 in the Scale text box on the Standard toolbar and press Enter to set the map scale.



Use the Pan tool on the Tools toolbar to place the noise contour in the center of the map.

You can continue on with the final exercise or stop here. If you stop, be sure to save your work so far (click the File menu and click Save).

- Turn the `cnel65` and `airport_area` layers back on by checking their boxes in the table of contents.



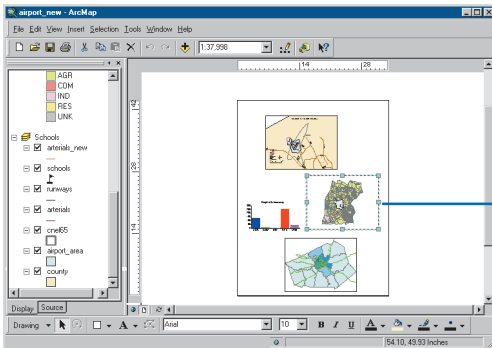
## Exercise 5: Working with map elements

In this exercise, you'll add additional map elements to complete your poster and print it.

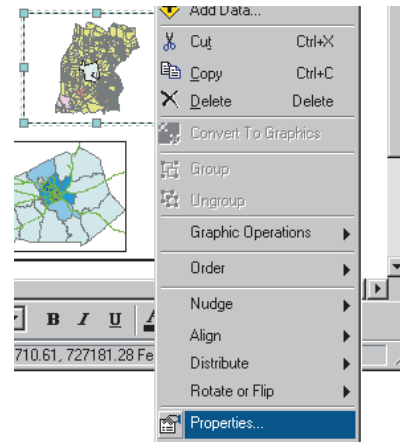
If necessary, start ArcMap, navigate to the folder where you saved the map from Exercise 4 (airport\_ex), and open the map.

### Adding a background, titles, legends, and scale bars

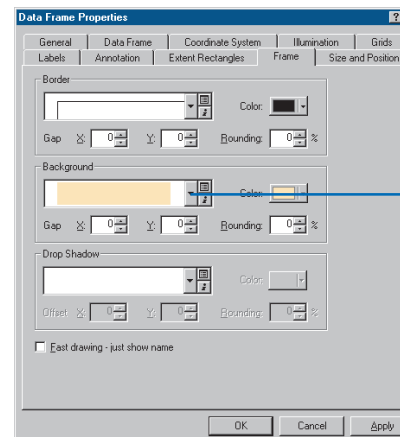
1. Switch to Layout view, if necessary (click View and click Layout view).
2. Click the land use data frame on the page so it's highlighted. In the table of contents, uncheck the parcels\_sel layer so it's not displayed (that way the map will show the land use types within the noise contour).



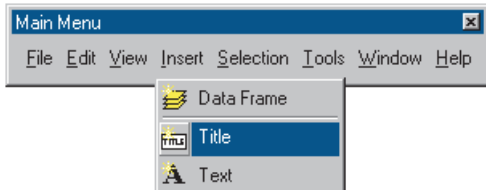
3. Right-click the data frame and click Properties.



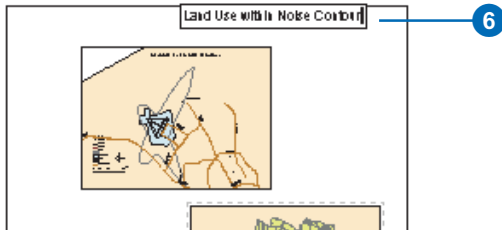
4. Click the Frame tab. Click the Background dropdown arrow and click Sand. Click OK.



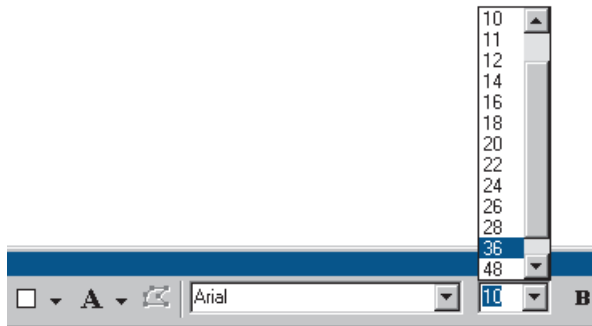
5. Click Insert and click Title.



6. Type “Land Use within Noise Contour” in the text box and press Enter.



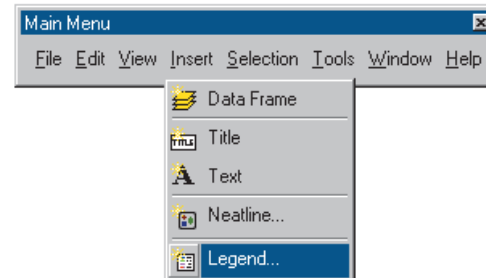
7. Click the Text Size dropdown arrow on the Draw toolbar. Click 36 to make the title 36 point.



8. Drag the title onto the land use data frame, as shown below.



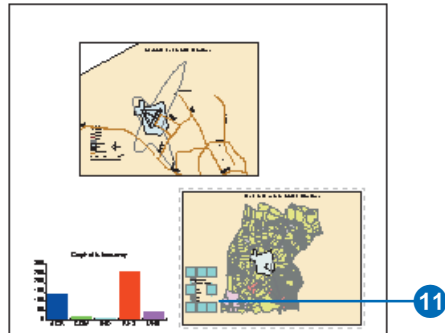
9. Click Insert and click Legend.



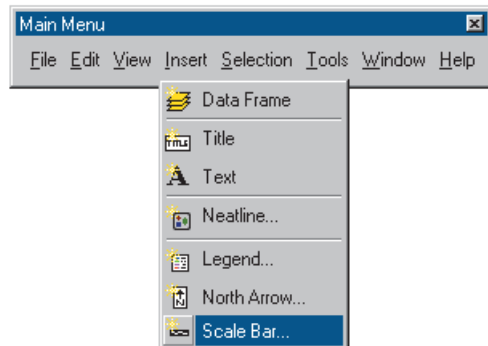
The Legend Wizard appears.

10. Click Next several times to step through the wizard accepting the default legend parameters. Click Finish when you're done.

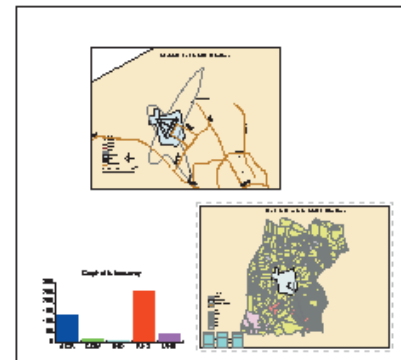
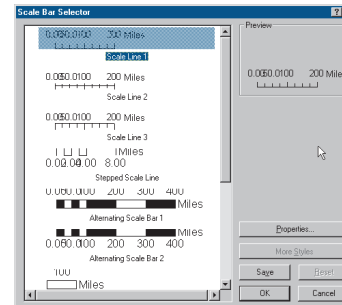
11. Drag the legend to the lower-left corner of the data frame, as shown below. Make it smaller by clicking the upper-right handle and dragging it down and to the left.



12. Click Insert and click Scale Bar.



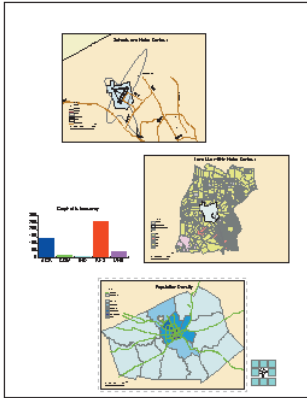
13. Click Scale Line 1 and click OK. Drag the scale bar under the legend and make it smaller.



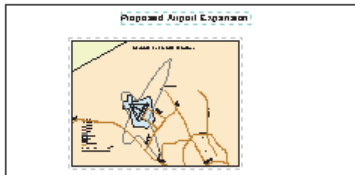
14. Now do the same for the Population Density data frame. First click to select it. Set the background to Sand, make the title read “Population Density”, and add a legend and scale bar. Place the legend in the upper-left corner of the data frame and place the scale bar in the lower-left corner.

15. Click the Schools data frame to select it and set the background to Olive.

16. You only need one North arrow since all maps are oriented in the same direction. Click the North arrow in the Schools data frame and enlarge it by dragging the upper-right handle. Then drag the North arrow to the lower-right corner of the page.



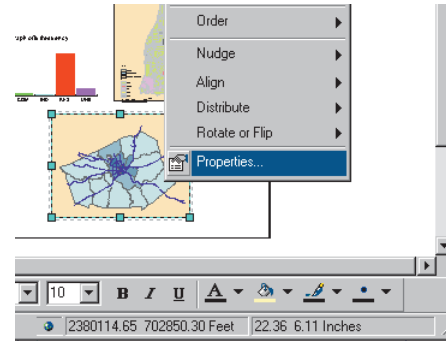
17. Click the Text tool on the Draw toolbar and click at the top of the page. Type “Proposed Airport Expansion” as the title and press Enter. Set the size to 72 point and make the title bold by clicking the Bold button. Position the title at the top and center of the page.



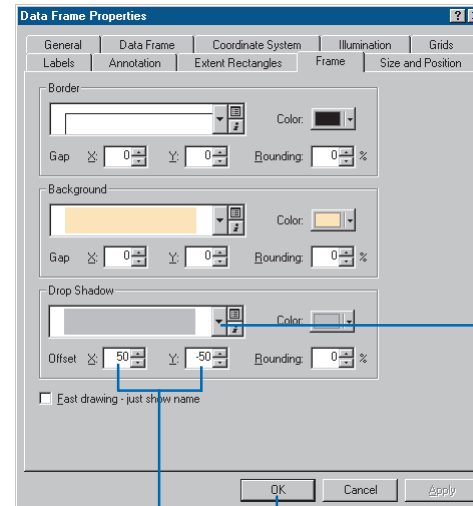
### Adding drop shadows

You can add drop shadows to most of the graphic elements on the layout page. Add a drop shadow to each data frame.

1. Click on the Population Density data frame to activate it.
2. Right-click the Population Density data frame and click Properties.
3. Click the Frame tab.

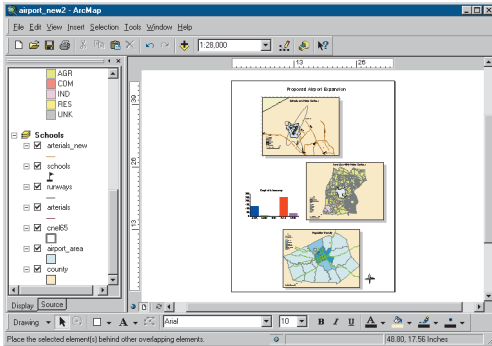


4. Click the Drop Shadow dropdown arrow and click Gray 30%.
5. Type 50 for the X Offset and -50 for the Y Offset.
6. Click OK.



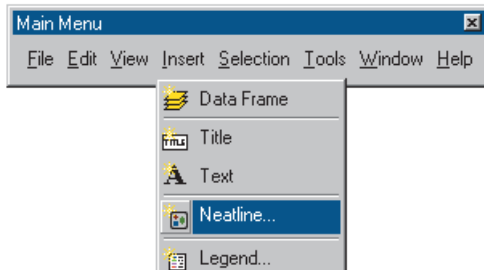


- Repeat the steps above to add drop shadows to the Schools and Land Use data frames. When finished, your map should look like this:

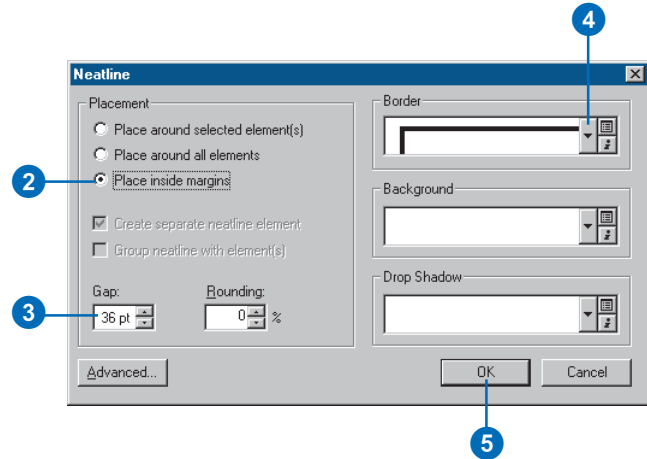


## Adding a neatline

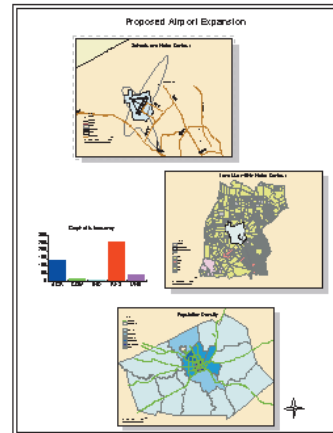
- Click Insert and click Neatline.



- Click Place inside margins.
- Type in a gap of 36 points. This places the neatline about one-half inch inside the margin of the page.



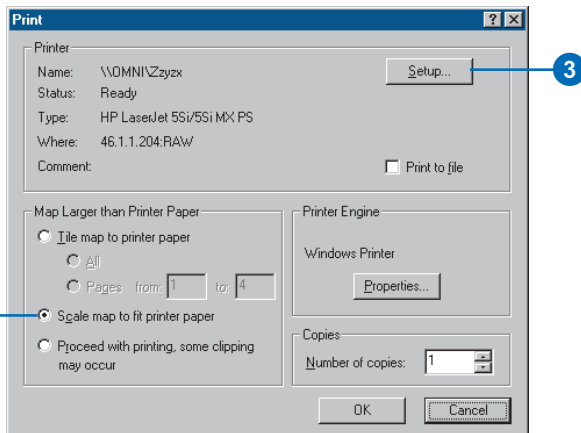
- Click the Border dropdown arrow and click a border size of 3.0 points.
- Click OK. Your map should look like this.



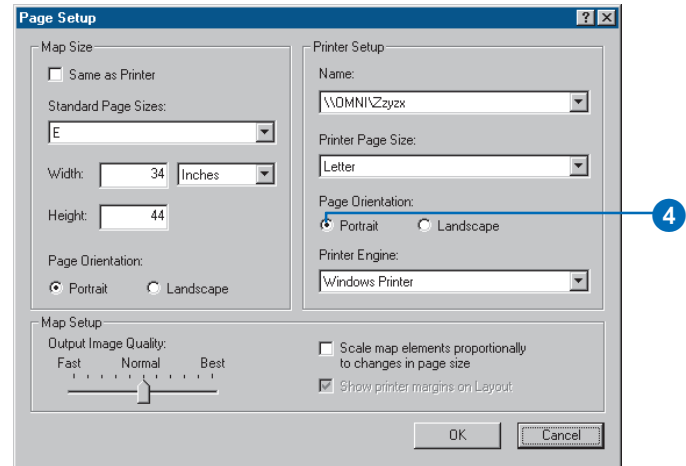
## Printing a map

Your map is finished. You can print it if you have a printer connected to your computer. If your printer doesn't print the full size (34 by 44 inches), you can scale the map down to fit your printer.

1. Click the File menu and click Print.
2. If the map is larger than the printer paper, click Scale map to fit printer paper. (Tile map to printer paper will print the map at full scale on separate sheets of paper so you can paste them together to display the full map.)
3. Click Setup.



4. Click Portrait on the Printer Setup panel.



5. Click OK on the Page Setup dialog box, then click OK on the Print dialog.

For more information on adding graphics to your map, see Chapter 7, 'Labeling maps with text and graphics'. For more on map layout and composition, see Chapter 8, 'Laying out and printing maps'.

In this chapter, you've been introduced to many of the basic ArcMap tasks you'll often use. The rest of this book provides more detail on these tasks and shows you many more tasks you can perform using ArcMap.

# ArcMap basics

# 3

## IN THIS CHAPTER

- **Layers, data frames, and the table of contents**
- **Starting ArcMap**
- **The ArcMap window**
- **Opening a map**
- **Using the table of contents**
- **Looking at a map in data view and layout view**
- **Moving around the map**
- **Setting bookmarks**
- **Opening magnifier and overview windows**
- **Exploring data on a map**
- **Getting help**
- **Saving a map and exiting ArcMap**

A *map* is the fundamental component you work with in ArcMap. Maps help you visualize geographic data by showing you where things are, telling you what they are, and helping you understand why they are that way.

Maps serve a variety of purposes. Some maps are interactive and meant to be browsed online, while others are formatted for printing or embedding in another application such as a word processor. Every map can have a unique look—including both its graphic layout and interface—tailored to those who will ultimately use the map.

Maps are documents stored on disk and managed with ArcCatalog. Through ArcCatalog, you can find the map you want to work with and open it in ArcMap. Once your map is open, you might browse its contents, edit the geographic data it contains, or prepare it for printing by arranging map elements, such as titles, North arrows, legends, and scale bars, around the data in a visually pleasing manner. When you're through working with the map, you can save the document.

Whether you're building a map or just looking at one, you can make it show exactly what you want. For instance, you can choose what geographic data you want to see, focus on a particular geographic area and display it at a specific scale, and query features to find out about them and explore their relationship to other features. When you're finished, you can give the map to someone else to look at.

# Layers, data frames, and the table of contents

You display geographic information on a map as *layers*, where each layer represents a particular type of feature such as streams, lakes, highways, political boundaries, or wildlife habitats. A layer doesn't store the actual geographic data; instead, it references the data contained in coverages, shapefiles, geodatabases, images, grids, and so on. Referencing data in this way allows the layers on a map to automatically reflect the most up-to-date information in your GIS database.

The *table of contents* lists all the layers on the map and shows what the features in each layer represent. The check box next to each layer indicates whether it is currently turned on or off, that is, whether it is currently drawn on the map or not. The order of layers within the table of contents is also important; the layers at the top draw on top of those below them. Thus, you'll put the layers that form the background of your map, such as the ocean, at the bottom of the table of contents.

Table of contents

Click here to add a layer to the map.

The Cities layer draws on top of all other layers.

A layer displays geographic features and defines how it's drawn on the map.

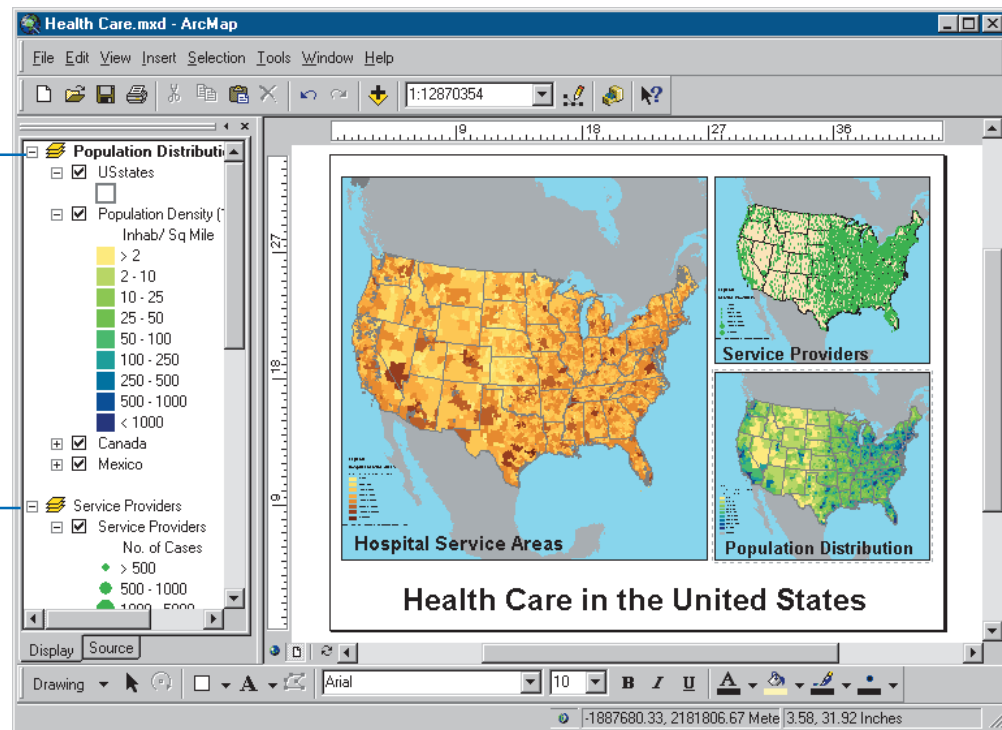
The screenshot shows the ArcMap interface for a project named 'Mexico Population.mxd'. The Table of Contents on the left lists several layers: Cities (checked), Roads (checked), Rivers (checked), Lakes (checked), States (checked), United States (checked), and Central America (checked). The 'States' layer is expanded to show a legend for 'Population per square' with five categories: 11 - 124 (lightest yellow), 153 - 238 (yellow), 315 - 625 (orange), 1191 (dark orange), and 14426 (darkest orange). The map window displays a map of Mexico with population density in 1990, showing major cities and state boundaries. A scale bar at the bottom of the map indicates 1:13800000. The Tools toolbar on the right contains various navigation and editing tools. Annotations with blue arrows point to the 'Add Layer' button in the top toolbar, the Table of Contents, and the 'Cities' layer in the Table of Contents.

Layers in the table of contents can be further organized into *data frames*. A data frame simply groups, in a separate frame, the layers that you want to display together. You always get a data frame when you create a map; it's listed at the top of the table of contents as "Layers", but you can change the name to something more meaningful if you like. For many of the maps you make, you won't need to think much more about data frames; you'll just add layers to your map and, depending on how you order them in the table of contents, some layers will draw on top of others. You will want to think more about data frames—and adding additional ones—when you want to compare layers side by side or create insets and overviews that highlight a particular location or attribute, as shown in the map below.

When a map has more than one data frame, one of them is the *active data frame*. The active data frame is the one you're currently working with. For example, when you add a new layer to a map, it is added to the active data frame. You can always tell which data frame is active because it's highlighted on the map and its name is shown in bold text in the table of contents. Of course, if a map has only one data frame, it's always the active one.

The active data frame is highlighted with bold text.

Use additional data frames to display layers in separate frames on the map.



## Starting ArcMap

Starting ArcMap is the first step to exploring your data. However, before you can start, ArcMap must be installed on your computer or network. If you don't know whether it's installed yet, check with your system administrator or install it yourself using the installation guide.

Once the software is installed, you can access ArcMap from the Start button on the Windows taskbar. Each ArcMap session can display one map at a time. You can work with several maps by starting additional ArcMap sessions.

After you first start ArcMap, you can decide whether or not you want to see the splash screen and Startup dialog box. If you don't want to see these, you can easily turn them off.

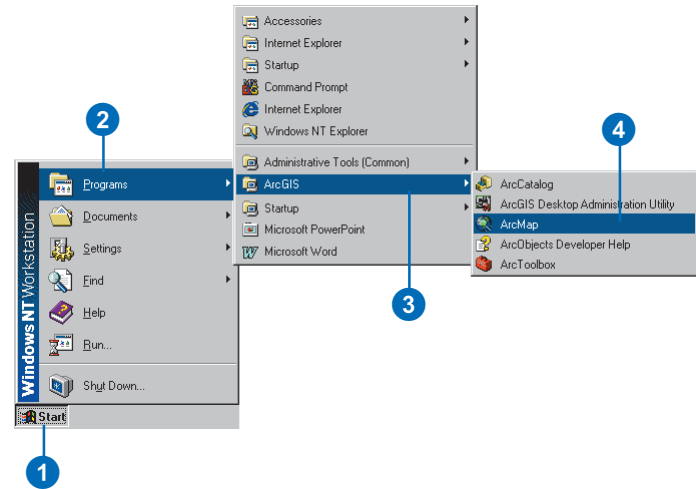
### Tip

#### Starting ArcMap by opening an existing map

*Double-clicking a map in ArcCatalog or the Windows Explorer will launch ArcMap and display the map.*

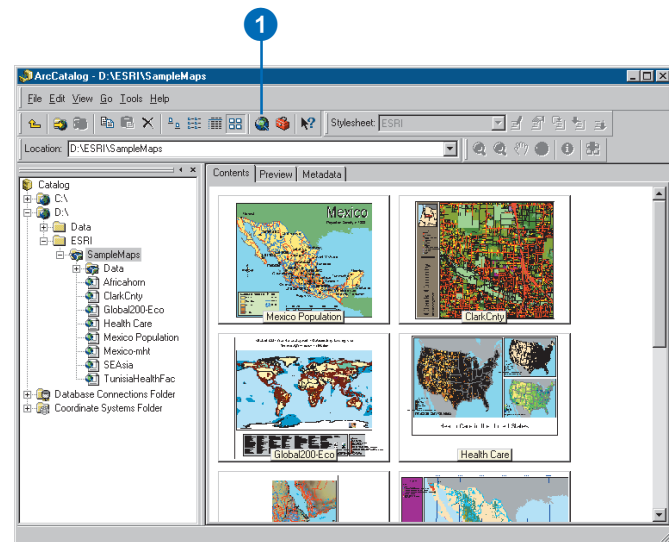
## Starting ArcMap from the Start menu

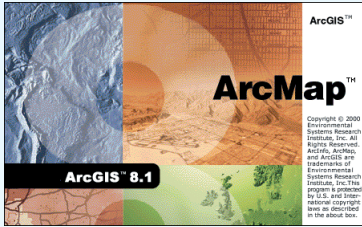
1. Click the Start button on the Windows taskbar.
2. Point to Programs.
3. Point to ArcGIS.
4. Click ArcMap.



## Starting ArcMap from ArcCatalog

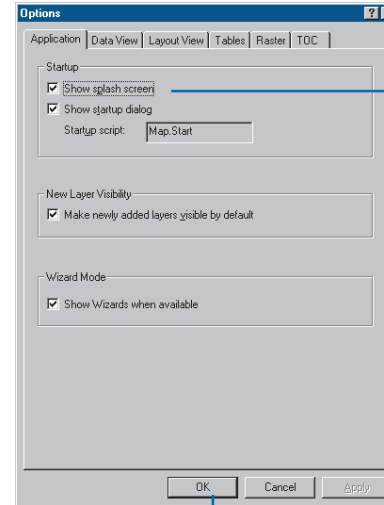
1. Click the Launch ArcMap button.



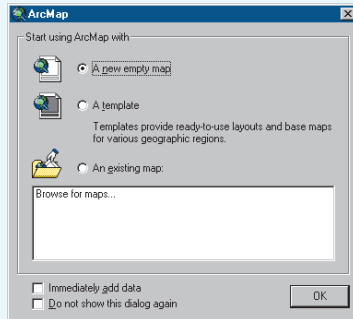


## Turning on the splash screen

1. Click the Tools menu and click Options.
2. Click the Application tab.
3. Check Show splash screen.
4. Click OK.

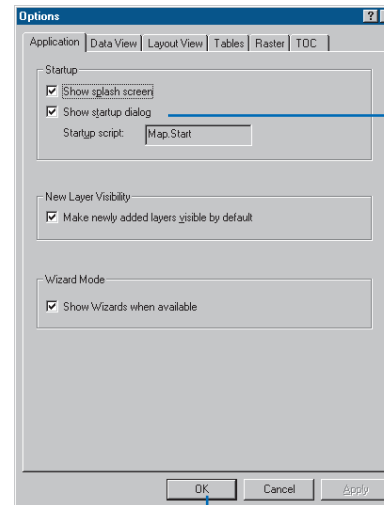


4



## Turning on the Startup dialog box

1. Click the Tools menu and click Options.
2. Click the Application tab.
3. Check Show startup dialog.
4. Click OK.



4

# The ArcMap window

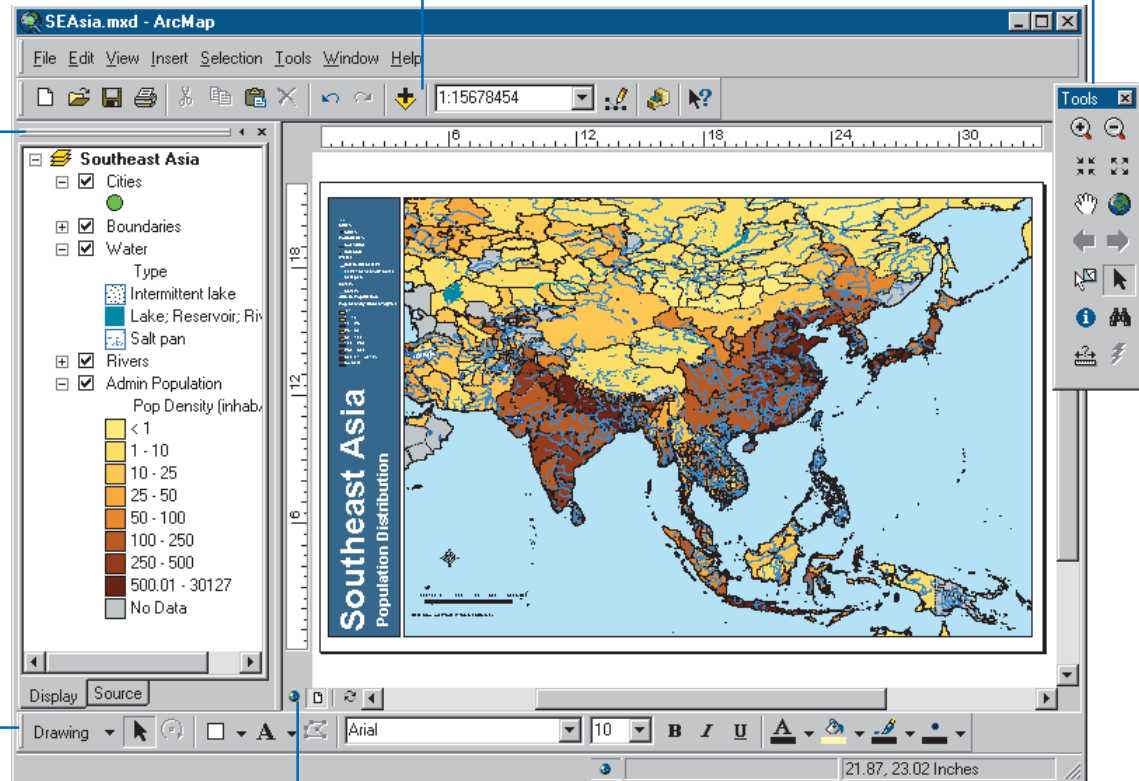
Frequently used commands, such as Open, Save, Print, Undo, and Add Layers, are on the Standard toolbar.

Browse a map with the Tools toolbar.

The table of contents lists the layers on the map. To see more of the map, drag the table of contents off.

Add map elements with the Draw toolbar.

Use these buttons to quickly switch between data view and layout view.





## Opening a map

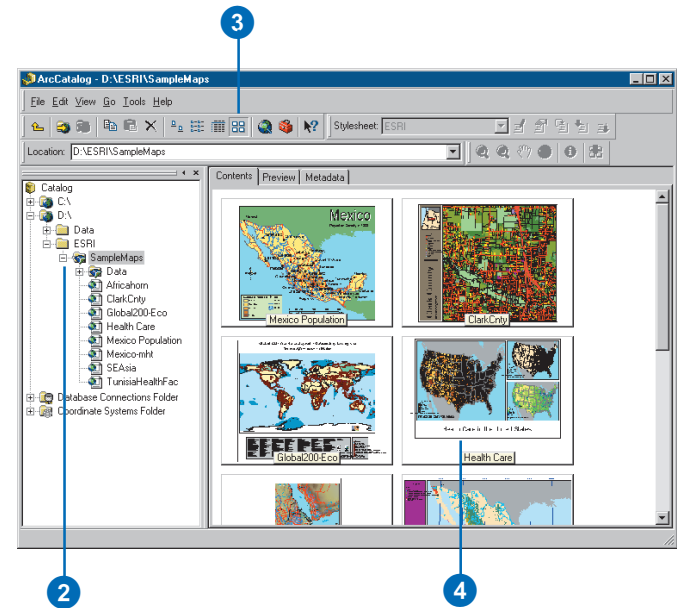
To work on a map, you open it in ArcMap. If you know its location on disk, you can navigate to it with ArcCatalog and open it in ArcMap. If you already have ArcMap running, you can open it directly within that session.

If you're not sure where your map is located, use ArcCatalog to find it by browsing for it in the folders in your database. Because ArcCatalog lets you preview a map before you open it, you'll always open the right one.

A map doesn't store the spatial data displayed on it. Instead, it stores references to the location of these data sources—for example, geodatabases, coverages, shapefiles, and rasters—on disk. Thus, when you open a map, ArcMap checks the links to the data. If it can't find some data—for instance, if the source data for a layer has been deleted or renamed, or a network drive is not accessible—ArcMap lets you locate it. If the data is currently unavailable, you can ignore the broken link and display the map without the layer. The layer will still be part of the map and listed in the table of contents; it simply won't display.

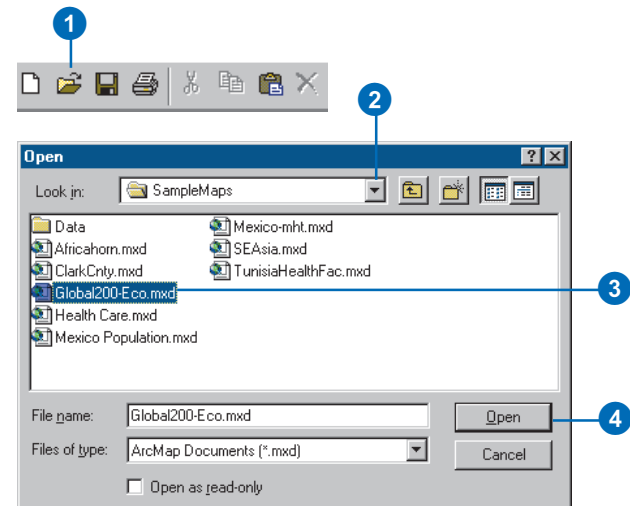
## Opening a map from ArcCatalog

1. Start ArcCatalog if it isn't already running.
2. In ArcCatalog, navigate to the folder that contains your map.
3. Click the Thumbnails button to get a look at the maps the folder contains.
4. Double-click the map to open it in ArcMap.



## Opening a map from ArcMap

1. Click the Open button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the map.
3. Click the map you want to open.
4. Click Open.



## Tip

### Running multiple ArcMap sessions

Double-clicking a map in ArcCatalog will always open that map in its own ArcMap session. You can also double-click a map in Windows Explorer to open it.

## Tip

### Why does the interface change when I open a map?

Every map can have its own interface. Anytime you change a map's interface—for example, move a button, add a button to a toolbar, or create your own toolbar—you can save the change to the map. Not only can you make a map look the way you want, you can also tailor the interface to work the way you want.

## Tip

### Working on one map at a time

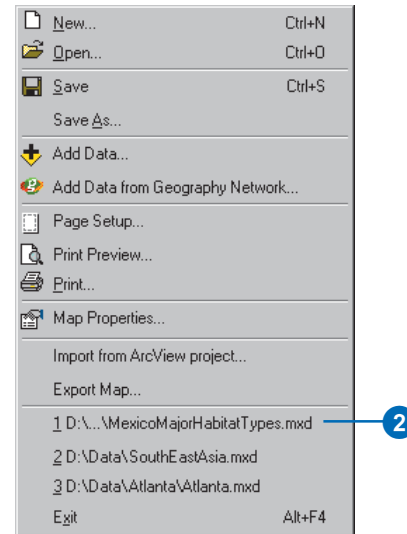
You can only work on one map at a time in an ArcMap session. ArcMap will close any open map before opening another one.

## See Also

For more information on creating maps, see Chapter 4, 'Creating maps'.

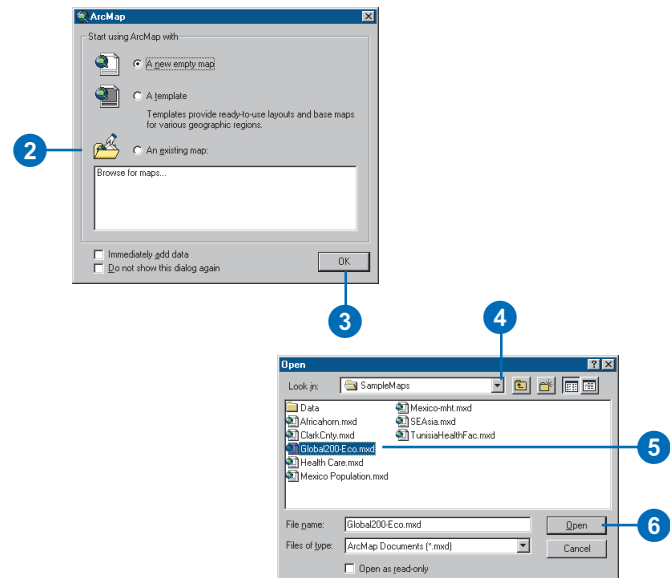
## Opening a recently opened map

1. Click the File menu on the Standard toolbar.
2. Click a map from the list of recently opened maps.



## Opening a map from the Startup dialog box

1. Start ArcMap.
2. Click to open an existing map.
3. Click OK.
4. In the dialog box that appears, click the Look in dropdown arrow and navigate to the folder that contains the map.
5. Click the map you want to open.
6. Click Open.



## Using the table of contents

Every map has a *table of contents*. The table of contents shows you what layers the map contains and also how the map presents the geographic features in those layers.

Some maps display all the layers in one data frame. Others, such as those with insets and overviews, will have more than one data frame. The table of contents shows how the layers are organized into data frames.

When viewing a map, you'll use the table of contents primarily to turn layers on and off. As you begin building your own maps, you'll find that the table of contents is the focal point for many tasks, such as adding and deleting layers and determining how to draw layers.

You can choose to display the table of contents with either the Display or Source tab. Use the Source tab while editing to see how your data is organized into workspaces.

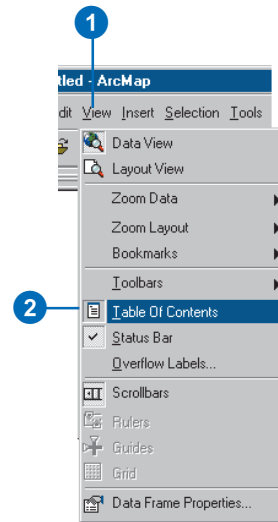
### Tip

#### Need to see more of your map?

*You can drag the table of contents off the ArcMap window.*

## Showing the table of contents

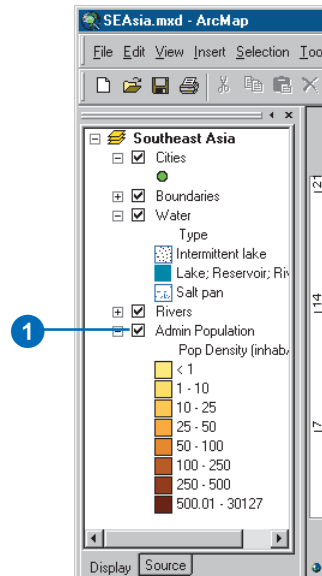
1. Click the View menu on the Standard toolbar.
2. Click Table Of Contents.



## Turning a layer on or off

1. In the table of contents, check the box next to the layer's name.

The layer should appear on your map. If you can't see the layer, it may be hidden by another layer or display only at a particular scale.



## Tip

### Drawing layers

Double-click a layer in the table of contents to see its properties. From there you can change how you draw the layer.

## Tip

### Changing colors

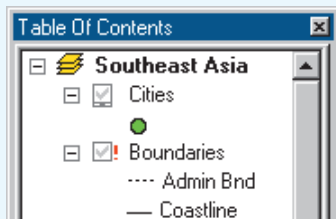
You can quickly change the color of a particular feature by right-clicking on the color in the table of contents.

## Tip

### Why isn't my layer drawing?

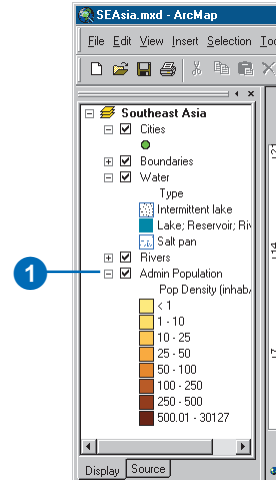
The layer may have a visible scale range set. If you see a gray scale bar underneath the layer's check box in the table of contents, it's not drawing because it's outside of a visible scale range. You'll need to zoom in or out to see it.

If you see a red exclamation point, the link to the layer's data source is broken. Right-click the layer, point to *Data*, and click *Set Data Source* to fix the link.



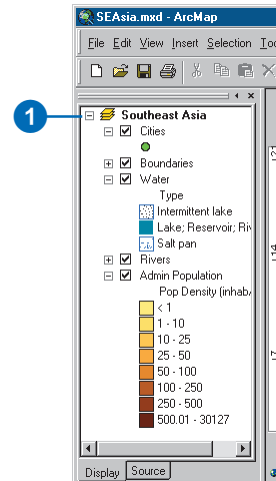
## Showing a layer's legend

1. Click the plus or minus sign to the left of the layer name in the table of contents to show or hide its legend.



## Showing the contents of a data frame

1. Click the plus or minus sign to the left of the data frame in the table of contents to show or hide the list of layers it contains.



## Looking at a map in data view and layout view

ArcMap provides two different ways to view a map: data view and layout view. Each view lets you look at and interact with the map in a specific way.

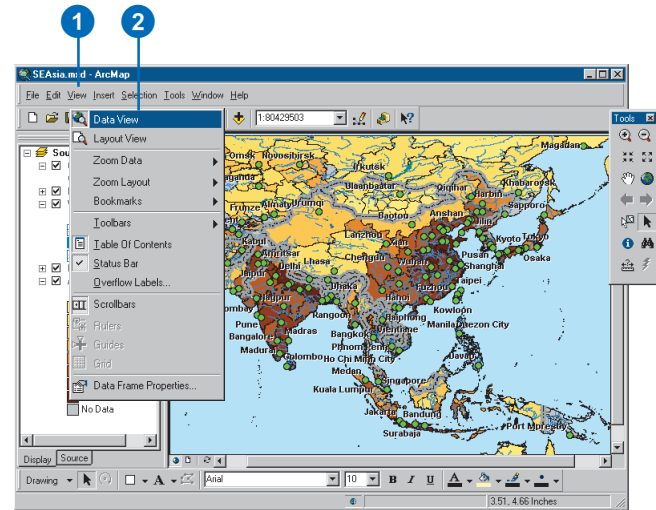
When you want to browse the geographic data on your map, choose data view. *Data view* is an all-purpose view for exploring, displaying, and querying the data on your map. This view hides all the map elements on the layout—such as titles, North arrows, and scale bars—and lets you focus on the data in a single data frame, for instance, to do editing or analysis.

When you're preparing your map to hang on the wall, put in a report, or publish on the Web, you'll want to work with it in layout view. *Layout view* is for laying out your map. In layout view, you'll see a virtual page upon which you can place and arrange map elements. In layout view, you can do almost everything you can in data view, plus design your map.

### Switching to data view

1. Click the View menu on the Standard toolbar.
2. Click Data View.

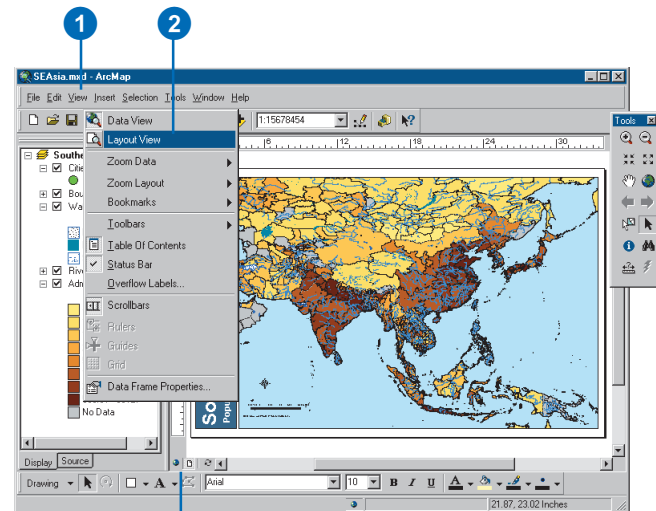
The ArcMap window displays the active data frame.



### Switching to layout view

1. Click the View menu on the Standard toolbar.
2. Click Layout View.

The ArcMap window displays the entire map.



You can also use these buttons to quickly switch between the data and layout view.

## Moving around the map

As you work with a map, you can easily change how you view the data it contains. When you're just browsing a map, you might want to pan and zoom around the data to investigate different areas and features. When you're creating a map to hang on the wall, displaying data at a specific scale may be important.

Most of the tools for navigating your data are found on the Tools toolbar.

### See Also

*For information on panning and zooming the entire map page in layout view, see Chapter 8, 'Laying out and printing maps'.*

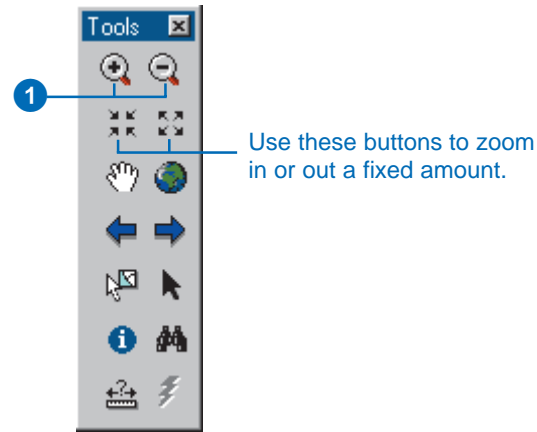
### Tip

#### **Panning using the scroll bars**

*In data view, you can also pan the map by dragging the scroll bars.*

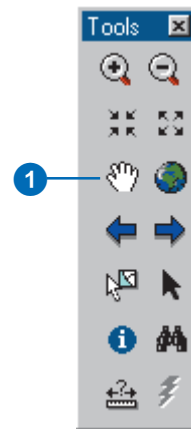
## Zooming in or out

1. Click the Zoom In or Zoom Out button on the Tools toolbar.
2. Move the mouse pointer over the map display and click once to zoom around a point. Alternatively, click and drag a rectangle defining the area you want to zoom in or out on.



## Panning

1. Click the Pan button on the Tools toolbar.
2. Move the mouse pointer over the map display and click and drag the pointer.



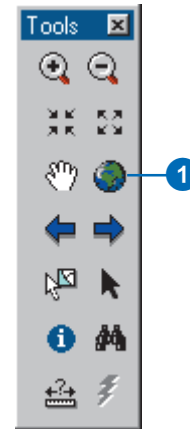
## Tip

### Panning and zooming in maps with more than one data frame

*If your map has more than one data frame, panning and zooming will occur in the active data frame. In layout view, clicking a data frame will activate it.*

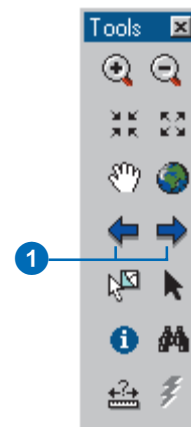
### Zooming to the full extent of the data

1. Click the Full Extent button on the Tools toolbar.



### Moving back or forward one display

1. Click the Back or Forward Extent buttons on the Tools toolbar.



## Tip

### Selecting layers in the table of contents

Click a layer to select it. Hold down the Shift or Ctrl key to select multiple layers.

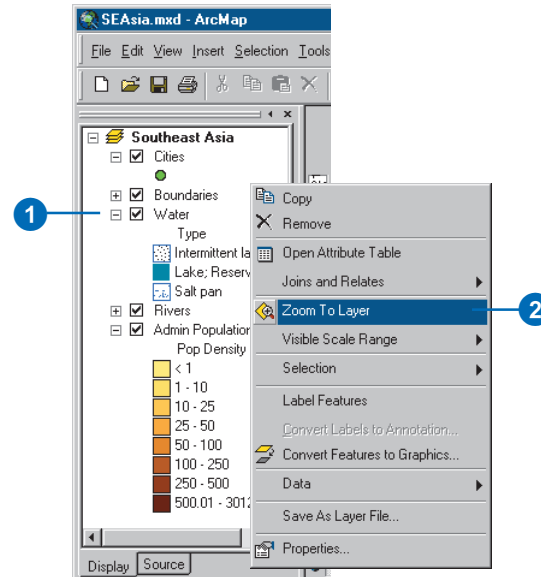
## Tip

### Why doesn't a layer draw when I zoom in or out?

The layer probably has a Visible Scale Range set that prevents the layer from displaying on the map at certain scales. You can clear the scale range by right-clicking on the layer in the table of contents, pointing to Visible Scale Range, and clicking Clear Scale Range.

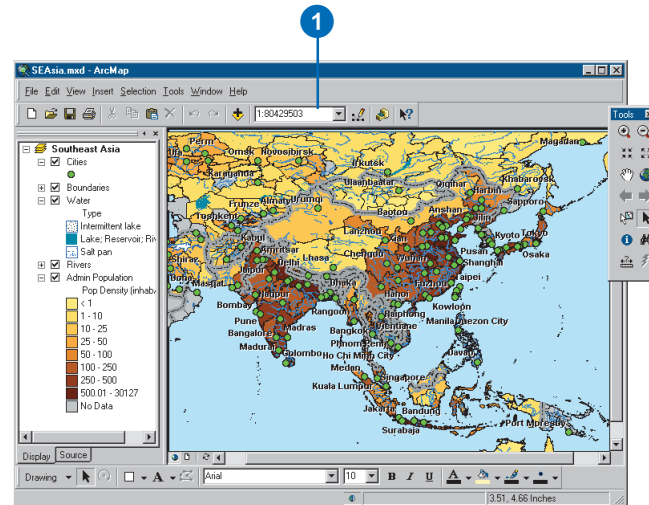
## Zooming to the extent of a layer

1. Right-click the layers you want to zoom to.
2. Click Zoom To Layer.



## Zooming to a specific scale

1. Type the desired scale on the Standard toolbar.





## Setting bookmarks

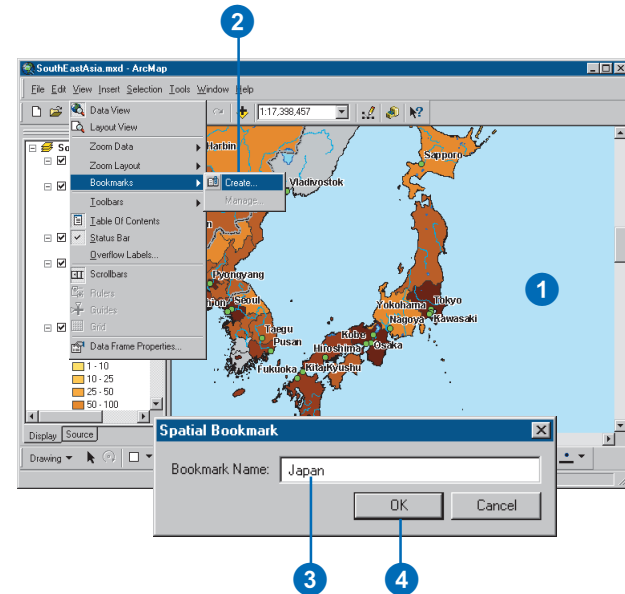
A *spatial bookmark* identifies a particular geographic location that you want to save and refer to later. For example, you might create a spatial bookmark that identifies a study area. That way, as you pan and zoom around your map, you can easily return to the study area by accessing the bookmark. You can also use spatial bookmarks to highlight areas on your map you want others to see.

You can create a spatial bookmark at any time. As a shortcut, you can also create bookmarks when you find and identify map features. Spatial bookmarks, however, can only be defined on spatial data; they can't be defined on an area of the page in layout view.

Each data frame on your map maintains its own list of bookmarks. In layout view, the list reflects the bookmarks of the active data frame.

## Creating a spatial bookmark

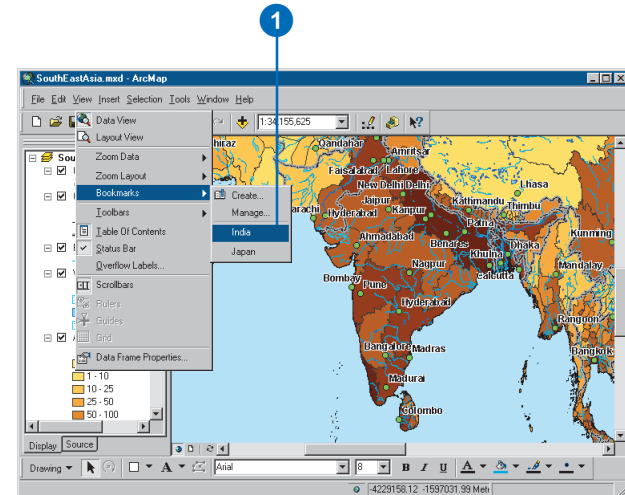
1. Pan and zoom the map to the area for which you want to create a bookmark.
2. Click the View menu, point to Bookmarks, and click Create.
3. Type a name for the bookmark.
4. Click OK.



## Using a spatial bookmark

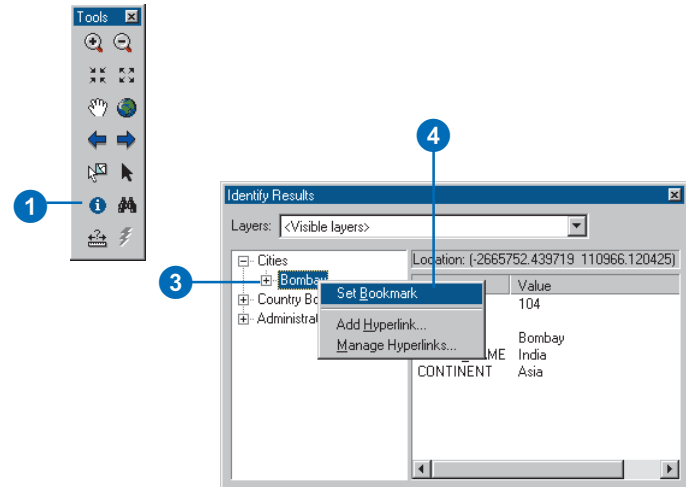
1. Click the View menu, point to Bookmarks, and click the name of the bookmark you want to use.

The bookmarked display appears.



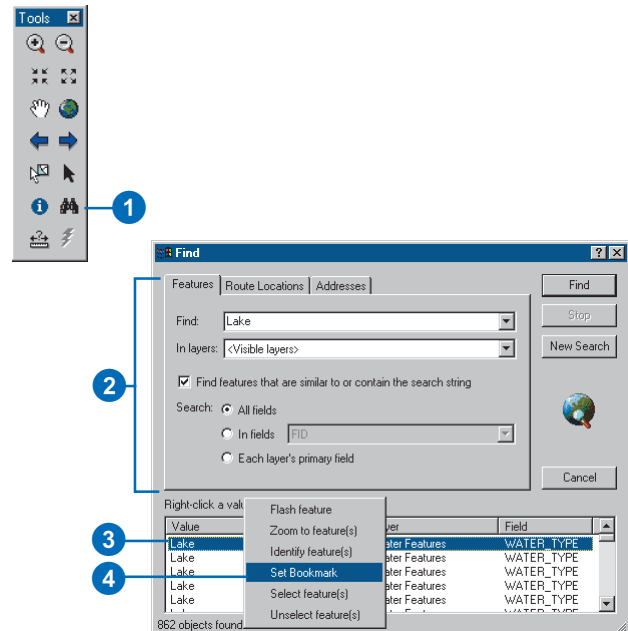
## Creating a spatial bookmark from the Identify Results dialog box

1. Click the Identify button on the Tools toolbar.
2. Click the mouse pointer over the map feature to identify.
3. Right-click the identified feature in the Identify Results dialog box.
4. Click Set Bookmark.  
The bookmark is named after the feature.



## Creating a spatial bookmark from the Find dialog box

1. Click the Find button on the Tools toolbar.
2. Fill in the dialog box to find the features you want.
3. Right-click the Value in the Find Results list.
4. Click Set Bookmark.  
The bookmark is named after the feature.



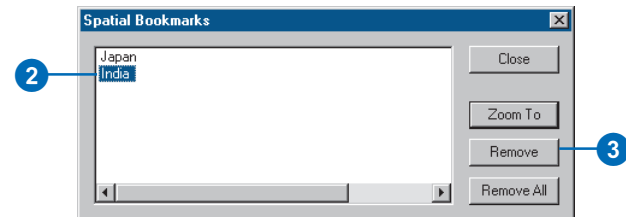
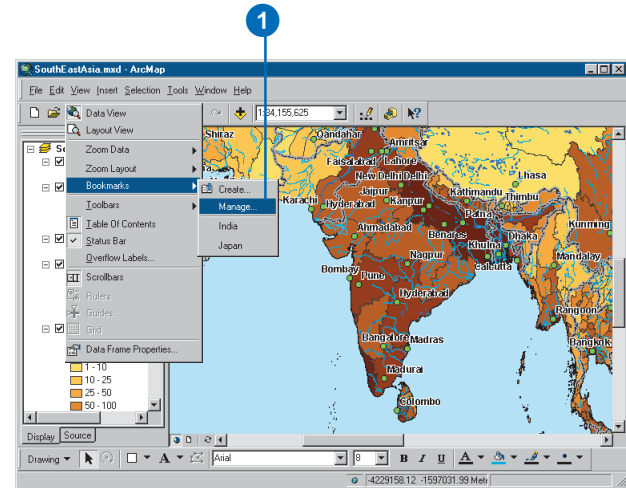
## Tip

### Removing more than one bookmark at a time

*Hold down the Shift key to select more than one bookmark and click Remove.*

## Removing a spatial bookmark

1. Click the View menu, point to Bookmarks, and click Manage.
2. Click a bookmark.
3. Click Remove.



## Opening magnifier and overview windows

When you don't want to adjust your map display, yet you want to see things a bit differently—see more detail or get an overview of an area—open another window. ArcMap provides two additional ways to explore the spatial data on your map through an overview and a magnifier window.

The magnifier window works like a magnifying glass: as you pass the window over the data, you see a magnified view of the location under the window. Moving the window around does not affect the current map display.

The overview window shows you the full extent of the data. A small box in the overview window represents the currently displayed area on the map. You can move this box around to pan the map and also shrink or enlarge it to zoom in or out.

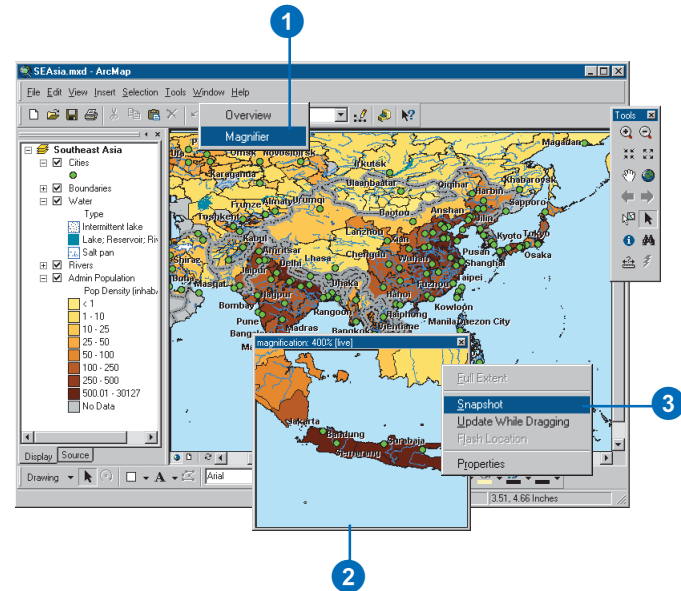
Both windows operate only in data view.

## Opening a magnifier window and setting the view

1. Click the Window menu and click Magnifier.

You must be viewing the map in data view to display a magnifier window.

2. When the magnifier window appears, drag it over the data to see a magnified view.
3. Right-click the title bar and click Snapshot to lock the view.

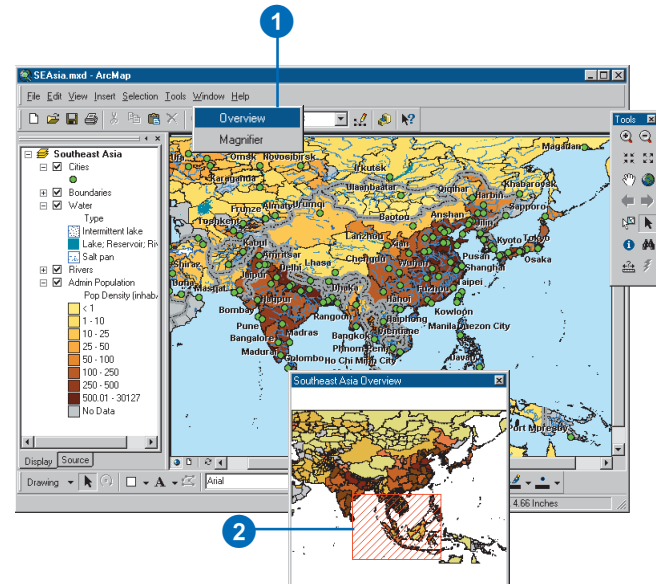


## Opening an overview window to pan and zoom the map

1. Click the Window menu and click Overview.

You must be viewing the map in data view to display an overview window.

2. Drag, shrink, or expand the box in the overview window to change the map display in the active data frame.



## Exploring data on a map

Sometimes just looking at a map isn't enough. You need to query data to solve problems. ArcMap lets you explore the data on the map and get the information you need.

You can point at features to find out what they are, find features that have a particular characteristic or attribute, examine all the attributes of a particular layer, and measure distances on the map. Map Tips also provide a quick way to browse map features. Like ToolTips for toolbar buttons, Map Tips pop up as you pause the mouse pointer over a feature.

### See Also

*For powerful ways to explore your data, see Chapter 13, 'Querying maps'.*

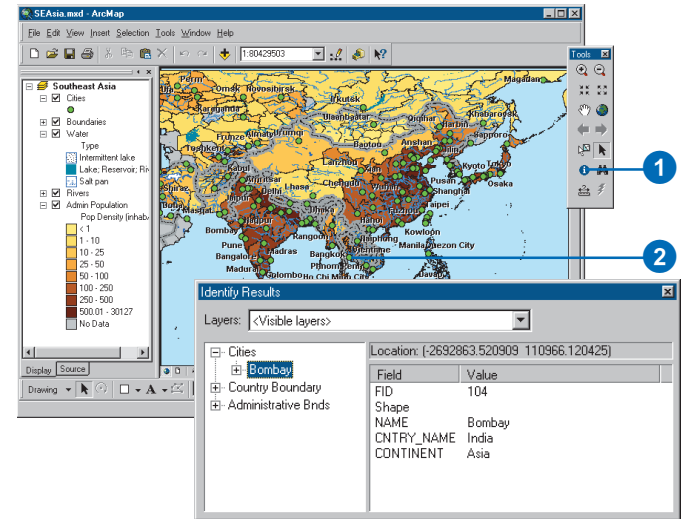
### Tip

**I can't see the Map Tips**  
*If you can't see Map Tips even after you've enabled them, make sure that the layer is turned on and the features in the layer are not being hidden by features in overlapping layers.*

## Identifying features by pointing at them

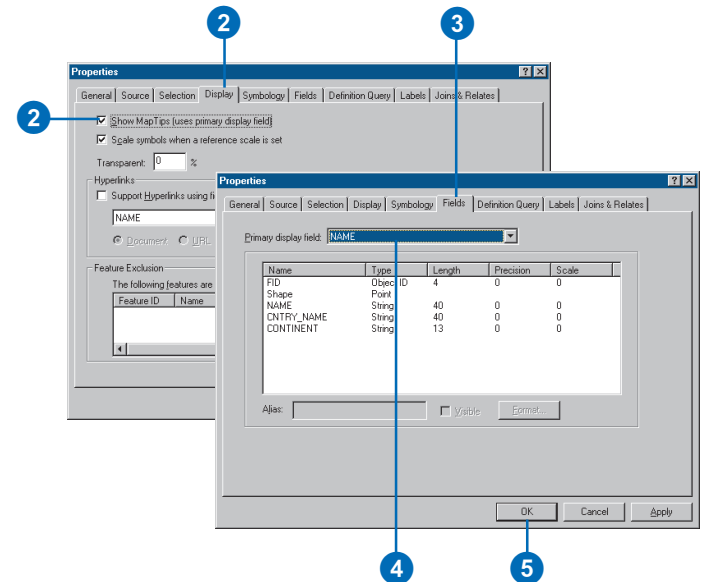
1. Click the Identify button on the Tools toolbar.
2. Click the mouse pointer over the map feature you want to identify.

The features in all visible layers under the pointer will be identified.



## Displaying Map Tips

1. In the table of contents, right-click the layer for which you want to display Map Tips and click Properties.
2. Click the Display tab and check Show Map Tips.
3. Click the Fields tab.
4. Click the Primary display field dropdown arrow and click the attribute field you want to display as the Map Tip.
5. Click OK.
6. Move the mouse pointer over a feature to see the Map Tip.



## See Also

For more information on working with attribute tables, see Chapter 10, 'Working with tables'.

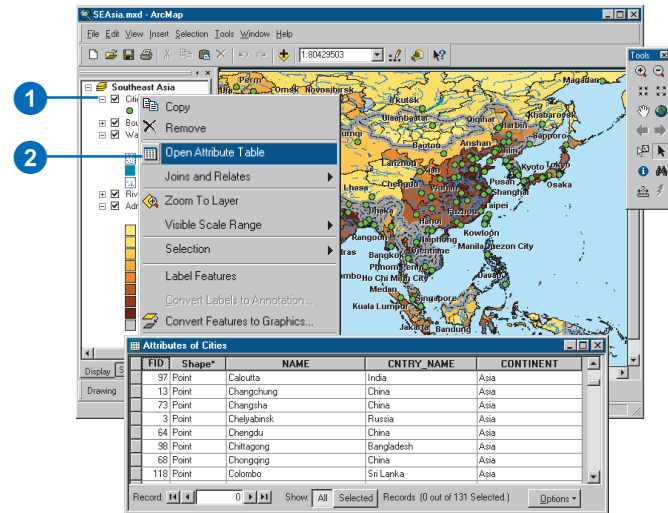
## Tip

### The primary display field

The primary display field is the field that contains the name or identifying characteristic of the feature. For example, on a map of the world, you might set the primary display field to the field that contains the country names. The primary display field is set through layer properties.

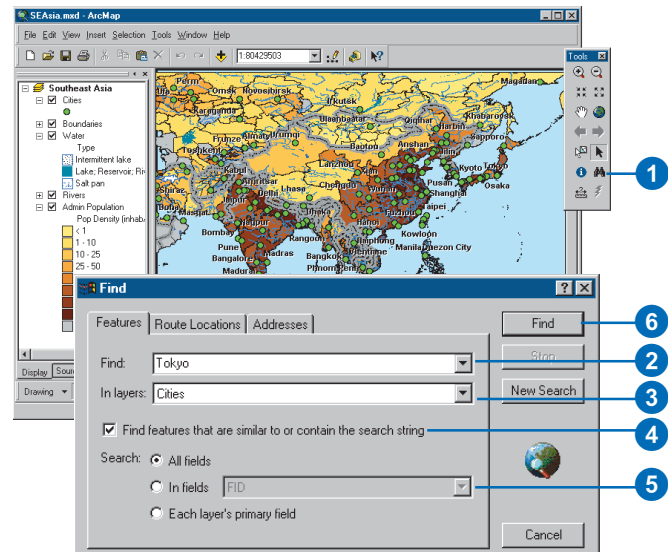
## Viewing a layer's attribute table

1. In the table of contents, right-click the layer for which you want to display the attribute table.
2. Click Open Attribute Table.



## Finding features with particular attributes

1. Click the Find button on the Tools toolbar.
2. Type the string you want to find in the Find text box.
3. Click the In layers dropdown arrow and click the layer you want to search.
4. Uncheck Find features that are similar to or contain the search string.
5. Search for the string in all fields, in a specific field, or in the primary display field.
6. Click Find.



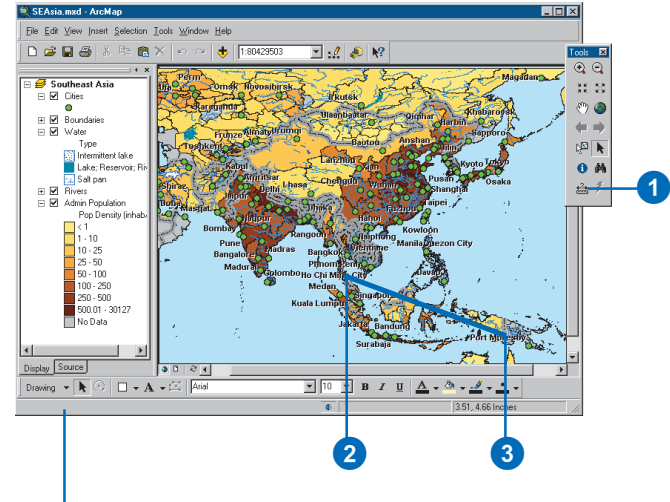
## Tip

**Do you want to measure distance in kilometers, miles, meters, or feet?**

*Each data frame can display distance measurements using whatever units you need. Set the distance units on the General tab of the data frame properties sheet.*

## Measuring distance

1. Click the Measure button on the Tools toolbar.
2. Use the mouse pointer to draw a line representing the distance you want to measure. The line can have more than one line segment.
3. Double-click to end the line.



The measurement displays here on the status bar.

## Getting help

A quick way to learn what ArcMap can do is to get help about the buttons and menu commands you see on the interface. After clicking the What's This? button, you can click an item in the window to display a popup description of it.

You can also get help in some dialog boxes. When you click the What's This? button in the upper-right corner and click an item in the dialog box, a description of the item pops up.

Much of the information in this book is available in the online Help system. The Help topics are organized around the main tasks you want to complete as well as the concepts behind the tasks.

You can look up general Help topics in the Help Contents. You can search the Index for specific tasks and issues. You can also use the Find tab to look up Help topics that have specific words or phrases.

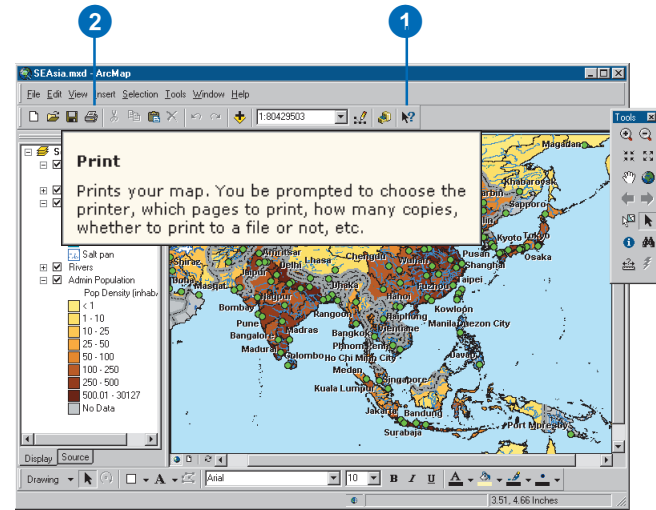
### Tip

#### Another way to get help in a dialog box

*Sometimes a dialog box will also have a Help button on the bottom; clicking it opens a Help topic with detailed information about the task you're trying to accomplish.*

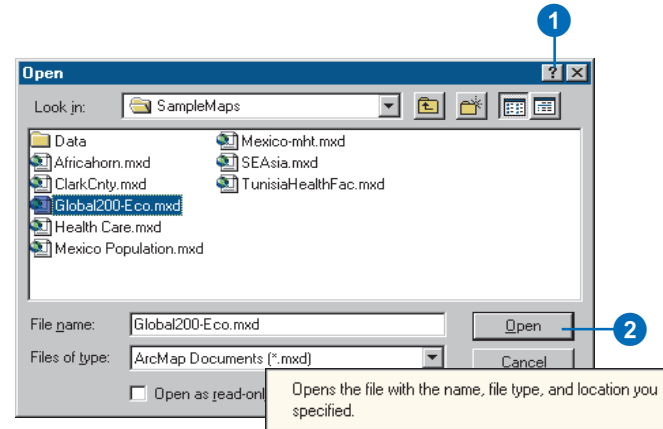
## Getting help in the ArcMap window

1. Click the What's This? button.
2. With the Help pointer, click the item in the ArcMap window about which you want more information.
3. Click anywhere on the screen to close the Help description box.



## Getting help in a dialog box

1. Click the What's This? button.
2. With the Help pointer, click the item in the dialog box about which you want more information.
3. Click anywhere on the screen to close the Help description box.





## Tip

### Tips for buttons and menus

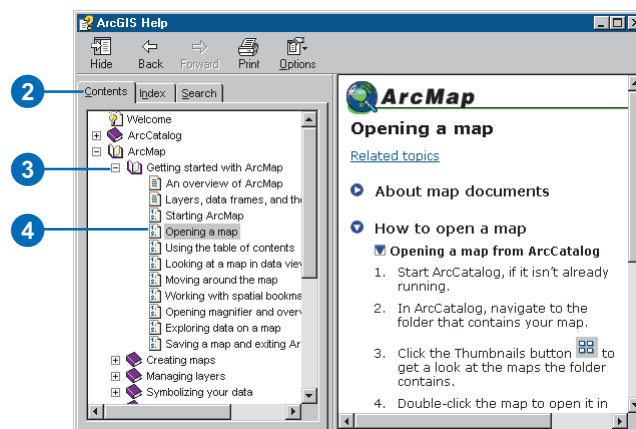
When you pause the mouse pointer over a button, the button's name appears in a small box called a *ToolTip*. When you position the mouse pointer over a button or menu command, a description of what it does appears in the status bar.

## Using the Help Contents to get help

1. Click the Help menu and click ArcGIS Help.
2. Click the Contents tab.
3. Double-click a book to see a list of the topics in that category.

Double-clicking an open book closes its list.

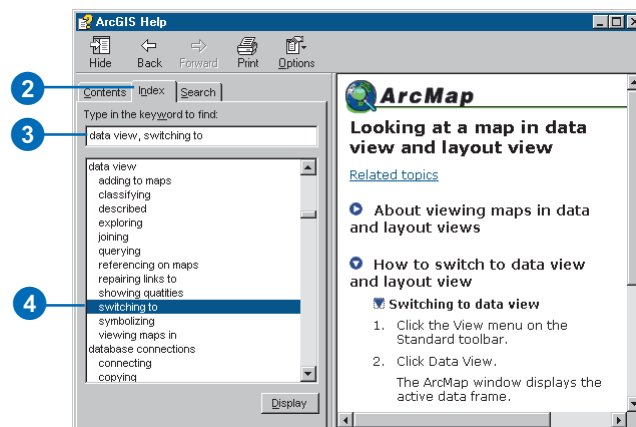
4. Click the topic you want to read.



## Searching the Index for help

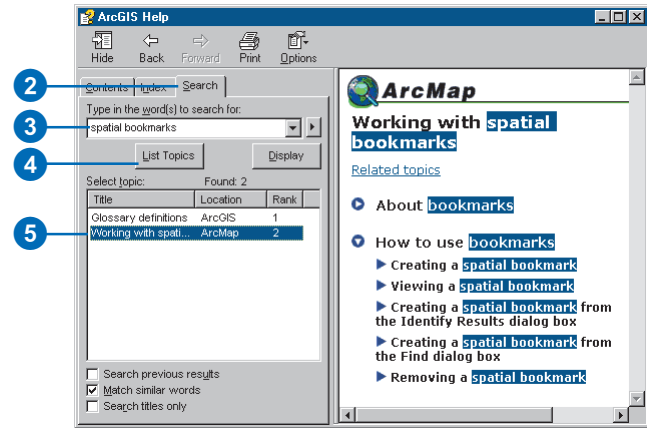
1. Click the Help menu and click ArcGIS Help.
2. Click the Index tab.
3. Type the subject about which you want information.
4. Double-click the topic you want to read.

If several topics are related to your selection, the Topics Found dialog box appears. Simply double-click the topic you want to read.



## Finding Help topics containing specific words

1. Click the Help menu and click ArcGIS Help.
2. Click the Search tab.
3. Type the word that should be contained in the topics you want to find.
4. Click List Topics.
5. Double-click the topic you want to see.



## Saving a map and exiting ArcMap

After you finish working on a map, you can save it and exit ArcMap. You save a map as a document and store it on your hard disk. If you haven't saved the map before, you'll need to name it, preferably with one that adequately describes its contents. ArcMap automatically appends a file extension (.mxd) to your map document name.

The data displayed on a map is not saved with it. Map layers reference the data sources in your GIS database. This helps to keep map documents relatively small in size. So if you plan to distribute your map to others, they'll need access to both the map document and the data your map references.

In general, it's a good idea to save your map periodically while editing it just in case something unexpected happens.

### Tip

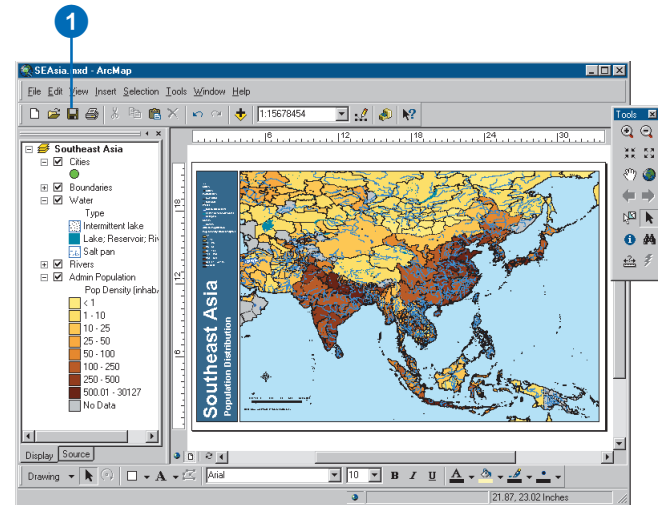
#### Opening a map will close the current one

*In ArcMap, you work with one map at a time. If you need to work with more than one, start another ArcMap session.*

## Saving a map

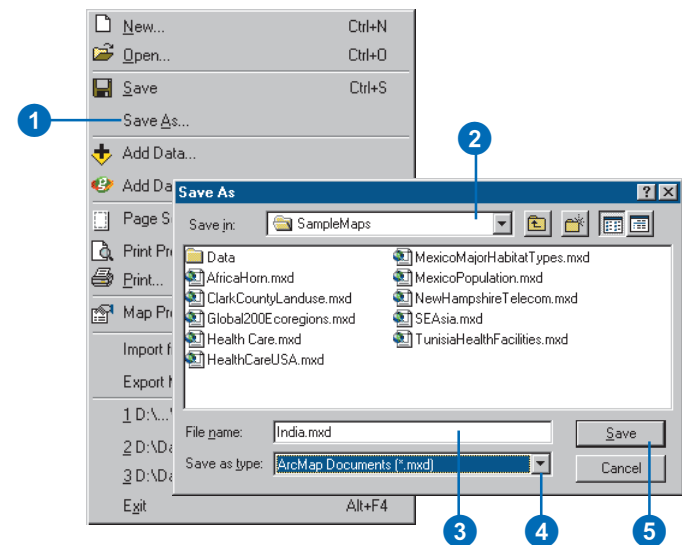
1. Click the Save button on the Standard toolbar.

If you haven't saved the map before, you'll need to provide a name for it.



## Saving a map as a new map

1. Click the File menu and click Save As.
2. Navigate to the location to save the map document.
3. Type a file name.
4. Click the Save as type dropdown arrow and click ArcMap Documents.
5. Click Save.



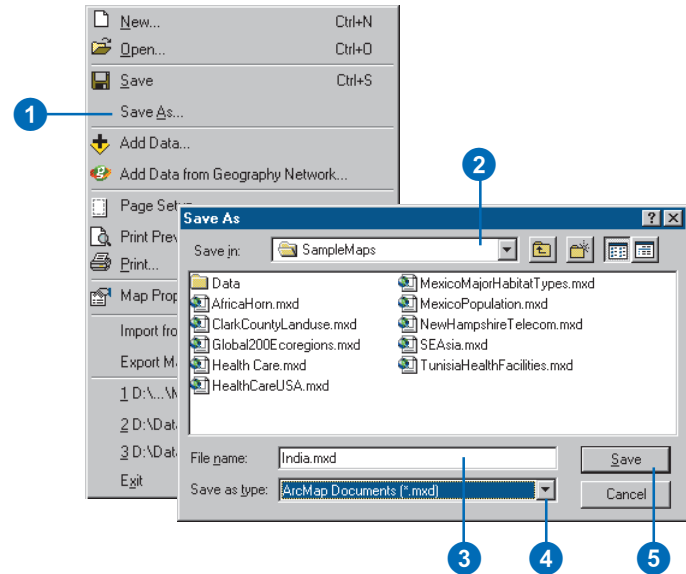
## Tip

### Differentiating a map template from a map document

Map templates have a *.mxt* file extension. Map documents have a *.mxd* file extension.

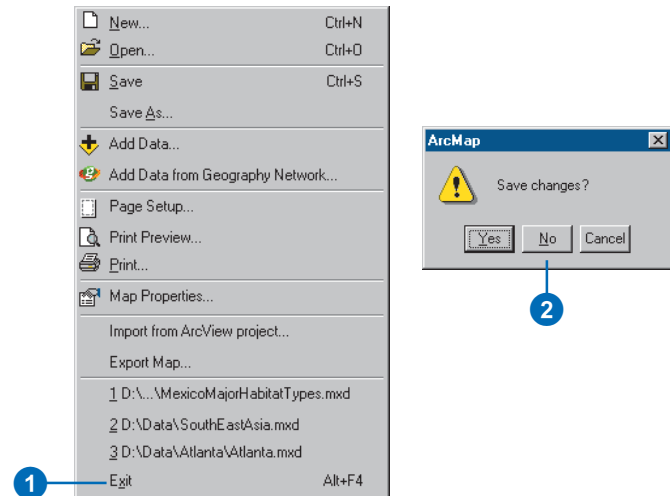
## Saving a map as a map template

1. Click the File menu and click Save As.
2. Navigate to the location to save the map template.
3. Type a filename.
4. Click the Save as type dropdown arrow and click ArcMap Template.
5. Click Save.



## Exiting ArcMap

1. Click the File menu and click Exit.
2. Click Yes to save any changes, No to discard any changes, or Cancel to continue working on your map.



# Displaying data

**Section 2**



# Creating maps

# 4

## IN THIS CHAPTER

- **Creating a new map**
- **Adding layers**
- **Adding coverages, shapefiles, and geodatabases**
- **Adding data from the Internet**
- **Adding TINs as surfaces**
- **Adding CAD drawings**
- **Adding x,y coordinate data**
- **Adding route events**
- **About coordinate systems**
- **Specifying a coordinate system**
- **Referencing data on the map**

Before you sit down to create a map, you need to think about its purpose. What do you want your map to show? Does the map need to stand on its own, or will it be part of a larger presentation? Who is the audience for the map? Answering these and other similar questions will help you determine how to organize and present the information on your map—for instance, what level of detail you need to show; what colors and symbols you should use to draw features; and whether you need to create an interactive map people use at the computer, or one you simply print out and display on a wall, or both.

The first step to creating a map is to locate the data you want to put on it. Finding data may be as simple as using ArcCatalog to browse your organization's GIS database or the spatial data distributed with ArcMap. The Internet is also an excellent resource for finding data—you can add data directly from the Internet using the Geography Network<sup>SM</sup> Web site at [www.geographynetwork.com](http://www.geographynetwork.com). Many government agencies distribute data to the public at minimal or no cost. Commercial data vendors also package data for a wide variety of applications, from business to natural resources. If you have special data requirements, you might create your own data (see *Editing in ArcMap*) or contact one of the many service bureaus or GIS consulting companies that can produce data for you. Even if you don't think you have any spatial data, you just might.

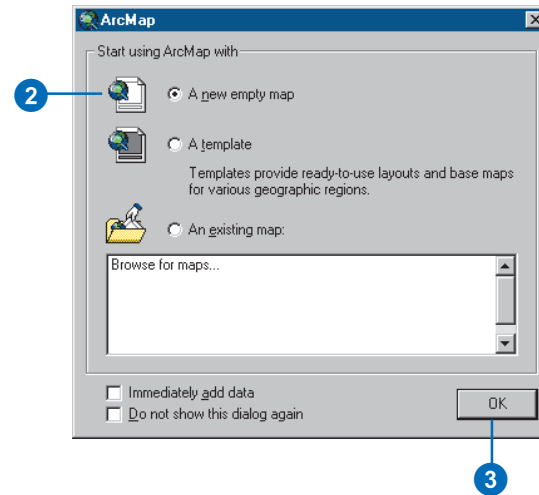
## Creating a new map

No matter what kind of map you want to make, you begin the same way—by creating a new map document. You can either create an empty map with nothing on it or use a *map template* as a starting point. Map templates typically contain a predefined page layout that arranges map elements such as North arrows, scale bars, and logos on the virtual page. This means you can just add your data and immediately print the map. Templates can also contain data (as layers), special symbols and styles, custom toolbars, and macros such as VBA forms and modules.

ArcMap comes with many predefined templates to choose from when making your maps. Also, any map you make can be saved as a template. Templates provide an ideal method for defining the standard maps your organization needs.

## Creating a new map from the Startup dialog box

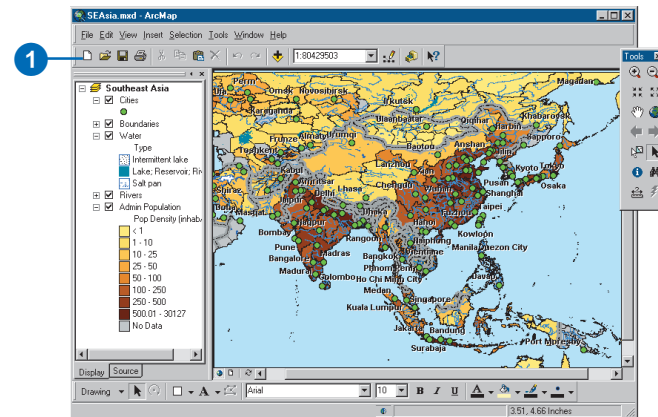
1. Start ArcMap.
2. Click to create a new empty map, create a map from a template, or browse for an existing map.
3. Click OK.



## Creating a new empty map

1. Click the New button on the Standard toolbar to create a new empty map.

If you have a map open already, you'll be prompted to save your changes.





## Tip

### Organizing templates

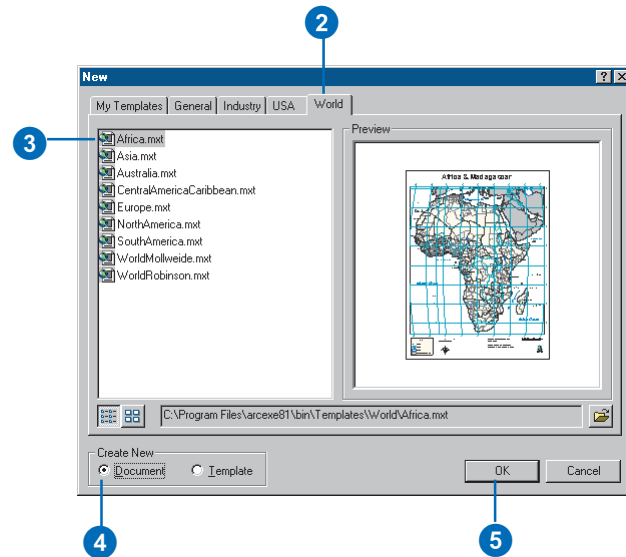
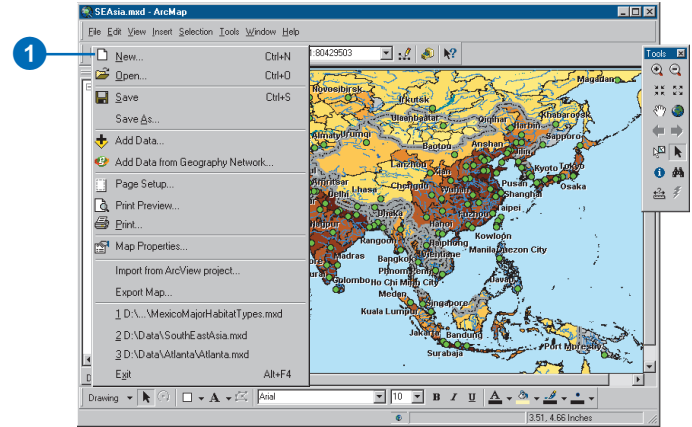
You can create your own templates and organize them into folders on your computer. These folders appear as tabs on the New dialog (lower right). Create folders in the `\bin\templates` folder where you've installed ArcGIS™.

## Using a map template

1. Click the File menu and click New.
2. Click the tab that corresponds to the type of map you want to make.

The tabs you see will depend on how you've organized your custom templates.

3. Click the template you want.  
Some of the templates included with ArcMap include data. You can add your data right on top.
4. Click Document to create a new map document.
5. Click OK.



## Adding layers

Geographic data is represented on a map as a *layer*. A layer might represent a particular type of feature, such as highways, lakes, or wildlife habitats, or it might represent a particular type of data such as a satellite image, a computer-aided design (CAD) drawing, or a terrain elevation surface in a triangulated irregular network (TIN).

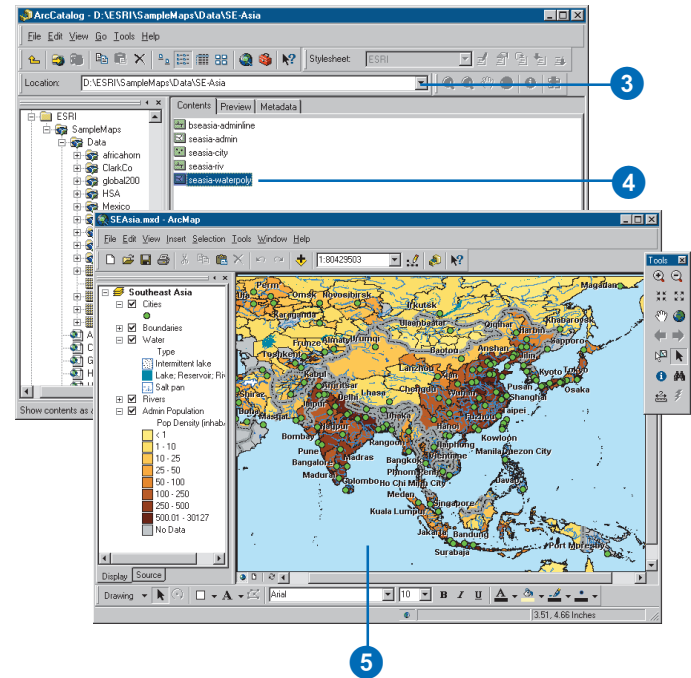
You don't need to know much about data to add a layer to a map. Simply drag one from the Catalog—or copy and paste one from another map—onto the map you're working on. The layer will draw as it was previously symbolized.

A layer doesn't store geographic data itself; instead, it references the data stored in coverages, shapefiles, rasters, and so on. Thus a layer always reflects the most up-to-date information in your database. If you don't have a layer, you can easily create one as described on the following pages. For example, you might create several layers that highlight different aspects of your data and distribute them to others in your organization.

## Adding a layer from ArcCatalog

1. Start ArcCatalog from the Start menu.
2. Arrange the ArcCatalog and ArcMap windows so that you can see both on the screen.
3. Navigate to the layer you want to add to the map.
4. Click and drag the layer from ArcCatalog.
5. Drop the layer over the map display in ArcMap.

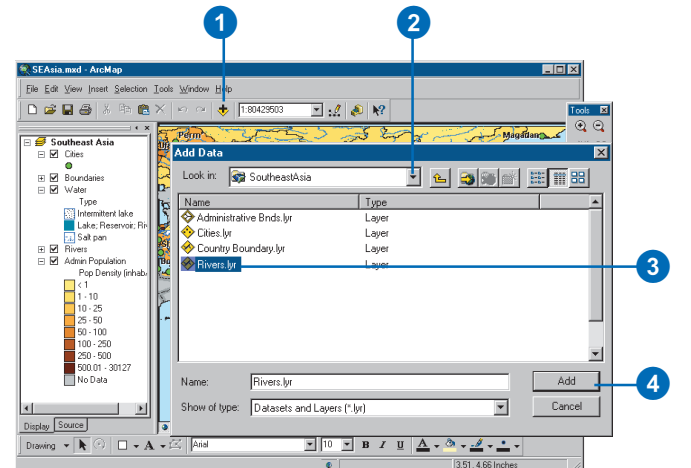
The layer is copied to the map. Any subsequent edits made to the layer on disk will not be reflected on this map.



## Adding a layer from the Add Data button

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the layer.
3. Click the layer.
4. Click Add.

The new layer appears on your map.



## Tip

To see a layer on a map, you must have access to its data source

Even though you have access to a layer on disk, it won't draw on your map unless you also have access to the data source the layer is based on.

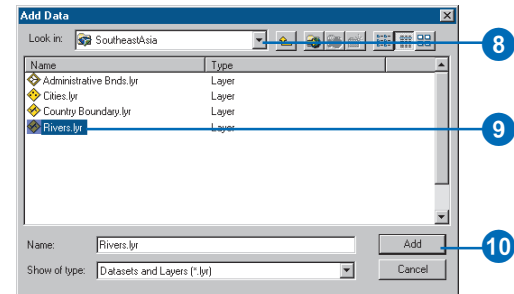
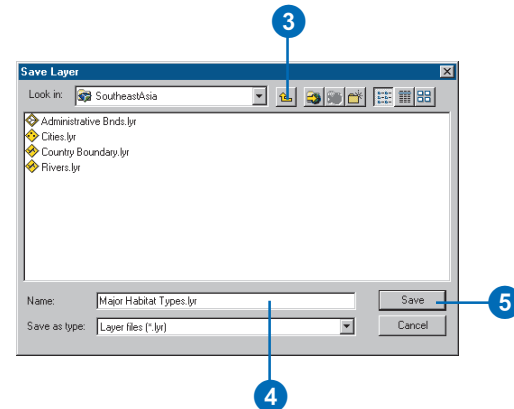
## Tip

Adding a layer from the Catalog

When you add a predefined layer to your map from the Catalog, a copy is placed on the current map. Your current map will not change if the original layer is modified.

## Adding a layer from another map

1. Open the map that contains the layer you want to copy.
2. In the table of contents, right-click the layer and click Save As Layer File.
3. Click the Look in dropdown arrow and navigate to the folder where you want to save the layer.
4. Type a name for the layer.
5. Click Save.
6. Click the Open button on the Standard toolbar to open the map you want to add the layer to.
7. Click the Add Data button.
8. Click the Look in dropdown arrow and navigate to the folder that contains the layer.
9. Click the layer.
10. Click Add.



## Adding coverages, shapefiles, and geodatabases

When you don't have a pre-defined layer at your disposal, you can create one directly from a data source such as a shapefile. To create a layer, add the data source to your map; ArcMap creates a new layer that references the data source.

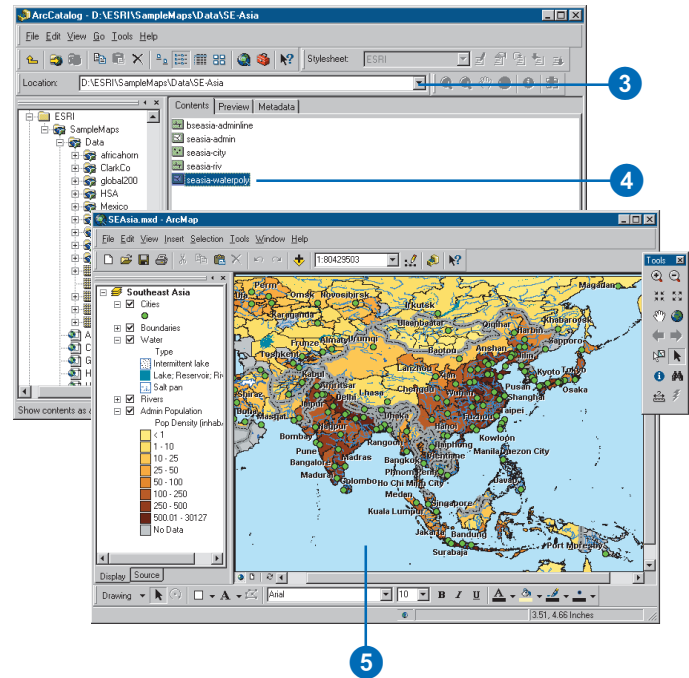
Once a layer is part of a map, you can decide whether or not to display it, the scale at which it should be visible, what features or subset of features to display, and how to draw those features. You can also join other tabular information you have about features to the layer and group layers so they appear as one layer on the map.

The data you display on a map comes in a variety of different forms—for example, raster, vector, and tabular—and is stored in a variety of different formats. If your data is stored in a format supported by ArcMap, you can add it directly to your map as a layer. If your data isn't stored in a supported format, you can use the data conversion utilities in ArcToolbox™ or other third party data conversion products to convert practically any data you have and display it on a map.

## Adding data from ArcCatalog

1. Start ArcCatalog from the Start menu.
2. Arrange the ArcCatalog and ArcMap windows so that you can see both on the screen.
3. Navigate to the data source you want to add to the map.
4. Click and drag the data source from ArcCatalog.
5. Drop the data source over the map display in ArcMap.

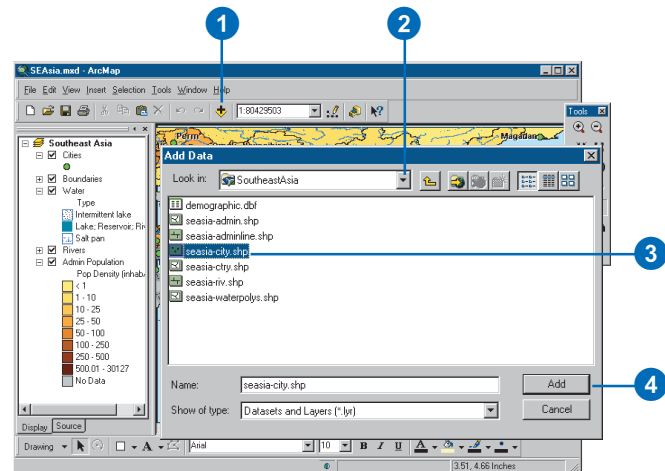
ArcMap creates a new layer on the map that references the data source.



## Adding data in ArcMap

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the data source.
3. Click the data source.
4. Click Add.

ArcMap creates a new layer on the map that references the data source.



## Tip

### Creating a layer in ArcCatalog

*In addition to creating a layer on the fly in ArcMap, you can create one in ArcCatalog.*

## Tip

### More than one layer can reference the same data source

*When you create a layer, you specify a data source that the layer references.*

## See Also

*For more information on how to draw a layer once you've added it to a map, see Chapter 6, 'Symbolizing your data'.*

## See Also

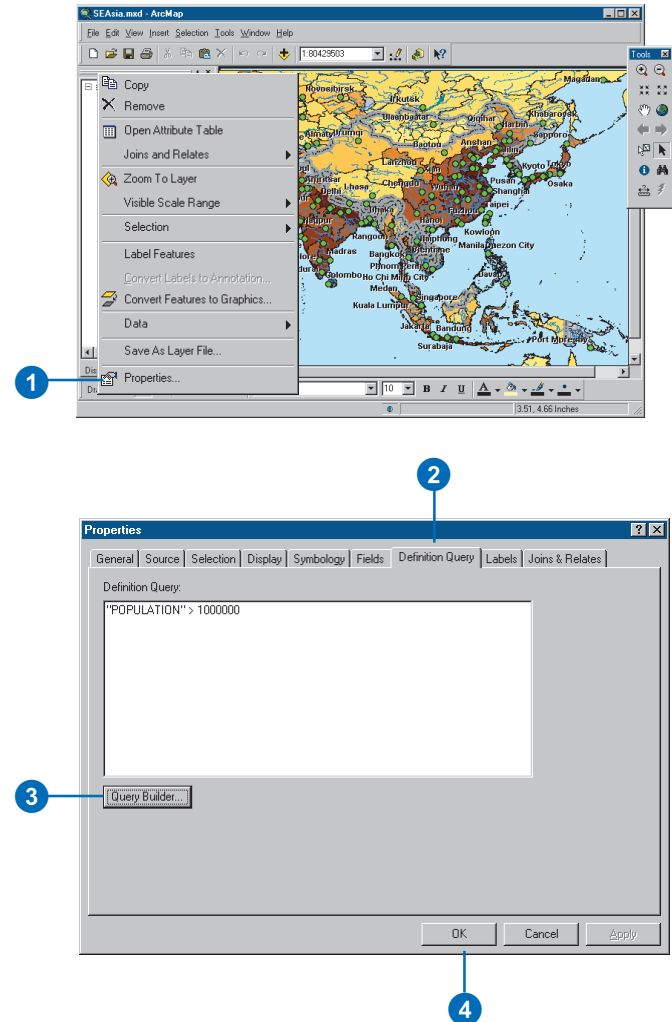
*For more information on the syntax for building a Definition Query expression, see Chapter 13, 'Querying maps'.*

## Displaying a subset of the features in a layer that meet some criteria

1. In the table of contents, right-click the layer and click Properties.
2. Click the Definition Query tab.
3. Type an expression or click Query Builder.

The Query Builder lets you create an expression to identify the particular features in the layer you want to display. For example, you might choose to display only those cities with a population greater than 1,000,000.

4. Click OK.



## Adding data from the Internet

The Internet is a vast resource for geographic data. Now you can utilize this data directly on your maps through Geography Network and other Internet servers.

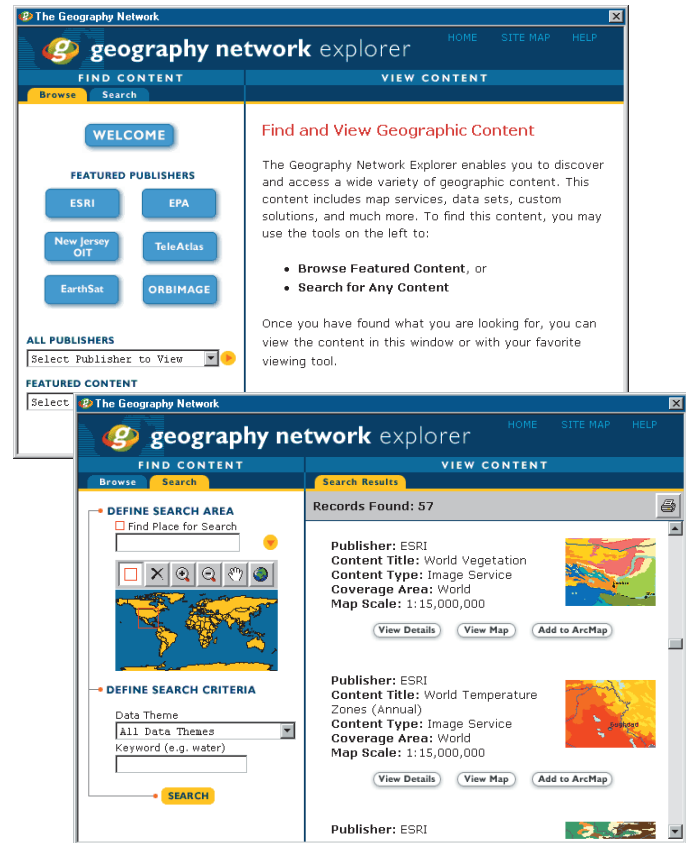
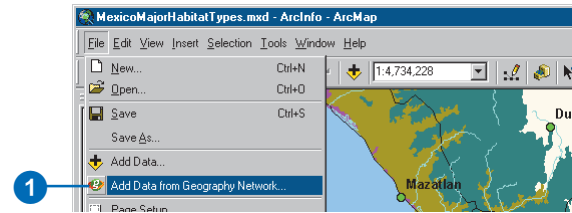
Geography Network is a global community of data providers committed to making geographic content available to the public. Published from sites around the world, Geography Network gives you immediate access to the latest maps, data, and related services over the Internet. Use Geography Network to search for and explore maps and other geographic content. When you find what you want, add it directly to your maps in ArcMap.

Geography Network is built using ArcIMS™, allowing member organizations to serve their data over the Internet. Thus the data you add to your maps is accessed directly from the organization providing the data. While Geography Network provides a centralized location for accessing data, any organization can publish their data using ArcIMS and serve it over the Internet to ArcMap. You can connect to an Internet server through ArcCatalog. ►

## Adding data through Geography Network

1. Click the File menu and click Add Data from Geography Network.
2. Browse Geography Network to find the data you want.

Geography Network allows you to search, for example, by data provider, data type, and geographic extent. Once you find data, you can read a description of it, view it over the Internet, and add it to your map in ArcMap.



Data served over the Internet—whether through Geography Network or not—looks like any other layer on your map. There are, however, a few differences depending on how the host organization decided to serve the data.

ArcIMS provides two types of map services, an image map service and a feature map service. An *image map service* works by taking a snapshot of a map on a server and delivering it to you as an image. A *feature map service* streams the actual map features to you, providing more sophisticated functionality because the geographic features are directly accessible by ArcMap.

When you add an image map service to ArcMap, you'll see one new layer on your map. You can customize its appearance by turning on or off the individual sublayers it contains. Image map services can serve as background to your own data.

When you add a feature map service to ArcMap, you'll see a new layer corresponding to each of the layers in the feature map service. You work with these layers in the same way you work with layers based on other data sources. For example, you can change their drawing order and symbology or perform analysis.

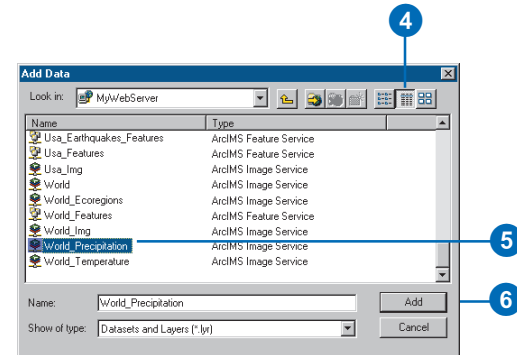
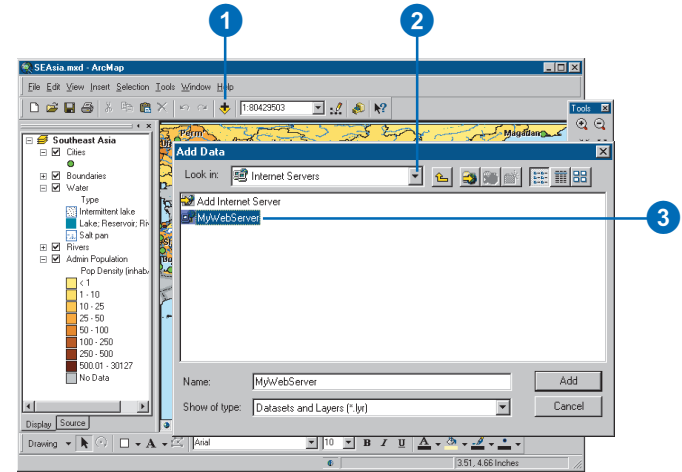
## Adding data through an Internet server

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the Internet Servers folder.
3. Double-click the server with data you want to access.

If you don't see the server you want, double-click Add Internet Server. For more information on connecting to an Internet server, see *Using ArcCatalog*.

4. Click the Details button so you can see which map services are image map services and which are feature map services.
5. Click the ArcIMS feature class you want to add.
6. Click Add.

ArcMap creates a new layer on the map that references the data source.



## Adding TINs as surfaces

Data that varies continuously across an area—elevation, rainfall, and temperature—is often represented on a map as a surface. Surface data comes from a variety of sources and in many formats. Aerial photographs, radar, sonar, and similar sources generate information used to build surfaces. This data is processed into formats such as SDTS raster profiles, USGS DEMs, DTED grids, vector coverages, and raw text files, all of which you can convert into TINs that display as surfaces on your map.

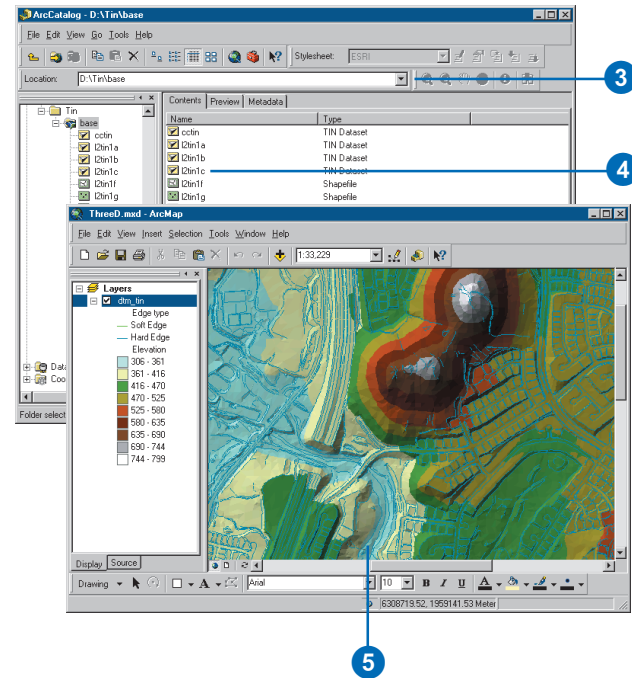
A TIN is built from a series of irregularly spaced points with values that describe the surface at that point (e.g., an elevation). From these points, a network of linked triangles is constructed. Adjacent triangles, sharing two nodes and an edge, connect to form the surface.

A height can be calculated for any point on the surface by interpolating a value from the nodes of nearby triangles. Additionally, each triangle face has a specific slope and aspect. You can display any one of these surface characteristics—slope, aspect, and elevation—or the internal structure of the TIN.

## Adding TIN data from ArcCatalog

1. Start ArcCatalog from the Start menu.
2. Arrange the ArcCatalog and ArcMap windows so that you can see both on the screen.
3. Navigate to the TIN data source you want to add to the map.
4. Click and drag the TIN data from ArcCatalog.
5. Drop the TIN data over the map display in ArcMap.

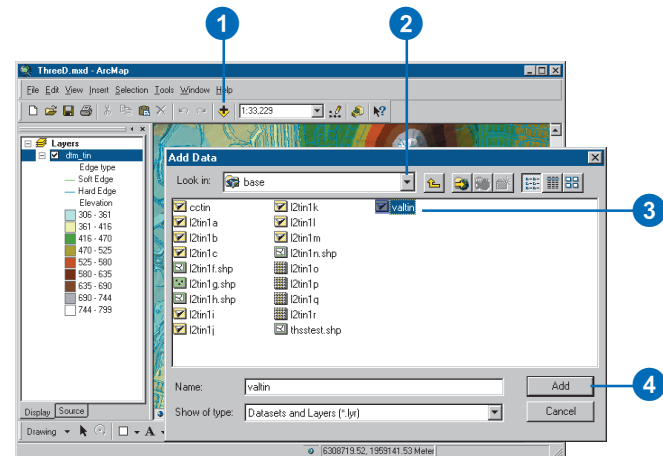
ArcMap creates a new layer on the map that references the TIN data source.



## Adding TIN data in ArcMap

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the TIN data source.
3. Click the TIN.
4. Click Add.

ArcMap creates a new layer on the map that references the TIN data source.





## Adding CAD drawings

If your organization has existing CAD drawing files, you can use these immediately on your maps. You don't need to convert the data, but you do need to decide how you plan to use the data.

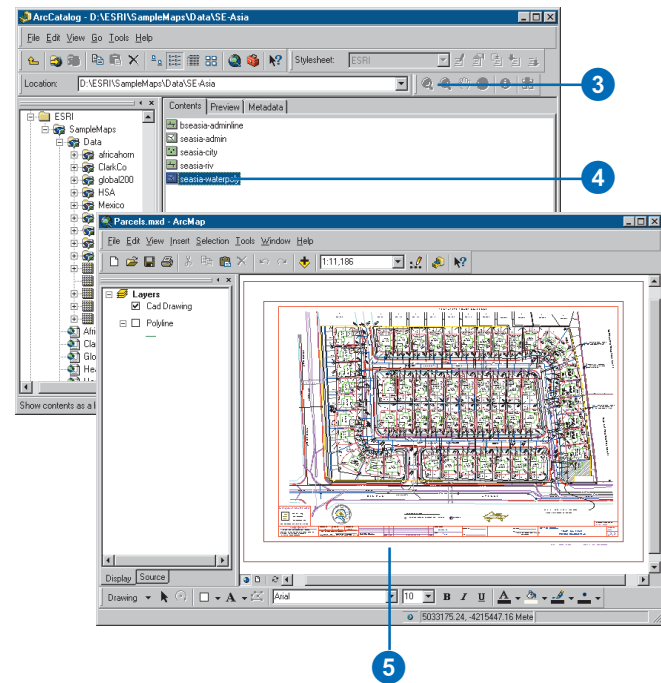
If you simply want to see the CAD drawing with your other data, you can add the CAD drawing as a layer for display only. The entities will draw as defined in the CAD drawing file. Alternatively, if you want to control how entities draw on the map or perform geographic analysis, you need to add the CAD data as features ArcMap can work with—specifically, point, line, or polygon features. When you browse for a CAD drawing to add to your map, you'll see two representations of the data: a CAD drawing file and a CAD dataset. Use the drawing file for display only and the dataset for display and geographic analysis.

CAD drawing files typically store different types of entities on different layers in a drawing file. One layer might contain building footprints, another streets, a third well locations, and a fourth textual annotation. CAD drawing files, however, do not restrict ►

## Adding a CAD drawing from ArcCatalog

1. Start ArcCatalog from the Start menu.
2. Arrange the ArcCatalog and ArcMap windows so that you can see both on the screen.
3. Navigate to the CAD drawing you want to add to the map.
4. Click and drag the CAD drawing from ArcCatalog.
5. Drop the CAD drawing over the map display in ArcMap.

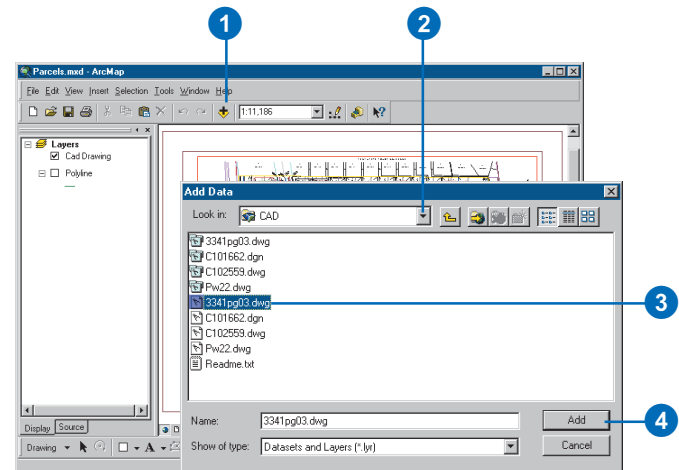
ArcMap creates a new layer on the map that references the CAD drawing.



## Adding a CAD drawing in ArcMap

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the CAD drawing.
3. Click the CAD drawing.
4. Click Add.

ArcMap creates a new layer on the map that references the CAD drawing.

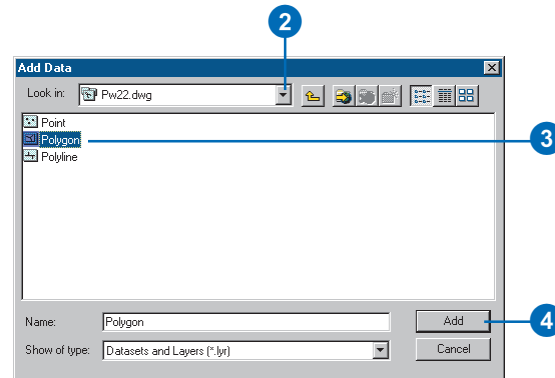
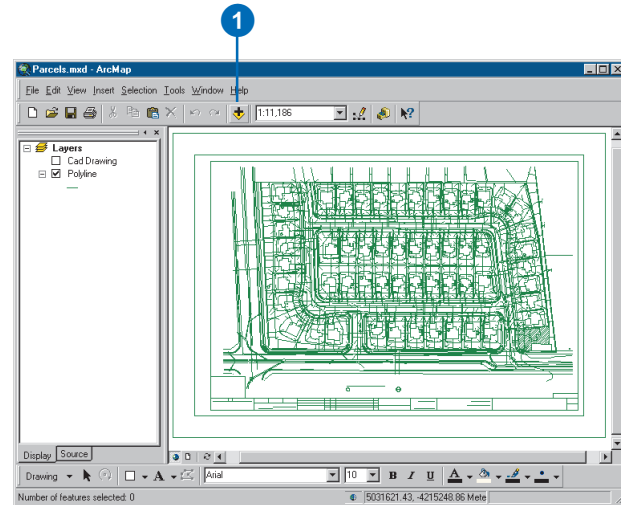


the type of entities you can have on a drawing layer. Thus building footprints might be on the same drawing layer as streets. When working with a CAD drawing as features, you'll likely add several ArcMap layers from the same CAD drawing file and adjust what features display in those layers.

## Adding a CAD dataset for display and analysis

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the CAD dataset.
3. Double-click the CAD dataset and click the CAD feature you want to add.
4. Click Add.

Only the subset of features in the layer will display.



## Adding x,y coordinate data

You don't always have to have a data source, such as a shapefile, to add data to your map. If you have some tabular data that contains geographic locations in the form of x,y coordinates, you can add this to a map as well.

X,y coordinates describe discrete locations on the earth's surface such as the location of fire hydrants in a city or the points where soil samples were collected. You can easily collect x,y coordinate data using a global positioning system (GPS) device.

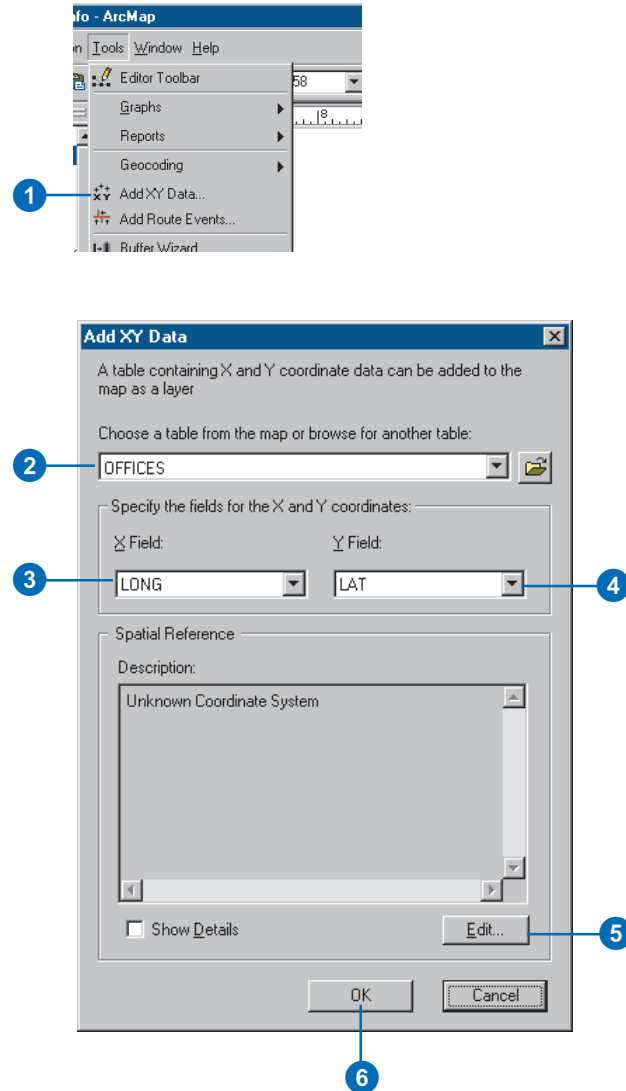
In order to add a table of x,y coordinates to your map, the table must contain two fields, one for the x-coordinate and one for the y-coordinate. The values in the fields may represent any coordinate system and units such as latitude and longitude or meters.

Once you have added the data to your map, the layer behaves just like any other feature layer. For instance, you can decide whether or not you want to display it, symbolize it, set the visible scale, or display a subset of features that meet some criteria.

## Adding a table with x,y coordinates

1. Click the Tools menu on the Standard toolbar and click Add XY Data.
2. Click the table dropdown arrow and click a table that contains x,y coordinate data. If the table is not on the map, click the browse button to access it from disk.
3. Click the X Field dropdown arrow and click the field containing x-coordinate values.
4. Click the Y Field dropdown arrow and click the field containing y-coordinate values.
5. Click Edit to define the coordinate system and units represented in the x and y fields.
6. Click OK.

The x,y coordinates will be automatically transformed to match the coordinate system of the data frame.



## Adding route events

A *route event* is an attribute that describes a portion of a route or a single location on a route. Route events are organized into tables based on a common theme. For example, route event tables for highways might include speed limits, year of resurfacing, present condition, signs, and accidents. Route events use route and measure information to reference the attributes of particular locations in a route feature class.

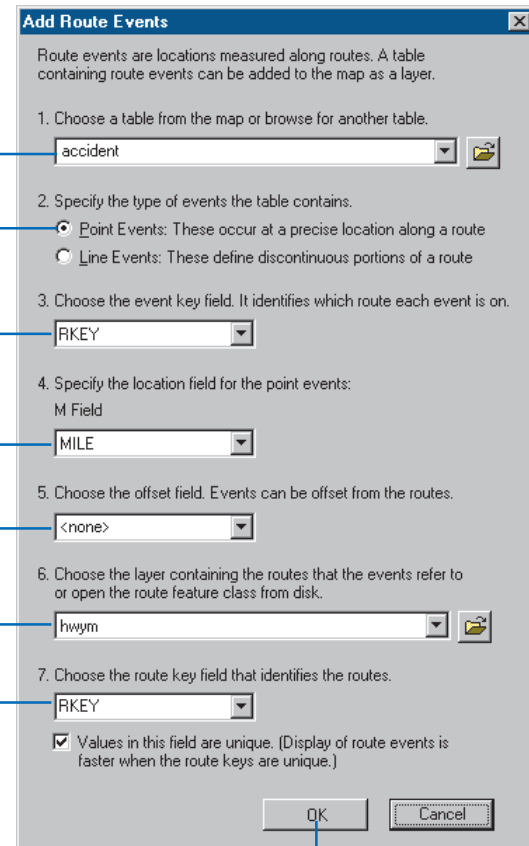
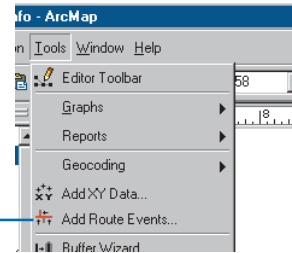
There are two types of route events: point and line. Point events occur at precise locations along on a route. They are referenced to a location along a route using a single measure value. Line events describe portions of routes. They differ from point events in that they use two measure values to describe the measure location of the event.

A route event table has at least two fields: an event key and one or more measure locations. The event key field identifies the route an event belongs to. A measure location is either one or two values describing the positions on the route where the event occurs.

## Adding a route event

1. Click the Tools menu on the Standard toolbar and click Add Route Events.
2. Click the table dropdown arrow and click a table on your map or click the browse button to find one on disk.
3. Click the type of route events the table contains.
4. Click the dropdown arrow and click the route key field.
5. Click the location field dropdown arrow and click the appropriate field.
6. Optionally, click the dropdown arrow and click a lateral offset field.
7. Click the layer dropdown arrow and click the route feature class or browse for the route feature classes.
8. Click the dropdown arrow and click the route key field.
9. Click OK.

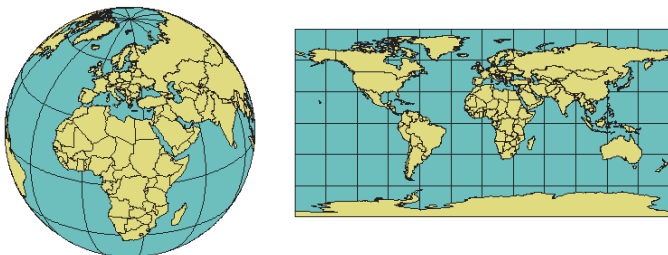
There are two location fields with line events.



## About coordinate systems

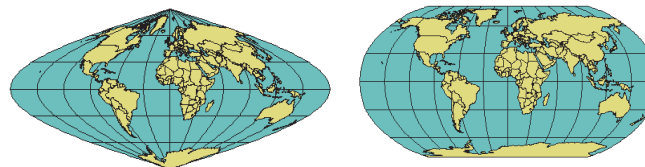
The features on a map reference the actual locations of the objects they represent in the real world. The positions of objects on the earth's spherical surface are measured in degrees of latitude and longitude, also known as *geographic coordinates*. While latitude and longitude can locate exact positions on the surface of the earth, they are not uniform units of measure; only along the equator does the distance represented by one degree of longitude approximate the distance represented by one degree of latitude. To overcome measurement difficulties, data is often transformed from the three-dimensional geographic coordinate system to the two-dimensional planar surface in a *projected coordinate system*. Projected coordinate systems describe the distance from an origin (0,0) along two separate axes, a horizontal x-axis representing east–west, and a vertical y-axis representing north–south.

Because the earth is round and maps are flat, getting information from the curved surface to a flat one involves a mathematical formula called a *map projection*. A map projection transforms latitude and longitude to x,y coordinates in a projected coordinate system.



*Locations are expressed as latitude and longitude on a globe and as x,y coordinates on a map.*

This process of flattening the earth will cause distortions in one or more of the following spatial properties: distance, area, shape, and direction. No projection can preserve all these properties and, as a result, all flat maps are distorted to some degree. Fortunately, you can choose from many different map projections. Each is distinguished by its suitability for representing a particular portion and amount of the earth's surface and by its ability to preserve distance, area, shape, or direction. Some map projections minimize distortion in one property at the expense of another, while others strive to balance the overall distortion. As a mapmaker, you can decide which properties are most important and choose a projection that suits your needs.



*Displaying the world using the sinusoidal projection (left) and the Robinson projection (right).*

### Do you need to display your data with a projected coordinate system?

If your spatial data references locations with latitude and longitude—for example, decimal degrees—you can still display it on your map. ArcMap draws the data by simply treating the latitude/longitude coordinates as planar x,y coordinates. If your map doesn't require a high level of locational accuracy—if you won't be performing queries based on location and distance or if you just want to make a quick map—you might decide not to transform your data to a projected coordinate system. If, however, you need to make precise measurements on your map, you should choose a projected coordinate system.

## Reasons for using a projected coordinate system

- You want to make accurate measurements from your map and be sure that spatial analysis options you use in ArcMap calculate distance correctly. Latitude/Longitude is a good system for storing spatial data, but not very good for viewing, querying, or analyzing maps. Degrees of latitude and longitude are not consistent units of measure for area, shape, distance, and direction.
- You are making a map in which you want to preserve one or more of these properties: area, shape, distance, and direction.
- You are making a small-scale map such as a national or world map. With a small-scale map, your choice of map projection determines the overall appearance of the map. For example, with some projections, lines of latitude and longitude will appear curved; with others they will appear straight.
- Your organization mandates using a particular projected coordinate system for all maps.

## What type of map projection should you choose?

Here are a few things to consider when choosing a projection:

- Which spatial properties do you want to preserve?
- Where is the area you're mapping? Is your data in a polar region? An equatorial region?
- What shape is the area you're mapping? Is it square? Is it wider in the east–west direction?
- How big is the area you're mapping? On large-scale maps, such as street maps, distortion may be negligible because your map covers only a small part of the earth's surface. On small-scale maps, where a small distance on the map represents a considerable distance on the earth, distortion may have a bigger impact, especially if you use your map to compare or measure shape, area, or distance.

Answering these questions will determine what map projection and thus what projected coordinate system you'll want to use to display your data.

Map projections can be generally classified according to what spatial attribute they preserve.

- *Equal Area* projections preserve area. Many thematic maps use an equal area projection. Maps of the United States commonly use the Albers Equal Area Conic projection.
- *Conformal* projections preserve shape and are useful for navigational charts and weather maps. Shape is preserved for small areas, but the shape of a large area such as a continent will be significantly distorted. The Lambert Conformal Conic and Mercator projections are common conformal projections.
- *Equidistant* projections preserve distances, but no projection can preserve distances from all points to all other points. Instead, distance can be held true from one point (or a few points) to all other points or along all meridians or parallels. If you will be using your map to find features that are within a certain distance of other features, you should use an equidistant map projection.
- *Azimuthal* projections preserve direction from one point to all other points. This quality can be combined with equal area, conformal, and equidistant projections, as in the Lambert equal area azimuthal and the azimuthal equidistant projections.
- Other projections minimize overall distortion but don't preserve any of the four spatial properties of area, shape, distance, and direction. The Robinson projection, for example, is neither equal area nor conformal but is aesthetically pleasing and useful for general mapping.

For more information on coordinate systems, see *Understanding Map Projections*.

## Specifying a coordinate system

If all the data you want to display on your map is stored in the same coordinate system—for example, you’re using your organization’s database—you can just add it to a map and not consider whether the layers will overlay properly; they will. If, however, you’ve collected data from a variety of sources, you’ll need to know what coordinate system each dataset uses to ensure ArcMap can display them together.

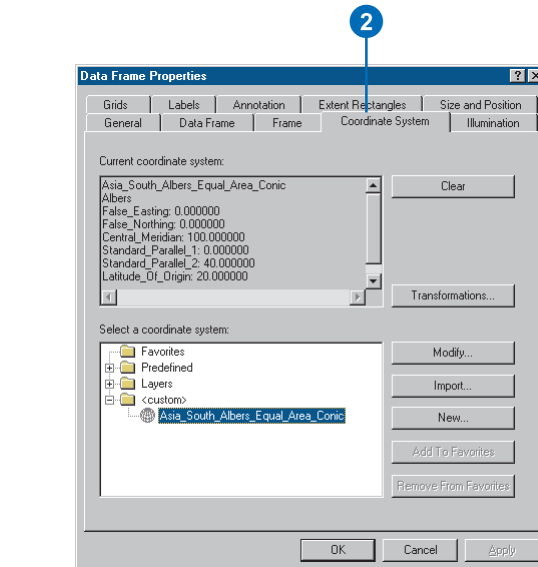
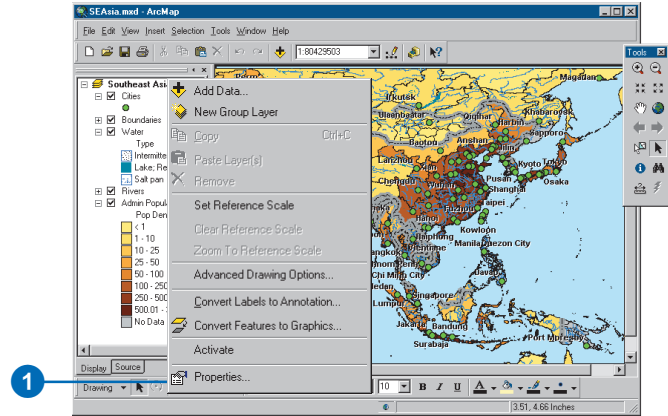
When you add a layer to an empty data frame, that layer sets the coordinate system for the data frame; you can change it later if necessary. As you add subsequent layers, they are automatically transformed to the data frame’s coordinate system as long as there’s enough information associated with the layer’s data source to determine its current coordinate system. If there isn’t enough information, ArcMap will be unable to align the data and display it correctly. In this case, you’ll have to supply the necessary coordinate system information yourself.

ArcMap expects coordinate system information to be stored with the data source. For a layer in a geodatabase, this information is part of the layer’s ▶

## Finding out what coordinate system your data is currently displayed with

1. Right-click the data frame that you want to determine the coordinate system of and click Properties.
2. Click the Coordinate System tab.

The details of the current data frame coordinate system display in the dialog.



metadata. For coverages, shapefiles, and rasters, it's stored on disk in a separate file named after the data source but with a .prj file extension (for example, streets.prj). These files are optional files; thus you may still need to define the coordinate system for one of these data sources. You can create a .prj file with ArcCatalog.

If no coordinate system information is associated with a data source, ArcMap will examine the coordinate values to see if they fall within the range: -180 to 180 for x-values and -90 to 90 for y-values. If they do, ArcMap assumes that these are geographic coordinates of latitude and longitude. If the values are not in this range, ArcMap simply treats the values as planar x,y coordinates.

## Tip

### Changing the coordinate system of a data frame

*Changing the coordinate system of a data frame does not alter the coordinate system of the source data contained in it.*

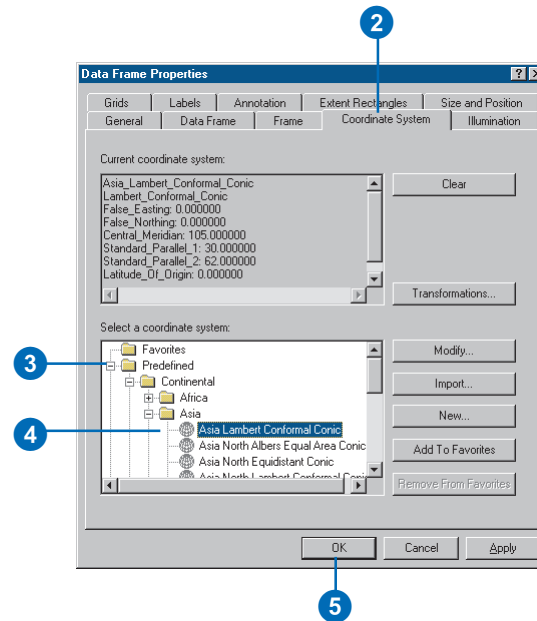
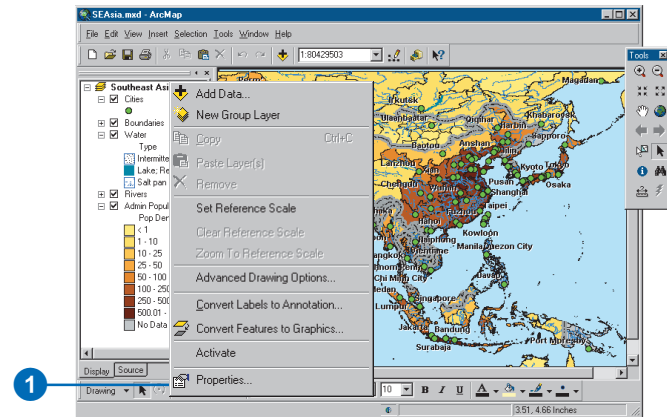
## See Also

*For more information on coordinate systems, see the book Understanding Map Projections.*

## Displaying data with a predefined coordinate system

1. Right-click the data frame that you want to set the coordinate system of and click Properties.
2. Click the Coordinate System tab.
3. Double-click Predefined.
4. Navigate through the folders until you find the coordinate system you want and click it.
5. Click OK.

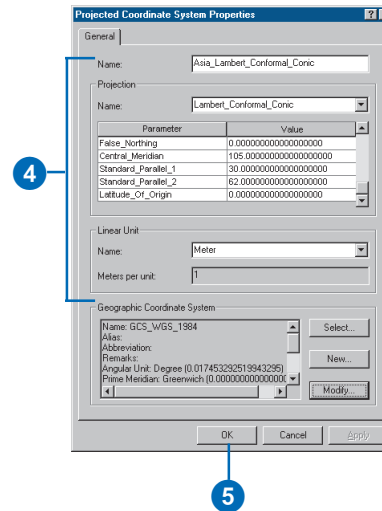
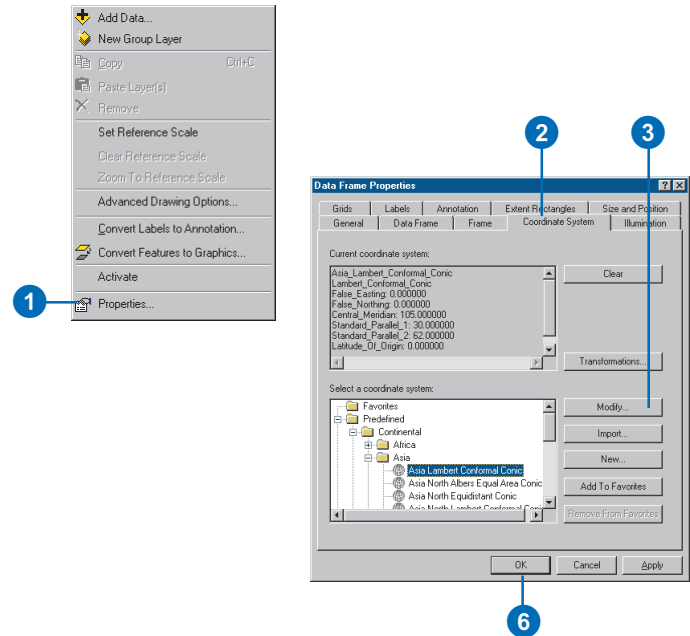
All layers in the data frame will now be displayed with that coordinate system.





## Modifying the parameters of a coordinate system

1. Right-click the data frame whose coordinate system you want to modify and click Properties.
2. Click the Coordinate System tab.
3. Click Modify.
4. Adjust the coordinate system properties as appropriate.
5. Click OK.
6. Click OK on the Data Frame Properties dialog.



## Tip

### Do you want to see meters, miles, or feet?

When you measure lengths or find places by their coordinates, you can choose what units you want to use. Set the *Display Units* property as needed.

## Tip

### Why can't I set the map units?

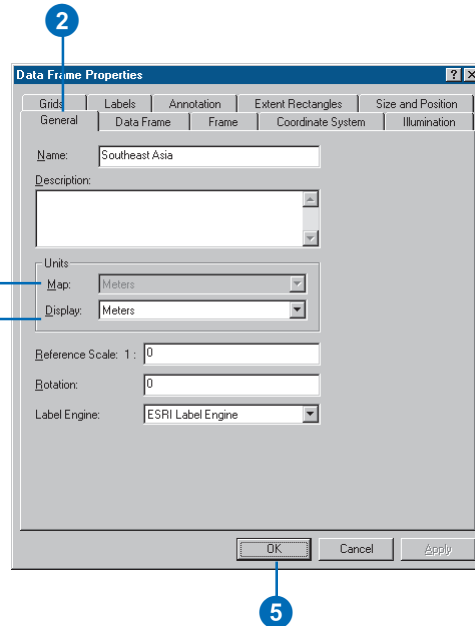
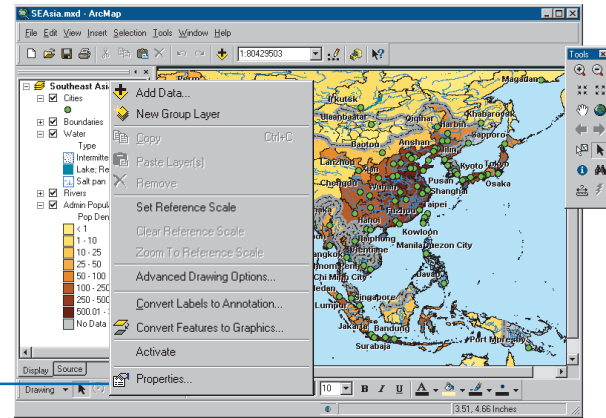
Map units are a property of the coordinate system defined with your data. You can change the map units by modifying the coordinate system. Right-click the data frame containing your data and click the *Coordinate System* tab. Here you can modify the parameters of the coordinate system.

## Setting the units for reporting lengths and displaying coordinates

1. Right-click the data frame and click Properties.
2. Click the General tab.
3. Click the Map dropdown arrow and click the appropriate units.

The map units option is only available when your data has no coordinate system information associated with it.

4. Click the Display dropdown arrow and click the appropriate units.
5. Click OK.



## Referencing data on the map

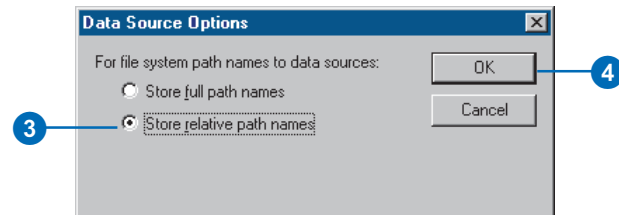
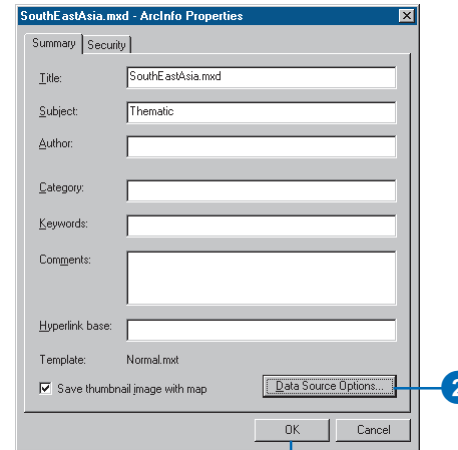
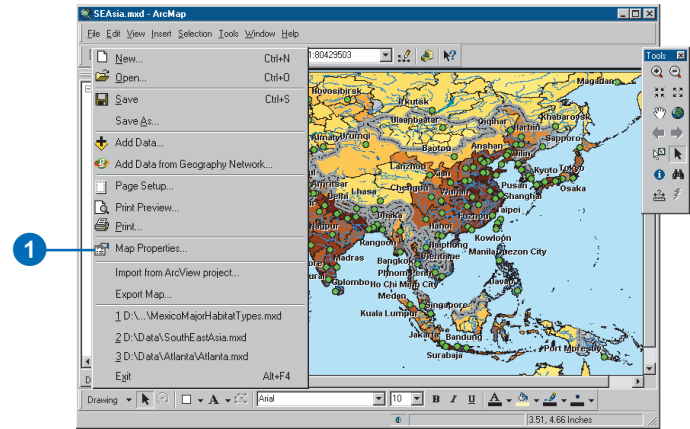
When you add a layer to your map, ArcMap references the data source the layer is based on. When you save the map, the data references are stored with it. The next time you open your map, ArcMap locates the data based on the references. If ArcMap can't find a data source, you'll need to either locate the data source yourself or ignore the reference, in which case the layer won't be drawn.

If you plan on distributing your maps to others, they'll need access to the data referenced on it. If they have access to the data—for example, data stored on a server—they can simply update the references to the data if necessary. If they don't have access to the data, you'll probably have to distribute the data with your map.

To help make it easier to distribute data with your map, ArcMap allows you to store relative pathnames to data sources referenced on a map. This lets you, for example, distribute your map and data in the same directory. The references stored in the map would be correct regardless of where they were placed on disk.

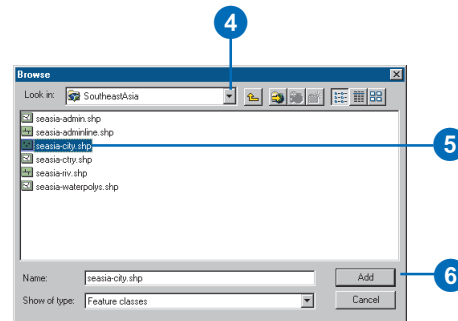
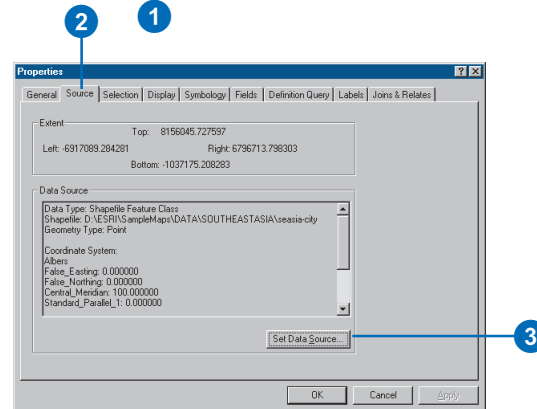
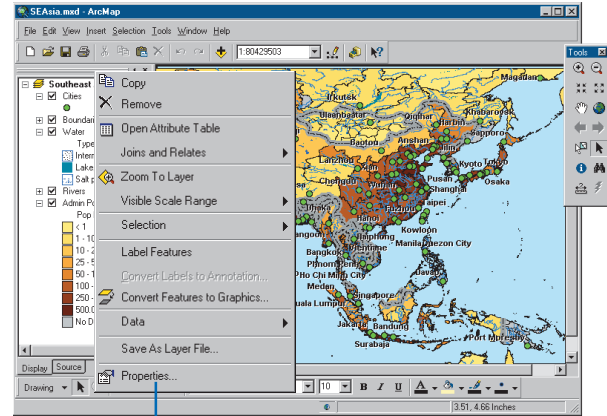
## Storing relative pathnames to data

1. Click the File menu and click Map Properties.
2. Click Data Source Options.
3. Click Store relative pathnames.
4. Click OK.
5. Click OK on the Map Properties dialog.



## Updating a link to a data source

1. In the table of contents, right-click the layer and click Properties.
2. Click the Source tab.
3. Click Set Data Source.
4. Click the Look in dropdown arrow and navigate to the data source.
5. Click the data source.
6. Click Add.



# Managing layers

# 5

## IN THIS CHAPTER

- **Changing a layer's text description**
- **Changing a layer's drawing order**
- **Copying layers**
- **Removing layers from the map**
- **Grouping layers**
- **Accessing layer properties**
- **Displaying a layer at certain scales**
- **Changing the appearance of the table of contents**
- **Using data frames to organize layers**
- **Saving a layer to disk**
- **Repairing broken data links**

You can think of a layer as a convenient way to access geographic data. A layer defines how to display the geographic data it references and where that data is located in your database. If you don't know much about the geographic data in your organization, you'll likely just add prebuilt layers to your maps. If you help maintain the geographic data, you'll probably create layers that effectively communicate information about the data for others to use on their maps.

As you saw in the previous chapter, it's easy to add layers to a map—you simply drag them from ArcCatalog to your map. Once they are on your map, you'll typically organize them to make your map look the way you want it to. You organize and manage layers through the table of contents. The table of contents lets you control when the layer draws, how it draws, and in what data frame on the map it appears. You can also remove layers, group them, and save them to disk.

A layer at the top of the table of contents draws on top of those below it. Thus, you'll place layers that form the background of your map, such as an ocean layer, at the bottom of the table of contents.

## Changing a layer's text description

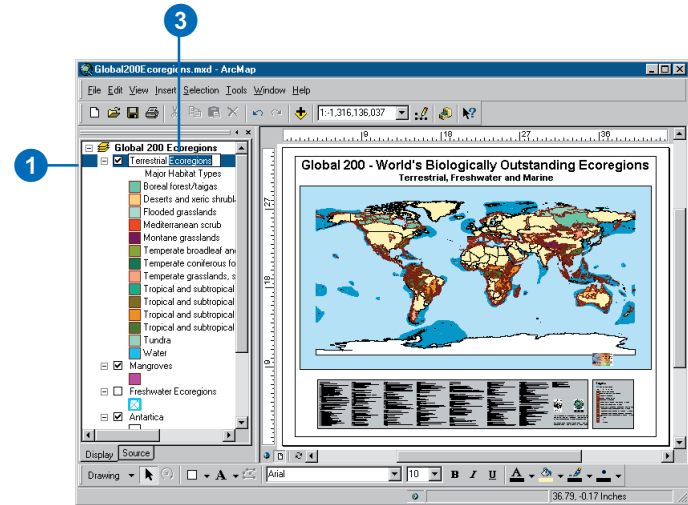
A few pieces of descriptive text display beside each layer in the table of contents. One text string is the layer's name and the others describe what the features in the layer represent, or more specifically, what the symbols in the legend mean.

By default, when you add data to a map, the resulting layer is named after its data source. Often, the name of the data source is an abbreviated name that doesn't serve well as the layer's name on the map. You can give a layer a more meaningful name without changing the name of the data source. This will make it easier to understand what layers are on the map.

When you draw the features of a layer, you use the attribute values in a particular field to symbolize them. These attribute values appear by default next to the symbol in the table of contents. As they don't usually provide a good text description of the features in your layer either, you'll likely want to change them as well.

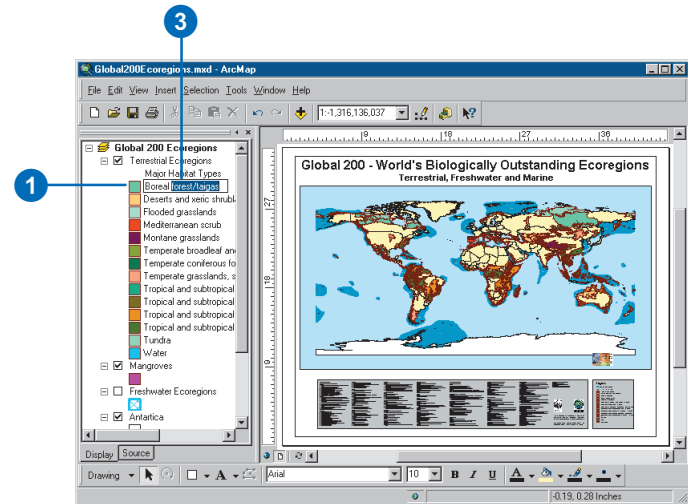
## Changing the name of a layer

1. In the table of contents, click the layer to select it.
2. Click again over the name. This will highlight the name and allow you to change it.
3. Type the new name and press enter.



## Changing map feature descriptions

1. In the table of contents, click the text you want to change.
2. Click again over the text string. This will highlight the string and allow you to change it.
3. Type the new description and press enter.



## Changing a layer's drawing order

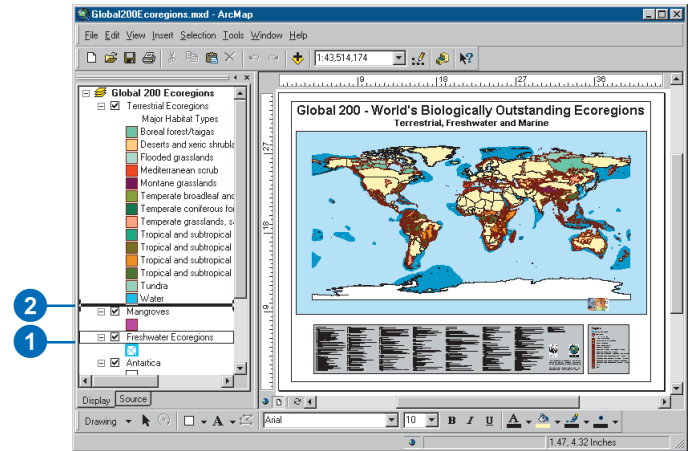
The order of layers in the table of contents determines how layers are drawn on a map. Within a data frame, the layers listed at the top will draw over those listed below them, and so on down the list. You can easily move layers around to adjust their drawing order or organize them in separate data frames.

## Moving a layer to change its drawing order

1. In the table of contents, click and drag the layer up or down.

A black line indicates where the layer will be placed.

2. Release the mouse pointer to drop the layer in its new position.



## Copying layers

A quick way to build maps that reference the same data source is to copy and paste layers within a map or between maps. For example, suppose you want to show the change in population for an area over time. You can add a layer to a map and display it using one population attribute, then copy the layer to another map (or another data frame in the same map) and display it using the second population attribute.

Copying layers from a map to disk is a convenient way to let others access the layers you've created. Once you've defined how to draw a layer, that information is saved with the layer. Thus, anyone who adds the layer to a map will see it exactly as you created it.

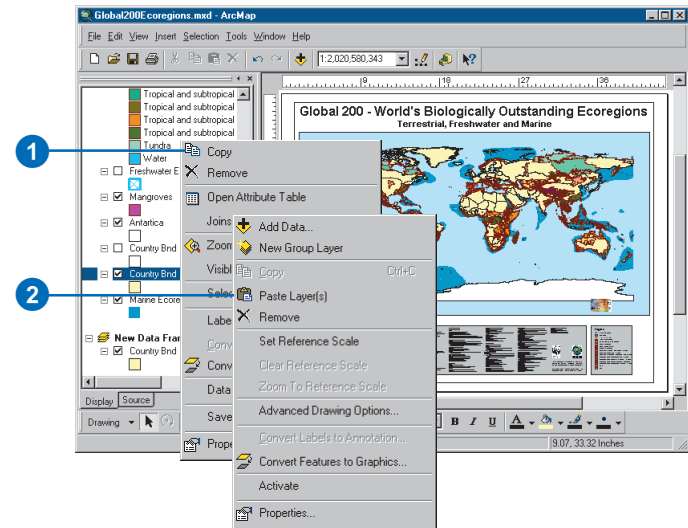
### See Also

*For information on copying a layer to disk, see the section 'Saving a layer to disk' at the end of this chapter.*

## Copying a layer between data frames

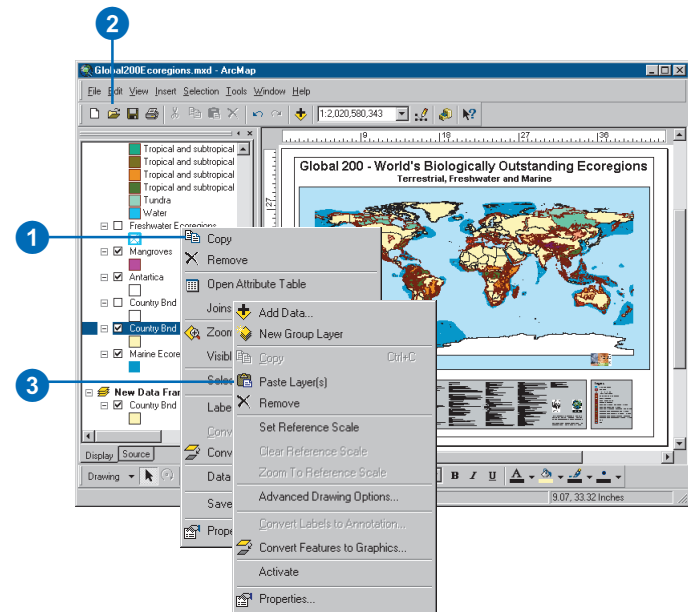
1. Right-click the layer you want to copy to another data frame and click Copy.
2. Right-click the data frame you want to copy the layer into and click Paste Layer(s).

You can also drag and drop a layer from one data frame to another.



## Copying a layer to another map

1. Right-click the layer you want to copy to another data frame and click Copy.
2. Click the Open button on the Standard toolbar and open the map you want to copy the layer into.
3. Right-click the data frame you want to copy the layer into and click Paste Layer(s).





## Removing layers from the map

When you no longer need a layer on your map, you can delete it. Deleting a layer from a map doesn't delete the data source upon which the layer is based.

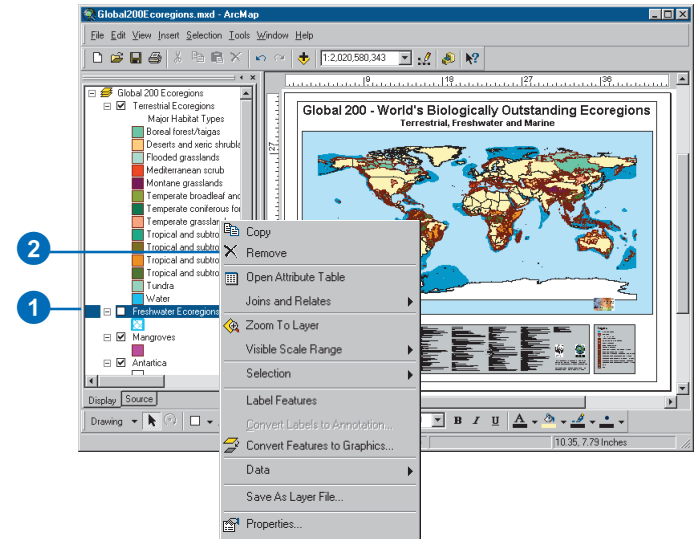
### Tip

#### Deleting a data source

You can delete a data source, such as a coverage, in ArcCatalog.

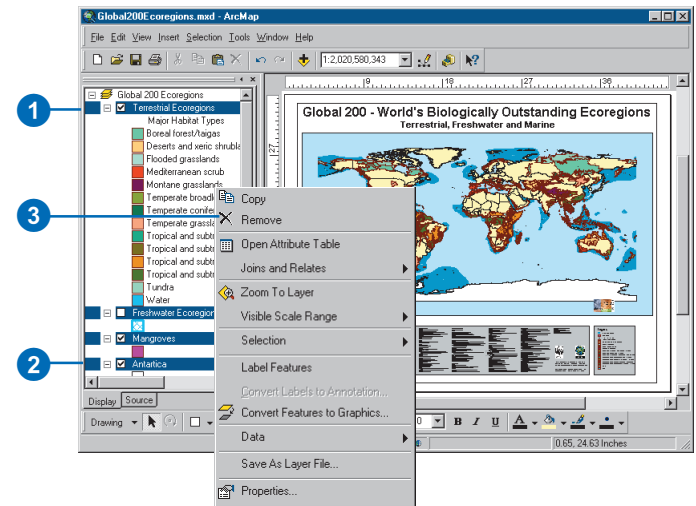
## Removing a layer

1. In the table of contents, right-click the layer you want to remove.
2. Click Remove.



## Removing several layers

1. In the table of contents, click the first layer you want to remove.
2. Hold down the Shift or Ctrl key and click to select additional layers.
3. Right-click the selection and click Remove.



## Grouping layers

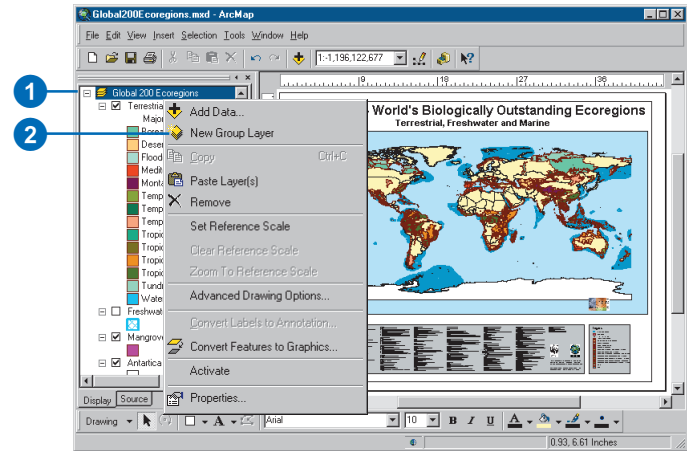
When you want to work with several layers as one layer, you gather them together into a *group layer*. For example, suppose you have two layers on a map representing railroads and highways. You might choose to group these layers together and name the resulting layer “transportation networks”.

A group layer appears and acts like an individual layer in the table of contents. Turning off a group layer turns off all its component layers. The properties of the group layer override any conflicting properties of its constituent layers. For example, a visibility scale range set on a layer will be overridden by a visibility scale range set on the group layer. If you need to, you can even create groups of group layers.

You can still work with the individual layers in the group. For instance, you can change how an individual layer is drawn, adjust the scale it is displayed at, and control whether or not it is drawn as part of the group. You can change the drawing order of the group and add and remove layers as needed.

## Creating a group layer

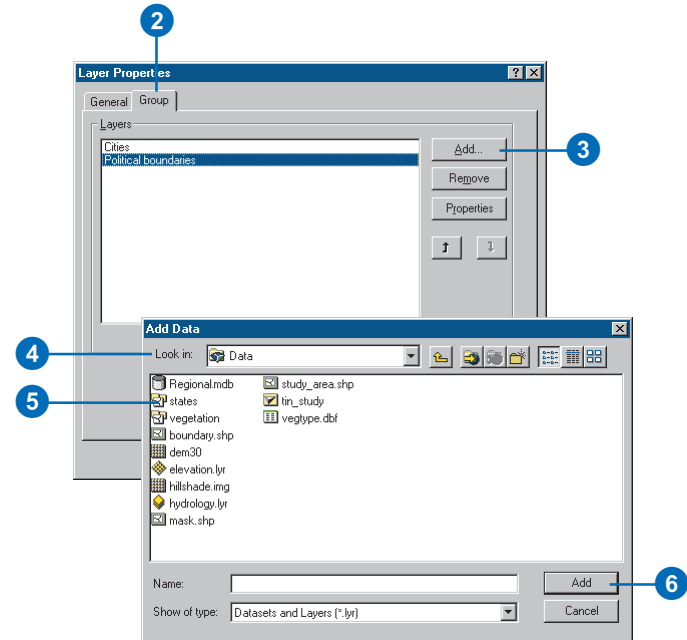
1. Right-click the data frame you want to create a group layer in.
2. Click New Group Layer.  
A new group layer appears in the table of contents.



## Adding layers to a group layer

1. Double-click the group layer in the table of contents to display its properties.
2. Click the Group tab.
3. Click Add.
4. Click the Look in dropdown arrow and navigate to the data source you want to add to the group.
5. Click the data source.
6. Click Add.

Tip: If the layer you want to add to a group is already on the map, you can drag and drop it in the group.



## Tip

### Changing the drawing order of layers in a group

The layers listed at the top of a group layer are drawn over those beneath it. You can also drag and drop the layer to a new position to change the drawing order of the group.

## Tip

### Using ArcCatalog to create group layers

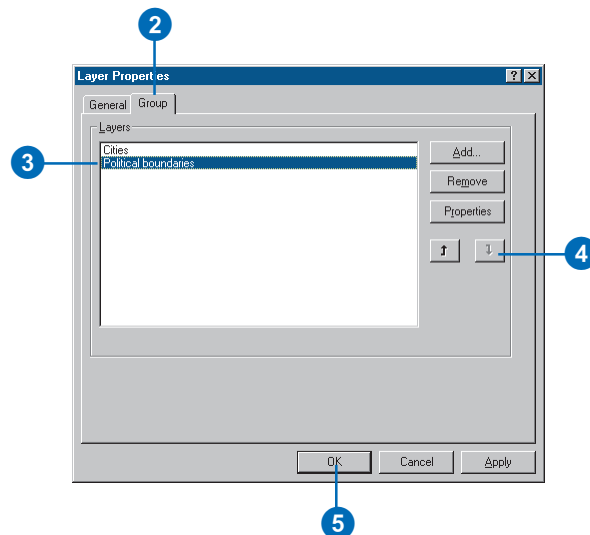
You can also create your group layer in ArcCatalog.

## See Also

For information on how to draw the individual layers in a group, see Chapter 6, 'Symbolizing your data'.

## Changing the layer order in a group layer

1. Double-click the group layer in the table of contents to display its properties.
2. Click the Group tab.
3. Click the layer you want to move.
4. Click the appropriate arrow button to move the layer up or down.
5. Click OK.

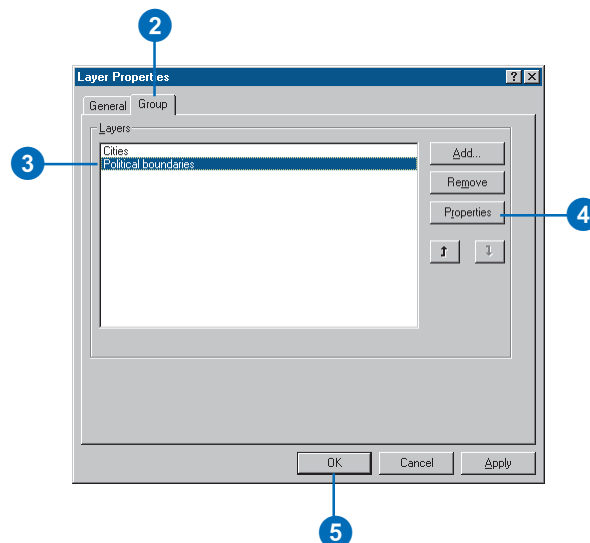


## Displaying the properties of a layer in a group layer

1. Double-click the group layer in the table of contents to display its properties.
2. Click the Group tab.
3. Click the layer for which you want to display properties.
4. Click Properties.

You can now modify the layer's properties, for example, you can change the drawing properties.

5. Click OK.



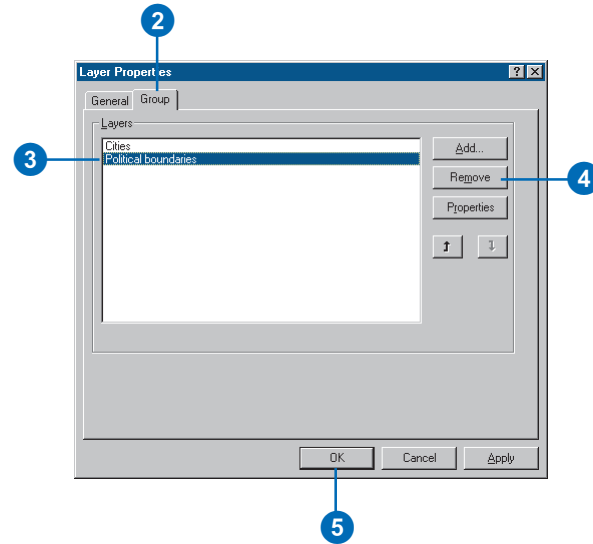
## Tip

### Removing several layers from a group layer

*Hold down the Shift or Ctrl key to select more than one layer in the group.*

## Removing a layer from a group layer

1. Double-click the group layer in the table of contents to display its properties.
2. Click the Group tab.
3. Click the layer that you want to remove.
4. Click Remove.
5. Click OK.

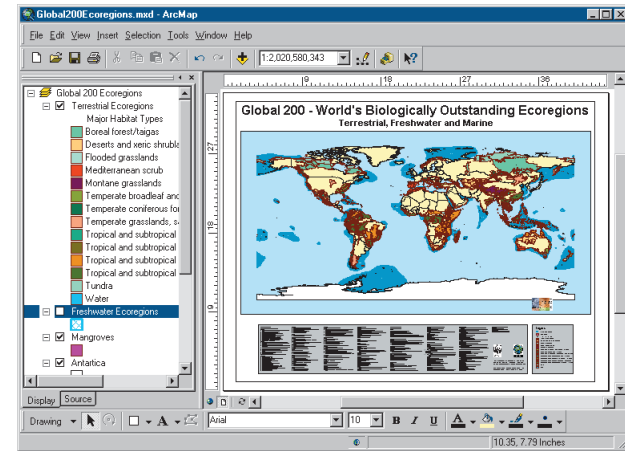


## Accessing layer properties

You control all aspects of a layer through the layer's properties. From here, you can define how to draw the layer, what data source the layer is based on, whether to label the layer, and what attribute fields the layer contains.

## Displaying layer properties

1. In the table of contents, right-click the layer and click Properties.
2. Click the tab containing the properties you want to adjust.
3. When finished, click OK.



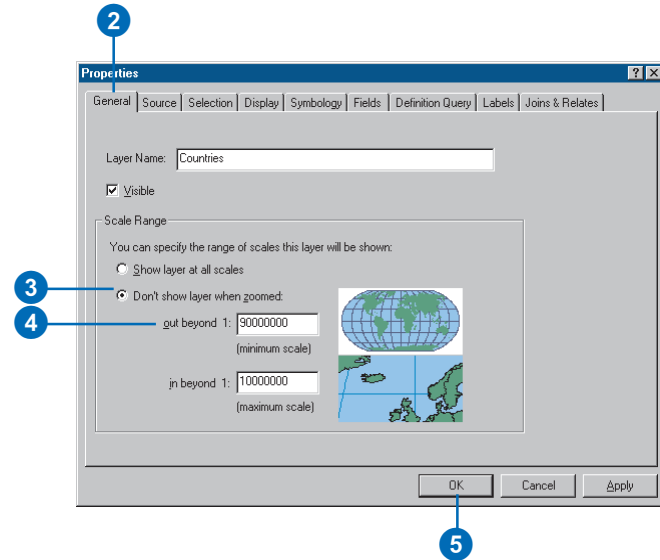
## Displaying a layer at certain scales

As long as a layer is turned on in the table of contents, ArcMap draws it, regardless of the map scale. As you zoom out, it may become harder to distinguish features in layers that contain more detailed information. While you can turn a layer off, this may be inconvenient, especially if your map contains several layers and you change scale frequently as you work.

To help you automatically display layers at the appropriate scale, you can set a layer's visible scale range and define the range of scales at which ArcMap draws the layer. Whenever the scale of the data frame is outside the layer's visible scale range, the layer won't draw. In this way, you can control how the map looks at various scales. For example, you can hide a detailed layer that might otherwise clutter up your map when you zoom out. Or, you can progressively display more detailed layers as you zoom in on an area, that is, as the scale of the data frame gets larger. Setting a visible scale range is especially useful if you are creating a map for others to use because it makes browsing the map easier.

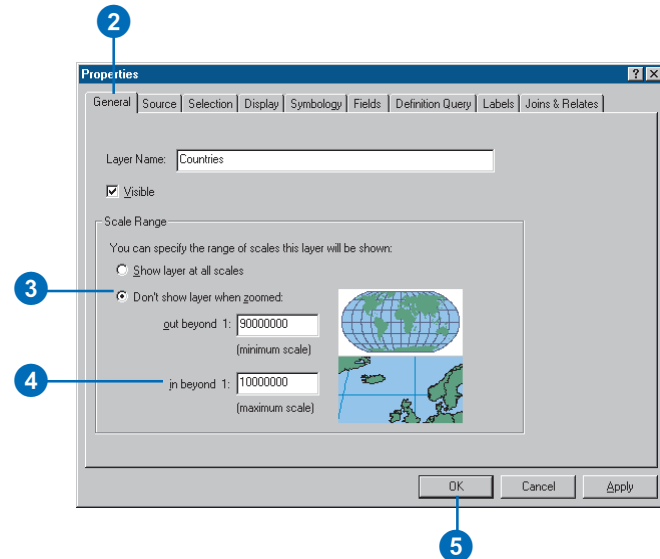
## Setting the minimum visible scale for a layer

1. Right-click the layer in the table of contents and click Properties.
2. Click the General tab.
3. Click Don't show layer when zoomed.
4. Type a minimum scale for the layer.  
  
If you zoom out beyond this scale, the layer will not be visible.
5. Click OK.



## Setting the maximum visible scale for a layer

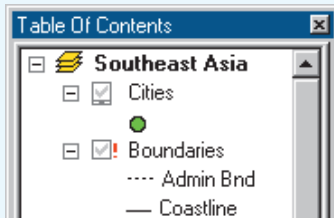
1. Right-click the layer in the table of contents and click Properties.
2. Click the General tab.
3. Click Don't show layer when zoomed.
4. Type a maximum scale for the layer.  
  
If you zoom in beyond this scale, the layer will not be visible.
5. Click OK.



## Tip

### How to tell when a layer has a visible scale range set

If a layer isn't drawing because it has a visible scale range set, you'll see a gray scale bar under the layer's check box in the table of contents.



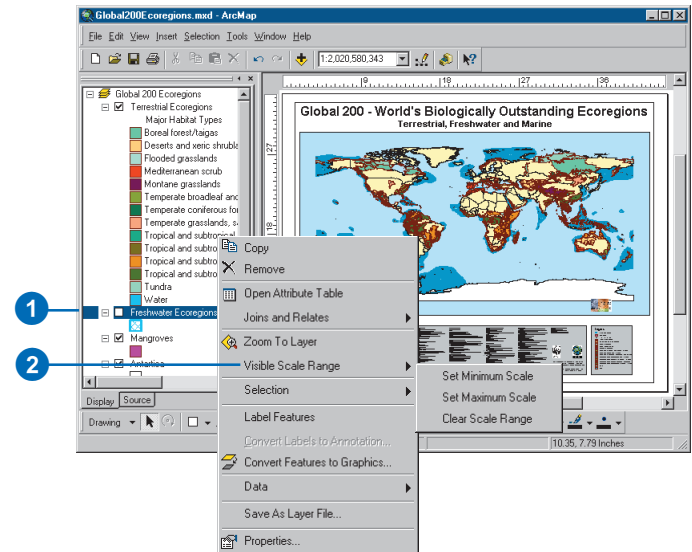
## Setting a visible scale based on the current scale

1. Adjust the data frame display to the appropriate scale.
2. Right-click the layer for which you want to set a visible scale.
3. Point to Visible Scale Range and click Set Maximum Scale or Set Minimum Scale.



## Clearing a layer's visible scale

1. Right-click the layer for which you want to clear a visible scale range.
2. Point to Visible Scale Range and click Clear Scale Range.



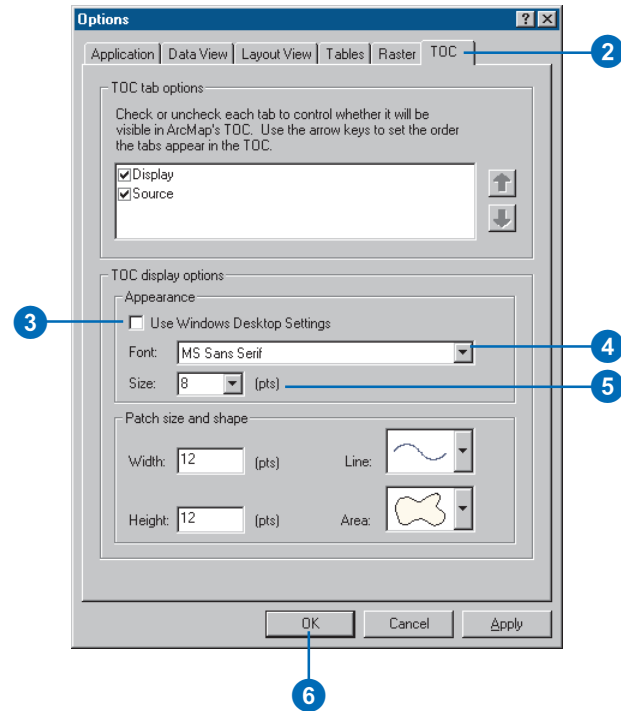
## Changing the appearance of the table of contents

You can adjust the look of the table of contents to suit your needs. For example, you might change the text size and font so that it makes a greater visual impact or is easier to read. Or, you might want to change the shape of the lines and patches that represent the features on a map.

The table of contents has two tabs at the bottom, a Display tab and a Source tab. The Display tab shows the drawing order of the layers and allows you to change the order. The Source tab sorts layers by where they're stored on disk. This is useful during editing, when you edit all layers in a given folder or database. If you're not planning on using your map for editing, you can hide the Source tab. You can't change the drawing order of layers from the Source tab.

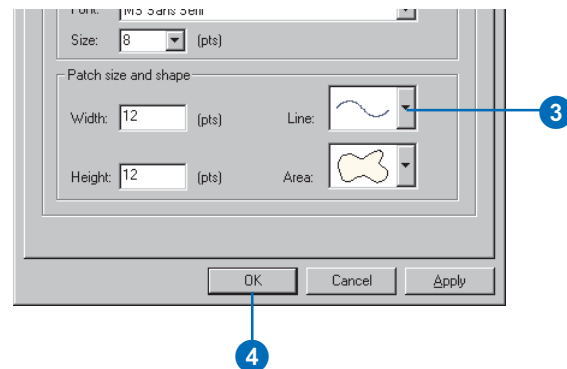
## Setting the text font for layers

1. Click the Tools menu on the Standard toolbar and click Options.
2. Click the TOC tab.
3. Uncheck Use Windows Desktop Settings.
4. Click the Font dropdown arrow and click the font you want to use.
5. Click the Size dropdown arrow and click the font size.
6. Click OK.



## Setting the line and patch for layer symbology

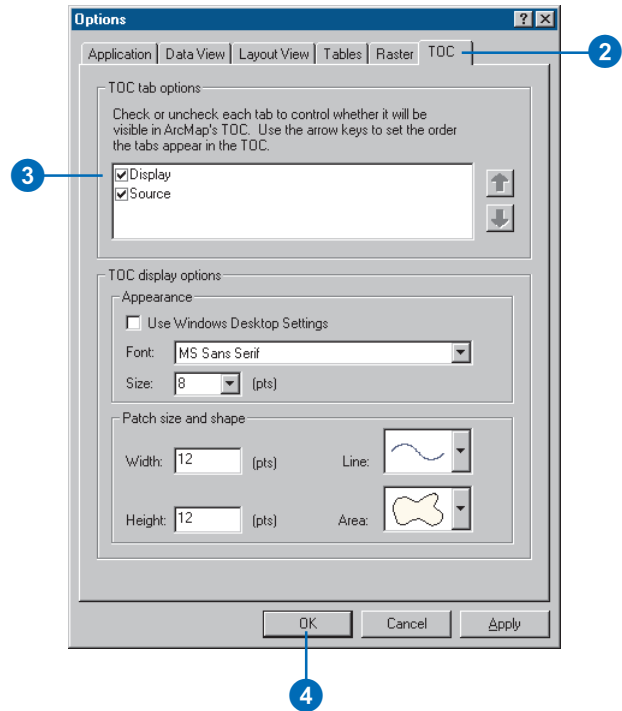
1. Click the Tools menu on the Standard toolbar and click Options.
2. Click the TOC tab.
3. Click the Line or Area dropdown arrow and click the appropriate shape.
4. Click OK.





## Showing the Display and Source tabs

1. Click the Tools menu on the Standard toolbar and click Options.
2. Click the TOC tab.
3. Check the boxes to show the Display and Source tabs.
4. Click OK.



## Using data frames to organize layers

A *data frame* is simply a frame on your map that displays layers. When you create a map, it contains a default data frame listed in the table of contents as “Layers”. You can immediately add layers to this data frame and give it a more meaningful name.

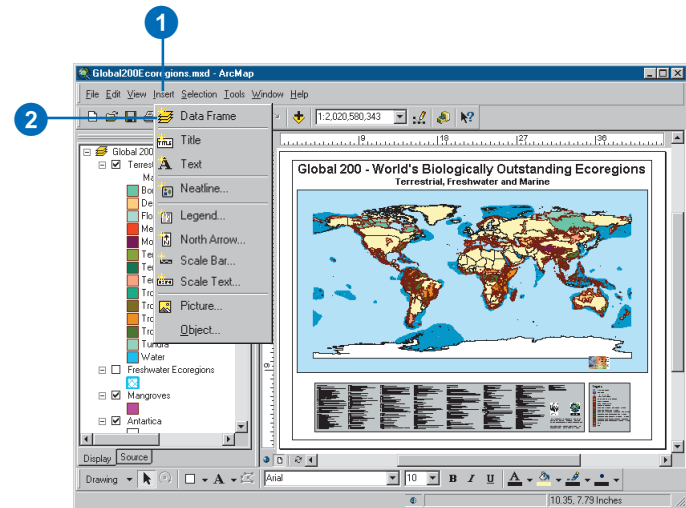
The layers in a data frame display in the same coordinate system and therefore may overlap. When you want to display layers separately and not have them overlap—for example, to compare layers side by side or create insets and overviews that highlight an area—add additional data frames to your map. When a map has more than one data frame, one of them is the *active* data frame. The active data frame is the one you’re currently working with, for instance, adding layers to or panning and zooming. The active data frame is highlighted on the map in layout view or is the displayed data frame in data view. The name of the active data frame is also shown in bold text in the table of contents.

Once on a map, a data frame acts like any other map element. You can change its size, move it around, or delete it.

## Adding a data frame

1. Click the Insert menu.
2. Click Data Frame.

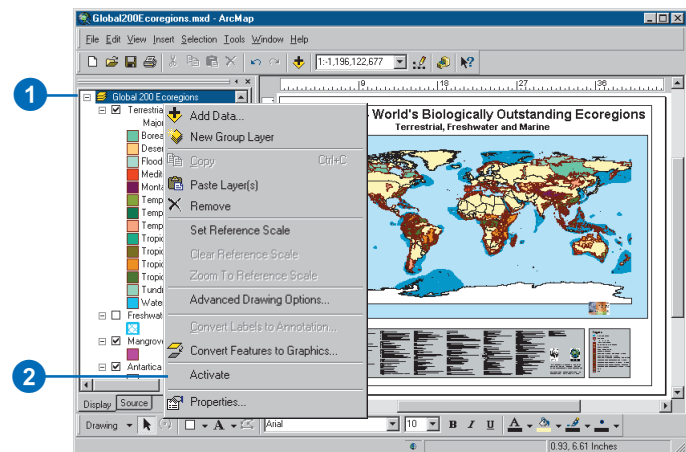
The new data frame will appear in the center of the layout.



## Making a data frame active

1. Right-click the data frame in the table of contents.
2. Click Activate.

You can also click the frame in layout view to activate it.



## Tip

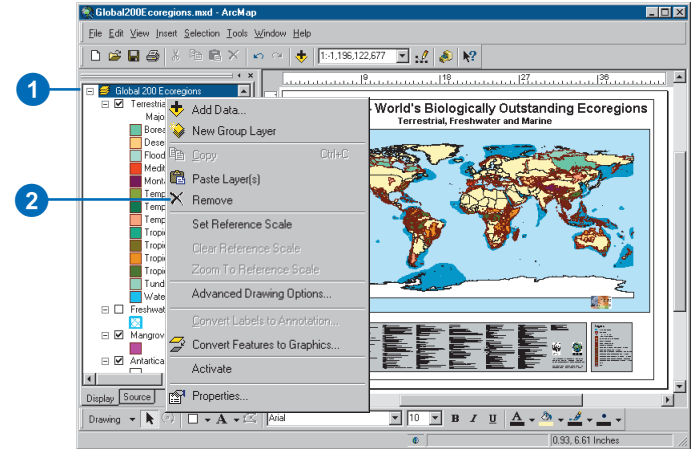
### A map always has one data frame

A map must have at least one data frame on it. You can't delete the last data frame on a map.

## Removing a data frame

1. Right-click the data frame in the table of contents that you want to remove.
2. Click Remove.

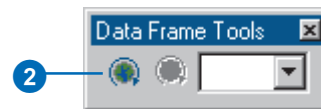
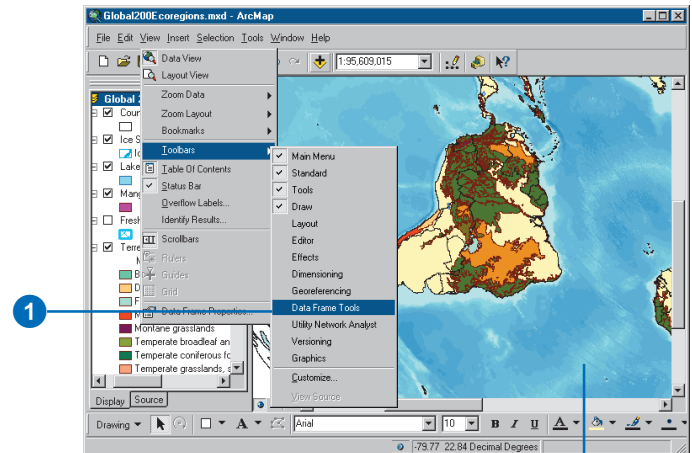
In layout view, you can select the data frame and press the Delete key on the keyboard.



## Rotating the data in a data frame

1. Click View on the Standard toolbar, point to Toolbars, and click Data Frame Tools.
2. Click the Rotate Data Frame tool.
3. Click and drag the mouse over the data frame to rotate its contents.

Rotating the data in this manner does not alter the original source data, just its display in the data frame.



Click and drag the mouse to rotate the data in the data frame.

## Saving a layer to disk

One of the main features of a layer is that it can exist as a file in your GIS database. This makes it easy for others to access the layers you've built.

When you save a layer to disk, you save everything about the layer. When you add the layer to another map, it will draw exactly as it was saved. This is very convenient when others at your organization need to make maps but don't know how to represent or access the data in your database. All they need to do is add the layer.

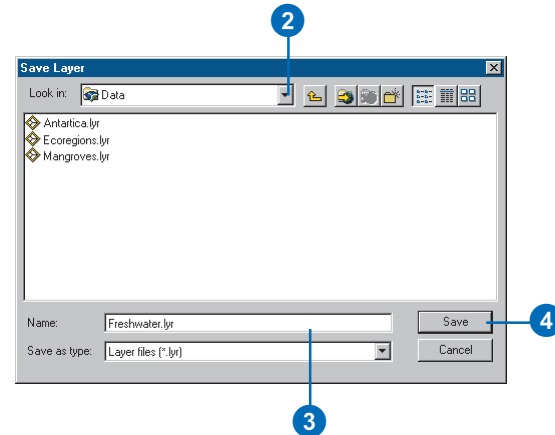
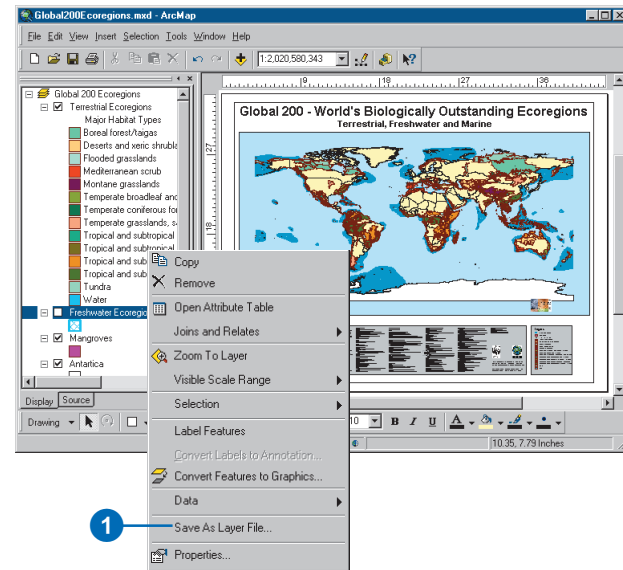
### Tip

#### Layer filenames

*The filename you provide when you save a layer to disk does not have to be the same as its name on the current map. The layer name on the map, not the layer filename, will be displayed whenever the layer is added to another map.*

## Saving a layer to disk

1. In the table of contents, right-click the layer and click Save As Layer File.
2. Click the Look in dropdown arrow and navigate to the location where you want to save the layer.
3. Optionally, change the layer name.
4. Click Save.



## Repairing broken data links

When you first open a map, ArcMap searches for the data referenced by the layers on the map. If it can't find the data—for example, the data has been moved—the layer won't display. You can immediately tell which layers on your map have broken links because you'll see a red exclamation mark next to their name in the table of contents. If you know the new location of the data, you can repair the link.

### Tip

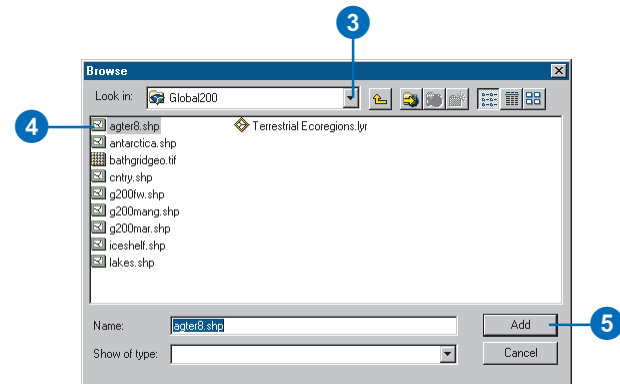
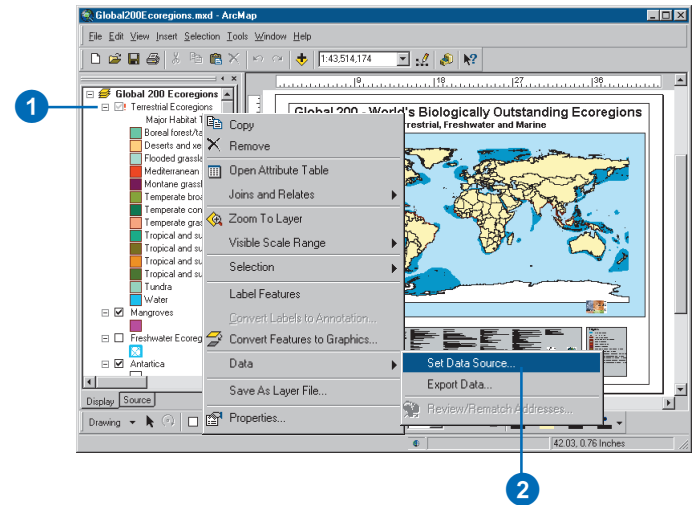
#### Storing relative pathnames to data

*If you plan on distributing your maps to others, you might choose to reference data using relative pathnames. See the topic 'Referencing data on the map' in Chapter 4.*

## Linking a layer to its data source

1. Locate the layer with the broken link in the table of contents. It will have a red exclamation mark next to it.
2. Right-click the layer, point to Data, and click Set Data Source.
3. Click the Look in dropdown arrow and navigate to the location of the data source.
4. Click the data source.
5. Click the Add button.

The link to the data source is now updated.





# Symbolizing your data

# 6

## IN THIS CHAPTER

- A map gallery
- Drawing all features with one symbol
- Drawing features to show categories like names or types
- Managing categories
- Ways to map quantitative data
- Standard classification schemes
- Drawing features to show quantities like counts or amounts
- Setting a classification
- Drawing features to show multiple attributes
- Drawing features with charts
- Drawing TINs as surfaces
- Drawing CAD layers
- Advanced symbolization

Choosing how to represent your data on a map may be the most important mapmaking decision you make. How you represent your data determines what your map communicates.

On some maps, you might simply want to show where things are. The easiest way to do this is to draw all the features in a layer with the same symbol. On other maps, you might draw features based on an attribute value or characteristic that identifies them. For example, you could map roads by type to get a better sense of traffic patterns or map the wildlife habitat suitability of a particular bird species, ranked from least to most suitable.

In general, you can draw map features as follows:

- With a single symbol
- To show a category such as a name (unique values maps)
- To represent a quantity such as population (graduated color, graduated symbol, and dot density maps)
- To show multiple attributes that are related (multivariate and chart maps)

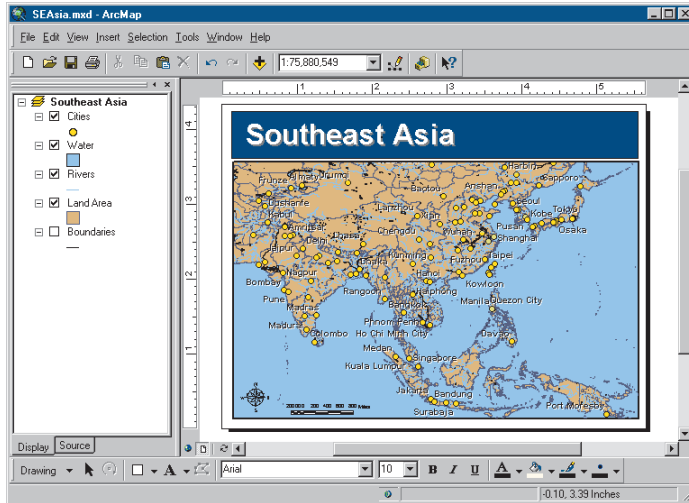
You can also draw these other data types:

- Images and rasters (see Chapter 14, ‘Working with rasters’)
- TINs representing a three-dimensional surface
- CAD drawing files

Browse the map gallery on the next few pages to see the various ways you can symbolize your data.

# A map gallery

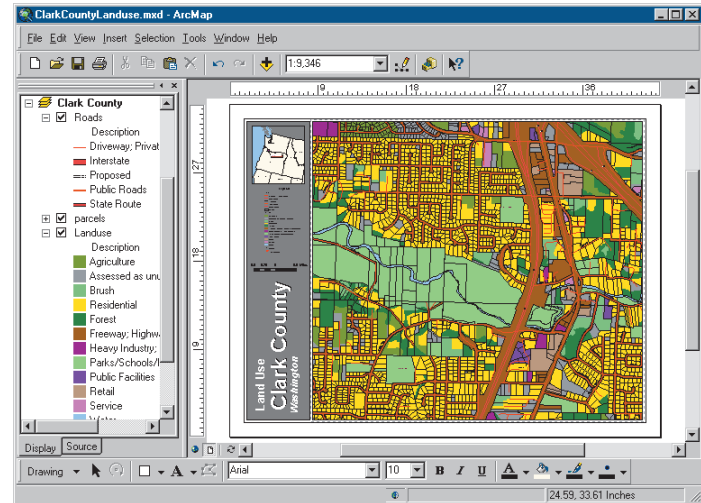
## Single symbol map



Drawing your data with just a single symbol gives you a sense of how features are distributed—whether they're clustered or dispersed—and may reveal hidden patterns.

In the map above, you can easily see where people live and conclude that some areas are more densely populated based on the number of cities clustered together.

## Unique values map

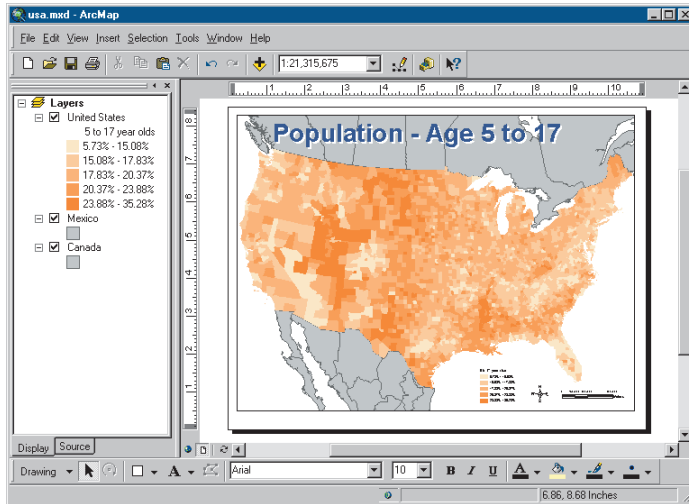


On a unique values map, you draw features based on an attribute value, or characteristic, that identifies them. In the map above, each land use type is drawn with a specific color. Typically, each unique value is symbolized with a different color. Drawing features based on unique attribute values shows the following:

- How similar features are distributed—whether they're grouped or dispersed
- How different feature types are located in relation to each other
- How much of one category there is compared to other categories



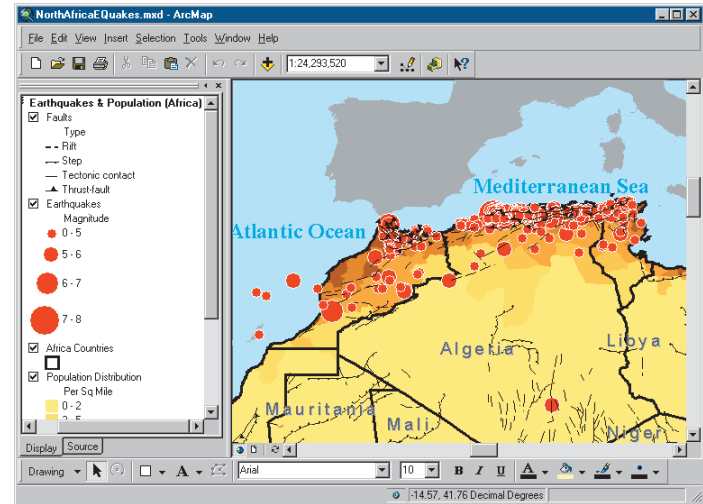
## Graduated color map



When you need to map quantities or amounts of things, you might choose to use a graduated color map. Graduated color maps have a series of symbols whose colors change according to the values of the particular attribute. Graduated color maps are most useful for showing data that is ranked (for example, 1 to 10, low to high) or has some kind of numerical progression (for example, measurements, rates, percentages).

The map above uses different shades of color—in a graduated color ramp—to represent different amounts of people. Here, darker shades indicate a greater number of people.

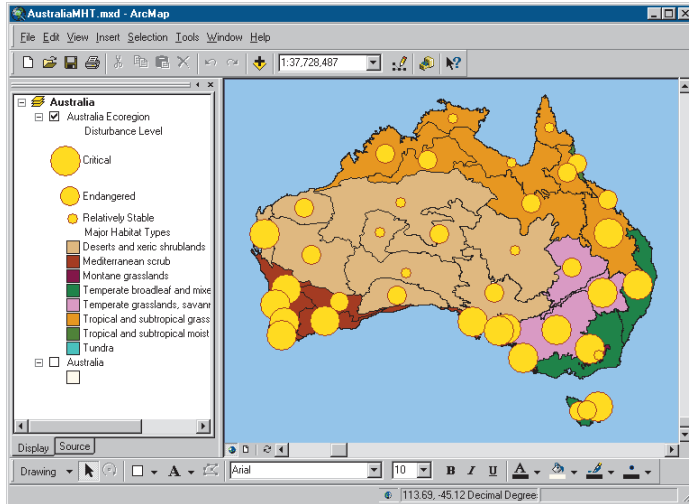
## Graduated symbol map



Another way to represent amounts of things is to vary the size of the symbol a feature is drawn with. The graduated symbol map above uses a larger symbol to show earthquakes with a larger magnitude. Like graduated color maps, graduated symbol maps are most useful for showing rank or progression of values. However, instead of using color to represent the differences in values, the size of the symbol varies.

When making a graduated symbol map, it is important to choose the range of symbol sizes carefully. The largest symbols need to be small enough that neighboring symbols don't completely cover one another. At the same time, the range in size from the smallest to the largest needs to be great enough that the symbol for each class is distinct.

## Multivariate map



The maps on the previous pages display one attribute, or characteristic, of the data—for example, a name or an amount. Multivariate maps display two or more attributes at the same time. The map above illustrates the level of human impact on the natural landscape of Australia. Major habitat types are shown with unique colors, and the level of disturbance for each habitat is shown with a graduated symbol. The larger the symbol, the higher the human impact is on the particular habitat.

## Chart map

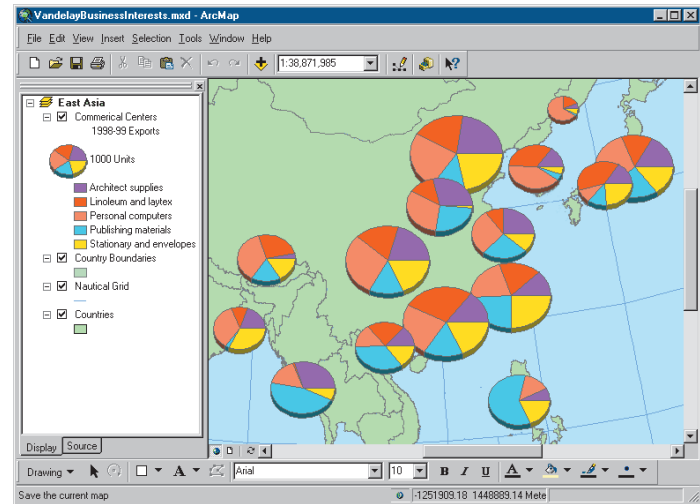
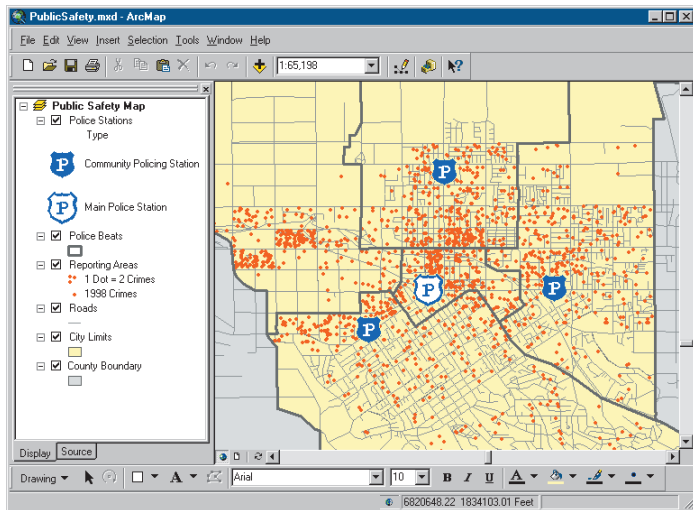


Chart maps allow you to symbolize multiple attributes on one map as well as communicate the relationship among different attributes. Chart maps display charts—bar and pie charts—over features. The map above shows you the volume and type of goods distributed by an exporter throughout Asia.

Pie charts show relationships between parts and the whole and are particularly useful for showing proportions and ratios. Bar charts compare amounts of related values and are well suited to showing trends over time. Stacked bar charts can show both the relative relationship between data as well as allowing for absolute comparisons.

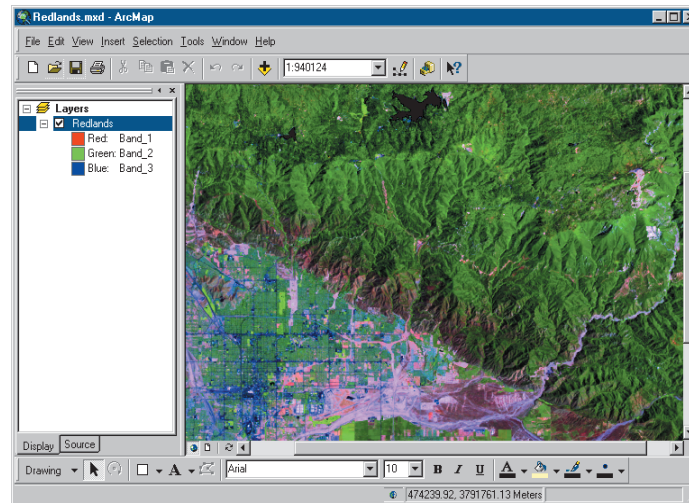
## Density map



Mapping the density of features lets you see the patterns of where things are concentrated. This helps you find areas that require action or meet some criteria. For example, the map above shows where the highest concentration of crimes occurs in a city. Using this map, the city may choose to increase the number of police patrols in the areas of high density.

One way to map density is with a dot density map. This type of map symbolizes features using dots drawn inside polygons to represent a quantity. Each dot represents a specific value. For example, on the crime map, each dot might represent five incidents of crime. When creating a dot density map, you specify how many features each dot represents and how big the dots are. You may need to try several combinations of amount and size to see which one best shows the pattern.

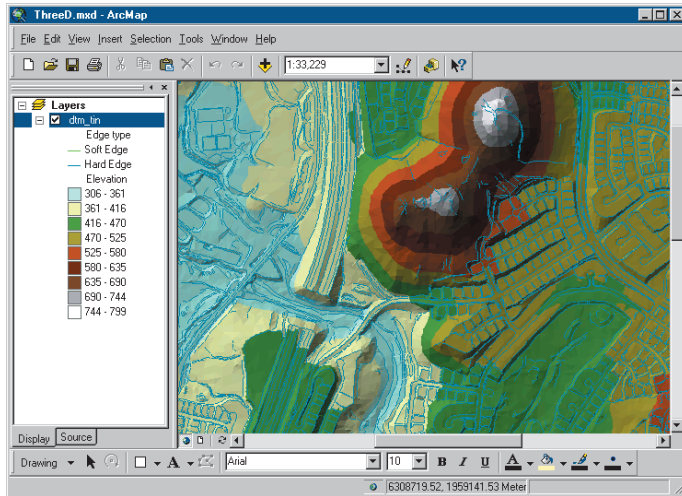
## Raster map



Much of the most readily available geographic data is in the form of rasters. A raster can represent almost any geographic features, though most rasters you'll work with in ArcMap will probably be scanned maps or photographs of the earth's surface. You might add an aerial photograph to your map to provide a realistic background to your other data, or you might use satellite imagery to add up-to-the-minute information about weather conditions or flood levels. You can even update your other data by using a raster as a guide for editing.

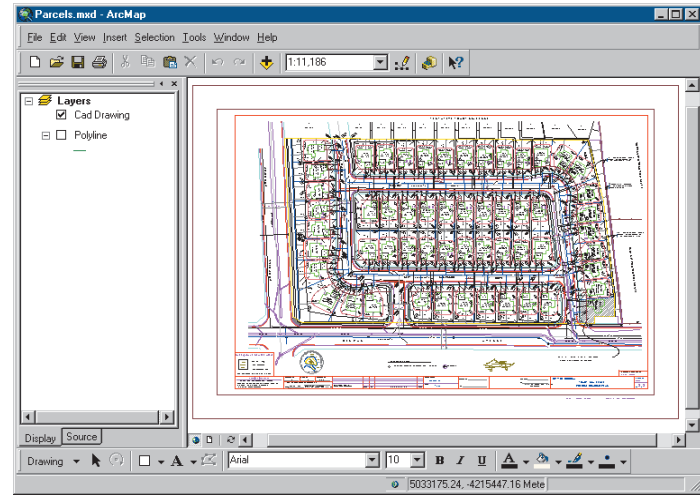
For more information on displaying raster data, see Chapter 14, 'Working with rasters'.

## Color-shaded relief map



One of the ways you can represent a continuous surface, such as terrain elevation or temperature gradient, is to display the surface as a color-shaded relief map. This type of map displays elevation ranges in graduated colors and shades ridges, valleys, and hillsides using a simulated light source. The shading adds a realistic effect that makes the surface look as though you are viewing it from high above. The combined use of color for elevation and shading for surface morphology results in a highly informative, yet easy to interpret, view of your surface.

## Computer-aided design map



You can integrate CAD drawings onto your maps seamlessly, without having to convert these files into other GIS formats. This is particularly useful if your organization has existing CAD data resources. For example, some departments in your organization may be using a CAD package to help manage facilities and other infrastructure. You can let ArcMap draw these layers as they appear in the CAD package, or you can precisely control how to draw them.

## Drawing all features with one symbol

Often, seeing where something is—and where it isn't—can tell you exactly what you need to know. Mapping the location of features reveals patterns and trends that can help you make better decisions. For example, a business owner might map where his customers live. Seeing where they live can help him decide where to target his advertising.

The easiest way to see where features are is to draw them using a single symbol. You can draw any type of data this way. When you create a new layer, ArcMap by default draws it with a single symbol.

### Tip

#### Changing the symbol

To quickly change the symbol features are drawn with, click the symbol in the table of contents to display the Symbol Selector.

### Tip

#### Changing the color

To quickly change the color of a symbol, right-click the symbol in the table of contents to display the Color Selector.

## Drawing a layer using a single symbol

1. In the table of contents, right-click the layer you want to draw with a single symbol and click Properties.

2. Click the Symbology tab.

3. Click Features.

Because Single symbol is the only option, ArcMap automatically selects it.

4. Click the Symbol button to change the symbol.

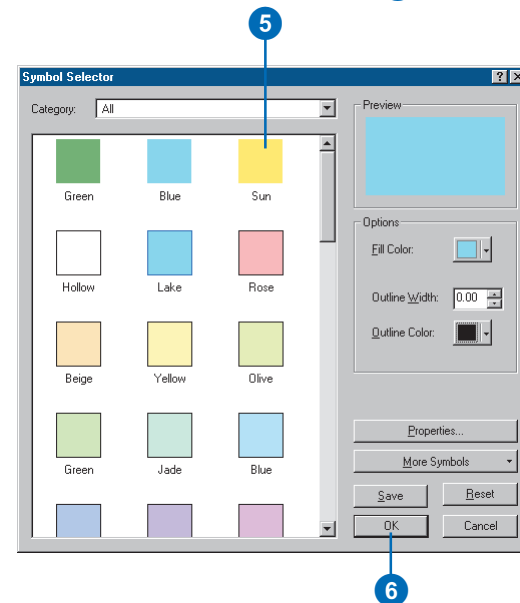
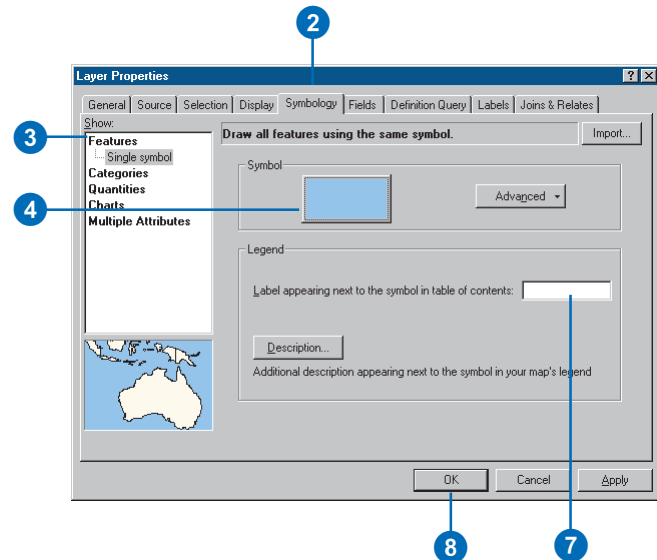
5. In the Symbol Selector dialog box, click a new symbol or change specific properties of the symbol.

6. Click OK on the Symbol Selector dialog box.

7. Type a Label for the feature.

The label appears next to the symbol in the table of contents.

8. Click OK.



## Drawing features to show categories like names or types

A category describes a set of features with the same attribute value. For example, given parcel data with an attribute describing land use—for example, residential, commercial, and public areas—you can use a different symbol to represent each unique land use type. Drawing features this way allows you to see where features are and what category they belong to. This can be useful if you're targeting a specific type of feature for some action or policy. For instance, a city planner might use the land use map to target areas for redevelopment.

In general, look for these kinds of attributes when mapping by category, or unique value:

- Attributes describing the name, type, or condition of a feature.
- Attributes containing measurements or quantities that are already grouped, for example, “0–99”, “100–199”.
- Attributes that uniquely identify features, for example, a county name attribute could be used to draw each county with a unique color. ►

## Drawing a layer showing unique values

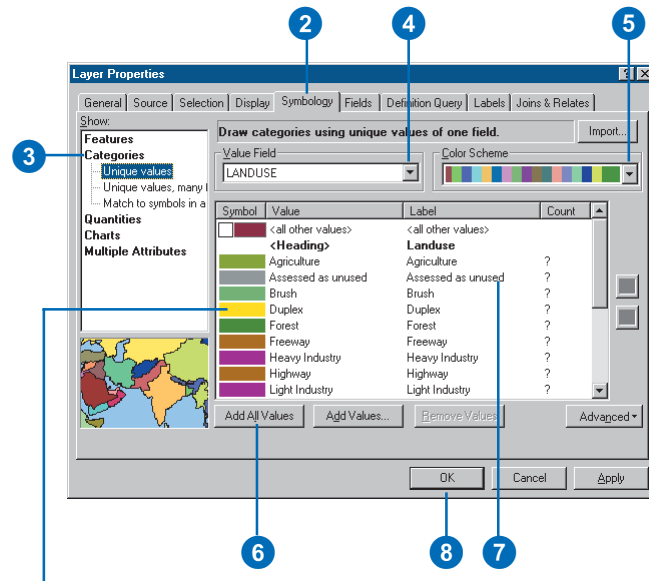
1. In the table of contents, right-click the layer you want to draw showing unique values and click Properties.
2. Click the Symbology tab.
3. Click Categories.

ArcMap automatically selects the Unique values option.

4. Click the Value Field dropdown arrow and click the field that contains the values you want to map.
5. Click the Color Scheme dropdown arrow and click a color scheme.
6. Click Add All Values.

This adds all unique values to the list. Alternatively, click the Add Values button to choose which unique values to display.

7. If you want to have more descriptive labels, click a label in the Label column and type a new one.
8. Click OK.



Double-click a symbol to change it.

You can let ArcMap assign a symbol to each unique value based on a color scheme you choose or explicitly assign a specific symbol to a specific attribute value.

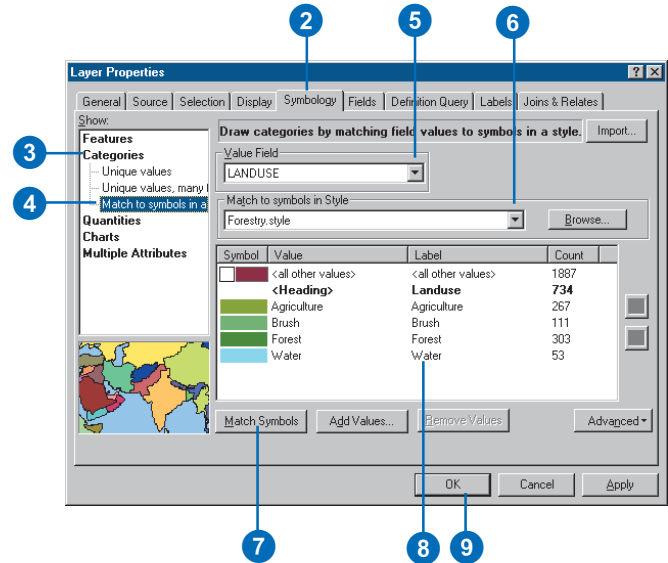
To draw features with specific symbols, you need to create a style beforehand that contains symbols named after the attribute value they represent. For example, if you have a dataset that categorizes roads as either major or minor, then you would need to have line symbols within that style named “major” and “minor”. ArcMap will match the attribute value to the line symbol name to draw the feature. Features that don’t have a matching line symbol won’t be drawn. This way of drawing features is especially useful if you want to draw your data the same way on different maps.

## See Also

*For more information on creating styles, see Chapter 9, ‘Working with styles and symbols’.*

## Drawing features by referencing specific symbols in a style

1. In the table of contents, right-click the layer you want to draw showing unique values and click Properties.
2. Click the Symbology tab.
3. Click Categories.
4. Click Match to symbols in a style.
5. Click the Value Field dropdown arrow and click the field that contains the values you want to map.
6. Click the Match to symbols in Style dropdown arrow and click the style that contains symbol names that match attribute values.  
  
If the style is not loaded, click the Browse button to browse for it on disk.
7. Click Match Symbols.
8. If you want to have more descriptive labels, click a label in the Label column and type a new one.
9. Click OK.



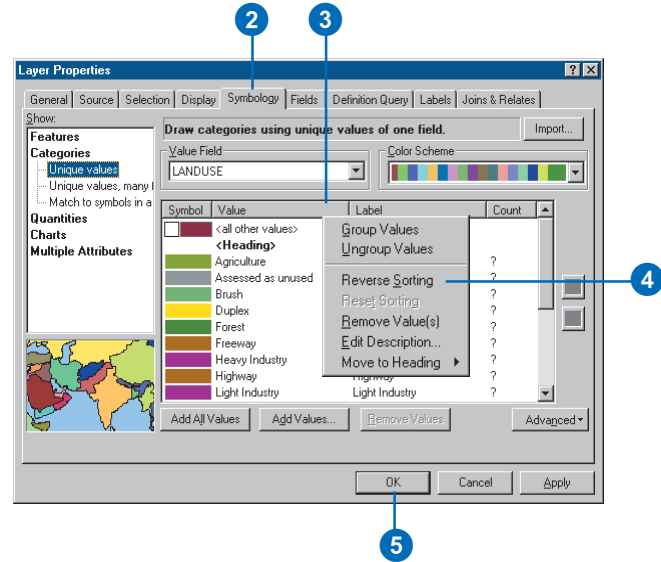
## Tip

### Ordering unique value headings

You can also arrange the headings for unique values. Just select a heading and use the arrow keys to move it.

## Sorting unique values

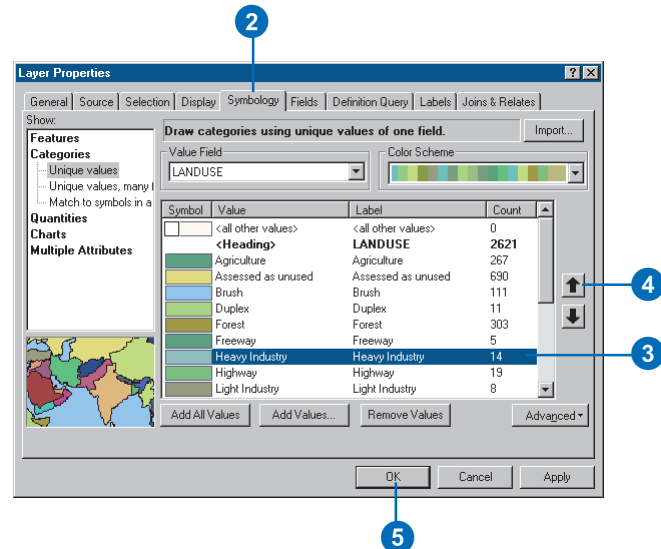
1. In the table of contents, right-click the layer whose unique values you want to sort and click Properties.
2. Click the Symbology tab.
3. Click the Value column to show a context menu.
4. Click Reverse Sorting.
5. Click OK.



## Ordering unique values

1. In the table of contents, right-click the layer whose unique values you want to reorder and click Properties.
2. Click the Symbology tab.
3. Click the value you want to move up or down in the list.
4. Use the up and down arrows to either promote or demote the value in the list.
5. Click OK.

The arrow buttons only move values within a heading.





## Managing categories

If you're drawing features by category, the number of categories you display will affect what patterns are revealed on the map. Most people can easily discern up to seven categories for a given layer. The more technical the audience, the more categories they will be able to identify and the more easily they will be able to interpret complex patterns. Conversely, a less technical audience may benefit more from a map with fewer categories.

When displaying your data, you can control how you organize and display categories for a layer. If you want to display fewer categories, you can combine similar categories into one category—for example, combine two detailed land use categories into a more general one. Combining categories in this manner can make the patterns more apparent. However, the trade-off is that some information may be lost.

Instead of reducing the number of categories, you might organize individual categories into groups that you define. This allows you to work with and view them as a group. Additionally, a map reader will see the groups listed in the table of contents.

### Combining two or more categories into one

1. In the table of contents, right-click the layer drawn with unique values for which you want to combine categories and click Properties.

2. Click the Symbology tab.

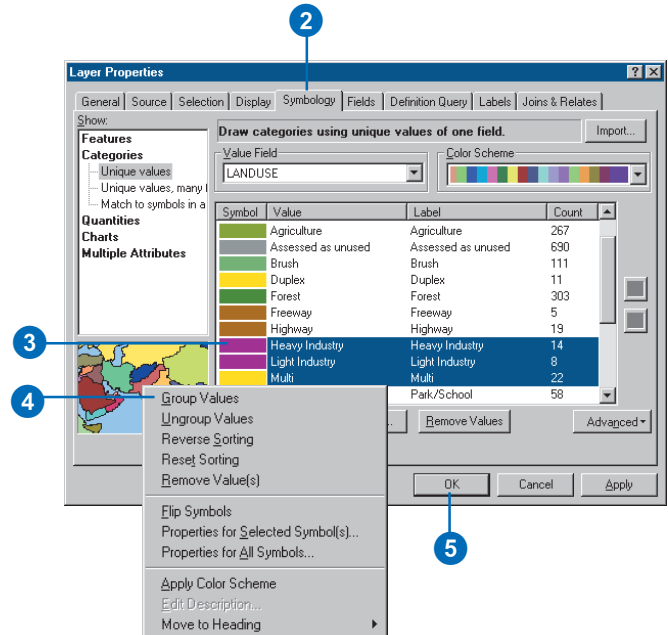
You should already see categories in the scrolling list. If you don't, follow the steps for 'Drawing a layer showing unique values' in this chapter.

3. Click the first value you want to combine. Hold down the Shift or Ctrl key and click the additional values that you want to combine.

4. Right-click over the values and click Group Values.

The selected values will now be combined into one category.

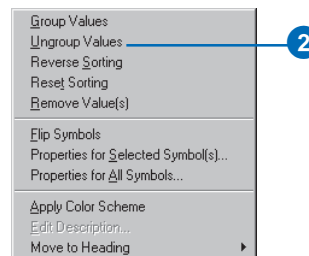
5. Click OK.



### Splitting up combined categories

1. Right-click a combined category.

2. Click Ungroup Values.



## Tip

### Deleting groups

*ArcMap will automatically delete groups that contain no attribute values in them.*

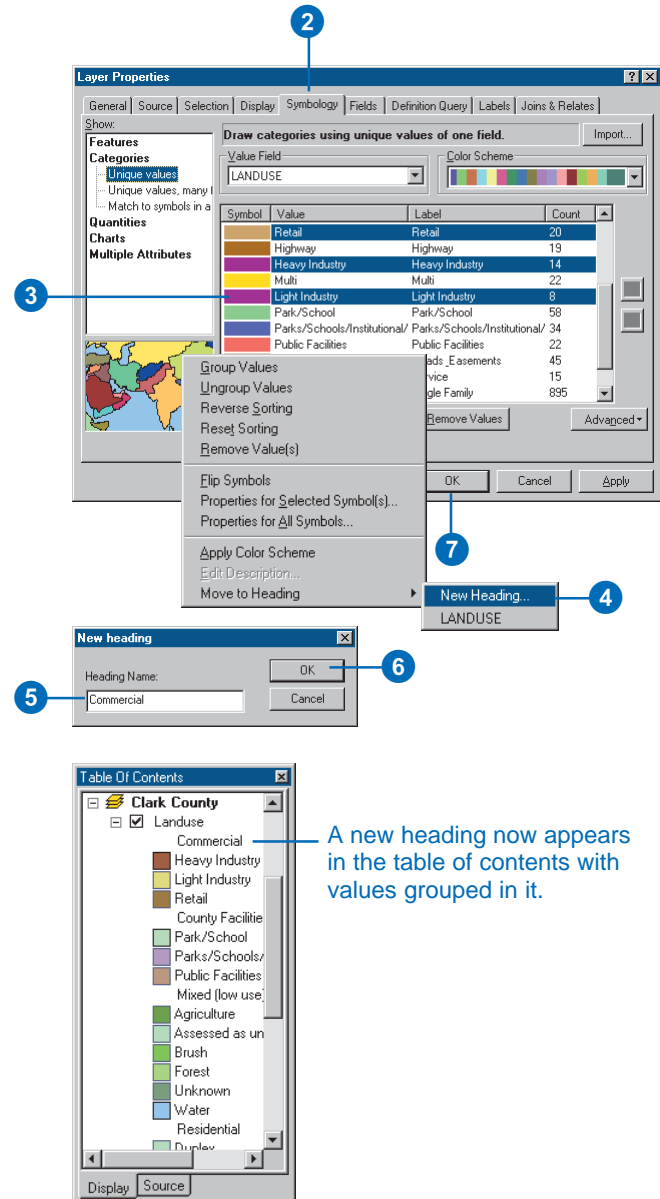
## Tip

### Renaming groups

*Click the group heading in the table of contents and type a new name.*

## Organizing categories in groups

1. In the table of contents, right-click the layer drawn with unique values for which you want to organize categories and click Properties.
2. Click the Symbology tab.  
You should already see categories in the scrolling list. If you don't, follow the steps for 'Drawing a layer showing unique values' in this chapter.
3. Click the first value you want to group together. Hold down the Shift or Ctrl key and click the additional values that you want to group.
4. Right-click a selected value, point to Move to Heading, and click New Heading.
5. Type a name for the new heading.
6. Click OK.
7. Click OK on the Layer Properties dialog box.



A new heading now appears in the table of contents with values grouped in it.

# Ways to map quantitative data

Quantitative data is data that describes features in terms of a quantitative value measuring some magnitude of the feature. Unlike categorical data, where features are described by a unique attribute value such as a name, quantitative data generally describes counts or amounts, ratios, or ranked values. For example, data representing precipitation, population, and habitat suitability can all be mapped quantitatively.

## Which quantitative value should you map?

Knowing what type of data you have and what you want to show will help you determine what quantitative value to map. In general, you can follow these guidelines:

- Map counts or amounts if you want to see actual measured values as well as relative magnitude. Use care when mapping counts as the values may be influenced by other factors and could yield a misleading map. For example, when making a map showing the total sales figures of a product by state, the total sales figure is likely to reflect the differences in population among the states.
- Map ratios if you want to minimize differences based on the size of areas or numbers of features in each area. Ratios are created by dividing two data values and are also referred to as *normalizing* the data. For example, dividing the 18- to 30-year-old population by the total population yields the percentage of people aged 18–30. Similarly, dividing a value by the area of the feature yields a value per unit area, or density.
- Map ranks if you're interested in relative measures and actual values are not important. For example, you may know a feature with a rank of “3” is higher than one ranked “2” and lower than a “4”, but you can't tell how much higher or lower.

## Should you map individual values or group them in classes?

When you map quantitative data, you can either assign each value its own symbol or group values into classes using a different symbol for each class.

If you're only mapping a few values (less than 10), you can assign a unique symbol to each value. This may present a more accurate picture of the data, since you're not predetermining which features are grouped together. More likely, your data values will be too numerous to map individually and you'll want to group them in classes, or *classify* the data. A good example of classified data is a temperature map you might find in a newspaper. Instead of displaying individual temperatures, these maps show temperature bands, where each band represents a given range in temperature.

## Ways to classify your data

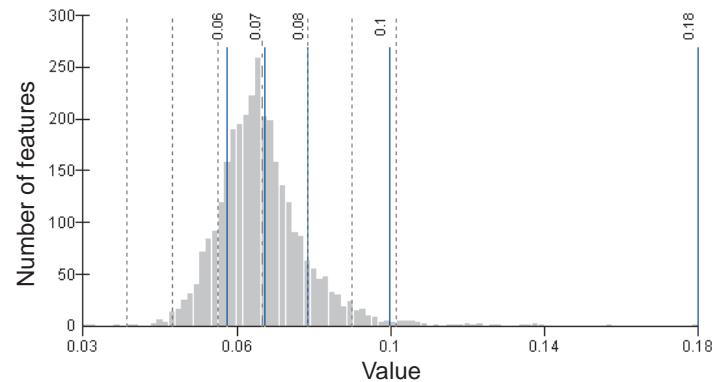
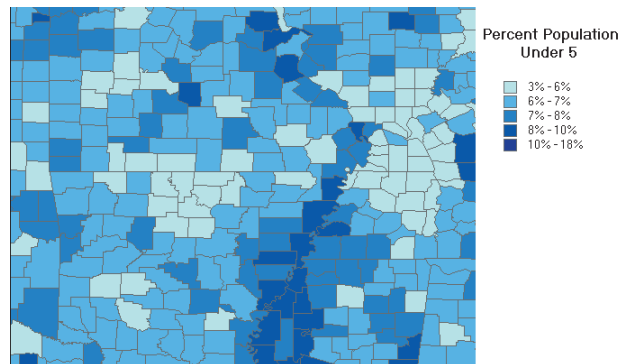
How you define the class ranges and breaks—the high and low values that bracket each class—will determine which features fall into each class and thus what the map will look like. By changing the classes you can create very different-looking maps. Generally, the goal is to make sure features with similar values are in the same class.

Two key factors for classifying your data are the classification scheme you use and the number of classes you create. If you know your data well, you can manually define your own classes. Alternatively, you can let ArcMap classify your data using standard classification schemes. The four most common schemes are natural breaks, quantile, equal interval, and standard deviation. These are described on the following pages.

# Standard classification schemes

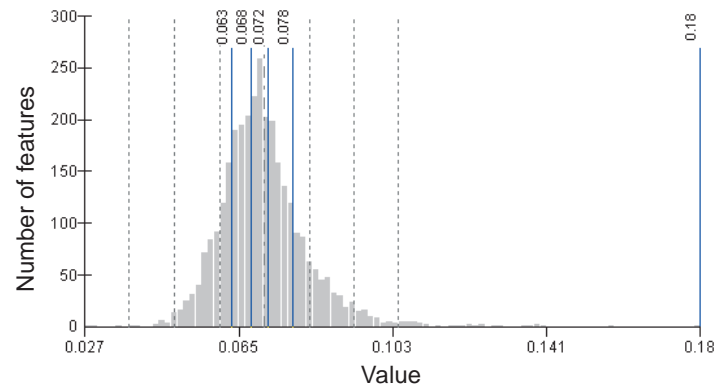
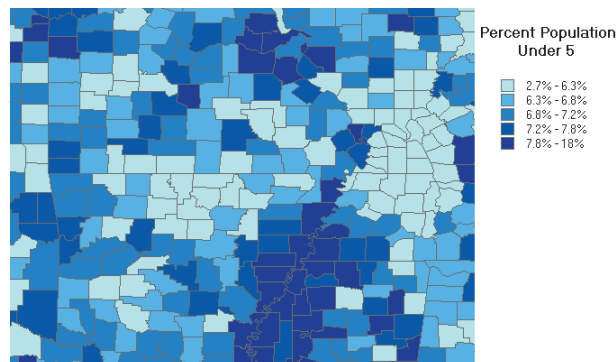
## Natural breaks (Jenks)

Classes are based on natural groupings of data values. ArcMap identifies break points by looking for groupings and patterns inherent in the data. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values.



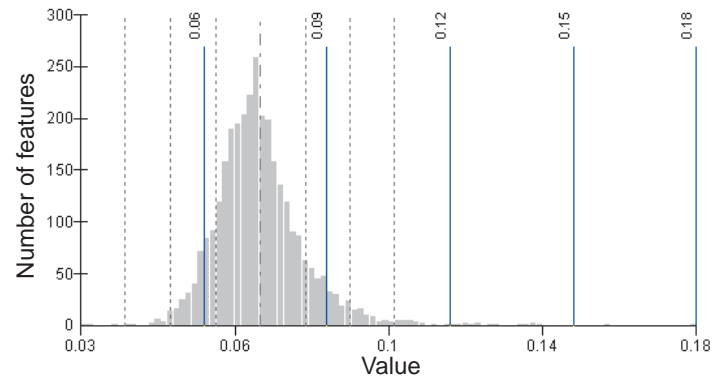
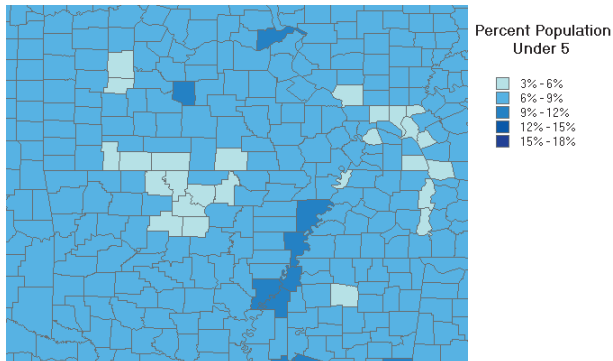
## Quantile

Each class contains an equal number of features. A quantile classification is well suited to linearly distributed data. Because features are grouped by the number in each class, the resulting map can be misleading. Similar features can be placed in adjacent classes, or features with widely different values can be put in the same class. You can minimize this distortion by increasing the number of classes.



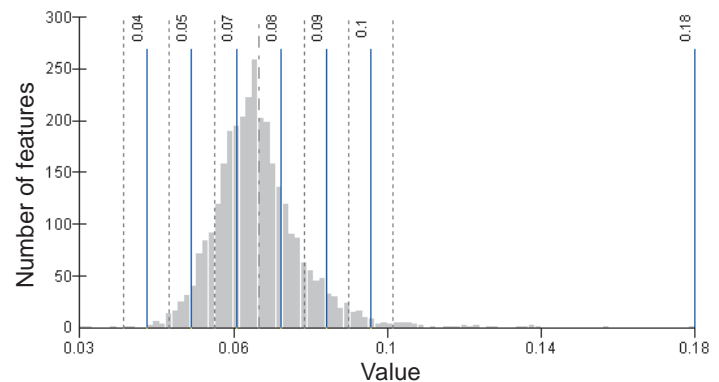
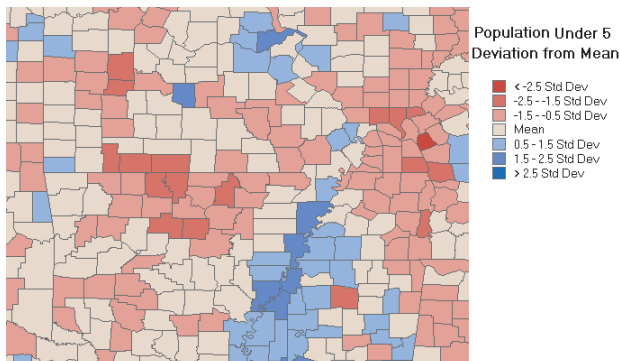
## Equal interval

This classification scheme divides the range of attribute values into equal-sized subranges. For example, if features have attribute values ranging from 0 to 300 and you have three classes, each class represents a range of 100 with class ranges of 0–100, 101–200, and 201–300. This method emphasizes the amount of an attribute value relative to other values, for example, to show that a store is part of the group of stores that made up the top one-third of all sales. It's best applied to familiar data ranges such as percentages and temperature.



## Standard deviation

This classification scheme shows you the amount a feature's attribute value varies from the mean. ArcMap calculates the mean value and then generates class breaks by successively adding to it or subtracting from it the standard deviation. A two-color ramp helps emphasize values above (shown in blue) and below (shown in red) the mean.



# Drawing features to show quantities like counts or amounts

When you want your map to communicate how much of something there is, you need to draw features using a quantitative measure. This measure might be a count; a ratio such as a percentage; or a rank such as high, medium, and low.

You can represent quantities on a map by varying the color or symbol size you use to draw features. For example, you might use increasingly darker shades of blue to represent increasingly higher rainfall amounts or larger circles to represent cities with larger populations.

Generally, you'll need to classify your data when you display it. Classifying data groups features with similar values into discrete classes and displays them with the same symbol. You can either manually define classes or apply one of the standard classification schemes to do so automatically—just specify the number of classes you want to show. Once you've defined the classes, you can add more classes, delete classes, or redefine class ranges. ►

## Representing quantity with color

1. In the table of contents, right-click the layer you want to draw showing a quantitative value and click Properties.

2. Click the Symbology tab.

3. Click Quantities.

ArcMap automatically selects Graduated colors.

4. Click the Value dropdown arrow and click the field that contains the quantitative value you want to map.

5. To normalize the data, click the Normalization dropdown arrow and click a field.

ArcMap divides this field into the Value to create a ratio.

6. Click the Color Ramp dropdown arrow and click a ramp to display data with.

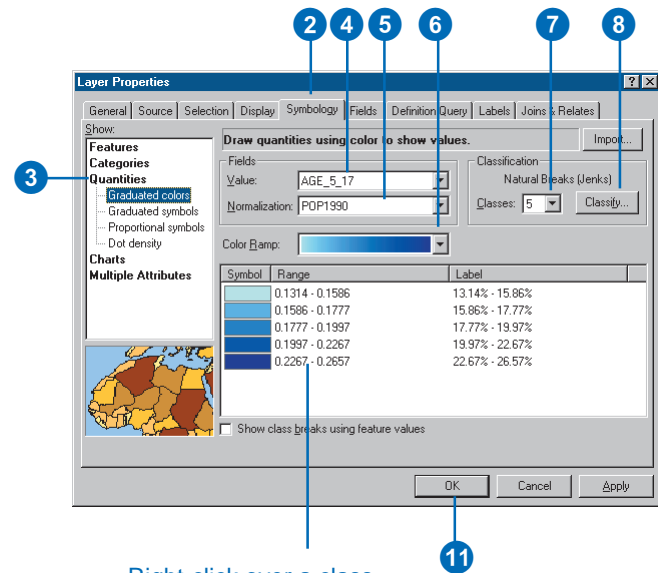
7. Click the Classes dropdown arrow and click the number of classes you want.

8. Click Classify.

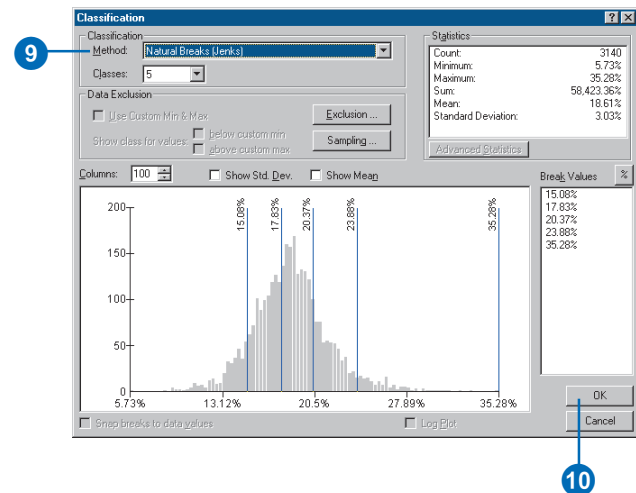
9. In the Classification dialog box, click the Method dropdown arrow and click the classification method you want.

10. Click OK on the Classification dialog box.

11. Click OK on the Layer Properties dialog box.



Right-click over a class to see additional options such as sorting and number formatting.



It's always a good idea to examine your data before you map it. For instance, you may find that you have a few extremely high or low values or null values where no data is available. These values can skew a classification and thus the patterns on the map. Fortunately, you can choose to exclude these values before you classify your data.

You may also want to normalize your data before you map it. When you normalize data, you divide it by another attribute to come up with a ratio. Often, ratios are easier to understand than the raw data values. For example, dividing total population by area yields the number of people per unit area, or a density. Dividing a store's sales figure by the total sales for all stores yields a percentage of sales at that store.

## See Also

For more information on creating and managing styles, see Chapter 9, 'Working with styles and symbols'.

## Creating your own color ramp for a layer

1. In the table of contents, right-click the layer that shows a quantitative value and click Properties.
2. Click the Symbology tab.
3. Click Quantities.
4. Double-click the top symbol in the list and set the start color for the ramp.
5. Double-click the bottom symbol and set the end color for the ramp.
6. Optionally, double-click any middle symbol to set its color.

This lets you create a multicolor ramp.

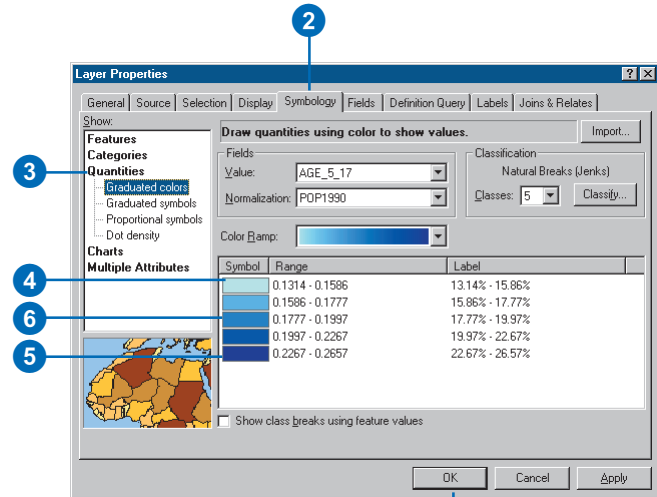
7. Click all the middle symbols you've set the color of.

By selecting one or more middle symbols, the color of those symbols is included in the new ramp. Otherwise, ArcMap only uses the top and bottom symbols.

8. Right-click a symbol and click Ramp Colors.
9. Optionally, right-click the Color Ramp dropdown and click Save to save your new ramp to your default style.

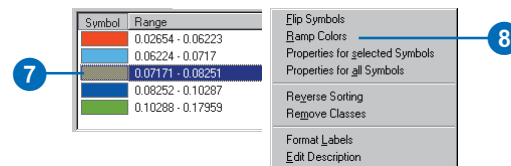
You only need to save the ramp if you want to use it again on another layer.

10. Click OK.



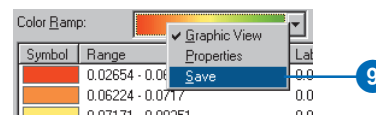
Symbol	Range
[Red]	0.02654 - 0.06223
[Orange]	0.06224 - 0.0717
[Yellow]	0.07171 - 0.08251
[Green]	0.08252 - 0.10287
[Dark Green]	0.10288 - 0.17959

Appearance after the top, middle, and bottom colors have been set.



Symbol	Range
[Red]	0.02654 - 0.06223
[Orange]	0.06224 - 0.0717
[Yellow]	0.07171 - 0.08251
[Green]	0.08252 - 0.10287
[Dark Green]	0.10288 - 0.17959

Resulting ramp goes from red to yellow to green.



## Tip

### Why don't the symbols get bigger when I zoom in?

As you zoom in on the map, the graduated symbols will not get bigger. If you want them to get bigger, you need to set a reference scale. Right-click the data frame and click *Set Reference Scale*. Now when you zoom in, all the symbols in the data frame will become larger.

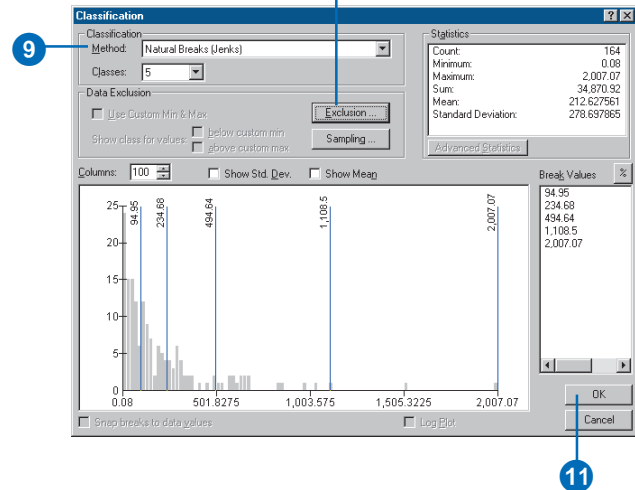
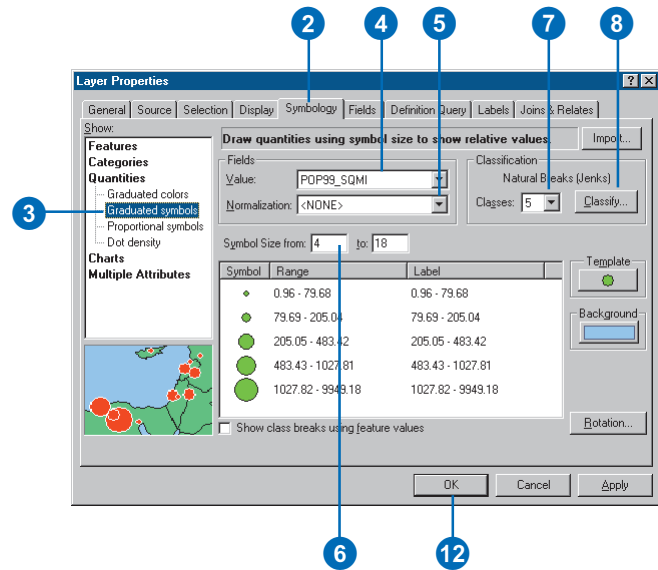
## Tip

### With how many digits do you want to display your labels?

You can set the number of significant digits for labels by clicking the *Label* column heading. This reveals a menu that lets you format the labels.

## Representing quantity with graduated symbols

1. In the table of contents, right-click the layer you want to draw showing a quantitative value and click Properties.
2. Click the Symbology tab.
3. Click Quantities and click Graduated symbols.
4. Click the Value dropdown arrow and click the field that contains the quantitative value you want to map.
5. To normalize the data, click the Normalization dropdown arrow and click a field. ArcMap divides this field into the Value to create a ratio.
6. Type the minimum and maximum symbol sizes.
7. Click the Classes dropdown arrow and click the number of classes you want.
8. Click Classify.
9. Click the Method dropdown arrow and click the classification method you want.
10. Optionally, click Exclusion to remove unwanted values from the classification (e.g., null values).
11. Click OK on the Classification dialog box.
12. Click OK on the Layer Properties dialog box.





## Tip

### What's the difference between graduated symbols and proportional symbols?

When you draw features with graduated symbols, the quantitative values are grouped into classes. Within a class, all features are drawn with the same symbol. Thus, you can't discern the value of individual features; you can only tell that its value is within a certain range.

Proportional symbols represent data values more precisely. The size of a proportional symbol reflects the actual data value. For example, you might map earthquakes using proportional circles, where the radius of the circle is based on the magnitude of the quake. The difficulty with proportional symbols arises when you have too many values; the symbols may become indistinguishable. Also, the symbols for high values can become so large as to obscure each other.

## Tip

### The maximum value symbol is too large

If the symbol for the maximum value fills the space on the dialog box, it will probably be too big on the map. Try reducing the symbol size for the minimum value, normalizing the data, or excluding some values. If it's still too large, use graduated symbols instead.

## Representing quantity with proportional symbols

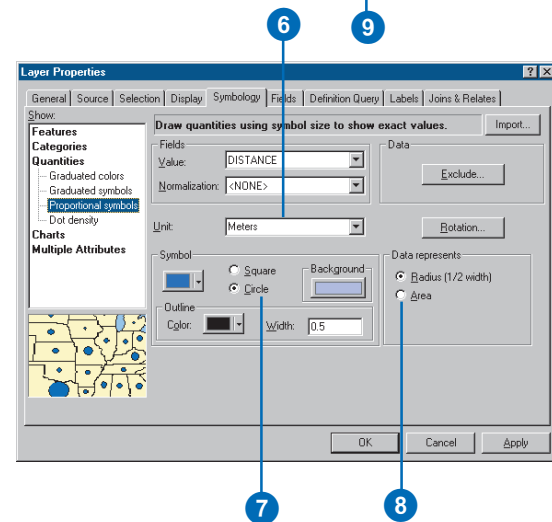
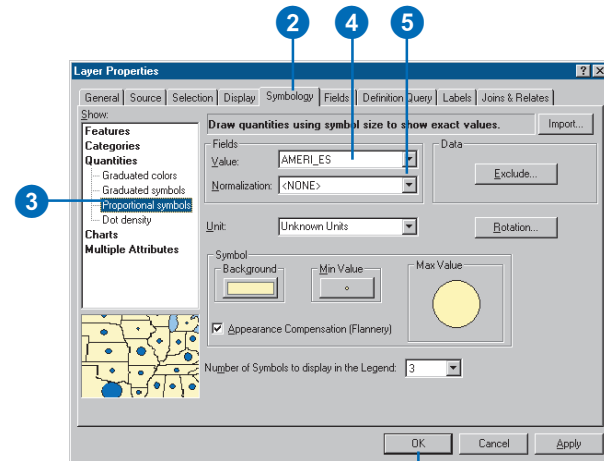
1. In the table of contents, right-click the layer you want to draw showing a quantitative value and click Properties.
2. Click the Symbology tab.
3. Click Quantities and click Proportional symbols.
4. Click the Value dropdown arrow and click the field that contains the quantitative value you want to map.
5. To normalize the data, click the Normalization dropdown arrow and click a field.

ArcMap divides this field into the Value to create a ratio.

6. If the Value represents a measurement on the map—an area or distance—click the Unit dropdown arrow and click a unit. Otherwise, skip to step 9.
7. Click Square or Circle as the symbol.
8. Click Radius or Area.

For example, click Radius if your data represents the distance an earthquake was felt from its epicenter. Click Area if the value represents an area.

9. Click OK.



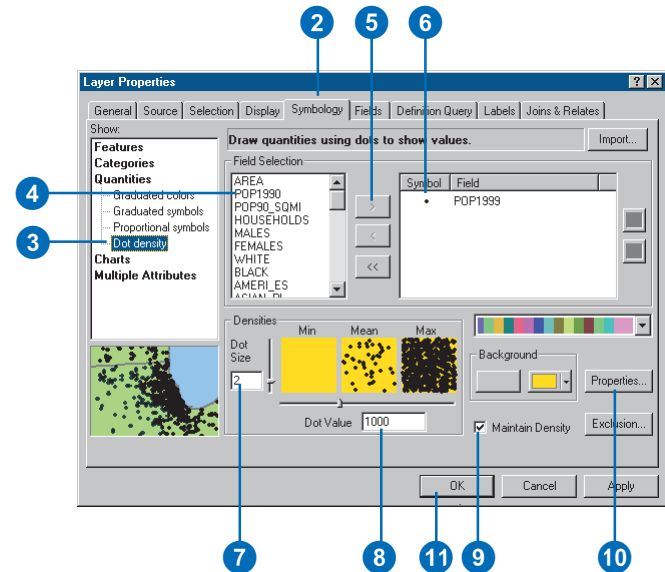
## Tip

### How big should the dots be?

When creating a dot density map, you specify how many features each dot represents and how big the dots are. You may need to try several combinations of amount and size to see which one best shows the pattern. In general, you should select values that ensure the dots are not so close as to form solid areas that obscure the patterns, or so far apart as to make the variations in density hard to see.

## Representing quantity with a dot density map

1. In the table of contents, right-click the layer you want to draw showing a quantitative value and click Properties.
2. Click the Symbology tab.
3. Click Quantities and click Dot density.
4. Click one or more fields under Field Selection that contain the quantitative values that you want to map.
5. Click the arrow button to add fields to the field list.
6. Double-click on a dot symbol in the field list to change its properties.
7. Type the dot size or click the slider to adjust the size.
8. Type the dot value or click the slider to adjust the value.
9. Check Maintain Density to preserve the dot density.
10. Optionally, click Properties to set the dot placement options.
11. Click OK.



## Setting a classification

When you classify your data, you can either use one of the standard classification schemes ArcMap provides or create custom classes based on class ranges you specify. If you choose to let ArcMap classify the data, simply choose the classification scheme you want and set the number of classes. If you want to define your own classes, you can manually add class breaks and set class ranges that are appropriate for your data. Alternatively, you can start with one of the standard classifications and make adjustments as needed.

Why set class ranges manually? There may already be certain standards or guidelines for mapping your data. For example, temperature maps are often displayed with 10 degree temperature bands. Or you might want to emphasize features with particular values, for example, those above or below a threshold value that determines whether some action will occur. Whatever your reason, make sure you clearly specify what the classes mean on the map.

## Setting a standard classification method

1. In the table of contents, right-click the layer that shows a quantitative value for which you want to change the classification.

2. Click the Symbology tab.

3. Click Quantities.

You should see the current classification.

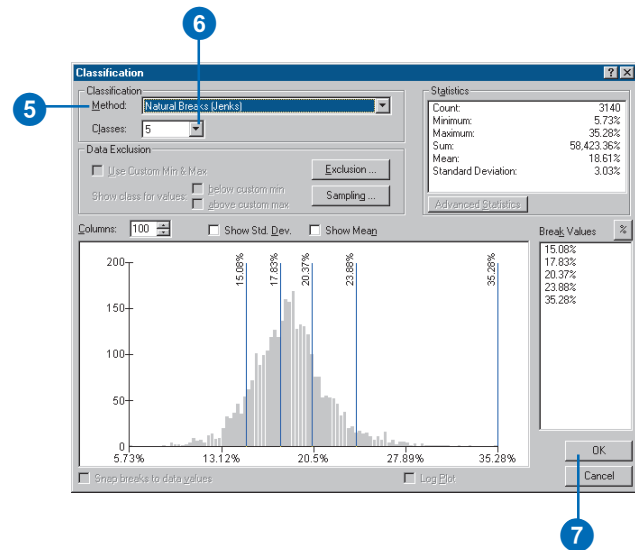
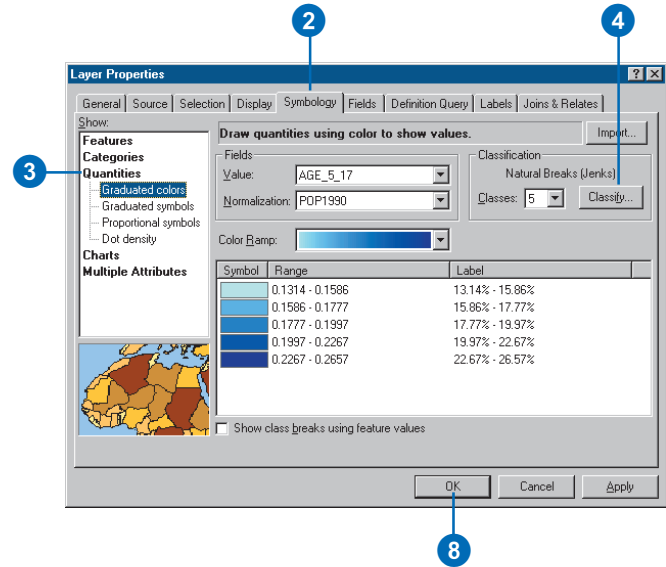
4. Click Classify.

5. Click the Method dropdown arrow and click the classification method you want.

6. Click the Classes dropdown arrow and click the number of classes you want to display.

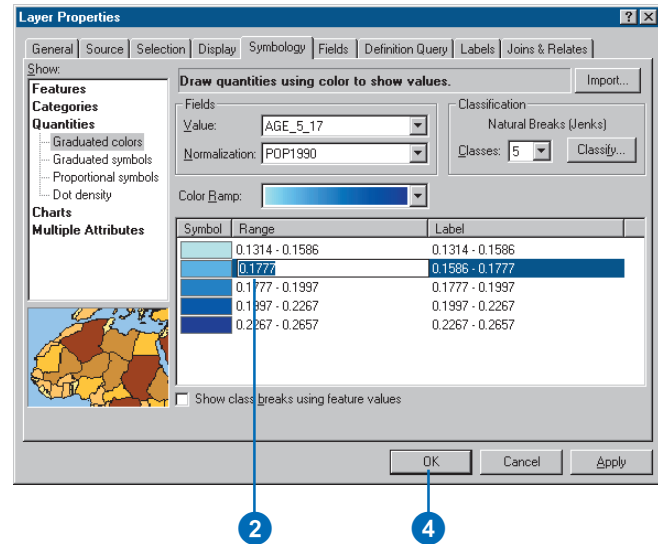
7. Click OK on the Classification dialog box.

8. Click OK on the Layer Properties dialog box.



## Inserting your own class break and setting a range

1. In the table of contents, right-click the layer you want to set class breaks for.  
  
You should see the current classification.
2. Click the Range you want to edit.  
  
Make sure to click the Range, not the Label.
3. Type a new value. This sets the upper value of the range.
4. Click OK.



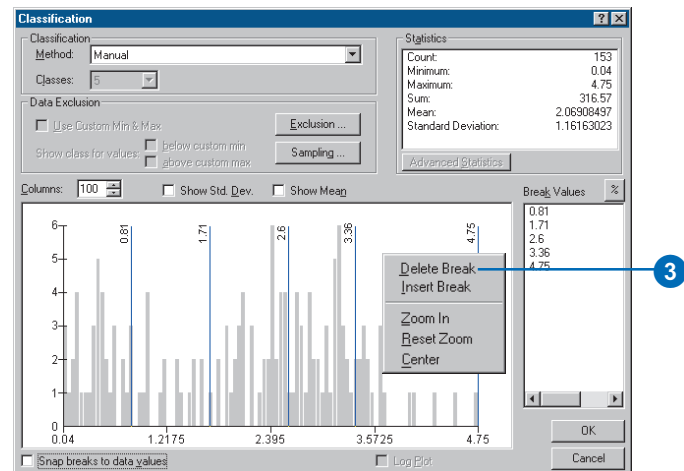
### Tip

#### Seeing more data values plotted on the histogram

*Increase the number of columns shown to see more data values in the histogram.*

## Deleting a class break

1. Click Classify from the Symbology tab of the Layer Properties dialog.
2. Click on the class break you want to delete.  
  
The selected break is highlighted.
3. Right-click over the histogram and click Delete Break.



## See Also

For more information on building query expressions, see Chapter 13, 'Querying maps'.

## Excluding features from the classification

1. Click Classify from the Symbology tab of the Layer Properties dialog.

2. Click Exclusion.

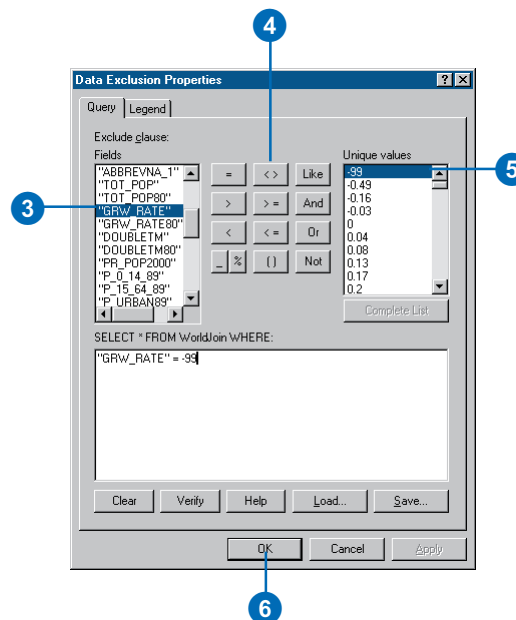
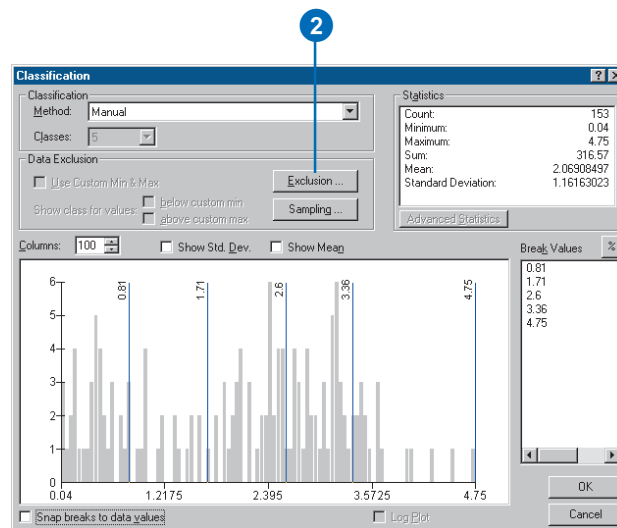
3. Double-click the field you're using to draw the layer.

4. Double-click an operator.

5. Double-click the value you want to exclude.

If you don't see the value in the list, click the Complete List button.

6. Click OK to execute the expression and exclude values.



## Drawing features to show multiple attributes

Geographic data usually has a number of different attributes that describe the features it contains. While you'll commonly use one of the attributes to symbolize the data—for example, show categories or quantities—you may sometimes want to use more than one. For example, you might display a road network using two attributes: one representing the type of road and the other representing the traffic volume along it. In this case, you could use different line colors to represent the different types of roads and also vary the line width to indicate traffic volume along each road.

When you symbolize your data using more than one attribute, you create a multivariate display. Symbolizing your data this way can effectively display more information about the data; however, it can also make your map more difficult to interpret. Sometimes it might be better to create two separate displays than to try to display the information together.

## Drawing a layer to show both categories and quantities

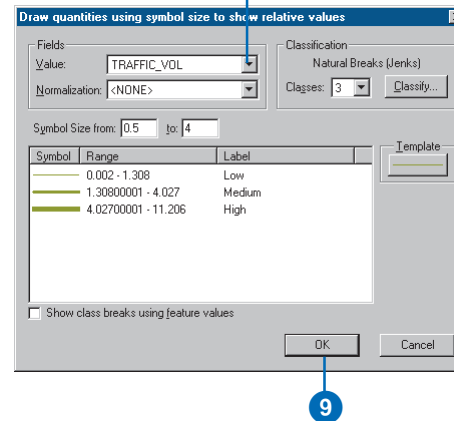
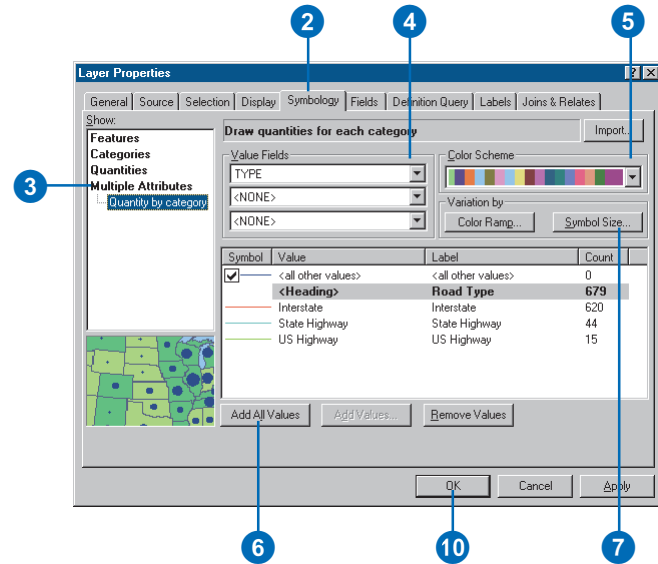
1. In the table of contents, right-click the layer you want to draw showing multiple attributes and click Properties.
2. Click the Symbology tab.
3. Click Multiple Attributes.

ArcMap automatically selects the Quantity by category option.

4. Click the first Value Fields dropdown arrow and click the field that contains the values you want to map.
5. Click the Color Scheme dropdown arrow and click a color scheme.
6. Click Add All Values.
7. Click Symbol Size or Color Ramp, depending on how you want to symbolize the quantitative value. This example shows Symbol Size.
8. Click the Value dropdown arrow and click the quantitative value you want to map.

Set other options as described in 'Drawing features to show quantities like counts or amounts'.

9. Click OK.
10. Click OK.



## Drawing features with charts

Pie charts, bar charts, and stacked bar charts can present large amounts of quantitative data in an eye-catching fashion. For example, if you're mapping population by county, you can use a pie chart to show the percentage of the population by ethnic group for each county.

Generally, you'll draw a layer with charts when your layer has a number of related numeric attributes that you wish to compare. Use pie charts if you want to show how much of the total amount each category takes up. Use bar charts to show relative amounts, rather than a proportion of a total.

### Tip

#### Charting negative values

Avoid using pie or stacked bar charts with data containing negative values.

## Drawing pie charts

1. In the table of contents, right-click the layer you want to draw showing quantitative values and click Properties.
2. Click the Symbology tab.
3. Click Charts and click Pie.
4. Click one or more fields under Field Selection that contain the quantitative values that you want to map.
5. Click the arrow button to add fields to the field list.

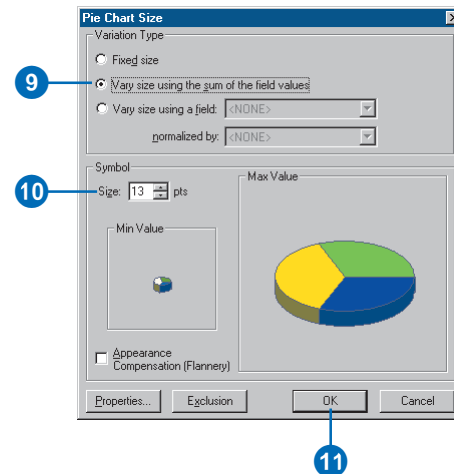
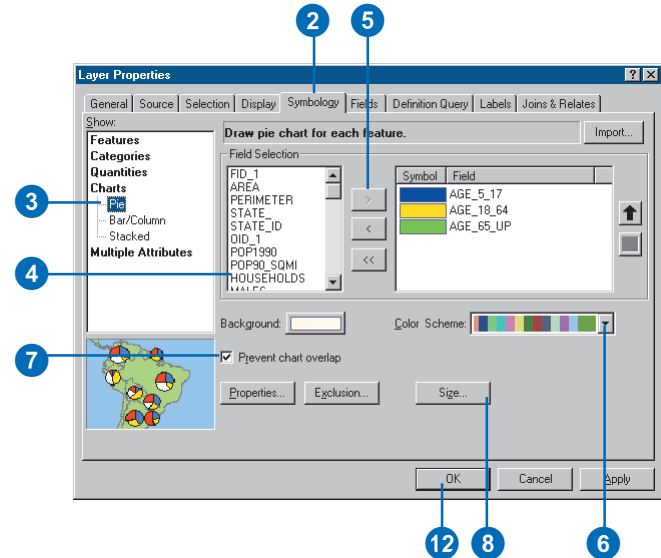
6. Click the Color Scheme dropdown arrow and click the colors you want to use.

You can double-click an individual symbol in the list to change its properties.

7. Check the box to prevent the charts from overlapping.
8. Click Size.
9. Click the Variation Type you want.

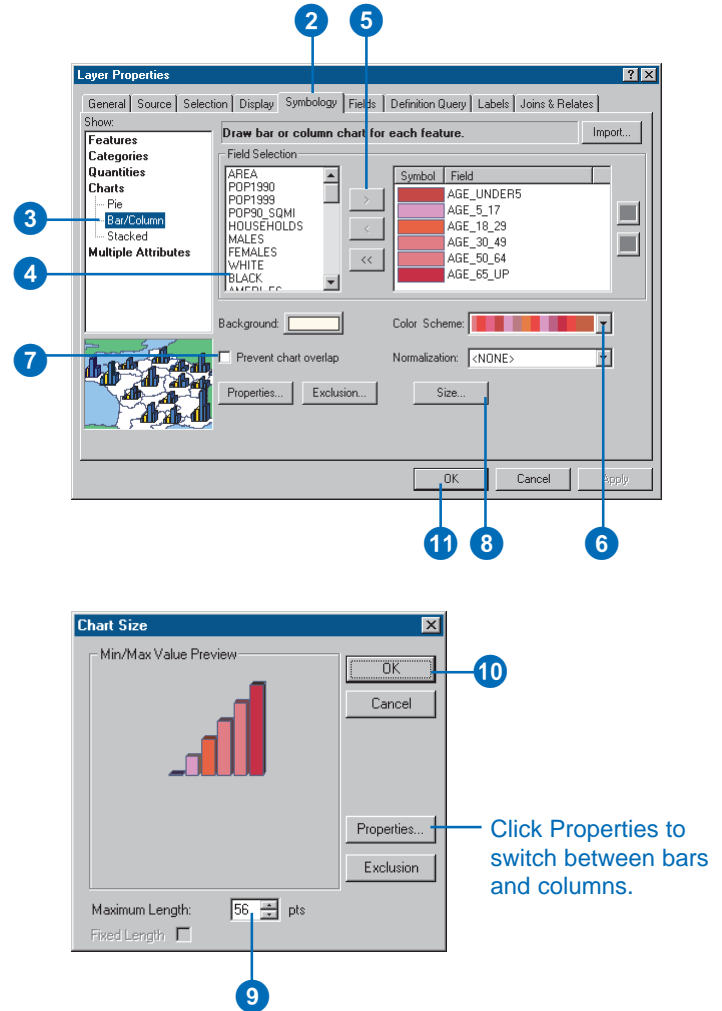
You can either draw all pies the same size or vary the size based on the sum of the attributes or a particular attribute value.

10. Type in a size or click the arrows to set the size.
11. Click OK.
12. Click OK.



## Drawing bar and column charts

1. In the table of contents, right-click the layer you want to draw showing quantitative values and click Properties.
2. Click the Symbology tab.
3. Click Charts and click Bar/Column.
4. Click one or more fields under Field Selection that contain the quantitative values that you want to map.
5. Click the arrow button to add fields to the field list.
6. Click the Color Scheme dropdown arrow and click the colors you want to use.
7. Check the box to prevent the charts from overlapping.
8. Click Size.
9. Type in a maximum length or click the arrows to set the length.
10. Click OK.
11. Click OK.



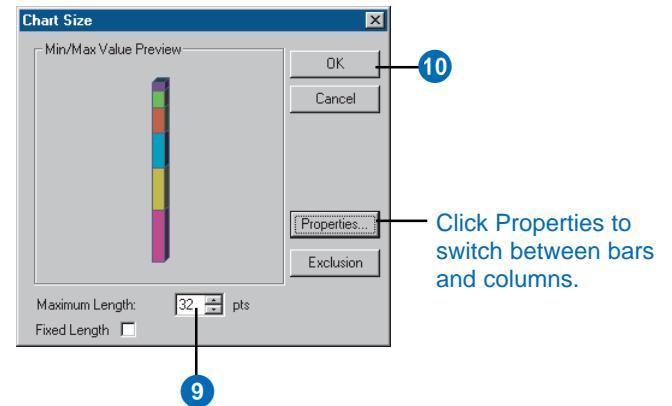
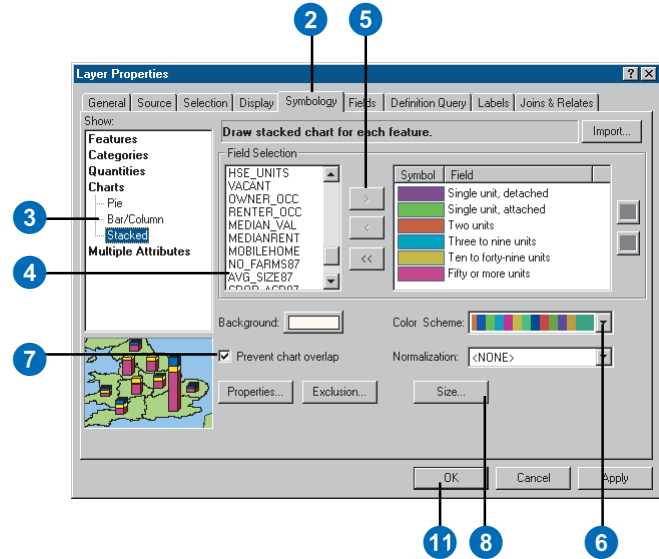


## Drawing stacked charts

1. In the table of contents, right-click the layer you want to draw showing quantitative values and click Properties.
2. Click the Symbology tab.
3. Click Charts and click Stacked.
4. Click one or more fields under Field Selection that contain the quantitative values that you want to map.
5. Click the arrow button to add fields to the field list.
6. Click the Color Scheme dropdown arrow and click the colors you want to use.

You can double-click an individual symbol in the list to change its properties.

7. Check the box to prevent the charts from overlapping.
8. Click Size.
9. Type in a maximum length or click the arrows to set the length.
10. Click OK.
11. Click OK.



## Drawing TINs as surfaces

TINs represent continuous surfaces such as terrain elevation or temperature gradient. Typically, you display a TIN using color-shaded relief. This lets you easily see the ridges, valleys, and hillsides and their respective heights. Seeing the data this way can help explain why other map features are where they are.

You can display any one of three surface characteristics—slope, aspect, and elevation—on your map and even simulate shaded relief.

Geographic features that cross the surface—such as a river, road, or shoreline—can be explicitly represented in a TIN with a breakline. These features form the edges of triangles and therefore influence the surface at their location. Since the underlying triangulation defines the surface, you might want to take a closer look at it. You can also display the internal structure of a TIN—for example, nodes and breaklines—independently or on top of the shaded relief display.

## Drawing a color-shaded relief surface

1. In the table of contents, right-click the TIN layer that you want to draw and click Properties.

2. Click the Symbology tab.

By default, ArcMap displays the face elevation and breakline edges of the TIN.

3. Click an entry in the list to see its symbolization properties.

4. Modify the symbolization properties as necessary. For example, set a new color ramp or change the number of classes.

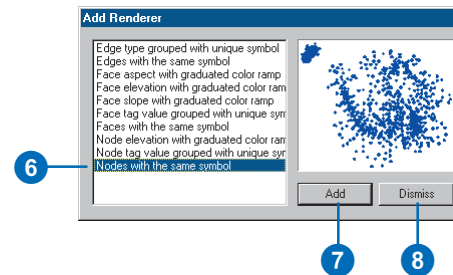
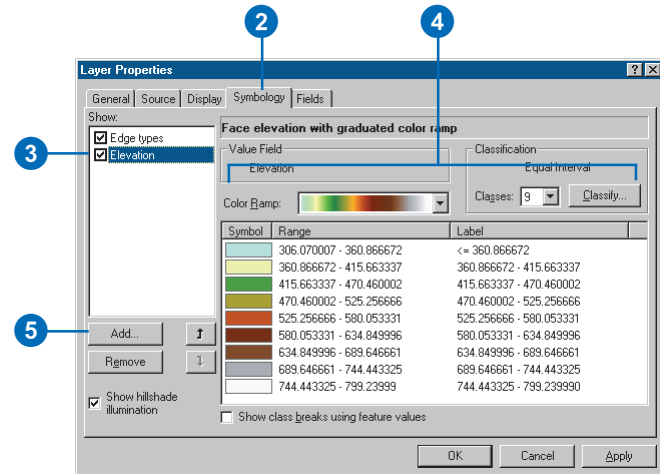
5. Click the Add button to draw additional elements of the TIN—for example, nodes.

6. Click the renderer that represents the TIN feature you want to draw.

7. Click Add.

8. Click Dismiss when you are finished adding renderers.

The list will update to show what you want to draw. ►



## Tip

### How are slope and aspect measured?

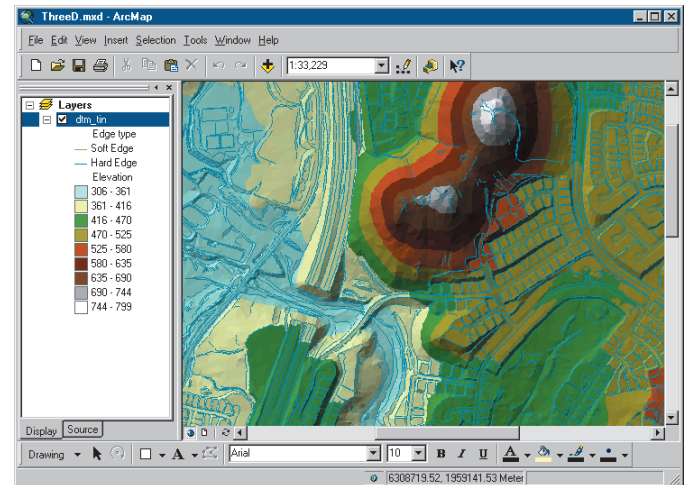
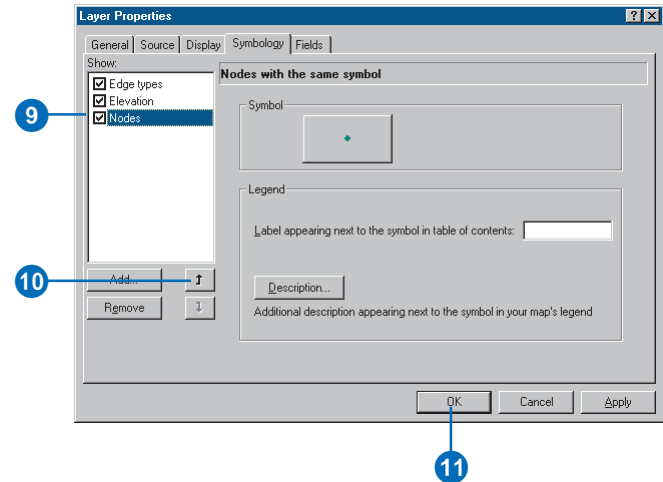
Slope values range between 0 and 90 degrees, where 0 indicates no slope. Aspect is also measured in degrees. North is 0 degrees, east is 90 degrees, south is 180 degrees, and west is 270 degrees.

9. Click an element in the list.

10. Click the Up or Down arrow to change its draw order.

The TIN features at the top of the list will draw on top of those below them.

11. Click OK.



## Drawing CAD layers

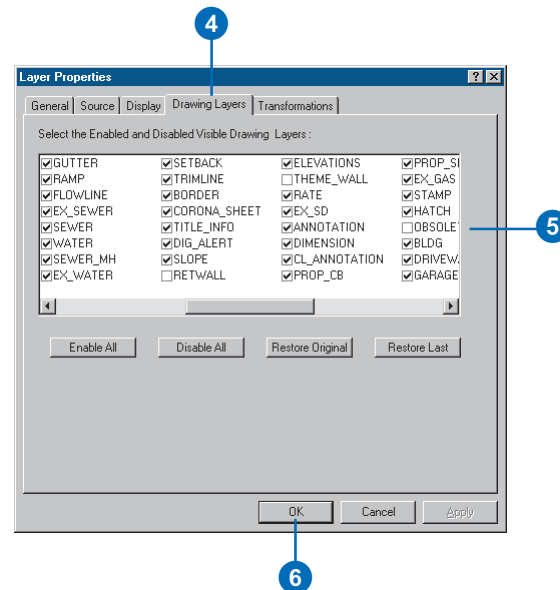
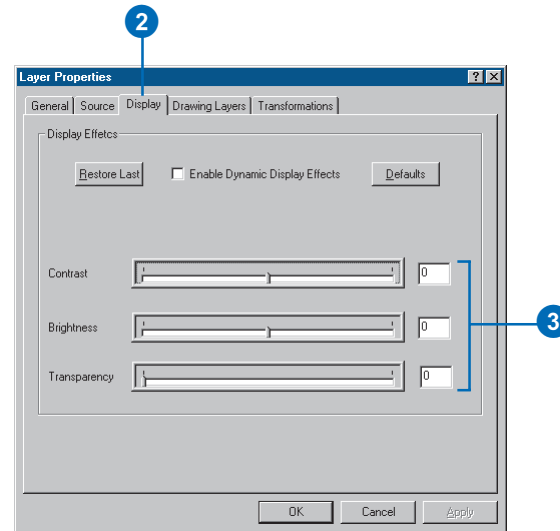
You can display CAD drawings on your map just like other data types. You can decide which CAD layers to draw and how to draw the entities on the layer.

Depending on how you added the CAD data to your map, you have two display options:

- If you added the CAD drawing file for display only, you can only choose which CAD layers to show or hide. ArcMap draws all entities according to the color specified in the drawing file. You can't override this drawing behavior.
- If you added the CAD drawing as features—point, line, or polygon—because you are interested in using the data for geographic analysis, you have access to all the symbolization options as other feature layers. For example, you can draw the polygon entities with a single symbol or classified by a unique value.

## Displaying a CAD drawing file

1. In the table of contents, right-click the CAD drawing layer and click Properties.
2. Click the Display tab.
3. Click and drag the sliders to adjust the CAD display.
4. Click the Drawing Layers tab.
5. Check the CAD layers that you want to display.
6. Click OK.



## See Also

For more information on symbolizing the features in a CAD dataset, see 'Drawing features to show categories like names or types' in this chapter.

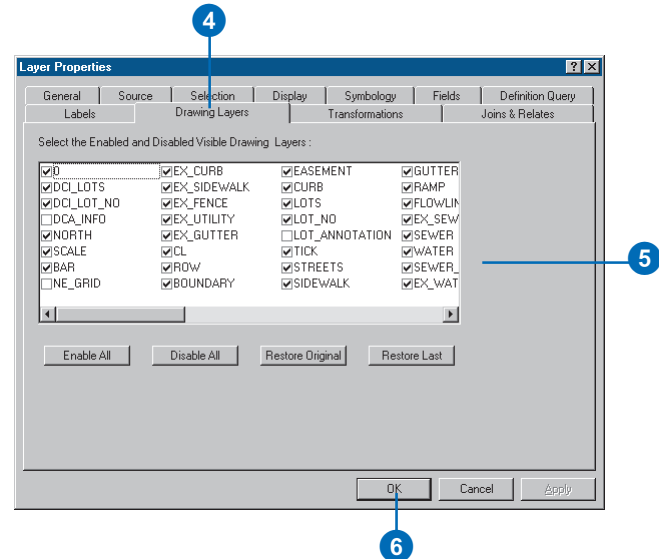
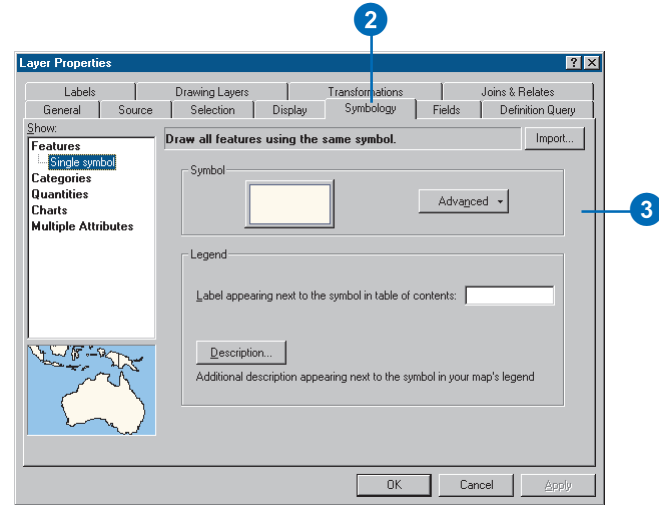
## Tip

### Adjusting transparency

You can also use the *Effects* toolbar to adjust the transparency of CAD layers.

## Drawing CAD features as points, lines, or polygons

1. In the table of contents, right-click the CAD dataset and click Properties.
2. Click the Symbology tab.  
The drawing options available to you are the same as other feature layers.
3. Modify the drawing properties as necessary.  
See the previous topics in this chapter for more detailed instructions.
4. Click the Drawing Layers tab.
5. Check the CAD layers that you want to display.
6. Click OK.



## Advanced symbolization

ArcMap provides a few other tools that let you control how layers draw. You can:

- Draw layers transparently.
- Set a reference scale for symbols so they'll, for example, get larger as you zoom in on the map.
- Order the drawing sequence of multilevel road networks with complex symbology.

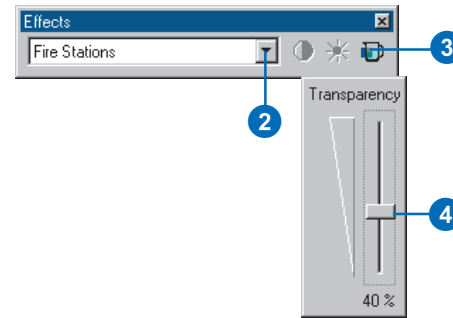
Transparency is especially useful for drawing raster layers over other layers on your map, allowing you to see the raster layer while still viewing underlying features.

When you set a reference scale, symbols and text will appear larger as you zoom in on your data frame and smaller as you zoom out on your data frame. So for example, text labels will get larger if you zoom in to a scale that is larger than the reference scale.

The current scale of the data frame is used as the reference scale to which all symbols and text in the data frame will be made relative. Setting a reference scale is like “freezing” the symbol and text sizes used in your data frame so that the way ►

### Drawing a layer transparently

1. Click the View menu, point to Toolbars, and click Effects. The Effects toolbar appears.
2. Click the Layer dropdown arrow and click the layer you want to adjust.
3. Click Adjust Transparency.
4. Drag the slider bar to adjust the transparency.



Fire station layer before (left) and after adjusting transparency.

they look at the reference scale is maintained at all scales.

One reason to set a reference scale is if you want the detail in your data frame to look the same onscreen in Data view as it will when you print it out. Let's say you are creating a map for publication that will be printed out at a scale of 1:25,000. If you set your data frame's scale to be 1:25,000 and then choose Set Reference Scale, the symbols and text sizes in your data frame will appear on-screen at the same size in relation to each other that they will have in your printed map.

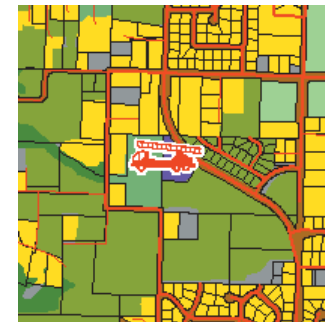
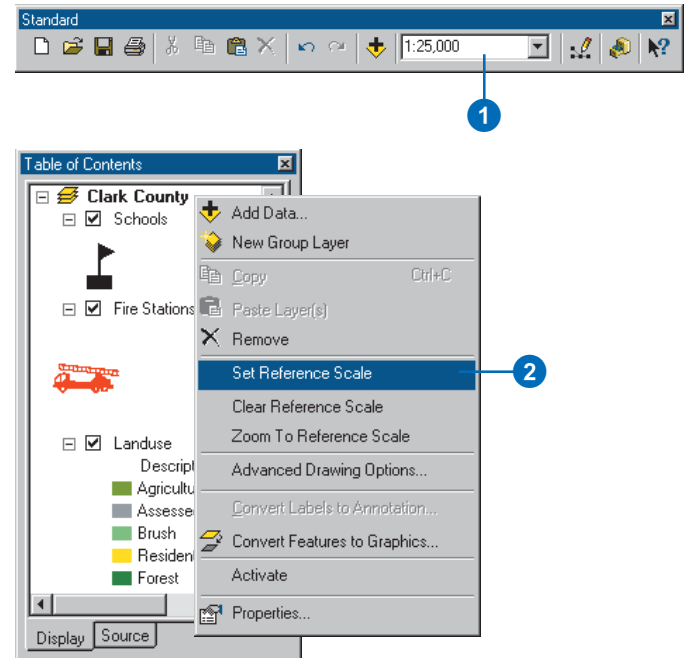
When a reference scale is set, all layers (except for raster layers) in the current data frame will have their symbols scaled relative to the reference scale. However, you can disable scaling for individual layers: double-click the layer, go to the Display tab, and uncheck "Scale symbols when a reference scale is set."

## Setting a reference scale for symbols

1. Set the scale of the data frame to the scale you want to use as the reference scale.
2. Right-click the data frame in the table of contents and click Set Reference Scale.

## Clearing a reference scale

1. Right-click the data frame in the table of contents and click Clear Reference Scale.



With (left) and without (right) a reference scale set.

## Tip

### What does Advanced Drawing Options provide?

Use the Advanced Drawing Options to order the drawing sequence of multilevel road networks with complex symbology. You can drag and reorder the drawing sequence, join features drawn with the same multilayered symbol, and merge features drawn with a variety of multilayered symbols.

## Tip

### Symbolizing your data

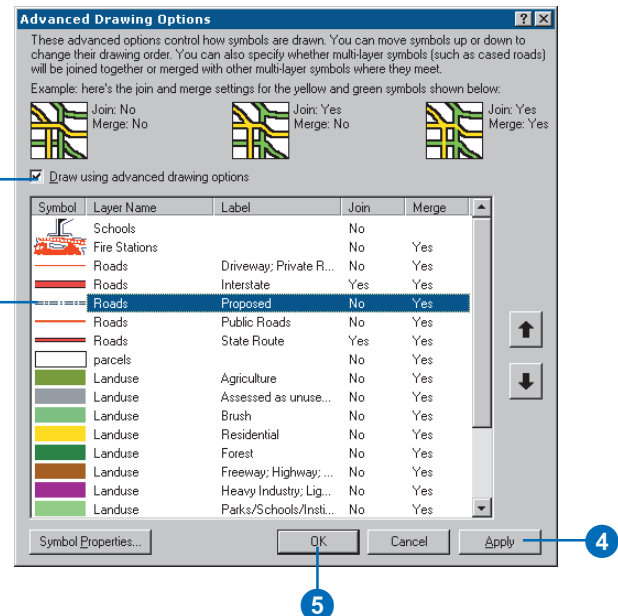
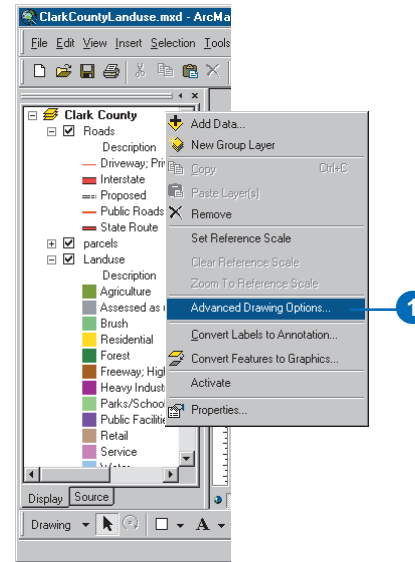
Symbolizing by unique values will help when drawing layers with complex intersecting features.

## Arranging the drawing order of complex symbols and features

1. In the table of contents, right-click a data frame and click Advanced Drawing Options.
2. Check Draw using advanced drawing options.
3. Click each symbol and set the appropriate properties.

Use the pictures to help you decide how you want the symbols to interact as they draw.

4. Click Apply to view your changes.
5. Click OK.





# Labeling maps with text and graphics

# 7

## IN THIS CHAPTER

- **Drawing points, lines, and circles**
- **Adding text**
- **Selecting graphics**
- **Moving, rotating, and ordering graphics**
- **Aligning, distributing, and grouping graphics**
- **Joining graphics**
- **About labeling**
- **Displaying labels**
- **Specifying the text of labels**
- **Prioritizing and positioning labels**
- **Printing a map with labels**
- **Feature-linked annotation**
- **Map tips and hyperlinks**

Maps convey information about geographic features. Yet displaying only features on a map—even those with symbols that describe exactly what they are—isn't always enough to make your point. Sometimes you'll want to add text and other graphics, such as polygons, circles, and lines, on top of your data to draw attention to particular features or highlight important areas. For example, you might want to outline a study area with a polygon, point out potential locations for new stores, or label city streets with their names. Other times, you'll use text and graphics to enhance your map presentation. For example, you can add titles to your map or draw neatlines around its border. These sorts of graphics are not associated with any particular map features, although they are added to the map the same way.

Text that's associated with a map feature is called a label. You can type in a label by hand if you know what the feature is, but more likely you'll let ArcMap label features automatically based on an attribute of the feature—for example, a soil type, street name, or land use category. If you're working with a geodatabase, you can dynamically link the label to the feature. That way, if you move the feature, the label will move with it; if you delete the feature, the label will also be deleted; and if you change the attribute value referenced by the label, the label will update with the new value.

Another more subtle way to label map features is with map tips and hyperlinks. Use map tips to display an attribute when you pause the mouse pointer over a feature. Use hyperlinks to display images, photographs, documents, drawings, video clips, Web pages, or any other information stored as a file on your system or on the Internet.

## Drawing points, lines, and circles

Points, lines, circles, polygons, and rectangles are among the graphic shapes you'll use to highlight features in your data and draw cartographic elements, such as neatlines, on your layout. Once you've added a graphic to your map, you can move it, resize it, change its color, or align it with other graphics.

If you want to add a graphic as part of the map layout, add it in layout view. If you want the graphic to display with your data, add it in data view. For example, suppose you want to draw a circle representing a buffer around a feature. Instead of drawing the circle over the data frame in layout view, draw it directly over your data in data view. Then, as you pan and zoom your data, the circle pans and zooms with it.















If you want more control over when graphics in a data frame draw in relation to other layers or when you want to draw graphics only when a particular layer is visible, you can create *annotation*. Annotation can be graphics, such as text, lines, and polygons, but not map elements such as scale bars and North arrows. ►

## Adding a graphic

1. On the Draw toolbar, click the type of graphic you want to add. (See the tools in the table to the right.)
2. Move the mouse pointer over the display and click to add the graphic.

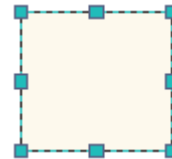
Some graphics require more than one click. For example, you'll need to click and drag the mouse to add a rectangle.

### Drawing tools

	Circle		Select Graphics
	Curve		Edit Vertices
	Ellipse		Rotate
	Freehand Line		Fill Color
	Line		Line Color
	Point		Point Color
	Polygon		
	Rectangle		

## Changing the size of a graphic

1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to resize.
2. Move the mouse pointer over one of the blue selection handles and click and drag the handle.



Click and drag a selection handle to resize the graphic. Use the Shift key to resize as a square or the Ctrl key to maintain the aspect ratio.

## Deleting a graphic

1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to delete.
2. Press the Delete key on the keyboard.

When you add graphics to a data frame, you can choose which *annotation target* they're added to. By default, the annotation target is your map, so your graphics will be stored in the map and will always be drawn. You can create an *annotation group* and make that the target that graphics will be added to. Annotation groups are useful for organizing a large number of graphics because you can turn them on and off individually. For example, you might make one annotation group and add graphics to it representing one planning proposal and another annotation group representing a competing proposal. In this way you can easily hide one of the annotation groups if you want to make a map just showing one proposal.

If you want to use annotation on different maps, store it in a geodatabase as an *annotation feature class* and make that the target for graphics you add. Annotation feature classes that you create appear in your map as *annotation layers* in the table of contents.

### See Also

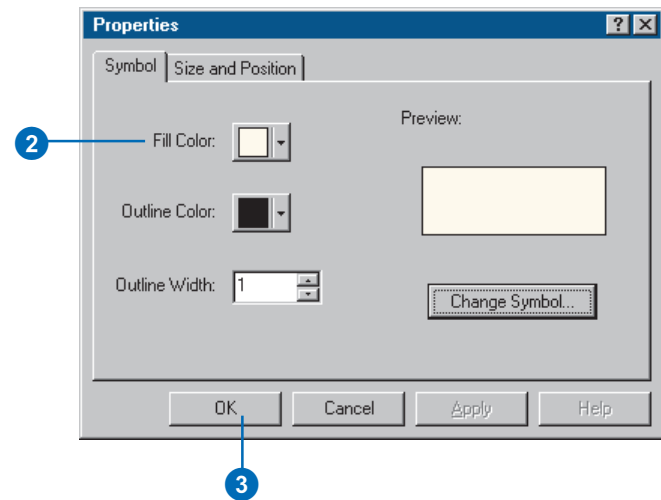
*For more information on adding other elements such as scale bars and North arrows, see Chapter 8, 'Laying out and printing maps'.*

## Changing the color or symbol of a graphic

1. Click the Select Graphics button on the Draw toolbar and double-click the graphic to display its properties.

The properties vary depending on the type of graphic you've selected.

2. To change the fill color, click the Fill Color dropdown arrow and click a new color.
3. Click OK.

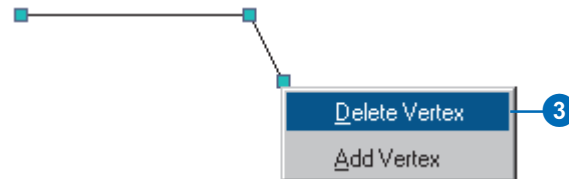


## Editing vertices of a graphic

1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to edit the vertices of.
2. Click the Edit Vertices button on the Draw toolbar.

If this button is dimmed, you can't edit the vertices of the selected graphic.

3. Right-click over the line and click Add Vertex to add a vertex, or right-click over a vertex and click Delete Vertex to delete it. Click and drag a vertex to move it.



## Tip

### Where should you save annotation?

If you want to display the annotation with a particular map, store it with the map. If you want to use it on other maps, store it in a geodatabase.

## Tip

### Adding graphics to a data frame while in layout view

When you add a graphic to a map while in layout view, ArcMap will, by default, add it to the layout. To add the graphic to a data frame, click the Select Graphics button on the Draw toolbar and double-click the data frame. Then click a drawing tool to add a graphic to the data frame.

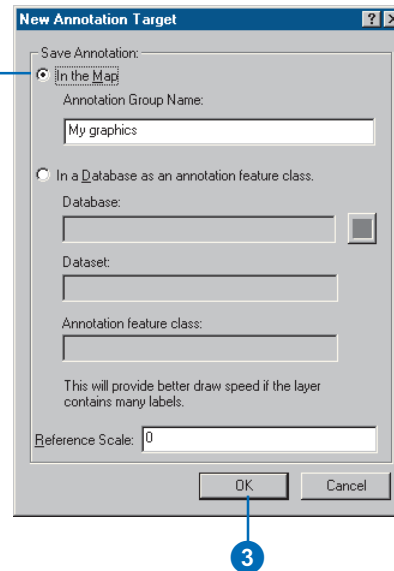
## Tip

### Why is my annotation target unavailable?

In order to add annotation to a target stored in a geodatabase, you must first start an edit session. Otherwise, the annotation target will be grayed out in the list of available targets.

## Creating an annotation target

1. On the Draw toolbar, click Drawing and click New Annotation Target.
2. Click Save Annotation In the Map to save the annotation in the current map or click In a Database as an annotation feature class.
3. Click OK.

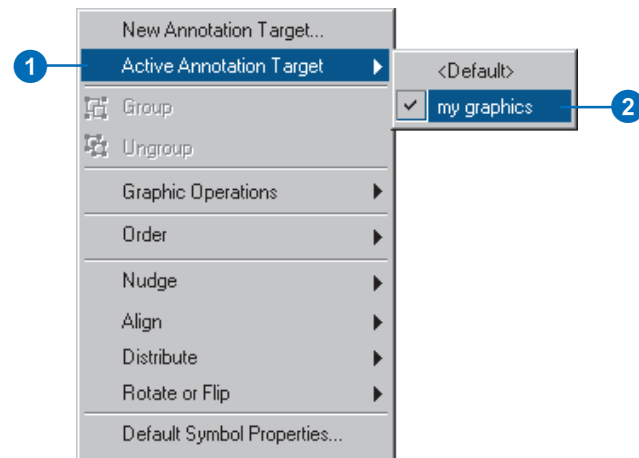


## Setting the annotation target

1. On the Draw toolbar, click Drawing and point to Active Annotation Target.
2. Click the annotation target you want to add graphics to.

All the annotation targets you have defined appear in the list. The default target saves the graphics into your map document.

If the annotation target is stored in a geodatabase, start an edit session to add graphics to it.



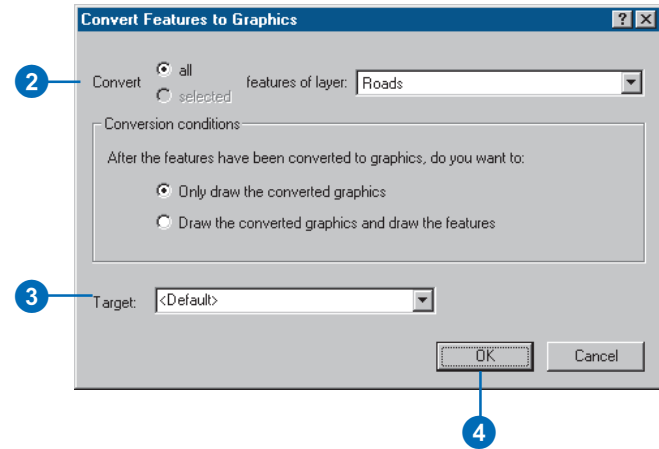
## Tip

### Why convert features to graphics?

*You can convert the features in a layer to graphics that can be moved, resized, and edited on the map. This option is useful if you want to change the location of features relative to each other for cartographic purposes, such as generalization, but you don't want to edit the source data that your layer represents.*

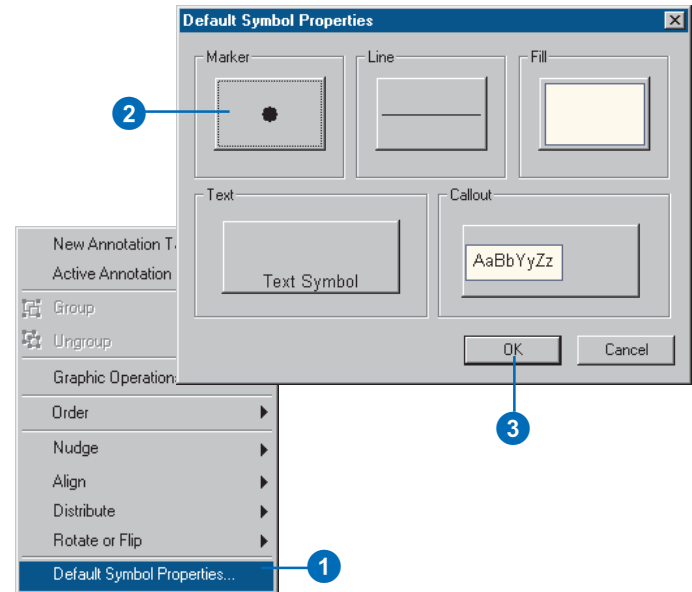
## Converting features into graphics

1. Right-click the layer in the table of contents that you want to convert to graphics and click Convert Features to Graphics.
2. Click all to convert all features or selected to convert the selected features.
3. Click the Target dropdown arrow and click the annotation target you want to add the graphics to.
4. Click OK.



## Setting the default symbol properties

1. On the Draw toolbar, click Default Symbol Properties.
2. Click the appropriate button to set the symbol properties for that type of graphic element.
3. Click OK.



## Adding text

Text serves a variety of purposes on a map. You can use text to annotate map features, to present information about the data on the map such as its coordinate system, or to provide a title that describes the purpose of the map.

You can interactively place text on a map in several ways. You can place text along a horizontal line, along a curved line, or with a callout box behind it that masks what's underneath the text. You can also control the font, color, style, and size of text as needed.

Text associated with map features should be added to the data frame containing the features. Text representing an element on the map layout—such as a title—should be added to the layout in layout view.








### See Also

*To dynamically label features based on an attribute value, see the section 'About labeling' in this chapter.*

## Adding text along a horizontal line

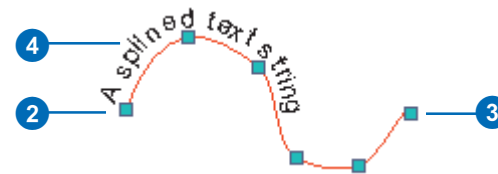
1. Click the Text button on the Draw toolbar.
2. Click the mouse pointer over the map display and type the text string.

### Text tools

	Text		Select Graphics
	Splined Text		Edit Vertices
	Label Tool		Rotate
	Callout Text		

## Adding text along a curved line

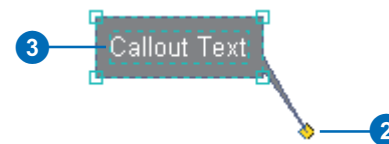
1. Click the Splined Text button on the Draw toolbar.
2. Click the mouse pointer over the map to add vertices along which the text should be splined.
3. Double-click to end the line.
4. Type the text string.



Click the Edit Vertices button on the Draw toolbar to edit the vertices of the splined text.

## Adding text with a callout box

1. Click the Callout Text button on the Draw toolbar.
2. Click and drag the mouse pointer over the map display to draw the callout line.
3. Type the text string.



You can click and drag the endpoint of the callout to position it correctly.

## Tip

### Adding text to a data frame while in layout view

When you add text to a map while in layout view, ArcMap will, by default, add it to the layout. To add the text to a data frame, click the *Select Graphics* button on the Draw toolbar and double-click the data frame. Click the *Text* tool to add text to the data frame.

## Changing the font, color, and size of text

1. Click the *Select Graphics* button on the Draw toolbar and click the text elements you want to edit.
2. Click the appropriate button on the Draw toolbar to modify a particular characteristic of the text.

## Change text from the Draw toolbar

**B** Make text bold

**I** Make text italic

**U** Underline text

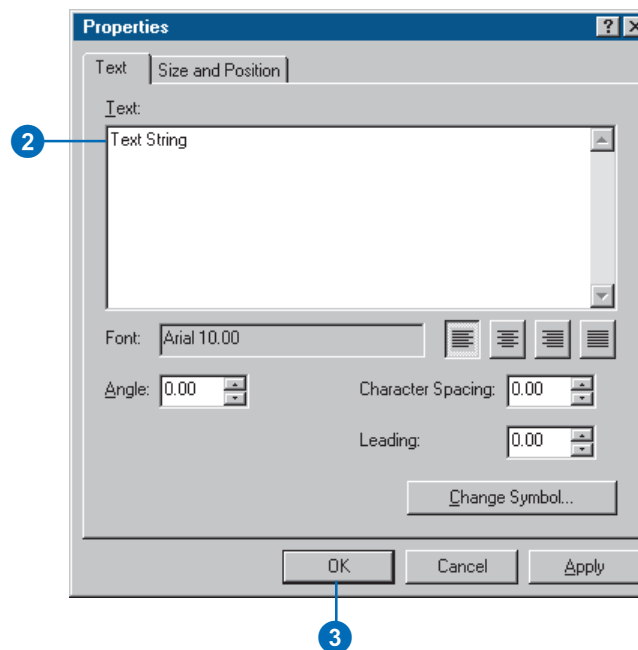
**A** Change text color

10 Change text size

Arial Change text font

## Editing a text string

1. Click the *Select Graphics* button on the Draw toolbar and double-click the text element you want to edit.
2. Type a new text string.
3. Click OK.



## Selecting graphics

To work with a graphic, you must select it first. Once selected, you can, for example, change its size, color, or shape. By selecting more than one graphic, you define a selected set that you can work with as a group. For example, you might align, move, or delete them.

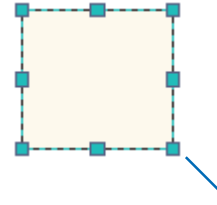
You select graphics with the Select Graphics tool. Select an individual graphic by pointing at it or select a group by dragging a rectangle around several graphics. Hold down the Shift key while selecting to add graphics to or remove graphics from the current selection.

You can tell when a graphic is selected because ArcMap draws selection handles around it. When you have selected more than one graphic, you'll notice that one of them has blue selection handles and the others have green. The blue handles indicate the dominant graphic, or the one that ArcMap will use, for example, to align other graphics with. To change the dominant graphic, hold down the Ctrl key and click on the selected graphic that you want as the dominant one.

## Selecting graphics one at a time

1. Click the Select Graphics button on the Draw toolbar.
2. Move the mouse pointer over the graphic you want to select and click the graphic.

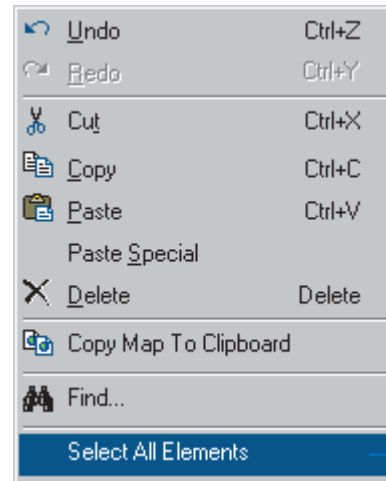
ArcMap draws selection handles around the selected graphic.



Move the mouse pointer over the graphic and click it. Hold down the Shift key and click to add to the current selected graphics.

## Selecting all graphics

1. Click the Edit menu and click Select All Elements.





## Moving, rotating, and ordering graphics

Much of the work you do while building your map involves arranging graphics and other elements on it. For instance, you might want to orient labels around the appropriate features in a data frame or position map elements, such as titles, neatlines, and North arrows, on the layout.

ArcMap provides a number of tools that let you position and orient graphics. You can move graphics by dragging them with the mouse or, when you need more precise control, you can nudge them up, down, left, or right. You can also position graphics to a specific coordinate location you type in. You can move one graphic on top of another one, rotate it, and flip it horizontally or vertically.

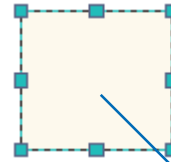
### Tip

#### Specifying coordinates

*In layout view, specify x,y coordinates relative to the lower-left corner of the layout. In data view, specify x,y coordinates in the units your data is stored in.*

### Moving a graphic

1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to move.
2. Click and drag the selected graphic to its new position.

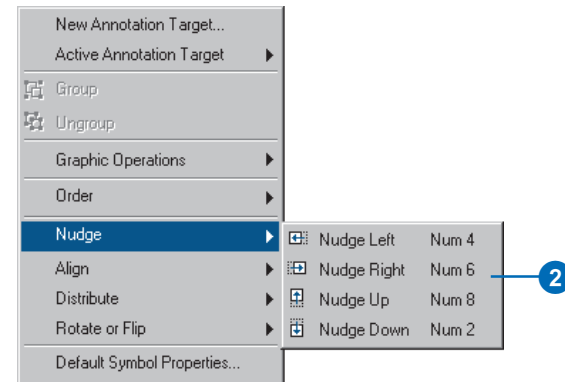


Move the mouse pointer over the graphic and click and drag it.

### Nudging a graphic

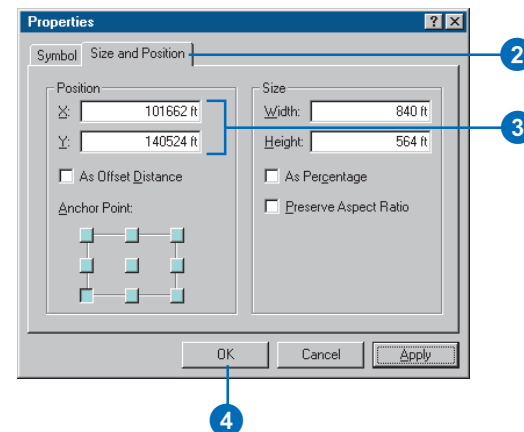
1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to move a small amount.
2. On the Draw toolbar, click Drawing, point to Nudge, and click the direction you want to nudge the graphic.

The graphic moves one pixel in the nudge direction.



### Positioning a graphic to a specific location

1. Click the Select Graphics button on the Draw toolbar and double-click the graphic you want to position.
2. Click the Size and Position tab.
3. Type an X and Y position.
4. Click OK.



## Tip

### Working with a graphic on a data frame while in layout view

If you want to work with a graphic in a data frame while in layout view, click the Select Graphics button on the Draw toolbar and double-click the data frame. Then click the appropriate tool to modify the graphic on the data frame.

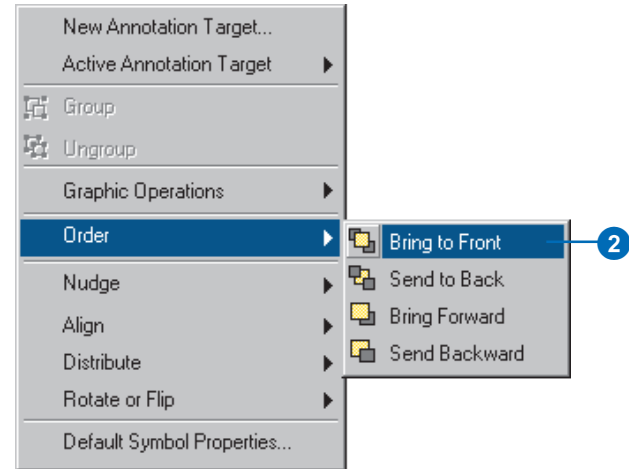
## Tip

### Rotating by 90 degrees

To rotate a graphic by 90 degrees left or right, click Drawing on the Draw toolbar, point to Rotate or Flip, and click Rotate Left or Rotate Right.

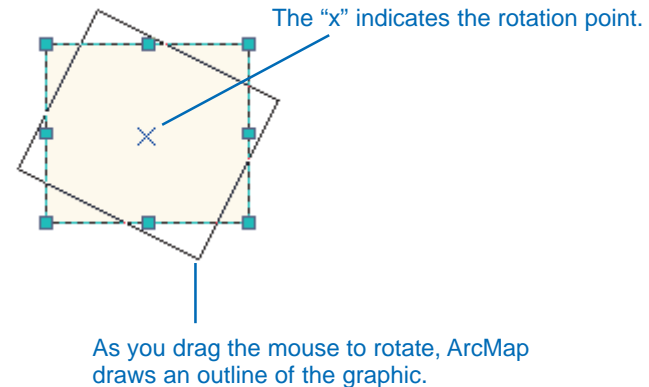
## Ordering a graphic

1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to place in front of or behind other graphics.
2. On the Draw toolbar, click Drawing, point to Order, and click the ordering option.



## Rotating a graphic

1. Click the Select Graphics button on the Draw toolbar and click the graphic you want to rotate.
2. Click the Rotate button on the Draw toolbar.
3. Position the mouse pointer over the "x", which indicates the rotation point, and move it as necessary.
4. Click and drag the mouse to rotate the graphic.



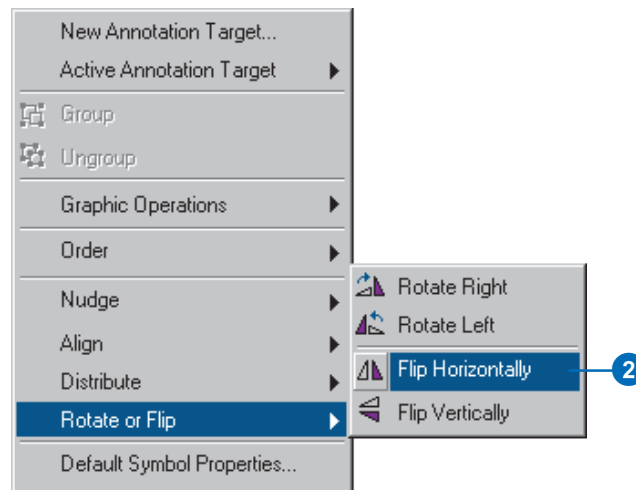
## Tip

### Displaying the Graphics toolbar

The *Graphics toolbar* provides quick access to frequently used tools for manipulating graphic elements. To display it, click the *View menu*, point to *Toolbars*, and click *Graphics*.

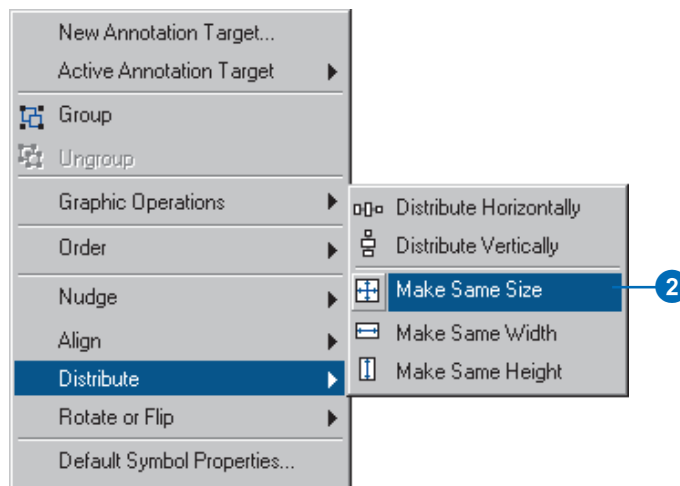
## Flipping a graphic horizontally or vertically

1. Click the *Select Graphics* button on the *Draw toolbar* and click the graphic you want to flip.
2. On the *Draw toolbar*, click *Drawing*, point to *Rotate or Flip*, and click *Flip Horizontally* or *Flip Vertically*.



## Making graphics the same size

1. Click the *Select Graphics* button on the *Draw toolbar* and click the graphics you want to make the same size.
2. Click *Drawing* on the *Draw toolbar*, point to *Distribute*, and click *Make Same Size*.



## Aligning, distributing, and grouping graphics

Most of the time you'll probably just drag a graphic where you want it to be. However, you can arrange them more precisely when you need to.

You can align graphics with other graphics—using the sides, middles, or top or bottom edges. You can arrange graphics so that they are equidistant from each other—distributing them either vertically or horizontally. Once you've arranged the graphics, you may want to group them together. That way, you can move them as a group and maintain their alignment.

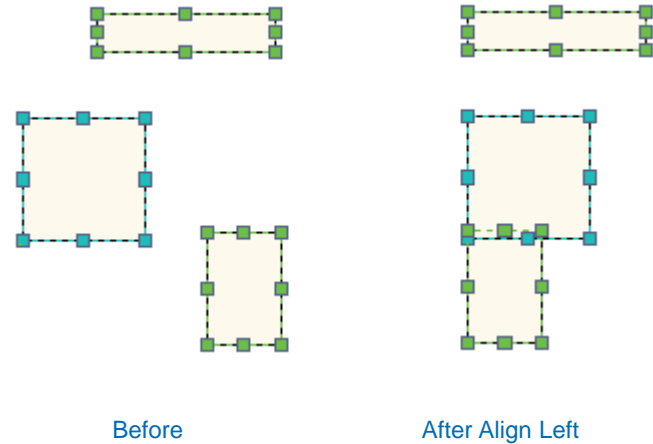
### Tip

#### What do the blue selection handles indicate?

*When you have more than one graphic selected, the blue handles indicate the dominant graphic, or the one that ArcMap will use, for example, to align other graphics with. To change the dominant graphic, hold down the Ctrl key and click on the selected graphic that you want to be the dominant one.*

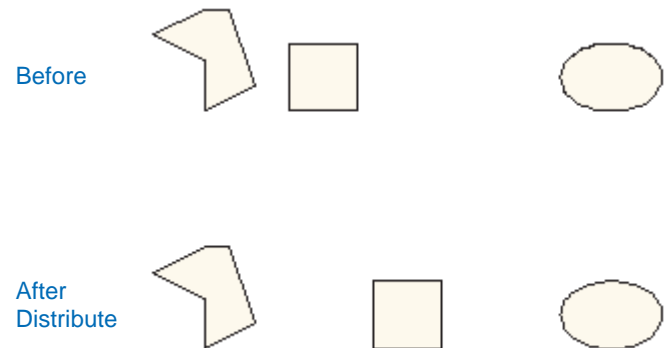
## Aligning graphics

1. Click the Select Graphics button on the Draw toolbar and click the graphics you want to align.
2. The dominant graphic has blue selection handles around it. To change the dominant graphic, press and hold the Ctrl key and click the graphic you want as the dominant one.
3. Click Drawing on the Draw toolbar, point to Align, and click the alignment you want.



## Distributing graphics

1. Click the Select Graphics button on the Draw toolbar and click the graphics you want to distribute.
  2. Click Drawing on the Draw toolbar, point to Distribute, and click the distribution method you want.
- The graphics are distributed with equal spacing between the centroid of each graphic.



## Tip

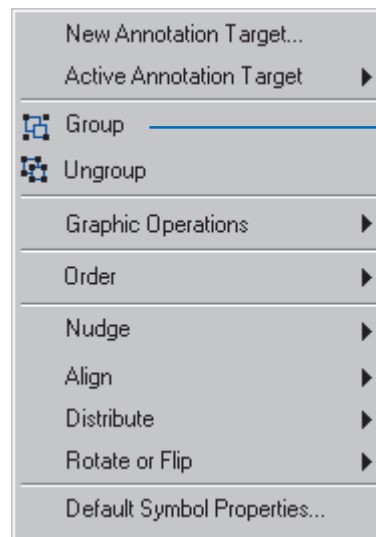
### Displaying the Graphics toolbar

The *Graphics toolbar* provides quick access to frequently used tools for manipulating graphic elements. To display it, click the *View* menu, point to *Toolbars*, and click *Graphics*.

## Grouping graphics

1. Click the *Select Graphics* button on the *Draw* toolbar and click the graphics you want to group.
2. Click *Drawing* on the *Draw* toolbar and click *Group*.

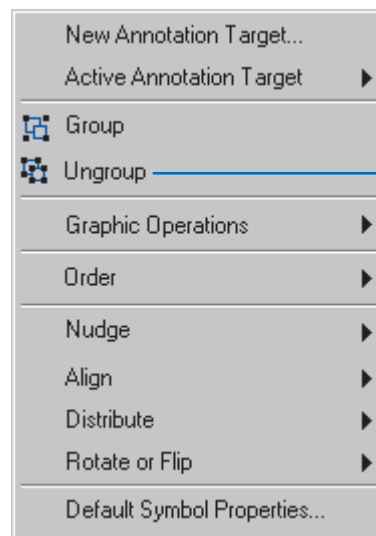
The individual graphics now form a group.



## Ungrouping graphics

1. Click the *Select Graphics* button on the *Draw* toolbar and click the graphics you want to ungroup.
2. Click *Drawing* on the *Draw* toolbar and click *Ungroup*.

Each graphic formerly in the group is now independent.



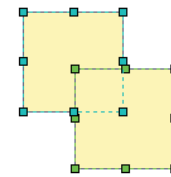
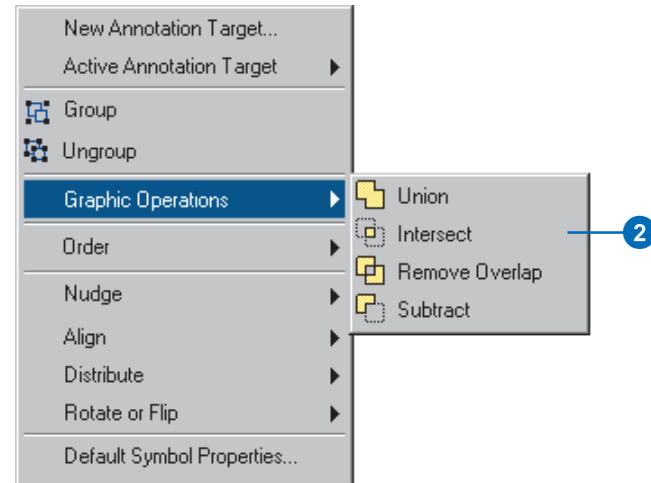
## Joining graphics

You can join two or more polygon graphics you've drawn on your map to form a new graphic that is a combination of the input graphics. You can:

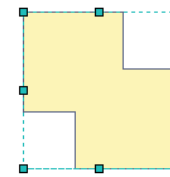
- Union—joins all graphics creating one large graphic. Where the graphics overlap, the boundaries are removed.
- Intersect—creates a new graphic from the shared area of the input graphics.
- Remove overlap—creates a new graphic from the nonoverlapping areas of two input graphics.
- Subtract—creates a new graphic by subtracting the overlapping area of one graphic from another.

## Joining graphics

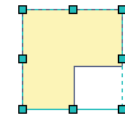
1. Select the polygon graphics on the map you want to join.
2. Click Drawing on the Draw toolbar, point to Graphic Operations, and click the method you want to use.  
The graphics will be joined.



Input Graphics



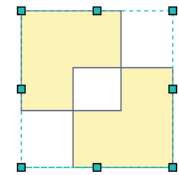
Union



Subtract



Intersect



Remove Overlap

## About labeling

Labeling is the process of placing a descriptive text string next to one or more features on your map. Labels help a map reader interpret a map. How you label your maps depends on the type of data you're displaying, what features you want to label, and how you'll ultimately use the map.

### What do you want to label?

Maps can display large amounts of geographic data in layers that generally overlap. The way you display your data—for example, what classification method and symbols you use—can help to describe and identify map features. Thus, you probably won't want to label every feature on your map. You will, however, need to decide what features do need labels.

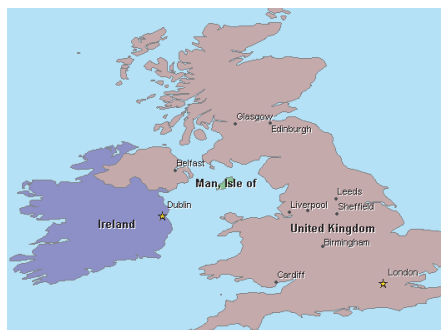
If you only want to label a few features, you can simply type in a text label and place it next to the feature it identifies. If you don't know exactly what the feature is beforehand, you can derive its label from an attribute of the feature. If instead you want to label all the features in a layer or several layers, you won't want to manually place a label for each feature. Instead, ArcMap can dynamically generate and place the labels for you.

### Dynamically displaying labels

To display labels for a layer, you simply specify what attribute of the features you want to label—for example, a street name or soil type—and then turn labeling on. ArcMap dynamically places labels on or near the features they describe. You can also control the font, size, and color of the text to help differentiate labels for different types of features. The following map of Europe shows the various countries and major cities, both labeled with a different text symbol.



You may have noticed that not every city on the map above has a label. ArcMap attempts to place as many labels on the map as possible without overlapping them. Thus, in areas where features are tightly clustered together, some features may not be labeled. As you zoom in to an area, more labels dynamically appear.



*As you zoom in to the United Kingdom, more city labels appear.*

## Controlling what features are labeled

As you pan and zoom around your map, ArcMap dynamically adjusts the labels to fit the available space. At smaller scales, you see fewer labels because ArcMap has less space to place them. Because fewer features can be labeled, you might want to prioritize the labeling of some features. For instance, on the map of Europe, you might want to label a country with its name instead of labeling a city if ArcMap can't fit both labels.

For each layer you want to label, you can set its labeling priority. This means that a feature in a layer with a higher priority will be labeled over a feature in another layer with a lower priority. Similarly, within a single layer you can set labeling priorities on specific groups of features—for example, you might set a high labeling priority on cities with larger populations and a low priority on cities with smaller populations.

Still, there's no guarantee that you'll get exactly the labels you want positioned exactly where you want them. Thus, dynamic labeling is best suited to maps where you don't need precise control over what is labeled and where the label is placed. When you do want precise control over labels, you must manage the labeling process more closely.

## Getting the labels you want, where you want them

When you need more precise control over label placement, you can convert the dynamic labels to *annotation*. Converting labels to annotation allows you to manually control the labeling of features. The conversion process creates text graphics from the dynamic labels and displays them on your map. Then you can work with each label, or text graphic, independently—move it, change its size or font, and change the text. For example, you might want to move a few labels to make room for one that ArcMap was unable to place due to space constraints. ArcMap

also provides you with a list of all the labels that weren't placed and lets you interactively place them on your map as needed.

While annotation is typically text, it can also be any graphic element that annotates your map—such as lines, circles, and polygons.

## Deciding where to store annotation

Suppose you've decided to convert your labels to annotation because you want direct control over what features are labeled and where. When you convert the labels to annotation, you can store them with the map as an *annotation group*, or you can store them separately in a geodatabase as an *annotation feature class* and reference it like other data on your map.

Storing annotation in a geodatabase is similar to storing geographic features—line, point, and polygon—in a geodatabase. You can add annotation stored in a geodatabase to any map. It appears as an *annotation layer* in the table of contents.

Where should you store your converted labels? The answer to this question depends on how you plan to use the labels. Here are some guidelines:

- If you're creating a map specifically for printing and the labels you've created apply only to this map, store the labels as an annotation group in the map document. Then, if you delete the map, the annotation is also deleted because it's stored with the map.
- If you want to use the labels you've just placed on other maps—because you've invested the time and effort to position them—store them as an annotation feature class in a geodatabase. You can add the annotation as a layer to other maps.



- If you intend to use the map to browse your data online and that map has numerous labels—as a general rule, more than 100—store them as an annotation feature class in a geodatabase for increased drawing performance. ArcMap can access and display labels stored in an annotation feature class much more rapidly than labels stored as an annotation group in the map document.

You can also link annotation in a geodatabase directly to the feature it annotates, creating *feature-linked annotation*. Then, if you move the feature, the annotation (label) moves with it; if you delete the feature, the annotation is also deleted; and if you change the attribute of the feature that the annotation is based on, the text of the annotation changes.

You create feature-linked annotation for a specific layer—rather than the entire map—and store it in the geodatabase along with the geographic data (feature class) it's associated with. You'll typically create feature-linked annotation while editing your geographic data with the Editor. However, you can convert your dynamic labels into feature-linked annotation.

For more information on working with feature-linked annotation, see *Building a Geodatabase*.

# Displaying labels

You can label features on your map in several ways. You can add static text, as described earlier in this chapter, and simply place it next to the feature you want to annotate. This assumes that you know what the feature you want to label is. If you don't, you can use the interactive labeling tool and label the feature by pointing at it. These methods work well when you only want to label a few features.

When you want to label all the features in a layer, or in several layers, turn dynamic labeling on in ArcMap. With dynamic labeling, ArcMap automatically places a label next to each feature as long as there's space to display it without overlapping other labels. The number of labels you see increases as you zoom in.

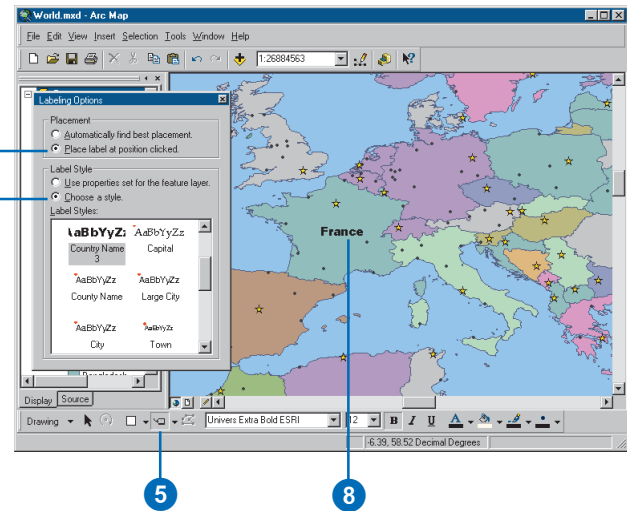
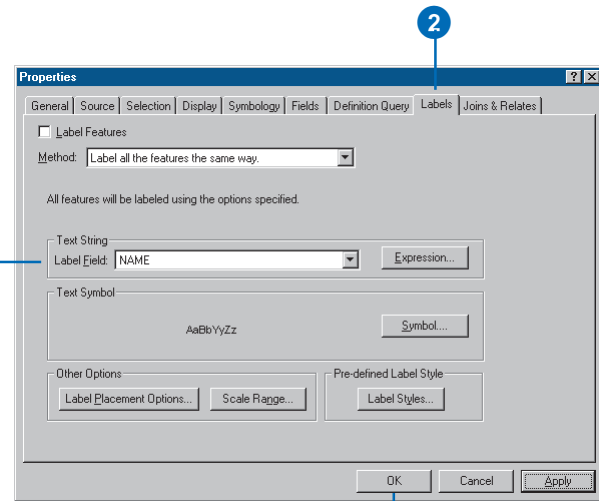
You can also display labels for a particular subset of features in a single layer. For example, in a layer of cities, you might only want to label those with a population greater than 100,000. You can create different subsets of features by querying the attribute values of the layer. You can label features in each subset with a different text font, size, and color.

## Labeling a feature by pointing at it

1. In the table of contents, right-click the layer you want to label and click Properties.
2. Click the Labels tab.
3. Click the Label Field dropdown arrow and click the field you want to use as a label.
4. Click OK.
5. On the Draw toolbar, click the Label button.
6. Click Place label at position clicked.

If you click Automatically find best placement, ArcMap finds the best location for the label.

7. Click Choose a style and click the label style you want.
  8. Click the mouse pointer over the feature you want to label.
- ArcMap labels the feature.



## Tip

### Automatically removing duplicate labels

*ArcMap automatically removes duplicate labels. You might want to disable this behavior when labeling features such as soil types or land use categories where several features can have the same attribute value. Click **Label Placement Options** on the **Labels** tab of the **Layer Properties** dialog and click **Remove Duplicate Labels**.*

## Tip

### Making the labels get bigger when you zoom in

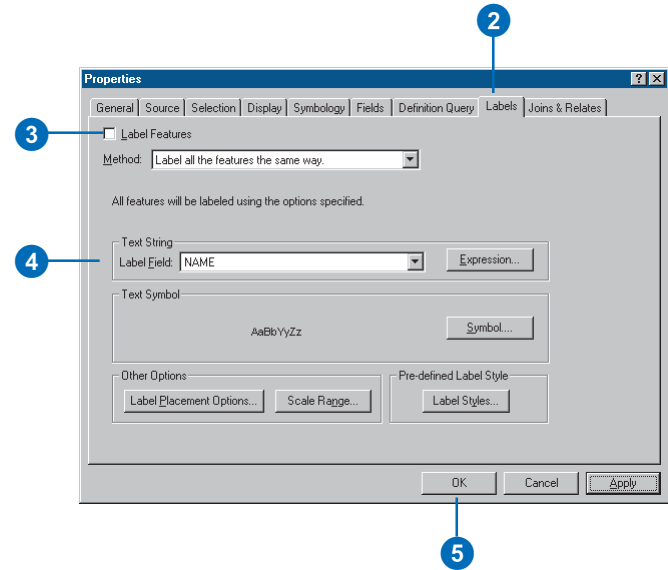
*As you zoom in and out on your map, the size of the labels does not change. If you want the text to scale with the map, set a reference scale. Right-click the data frame and click **Set Reference Scale**.*

## See Also

*If you need precise control over what features are labeled and where the labels are positioned, see 'Printing a map with labels' in this chapter.*

## Labeling all features in a layer dynamically

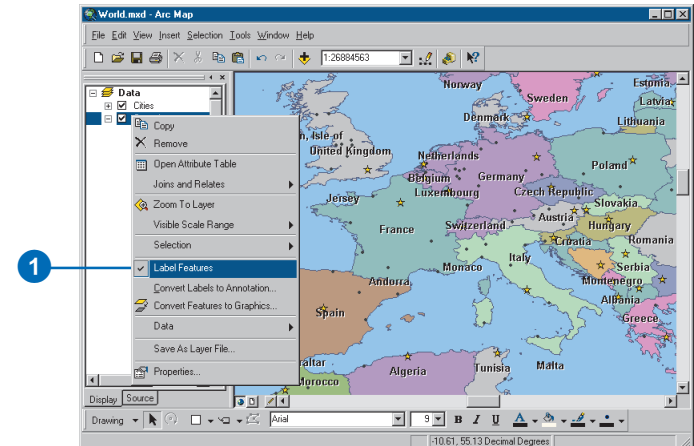
1. In the table of contents, right-click the layer you want to label and click **Properties**.
2. Click the **Labels** tab.
3. Check **Label Features**.
4. Click the **Label Field** dropdown arrow and click the field you want to use as a label.
5. Click **OK**.



## Turning dynamic labels on and off

1. In the table of contents, right-click the layer and check **Label Features** to turn dynamic labels on.

Uncheck **Label Features** to turn them off.



## Tip

### Using different text symbols to label features in a single layer

You can use a different text symbol to label features in each subset you create. For example, in a cities layer, you might want to label cities with a large population in a different font than those with a smaller population.

## Tip

### Displaying coverage annotation

If you have a coverage with annotation, you can display the annotation as a layer in the table of contents. Add the layer as you would any feature layer.

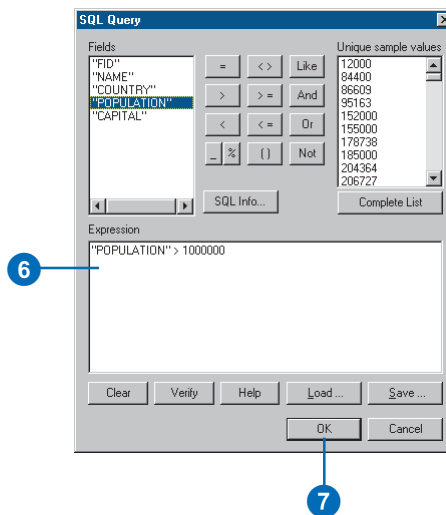
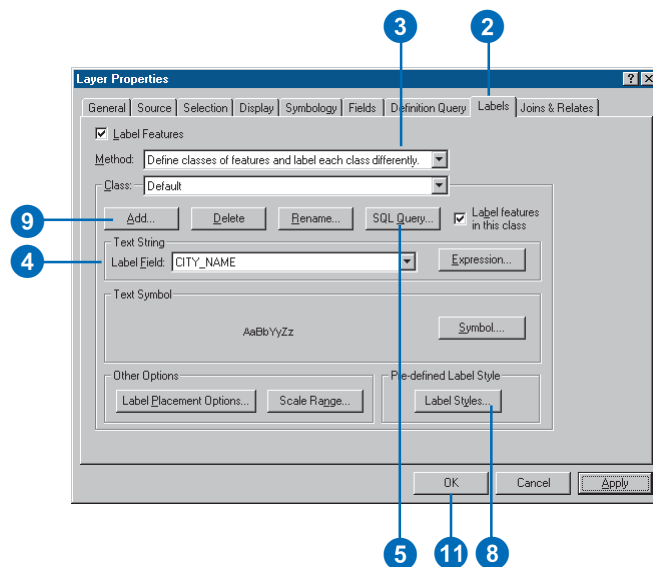
## Labeling a subset of features in a layer

1. In the table of contents, right-click the layer you want to label and click Properties.
2. Click the Labels tab.
3. Click the Method dropdown arrow and click Define classes of features and label each class differently.
4. Click the Label Field dropdown arrow and click the field to use as a label.
5. Click SQL Query.

6. Click on the operators to build an expression that identifies the subset of features you want to label.

In this example, cities with a population greater than 1,000,000 will be labeled.

7. Click OK.
8. Click Label Styles and choose the style—for example, font and size—of the label you want.
9. If you want to create additional subsets of features, click Add and type a new class name.
10. Repeat steps 5 through 8 to identify the subset of additional features you want to label.
11. Click OK.



## Specifying the text of labels

For each layer on your map that you want to label, you can choose one or more attribute fields to derive the text from. For example, you might label features with their name, a code value, or both.

You can also control how the text appears on the map. If you're labeling features with two attribute values, you might display them side by side or stacked with one on top.

For more advanced labeling needs, you can programmatically generate a text label by writing a script in VBScript or JavaScript™. Your script can include any valid statements those programming languages support.

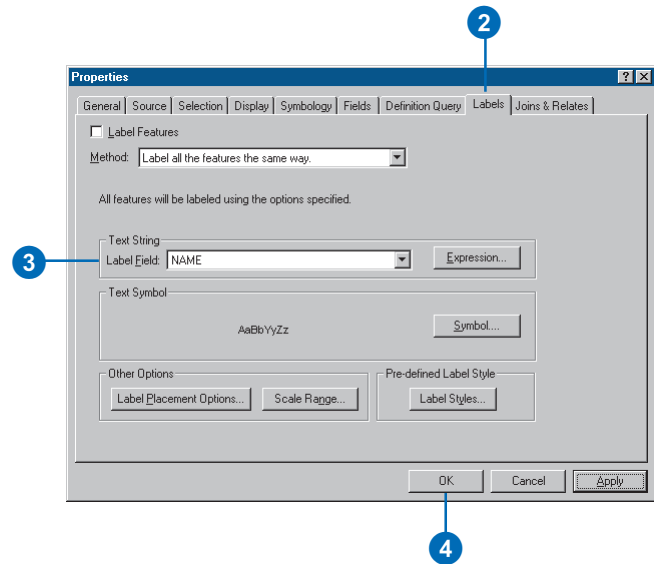
### Tip

#### Changing the case of the label

To convert your text labels to all uppercase or lowercase, use the VBScript functions, *UCase* and *LCase*, as part of your expression. For example, enter the expression as *LCase ([Name])*.

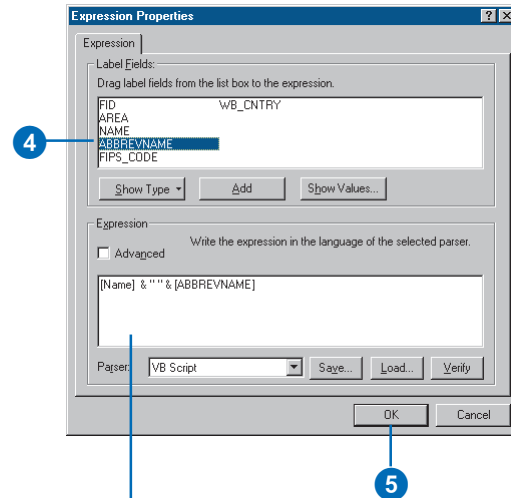
## Setting an attribute field for label text

1. In the table of contents, right-click the layer you want to label and click Properties.
2. Click the Labels tab.
3. Click the Label Field dropdown arrow and click the field you want to use as a label.
4. Click OK.



## Using more than one attribute field for label text

1. In the table of contents, right-click the layer you want to label and click Properties.
  2. Click the Labels tab.
  3. Click Expression.
  4. Double-click the Label Fields you want to use as the text of the label.
  5. Click OK.
- You can include other VBScript or JavaScript commands in the expression to modify the text string.



To create stacked text, use the VBScript constant, `vbNewLine`, between the field names—`[Name] & vbNewLine & [Abbrevname]`.

## Tip

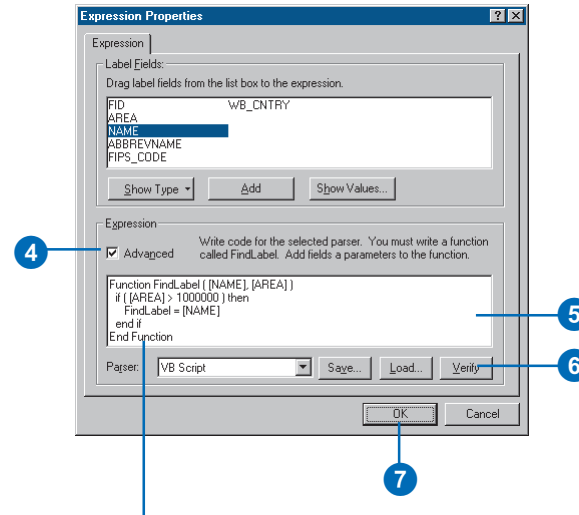
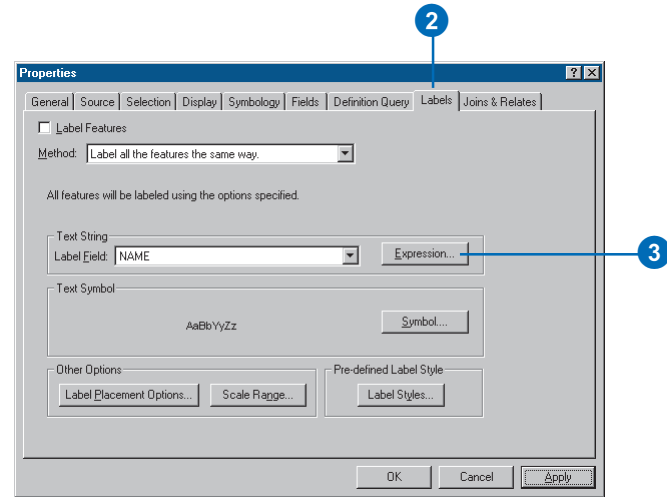
### Rounding numeric values

To round numeric values, use the VBScript Round function in your expression. For example, Round ([Area],2) displays labels rounded to two decimal places.

## Generating label text with a script

1. In the table of contents, right-click the layer you want to label and click Properties.
2. Click the Labels tab.
3. Click Expression.
4. Check Advanced.
5. Type a VBScript or JavaScript expression.
6. Click Verify to make sure there are no syntax errors.
7. Click OK.

ArcMap automatically creates a function called FindLabel. In your code, FindLabel should evaluate to a string.



This VBScript labels features only if the area is > 100000.

## Prioritizing and positioning labels

ArcMap fits as many labels as possible—without overlapping them—within the available space. Thus, as you pan and zoom around a map, the labels dynamically adjust to fit the space.

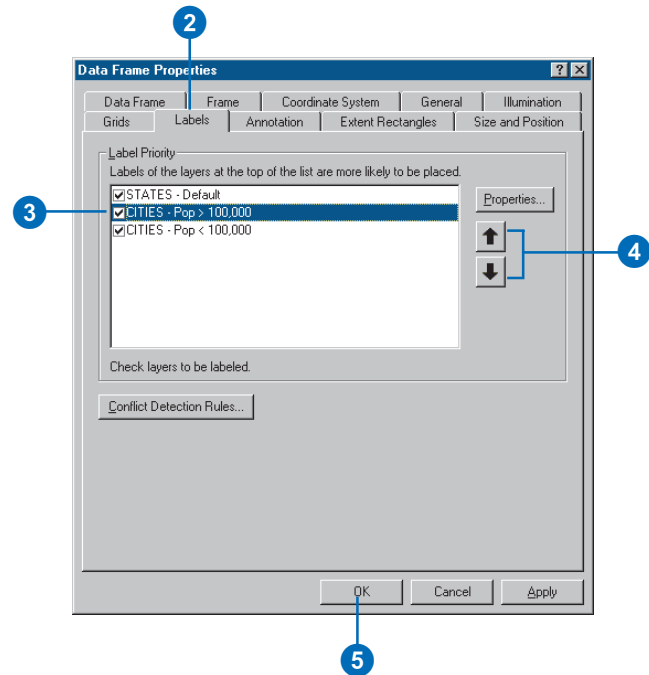
When viewing your data at a small scale, you generally see fewer labels than at a larger scale. To increase the chance that particular features or types of features are labeled, you can assign those features a higher labeling priority. For example, you'd probably assign a higher labeling priority to highways and a lower priority to residential streets. You control labeling priority by specifying the order in which ArcMap should label layers.

ArcMap also lets you control how to position a label relative to its features—for example, above it, below it, or on top of it. Label positioning is also dependent on whether you allow labels to overlap other labels or features on the map. When you allow labels to overlap, you can generally see more labels because ArcMap has a bit more room in which to place them.

### Setting a layer's labeling priority

1. Right-click the data frame containing the layers you're labeling and click Properties.
2. Click the Labels tab.
3. Click the layer that you want to change the labeling priority of.
4. Click the Arrow buttons to move the layer up to give it a higher priority or down for a lower priority.
5. Click OK.

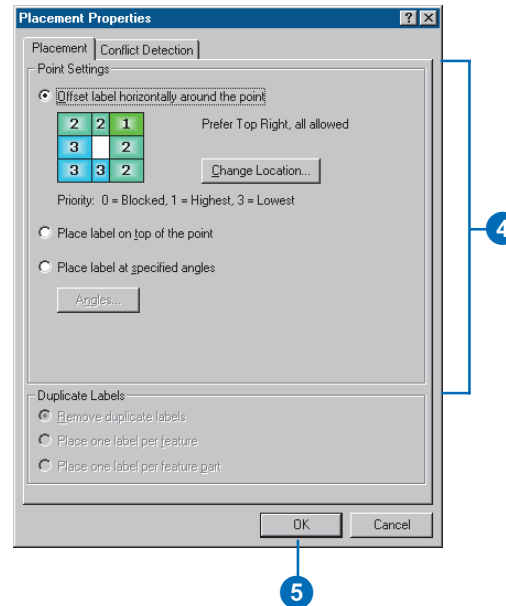
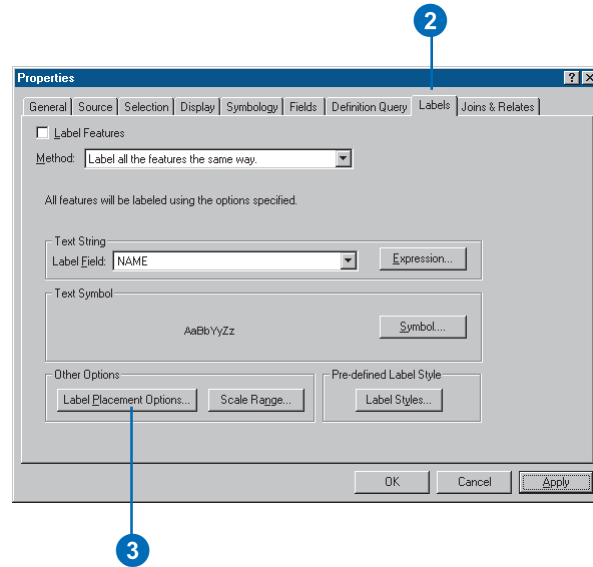
The layer at the top of the list will be labeled first, followed by the next layer in the list, and so on.



## Positioning labels

1. In the table of contents, right-click the layer you want to label and click Properties.
2. Click the Labels tab.
3. Click Label Placement Options.
4. Click the placement option you want.  

The options presented will vary depending on the type of feature you're labeling.
5. Click OK.





## Tip

### Preventing labels from overlapping features

Setting a feature weight to high will prevent ArcMap from placing a label over the feature. Because ArcMap will evaluate every feature before determining a label position, using feature weights can dramatically slow labeling speed.

## Tip

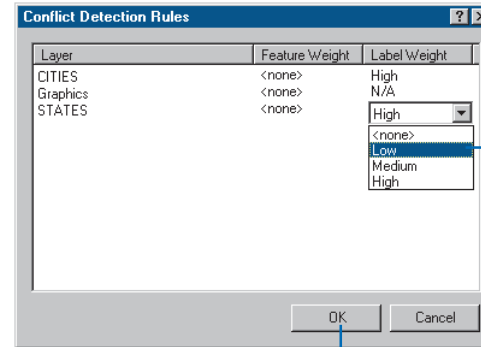
### Avoiding overlapping labels with annotation layers

If you've added an annotation layer to your map, set the Feature Weight for the layer to High. This will prevent dynamic labels from overlapping the annotation stored in the layer.

## Allowing label overlap

1. Right-click the data frame containing the layers you're labeling and click Properties.
2. Click the Labels tab.
3. Click Conflict Detection Rules.
4. Set the weights for the labels and features.
5. Click OK.

A feature or label with a lower weight can be overlapped by one with a higher weight.



Cities Label Weight = High  
Cities Feature Weight = None  
States Label Weight = High  
States Feature Weight = None

High label weights mean the labels will not overlap. No weights for features mean labels can overlap features. Notice that no city label overlaps a state label and that the city labels do overlap the city features.



Cities Label Weight = High  
Cities Feature Weight = High  
States Label Weight = Low  
States Feature Weight = None

State labels can be overlapped by other labels because of low weight. A high weight for City features prevents labels from overlapping the feature—compare the label placement around the cluster of cities above with the figure on the left. Including feature weights can dramatically slow labeling speed.

## Printing a map with labels

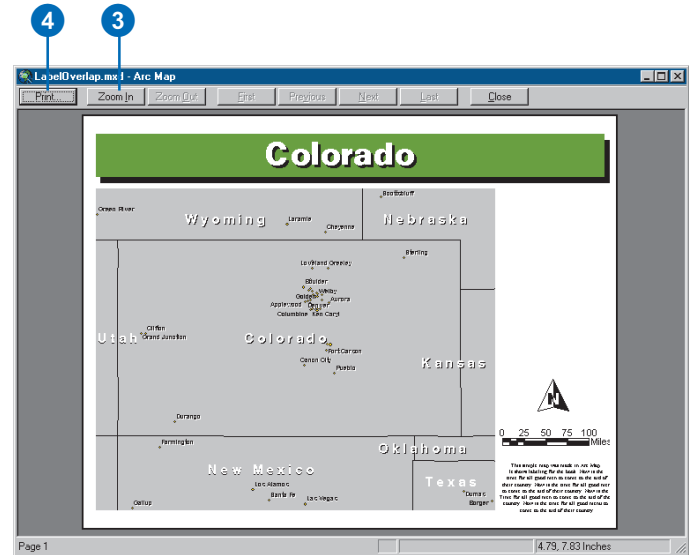
With dynamic labeling, ArcMap constantly adjusts labels to show the most labels within the space available. As you pan and zoom your map, you see more or fewer labels, depending on the current scale. This behavior extends to printing maps as well. ArcMap repositions labels during printing to fit the most labels in the available space. As you work with your layout, there's no guarantee that the labels you see online will be exactly the same as what you see on the printed map.

For some maps, you don't need precise control over labeling. You can use Print Preview to see what the printout will look like. If the labeling is acceptable, go ahead and print your map. If not, you'll probably want to take control of labeling.

When you want precise control over what labels appear and where they're positioned, you need to take control of the labeling process. Use dynamic labeling as a starting point to generate labels and then convert the dynamic labels to annotation. You can then move the text labels around and position them exactly where you want them. You'll find those labels that ►

## Using Print Preview to evaluate labels

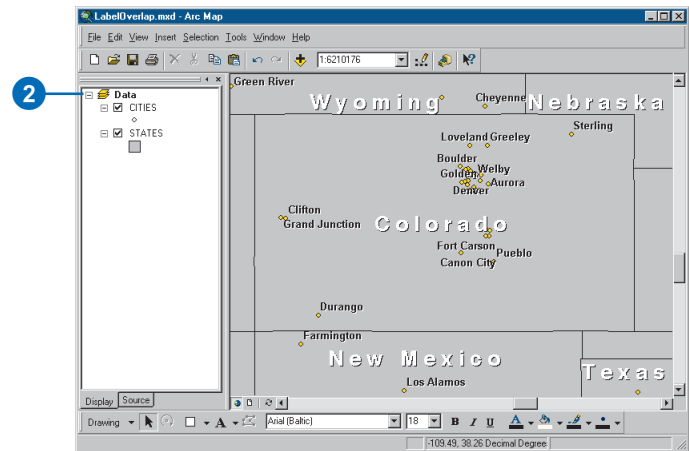
1. Turn on dynamic labeling and set the labeling properties as described on the previous pages.
2. Click the File menu and click Print Preview.
3. Click Zoom In and evaluate the labels.
4. If the labeling looks acceptable, click Print to send the map to the printer. If not, you should control the labeling process yourself as described below.



## Controlling the labeling process for a map

1. Zoom in to a sample area on your map to generate dynamic labels.  
  
The area should be a good representation of the general density of features you want to label.
2. In the table of contents right-click the data frame containing the layers you want to label and click Properties.
3. Click the Labels tab.

You'll see the list of layers in the data frame. ►



AreMap couldn't place on the map listed in the Overflow Labels window. From this window, you can choose individual labels and place them on your map. Once you've placed and positioned all the labels you need, you can print your map. The labels you see online will be exactly the same as the labels you get on the printed version.

It takes time and effort to place and position labels exactly where you want them. If you'd like to reuse some of your labeling work on other maps, save the labels in an annotation feature class in a geodatabase instead of as simple text graphics stored in the map. You can then load the annotation into another map. For example, suppose you labeled cities and states with their names and stored the labels as an annotation feature class in a geodatabase. You can then load the data and the labels for display on another map.

4. Check the layers you want to label.
5. Click Properties to set labeling properties for each layer as described earlier in this chapter.

6. Once you have your labels looking close to how you ultimately want them, convert them to annotation. Right-click the data frame and click Convert Labels to Annotation.

7. Click Create annotation for All features in the layer.

If you don't want to label all features in the layer, choose one of the other options.

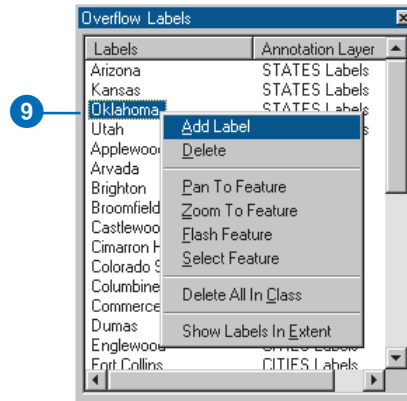
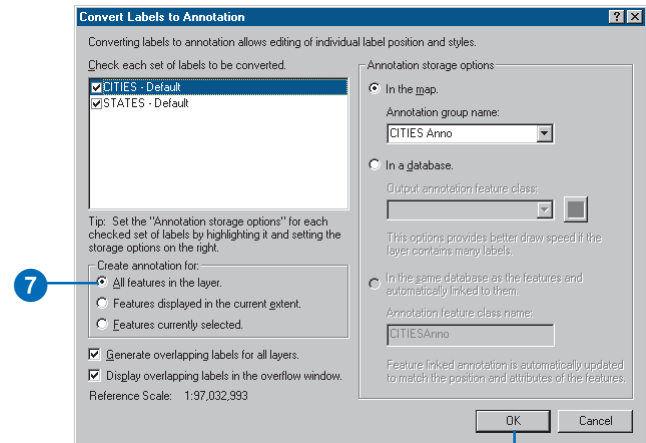
8. Click OK.

If any of your labels overlap, the Overflow Labels window appears.

9. In the Overflow Labels window, right-click the label you want to place on your map and click Add Label.

You'll probably need to move a few of the other labels around in order to place a new label on the map.

10. Repeat step 9 until you've placed all the labels you want on your map.
11. Print your map. The labels will be exactly where you've positioned them.



# Feature-linked annotation

*Feature-linked annotation* describes a special type of label that is directly linked to the feature it annotates. For example, if you move the feature, the label moves with it; if you delete the feature, the label is also deleted; if you update the attribute the label is based on, the text of the label changes.

Feature-linked annotation is stored as an annotation feature class in a geodatabase along with the geographic data it's associated with. You can create an annotation feature class in ArcCatalog and establish the link to a feature class in the geodatabase. As you edit the features in your geodatabase with the Editor, you can also annotate them one at a time. Alternatively, you can quickly create annotation for all features by converting dynamic labels to feature-linked annotation.

## See Also

*For more information on creating and working with feature-linked annotation, see Building a Geodatabase.*

## Converting labels to feature-linked annotation

1. In the table of contents, right-click the layers you want to label and click Label Features.
2. Right-click the data frame containing the labeled layers and click Convert Labels to Annotation.
3. Check the layers that you want to save labels as annotation for.

4. Click Create annotation for All features in the layer.

If you don't want to label all features in the layer, choose one of the other options.

5. Click Save annotation for the selected layer In the same database as the features and automatically linked to them.

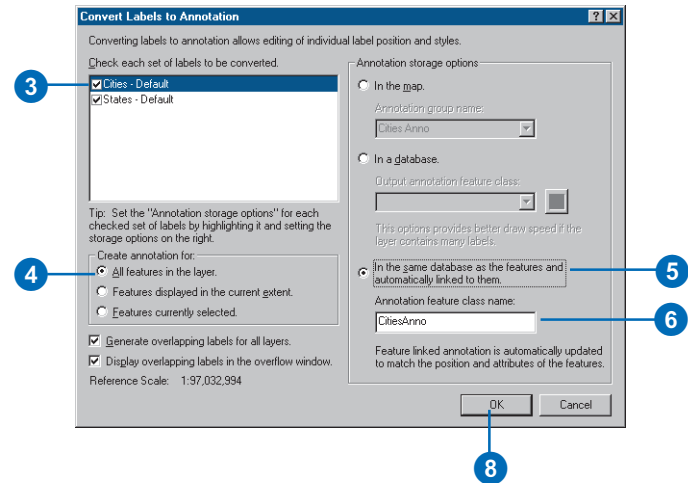
This option is only available if the layer on your map references data stored in a geodatabase.

6. Type a name for the annotation.

This creates a layer in a geodatabase. Spaces are not allowed in the name.

7. For each layer you checked in step 3, click the layer and repeat steps 4 through 6.

8. Click OK.



## Tip

### Creating an annotation feature class

You can create an annotation feature class in ArcCatalog or by converting labels to feature-linked annotation as described on the previous page.

## Tip

### Why is my annotation target unavailable?

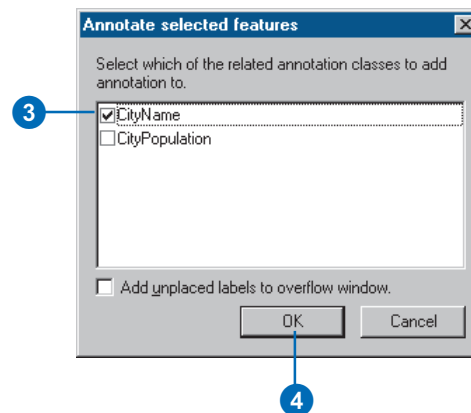
In order to add annotation to a target stored in a geodatabase, you must first start an edit session. Otherwise, the annotation target will be grayed out in the list of available targets.

## Annotating selected features

1. Select the features in the layer you want to create feature-linked annotation for.
2. Right-click the layer, point to Selection, and click Annotate selected features.

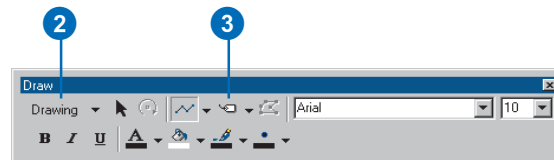
You must already have feature-linked annotation for the layer; otherwise, the option will be unavailable.

3. If you have more than one annotation feature class displayed for the layer, check the ones you want to add annotation to.
4. Click OK.



## Annotating an individual feature

1. If you haven't done so already, add an annotation feature class to your map that's linked to the layer you want to create feature-linked annotation for.
2. On the Draw toolbar, click Drawing, point to Active Annotation Target, and click the name of the annotation feature class.
3. Click the Label button.
4. Point to the feature you want to label.



## Map tips and hyperlinks

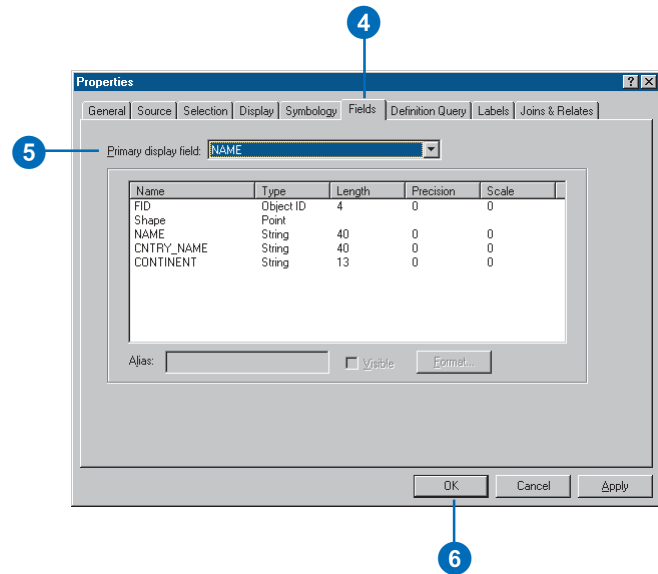
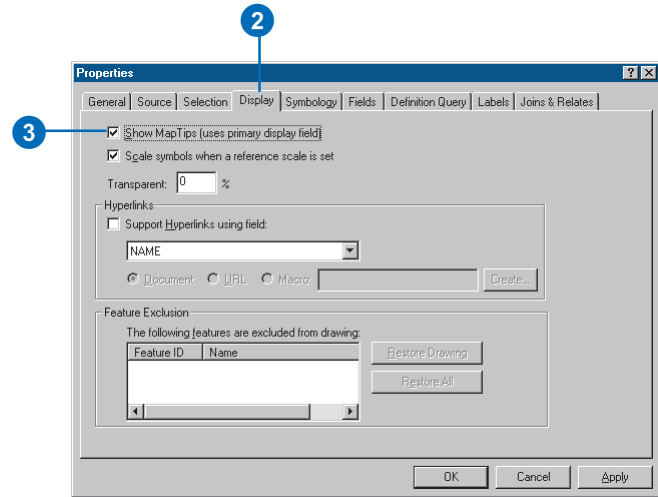
Map tips and hyperlinks provide additional ways to present more information about map features.

Like Tool Tips for toolbar buttons, map tips pop up as you pause the mouse pointer over a feature. ArcMap lets you choose which attribute field you want to display as your map tip.

Through hyperlinks, you can display documents—such as a text file or image—or Web pages accessed over the Internet. You can dynamically create hyperlinks as you browse your map, or alternatively, you can store hyperlinks with your data in an attribute field.

### Displaying map tips

1. In the table of contents, right-click the layer that you want to display map tips for and click Properties.
2. Click the Display tab.
3. Check Show Map Tips.
4. Click the Fields tab.
5. Click the Primary display field dropdown arrow and click the attribute field you want to display as the map tip.
6. Click OK.
7. Move the mouse pointer over a feature in the layer and pause to see the map tip.



## Tip

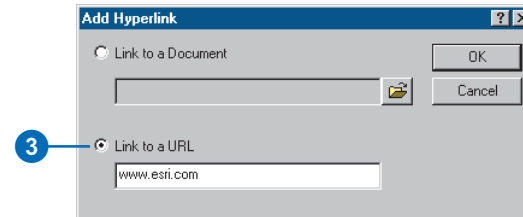
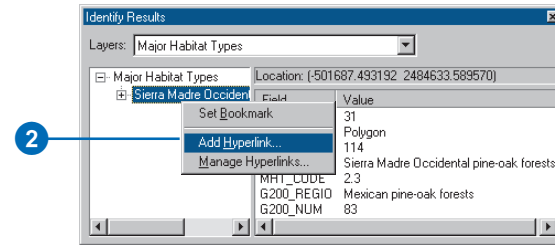
### Displaying hyperlinked documents

If you specify a Web address as a hyperlink, ArcMap launches your default Web browser and displays the Web page. If you specify a document as a hyperlink, ArcMap opens that document in its native program.

## Creating a hyperlink

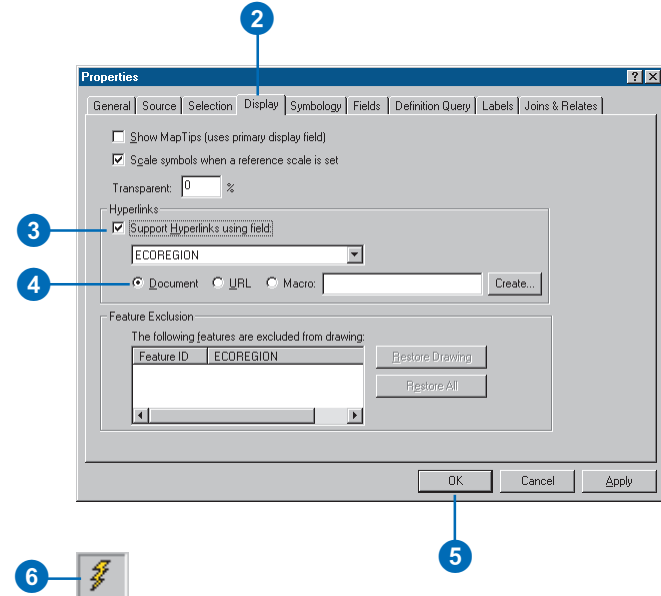
1. On the Tools toolbar, click the Identify button and click on a feature.
2. In the Identify Results dialog, right-click the feature you want to set a hyperlink for and click Add Hyperlink.
3. To add a hyperlink to a Web page, click Link to a URL and type a URL.

To link to a document instead, click Link to a Document and type a pathname to the document on your system.



## Using an attribute field as a hyperlink

1. In the table of contents, right-click the layer containing a field with hyperlinks and click Properties.
2. Click the Display tab.
3. Check Support Hyperlinks using field. Click the dropdown arrow and click a field.
4. Click Document or URL.
5. Click OK.
6. On the Tools toolbar, click the Hyperlink button.
7. Move the mouse pointer over a feature and click to display the hyperlink.







# Laying out and printing maps

# 8

## IN THIS CHAPTER

- About map templates
- Starting a map from a template
- Saving a map as a template
- Setting up the page
- Customizing data frames
- Using rulers, guides, and grids
- Adding data frames
- Adding map elements related to data frames
- Adding other map elements
- Aligning and grouping map elements
- Printing a map
- Changing the layout
- Exporting a map

Before you begin to symbolize data for a map, you'll need to think about how you want the map to look when it's printed or published.

You should consider questions such as:

- Will the map stand alone, or will it be part of a series of maps that share a similar design?
- What size will the printed version of the map be?
- How will the page be oriented?
- How many data frames will the map have?
- Will the map have other map elements such as a title, a North arrow, and a legend?
- Will the map contain graphs or reports to complement the geographic view of the data?
- How will scale be indicated on the map?
- How will the map elements be organized on the page?

If the map is part of a series, you may have a template to work from, or you may create a new template for the series. Map templates make it easy to produce maps that conform to a standard, and they save time by letting you do the layout work for all of the maps in the series at once.

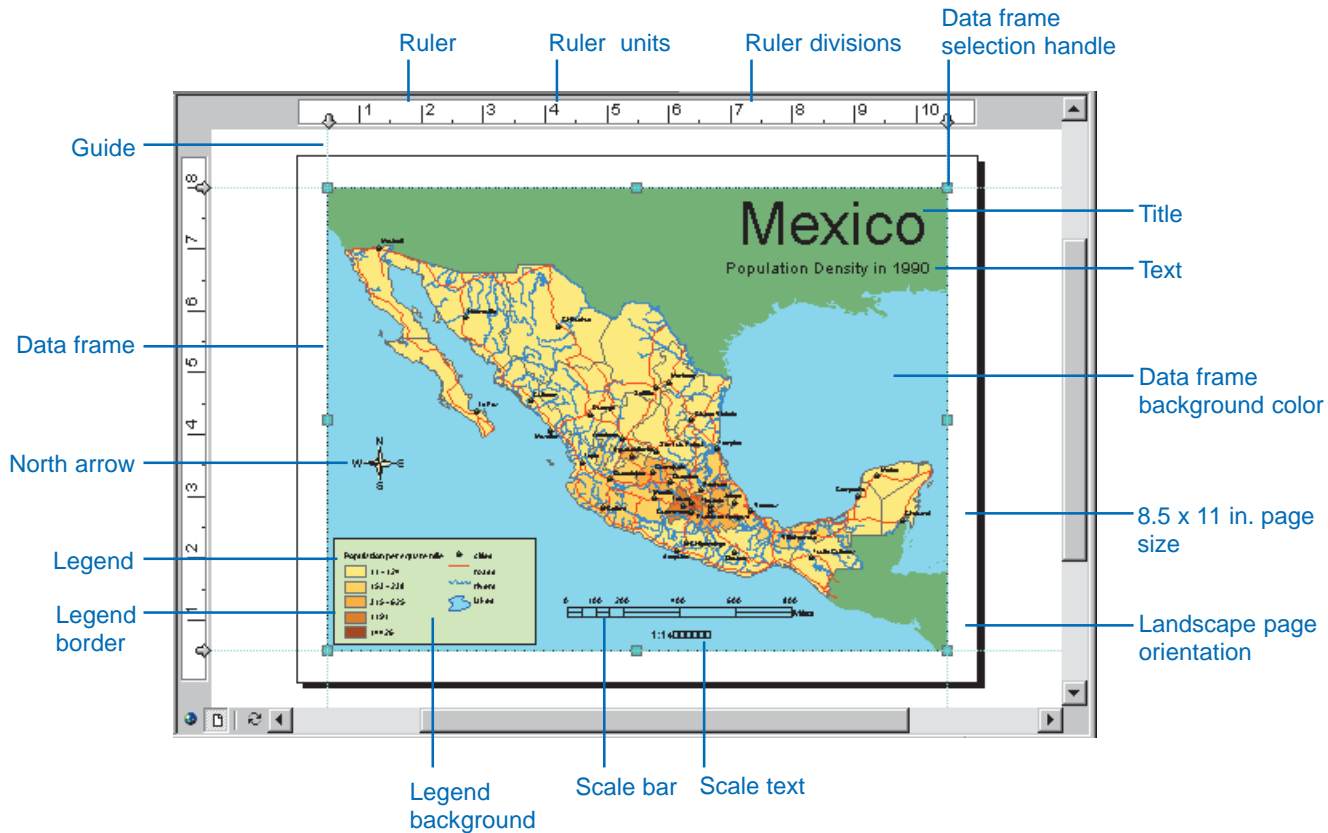
You can also use the map templates that come with ArcMap to quickly make a variety of styles of maps. You can use these templates to get ideas for your own maps, and you can modify them to suit your needs.

The Mexico and New Hampshire maps on this page and the next illustrate two different map layouts and show some of the ways you can use map elements to create a map.

Perhaps the most important part of a map is the geographic data. Geographic data is presented in the layout in a data frame. Simple maps usually have a single data frame, but maps can have multiple data frames.

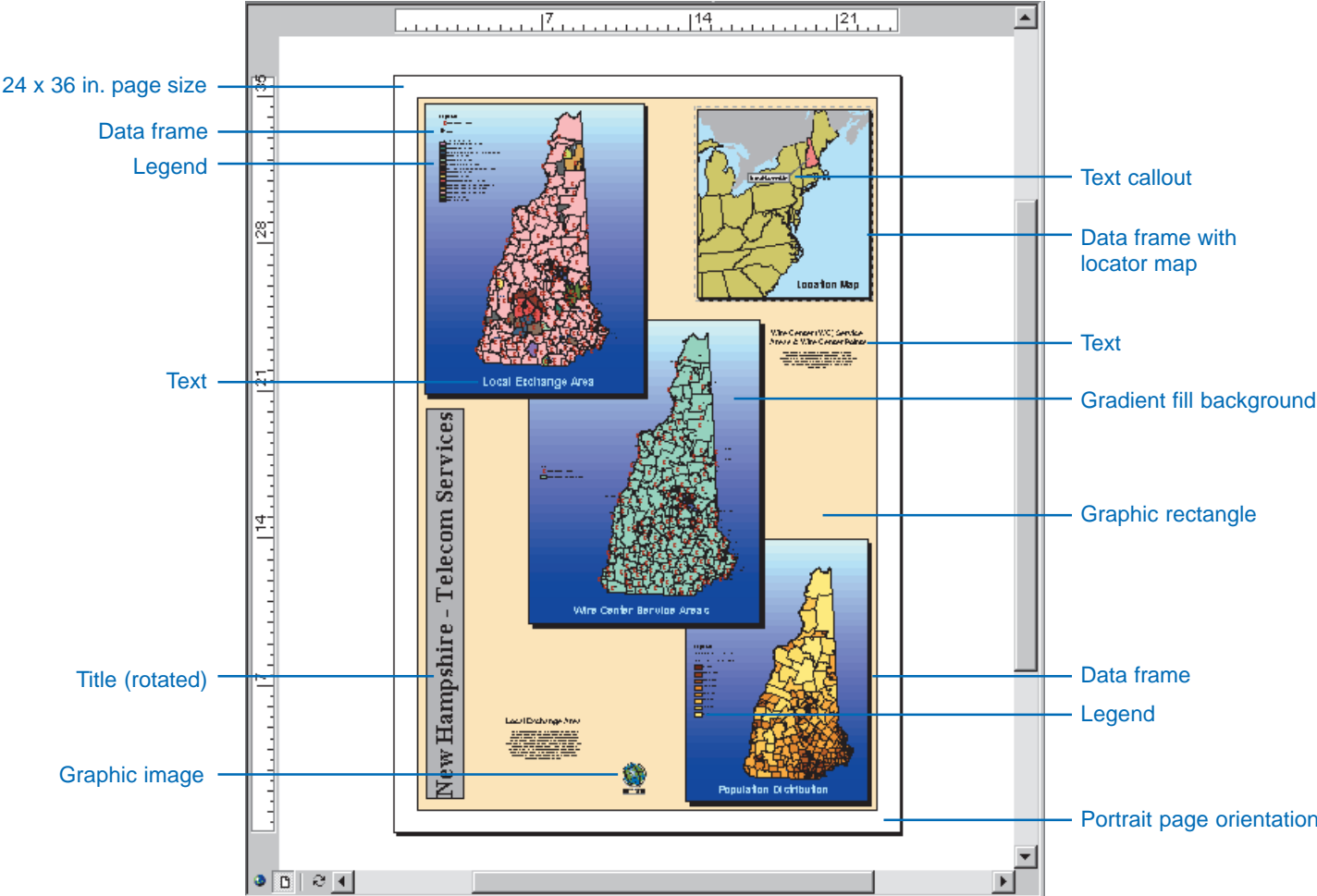
The shape and orientation of the geographic features you're depicting may influence the size and shape of the data frame on the map, as well as the orientation of the map on the page.

Aesthetic criteria, limitations of the media that you use to reproduce the map, and the number and size of other elements that you add to the map will bear upon your choice of page size and orientation.



In addition to a data frame, most maps contain one or more other map elements. These include titles, North arrows, legends, scale bars, scale text, graphs, reports, text labels, and graphics.

One challenge of cartography is to arrange the elements of the map on the page to create a useful, visually pleasing map. ArcMap includes adjustable rulers, guides, and grids that can help you position elements precisely where you want them.



# About map templates

If you are creating a series of maps and it is important that they have the same look and feel, you can use a map template to standardize the layout. If the series contains the same background data, you can include that data in the template. Using a template can save you time since you don't have to manually reproduce the common parts of the maps.

You can also use the map templates that come with ArcMap to quickly make a map that looks good, with a minimal amount of layout work on your part. Just choose a template that has the look you want, add your data, and make whatever changes you want, and your map is done.

Like maps and layers, templates can be shared within an organization to increase productivity and standardize the maps that the organization produces. You can use a template to store layout, data, and customization of the ArcMap interface that you want to be able to use over and over again.

You can modify existing maps or templates and save them as new templates, or you can create new maps from scratch and save them as templates.

Map templates are ArcMap documents that ArcMap recognizes as templates. When you start a new map using a template, ArcMap reproduces the template on a new map document and keeps the original template document intact. Map templates have the file extension `.mxt` to differentiate them from map documents (`.mxd`).

## Using map templates

If you want to make a map using a template, start a new map, choose the template that you want to use, then start adding layers to the map. Later, if you want to change the layout, you can apply a new template.

## The Normal template

ArcMap uses a special template called the Normal template (`Normal.mxt`) to store information about the default user interface, for example, the state—visible or hidden, docked or free-floating—of each of the ArcMap toolbars. This information is recorded automatically in the Normal template when you change it, so when you start ArcMap (whether you saved the map you were working on or not), the toolbars look the same as they did when you quit.

When you add custom toolbars or tools to ArcMap, you can save the changes to the Normal template or to the current map. If you save changes to the interface in the Normal template, they will be reflected in all the maps that you open. If you save changes to another map or template, they will only appear when you open that map or template.

## Starting a map from a template

Map templates make it easy to reuse the same layout or even the same data on a series of maps. You can use the templates that come with ArcMap to make maps quickly—all you need to do is add data, a title, and any other supporting information that you choose.

When you open a template, you get a new untitled ArcMap document plus any layout or data that's saved in the template.

### Tip

#### Starting a new map using a shortcut

If you click the New Map File button on the Standard toolbar, you can start a new, empty map.



New Map File button

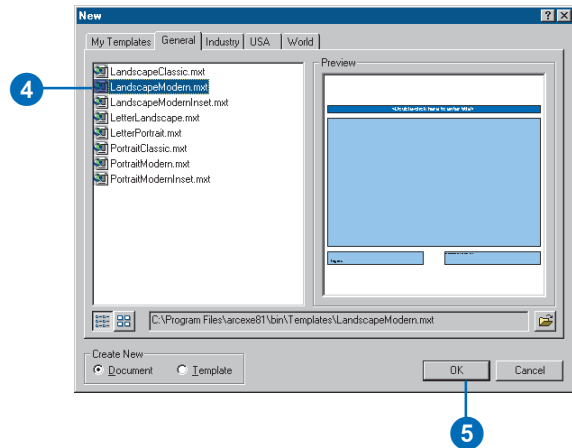
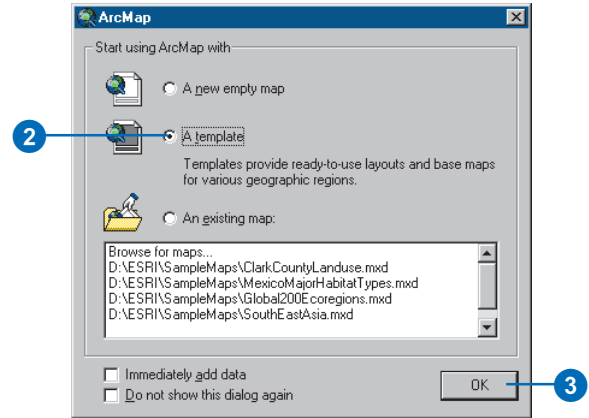
### Tip

#### Storing customization in templates

In addition to layout and data, map templates (like maps) can store customization of the ArcMap user interface such as custom toolbars and tools.

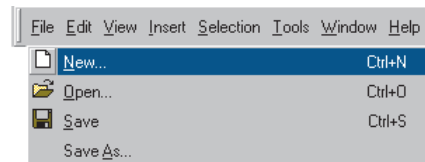
## Opening a template when you first start ArcMap

1. Start ArcMap.
2. Click Start using ArcMap with a template.
3. Click OK.
4. Click a template.
5. Click OK.



## Opening a new template while in ArcMap

1. Click File and click New.
2. Click a template and click OK.



## Saving a map as a template

If you create a map that you'd like to use as a template, or if you modify an existing template and want to use it again, you can save it as a template.

You can save a map template anywhere on your network. When you want to use the template, you can open it from ArcCatalog or ArcMap.

If you save a template in the ArcMap Templates folder (by default in the folder \bin\Templates where you've installed ArcGIS), it will show up in the list of templates on the New map document dialog box. You can also create subfolders in this folder, and they'll show up as separate tabs on this dialog—when you click each tab you'll see the templates in that folder. If you work with many different templates, this is a great way to organize them.

### Tip

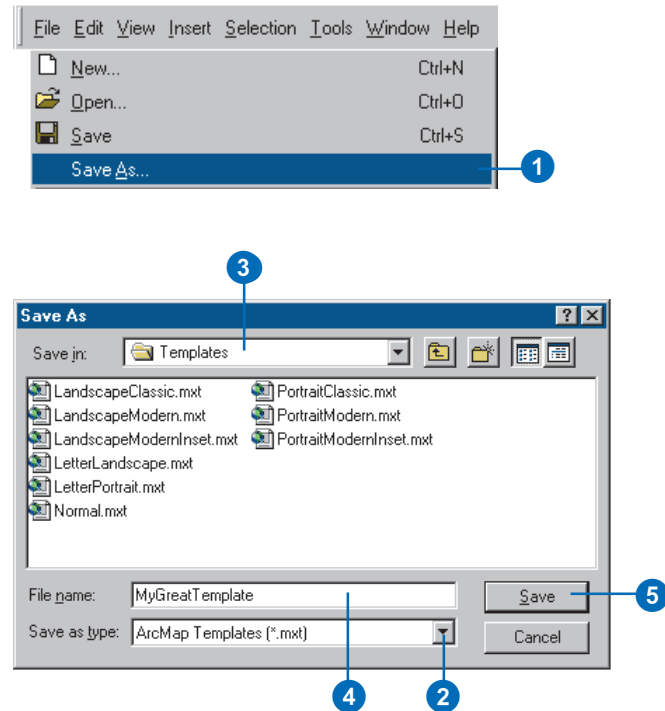
#### Changing a map template

To change an existing template, open the template (.mxd) file and make the necessary edits directly on it.

## Saving a template

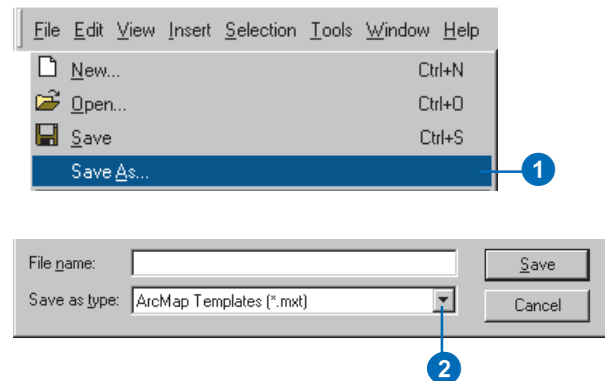
1. Click File and click Save As.
2. Click the Save as type dropdown arrow and click ArcMap Templates.
3. Navigate to the folder where you want the template saved.
4. Type a name for the new template.
5. Click Save.

Note: You can only save a map as a template if your map was built using Normal.mxt as the base template. If it wasn't, click the Edit menu and click Select All Elements while in layout view. Then copy and paste the elements into a new empty map. Then you can save the new map as a template.



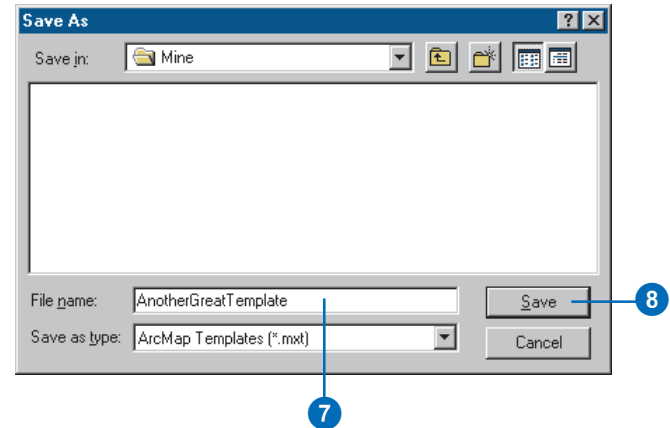
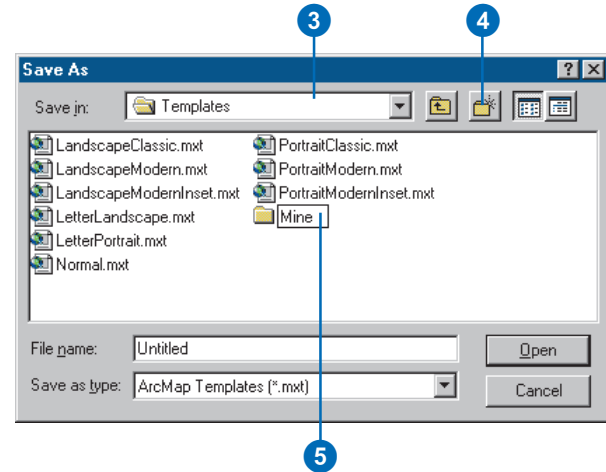
## Saving a template so it will appear in a new tab

1. Click File and click Save As.
2. Click the dropdown arrow and click ArcMap Templates. ▶



3. Navigate to the Templates folder.
4. Click the New Folder button.
5. Type the name of the new folder—this name will appear on the New map document dialog box as a tab.
6. Double-click the new folder.
7. Type the name of the new template.
8. Click Save.

Next time you start a map from a template, you'll see a new tab with your template on the New map document dialog box.



## Setting up the page

When you create a map for printing or publication, you'll work on the virtual page in layout view.

If you intend to print or export a graphic of a map, you should plan the size of the map. Will the map be printed on a small page or a large one? What printer will you use and which print engine will be most efficient for your map content? Will it be viewed close up or at a distance?

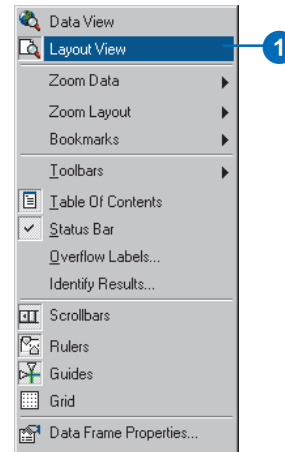
ArcMap makes it easy for you to change the size of the page if needed, but it is wise to have the final product in mind when you begin designing the map.

If the virtual page doesn't match the page size and orientation you've planned for your map, you can change the page setup. By default, the virtual page size is the same as your system printer's default page size, but you can set the page to be one of many standard sizes, or you can define a custom page size for your map.

You can set the page size, page orientation, printer, printer engine, and the visibility of printer margins in the layout from the Page Setup dialog box. ▶

## Switching to layout view

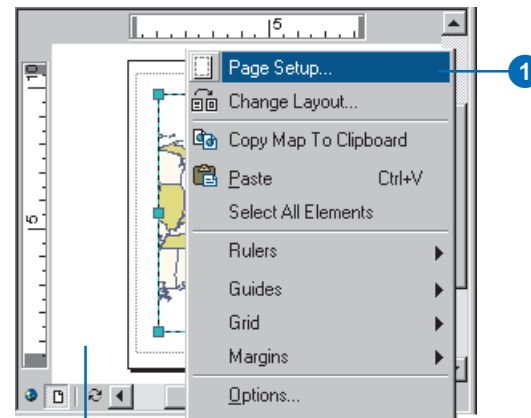
1. Click View and click Layout View.



## Setting up the page size and printer properties

1. Right-click the virtual page and click Page Setup.

You can also open the Page Setup dialog box from the File menu or the Print dialog box. ▶



Right-click outside of selected data frames to get the Page context menu.



The page setup is important because it affects the size of the features, symbols, labels, and other text, as well as other map elements.

## Tip

### Changing the page size later

While it's best to set the page size before you begin creating a map, you can make changes to the page size later if necessary. ArcMap will automatically rescale map elements to fit the new page size. You can turn off the rescaling function by unchecking the box on the Page Setup dialog if you'd prefer to adjust the size and shape of your map elements by hand.

## Tip

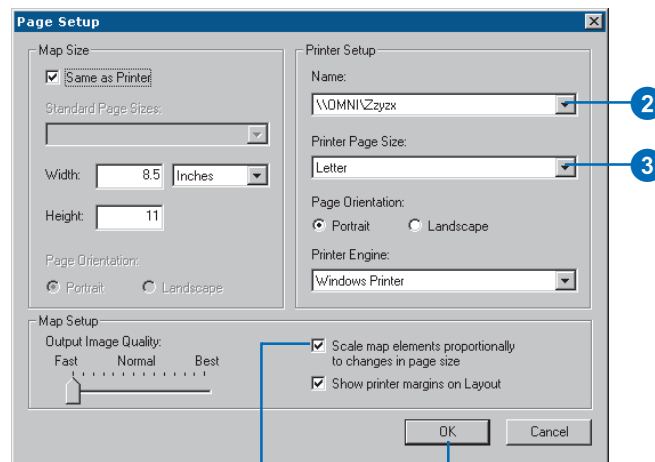
### Why make the map page independent of the printer?

If you give a map document—that's dependent on your printer setup—to someone who doesn't have that printer, they'll get a warning message when they open the map. The map will then rescale to fit their default printer size and page orientation—usually 8.5 x 11 inches and portrait orientation in the United States. The result may differ considerably from the map you designed.

You can prevent this by making the page size independent of the printer. If you do this, you'll need to specify a standard page size.

2. Click the Name dropdown arrow and click the printer you want to use.
3. Click the Printer Page Size dropdown arrow and click the page size that's right for your map.
4. Click OK.

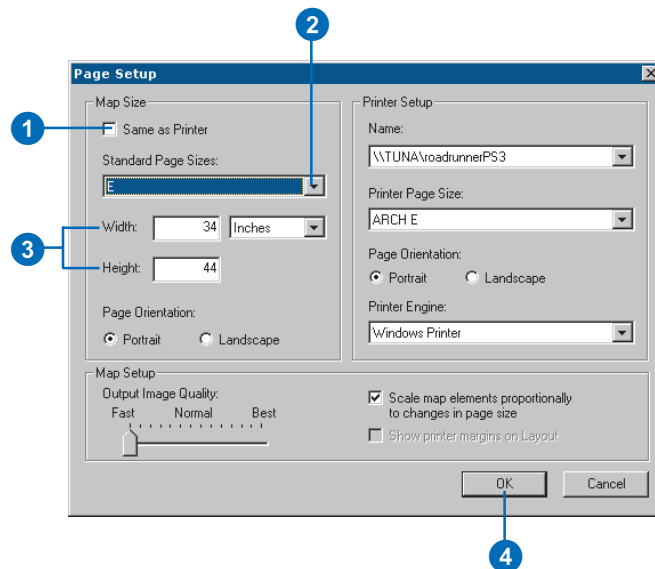
Because the Same as Printer box is checked, the map Width and Height text boxes are updated with the new page size, and the Page Orientation is set accordingly.



Check to automatically rescale map elements when you change the page size.

## Making the map page size independent of the system printer

1. Uncheck Same as Printer on the Page Setup dialog box.
2. Click the Standard Page Sizes dropdown arrow and click the page size that's right for your map.
3. Optionally, to define a custom page size, type the page size for your map in the Width and Height text boxes.
4. Click OK.



## Tip

### Changing the page orientation later

While it's a good idea to set up the page orientation before you begin laying out your map, you can change the page orientation at any time. If auto-rescaling is turned on, your map elements will be adjusted to fit the new orientation.

## Tip

### Why show printer margins?

It's useful to show the printer's built-in margins on the layout so you won't place map elements on a nonprinting part of the page.

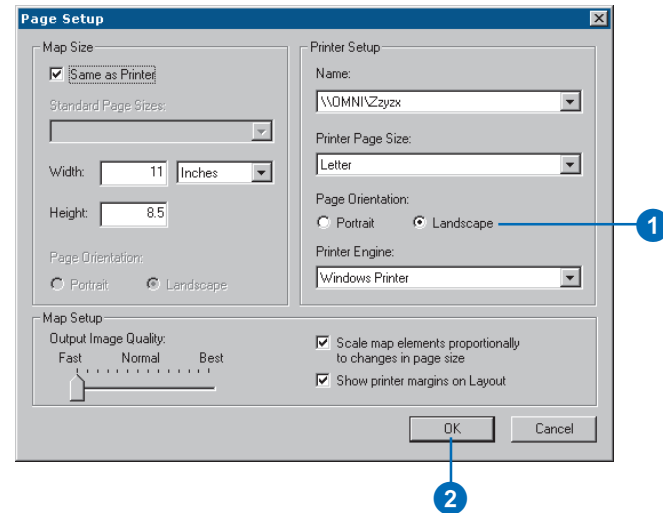
If you're working on a map where the virtual page size is not set to be the same as your printer's page size, you'll be unable to use the printer's margins. However, you can use guides to define the map's margins.

## See Also

For more information on using guides, see 'Using rulers, guides, and grids' in this chapter.

## Setting the page orientation

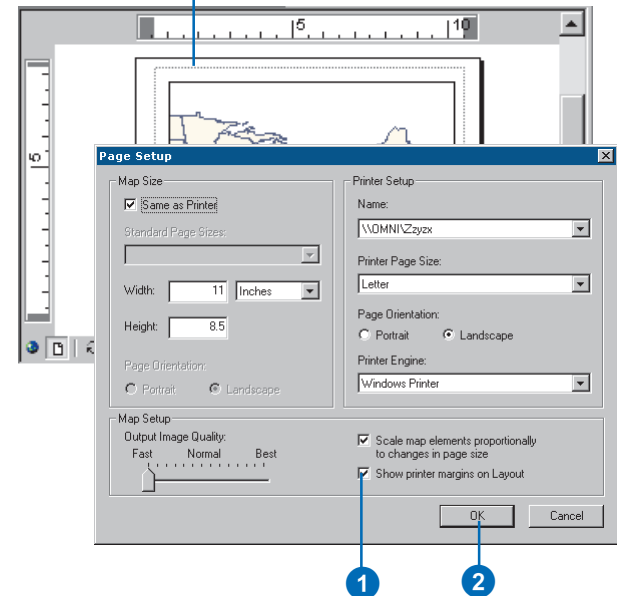
1. Click a page orientation (Landscape or Portrait) to set the page orientation.
2. Click OK.



## Showing or hiding printer margins

1. Check Show printer margins on Layout.
2. Click OK.

### Printer margins shown by light gray dotted line



## Customizing data frames

In layout view you see geographic data in a data frame on the virtual page. You can use the data frame to emphasize the geographic data on the map, for example, by adding a border, a background, or a drop shadow.

To help locate geographic features, you can add grids to your data frame. Grids subdivide the data frame by latitude and longitude, projected linear units, or a specified number of rows and columns.

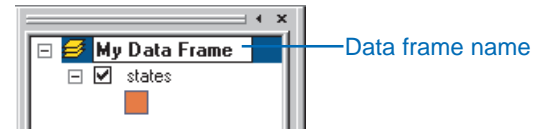
### Tip

#### Why rename a data frame?

*When you just have one data frame, its name isn't that important. However, if you make a map with multiple data frames, it can be convenient to name them.*

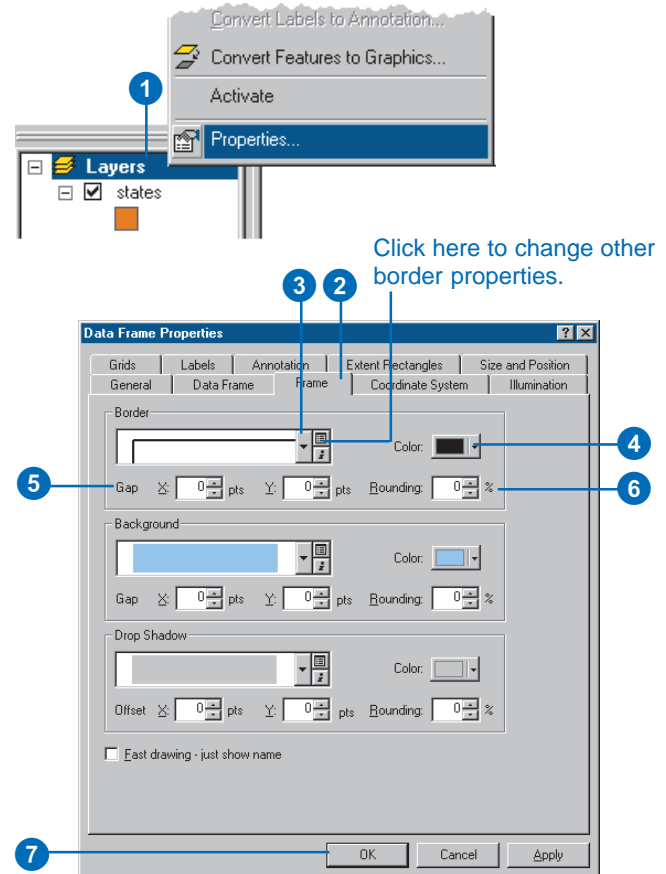
## Renaming a data frame

1. Click the data frame in the table of contents.
2. Wait a moment, then click the data frame a second time.
3. Type a new name for the data frame.



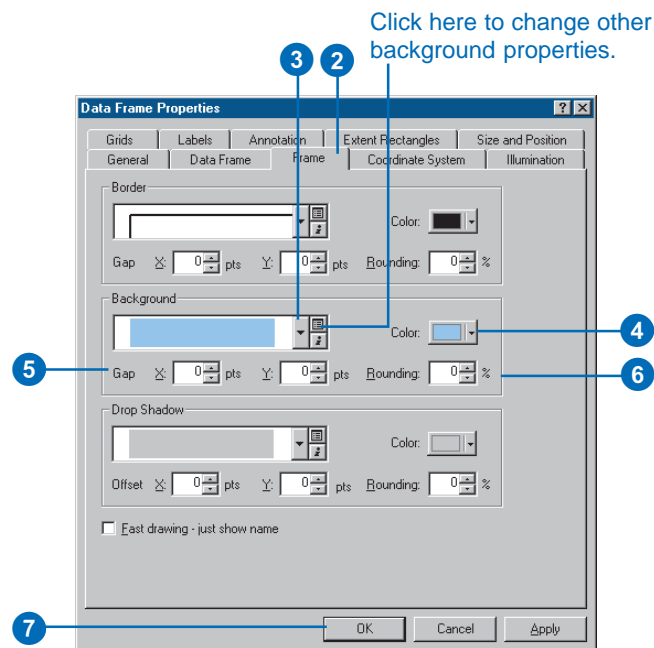
## Adding a border to a data frame

1. In the table of contents, right-click the data frame and click Properties.
2. Click the Frame tab.
3. Click the Border dropdown arrow and click a symbol.
4. Click the Color dropdown arrow and click a color.
5. Type an X and Y gap to offset the border from the edge of the data frame.
6. Type a Rounding percentage to round the corners of the border.
7. Click OK.



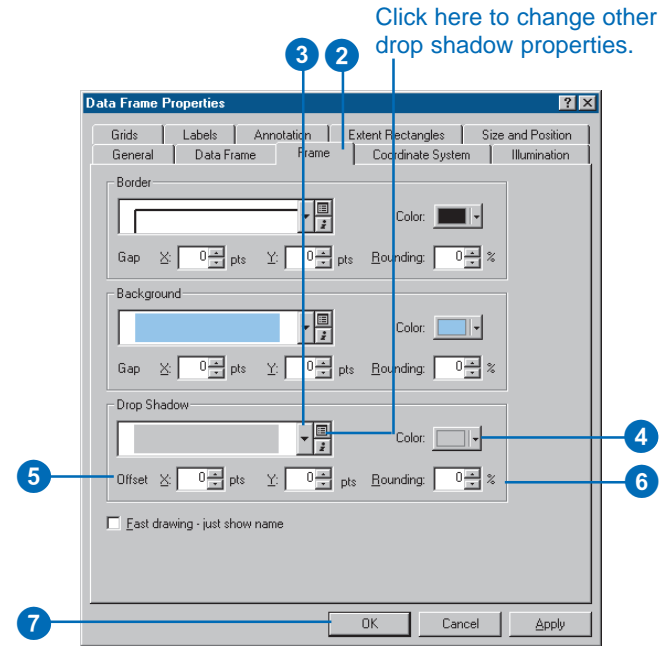
## Adding a background to a data frame

1. In the table of contents, right-click the data frame and click Properties.
2. Click the Frame tab.
3. Click the Background dropdown arrow and click a background.
4. Click the Color dropdown arrow and click a color.
5. Type an X and Y gap to offset the background from the edge of the data frame.
6. Type a Rounding percentage to round the corners of the background.
7. Click OK.



## Adding a drop shadow to a data frame

1. In the table of contents, right-click the data frame and click Properties.
2. Click the Frame tab.
3. Click the Drop Shadow dropdown arrow and click a drop shadow.
4. Click the Color dropdown arrow and click a color.
5. Type an X and Y offset to shift the drop shadow away from the border of the data frame.
6. Type a Rounding percentage to round the corners of the drop shadow.
7. Click OK.



## Tip

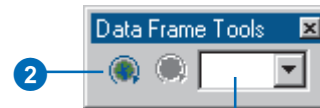
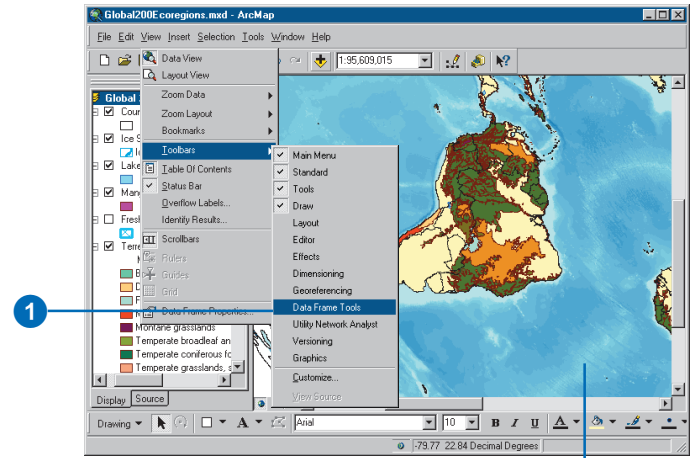
### Rotating using a specific angle

*If you want to rotate your data frame by a specific angle, you can type in the angle on the Data Frame Tools toolbar.*

### Rotating the data in a data frame

1. Click View, point to Toolbars, and click Data Frame Tools.
2. Click the Rotate Data Frame tool.
3. Click and drag the mouse over the data frame to rotate its contents.

Rotating the data in this manner does not alter the original source data, just its display in the data frame.



Click and drag the mouse to rotate the data in the data frame.

You can also type in an angle here.

## Tip

### What type of grid should I display?

If the data you're mapping covers a large area of the earth's surface, you can show graticules that represent lines of latitude and longitude.

If you're mapping a region, such as a country, you can show a measured grid that references a particular projected coordinate system.

If you're mapping a local area, such as a study area, you can show a reference grid that divides the data frame into squares that you can reference by row and column.

## Tip

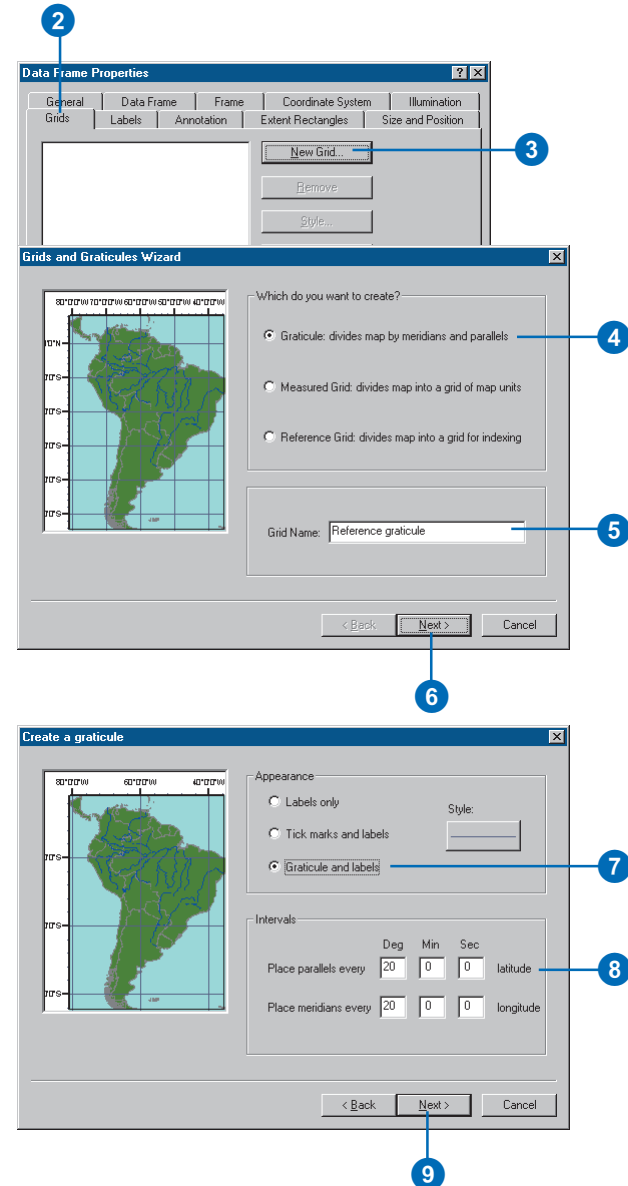
### Why don't I see the Grids and Graticules Wizard?

You need to enable wizards. From the Tools menu, click Options, then check Show Wizards when available.

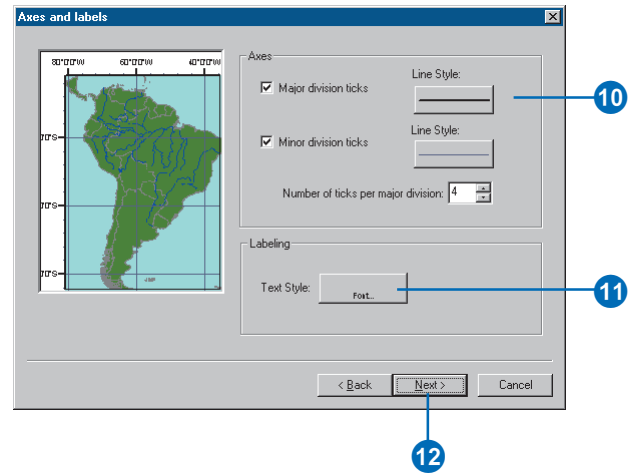
## Adding a graticule

1. In the table of contents, double-click the data frame you want to add a graticule to.
2. Click the Grids tab on the Data Frame Properties dialog box.
3. Click New Grid.
4. Click Graticule.
5. Type a name for the new grid.
6. Click Next.
7. Click an Appearance option.
8. Type the Intervals you want.
9. Click Next. ►

The Grids and Graticules Wizard should appear. If not, see the tip to the left.



10. Check the Axes you want and set how they should appear.
11. Click Font to set the text style.
12. Click Next.
13. Click the Graticule Border you want.
14. Check Place a border outside the grid.
15. Click to specify whether the graticule is static or updates with changes to the data frame.
16. Click Finish.





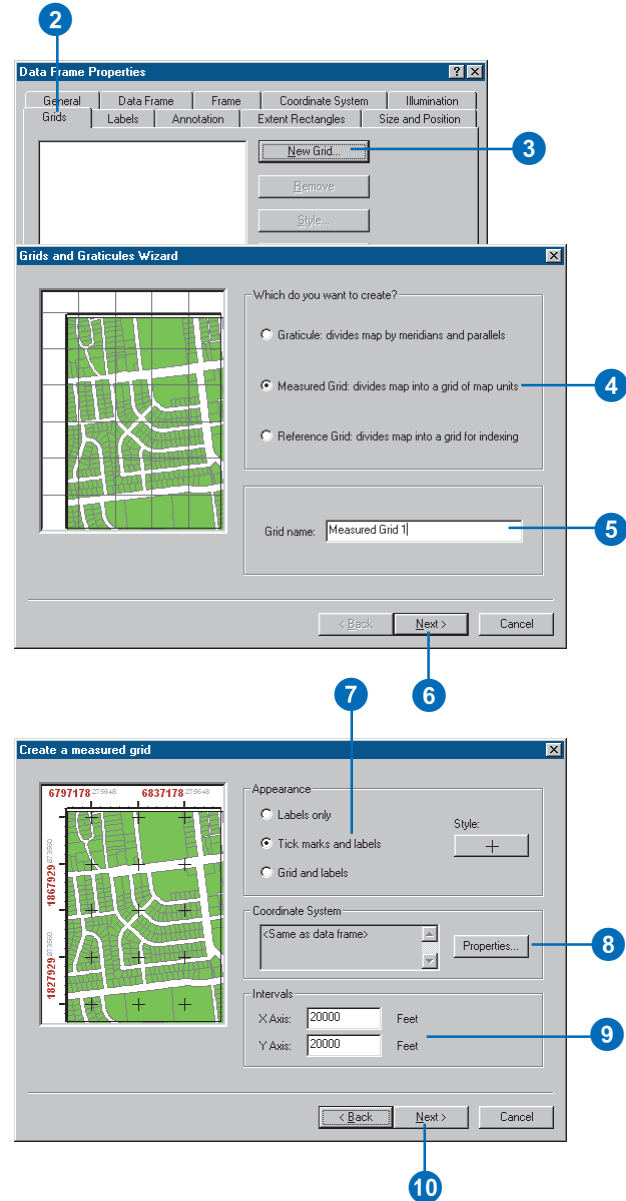
## Tip

### Why don't I see the Grids and Graticules Wizard?

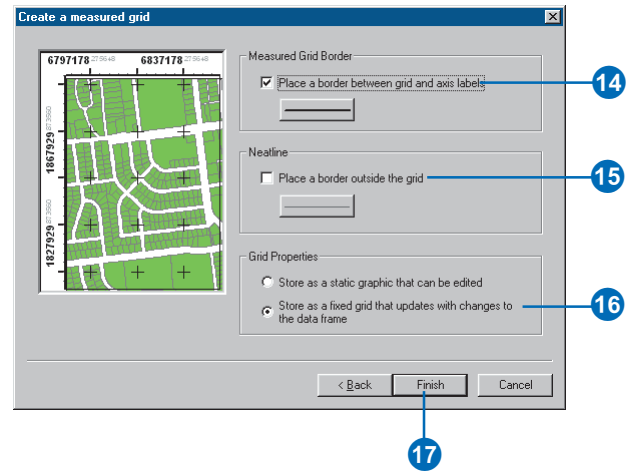
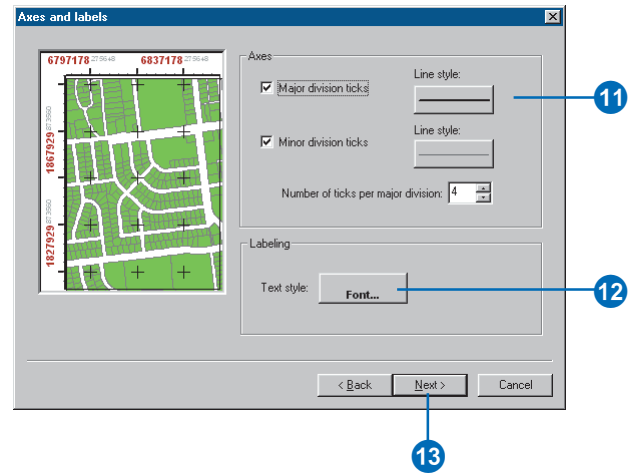
You need to enable wizards. From the Tools menu, click Options, then check Show Wizards when available.

## Adding a measured grid

1. In the table of contents, double-click the data frame you want to add a measured grid to.
2. Click the Grids tab on the Data Frame Properties dialog box.
3. Click New Grid.
4. Click Measured Grid.
5. Type a name for the new grid.
6. Click Next.
7. Click an Appearance option.
8. Click Properties to set a coordinate system for the grid that differs from that of the data frame.
9. Type the Intervals you want.
10. Click Next. ▶



11. Check the Axes you want and set how they should appear.
12. Click Font to set the text style.
13. Click Next.
14. Click the Measured Grid Border you want.
15. Check Place a border outside the grid.
16. Click to specify whether the measured grid is static or updates with changes to the data frame.
17. Click Finish.



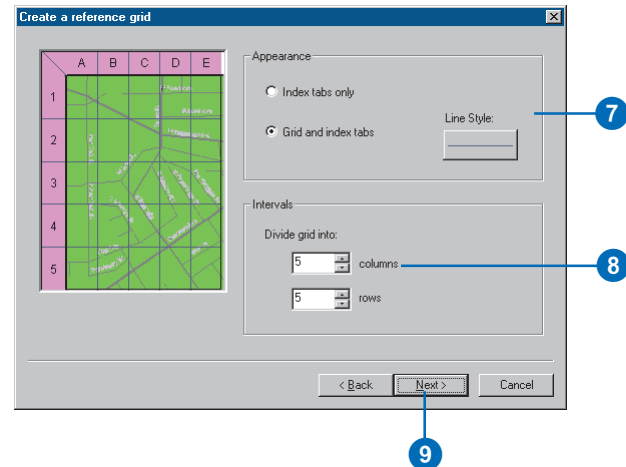
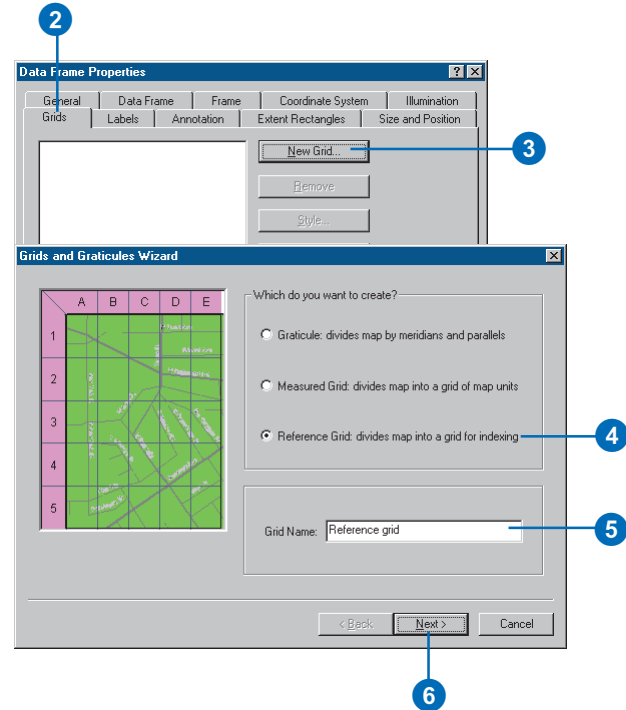
## Tip

### Why don't I see the Grids and Graticules Wizard?

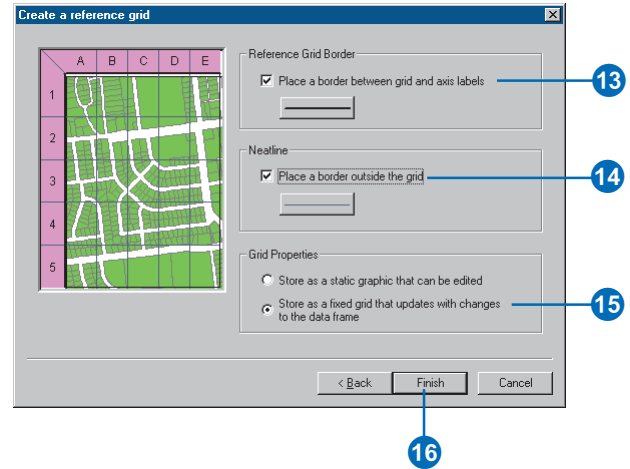
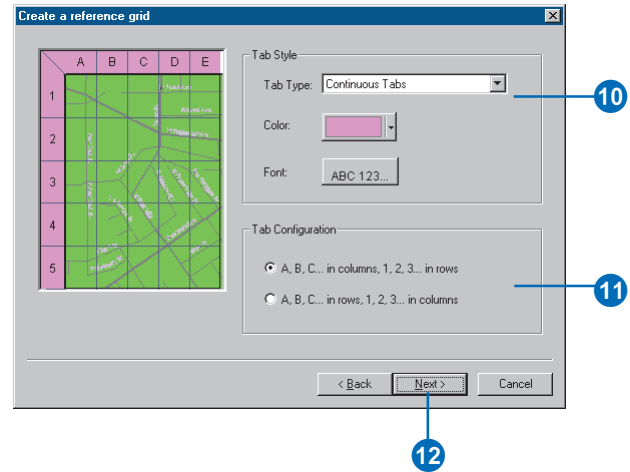
You need to enable wizards. From the Tools menu, click Options, then check Show Wizards when available.

## Adding a reference grid

1. In the table of contents, double-click the data frame you want to add a reference grid to.
2. Click the Grids tab on the Data Frame Properties dialog box.
3. Click New Grid.
4. Click Reference Grid.
5. Type a name for the new grid.
6. Click Next.
7. Click an Appearance option.
8. Type the Intervals you want.
9. Click Next. ▶



10. Set the Tab Style.
11. Set the Tab Configuration.
12. Click Next.
13. Check Place a border between grid and axis labels.
14. Check Place a border outside the grid.
15. Click to specify whether the graticule is static or updates with changes to the data frame.
16. Click Finish.



## Using rulers, guides, and grids

You can use rulers, guides, and grids in layout view to align map elements on the page.

Rulers show the size of the page and map elements on the final printed map. Guides are straight lines that you can use to align map elements on the page. A grid is a grid of reference points on the layout that you can use to position map elements.

You can use each of these layout aids as visual indicators of element size and position. You can also turn on snapping to force map elements to snap to the rulers, guides, or grid. Snapping makes it easy to align map elements precisely.

You can use guides in layout view to align map elements on the page. ►

### Tip

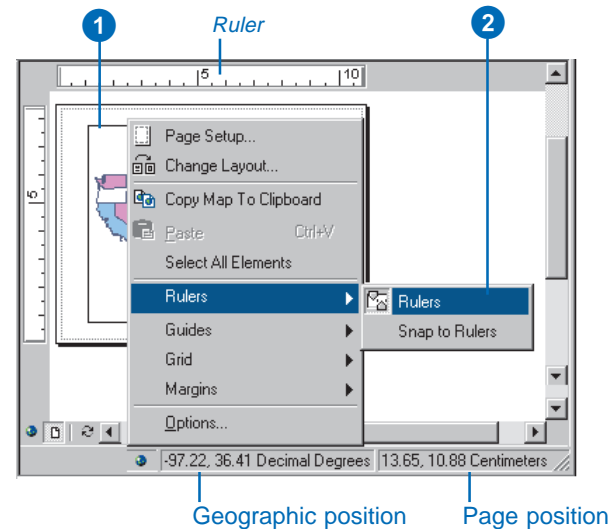
#### How can I tell exactly where the pointer is?

*You can use the readouts in the lower-right corner of the ArcMap window to find the geographic position and page position of the pointer.*

## Turning rulers on and off

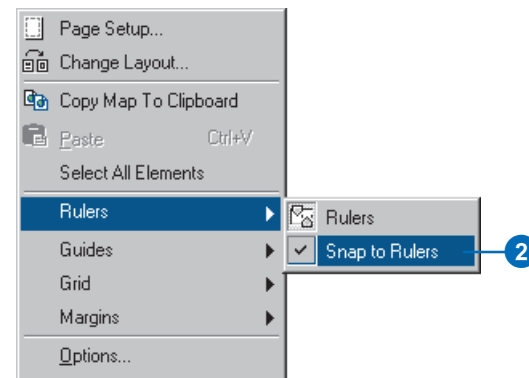
1. Right-click the page.
2. Point to Rulers and click Rulers.

The rulers are on by default.



## Snapping to rulers

1. Right-click the page.
2. Point to Rulers and click Snap to Rulers.



Although you can see guides on the virtual page in layout view, they will not show up when you print your map.

You can use a snapping grid in layout view to align map elements on the page.

Although you can see the grid on the virtual page in layout view, it will not show up when you print your map.

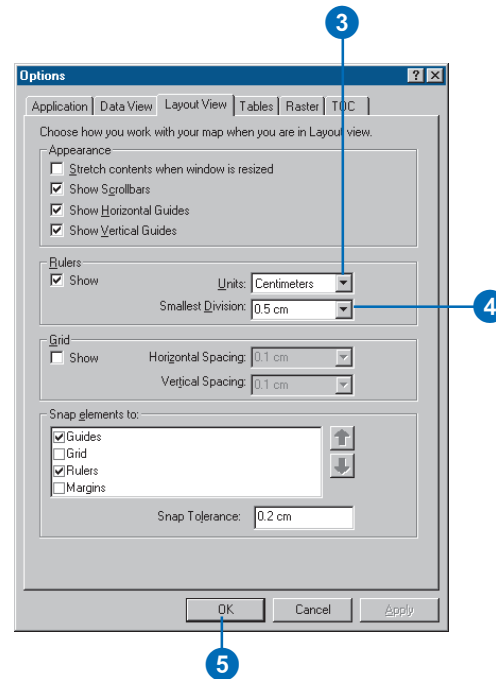
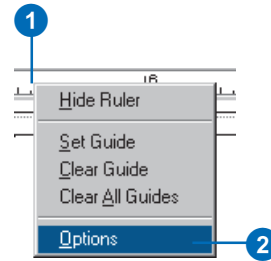
## Tip

### What units can I use to measure the page?

*You can set the units of measure shown on the rulers to points, centimeters, or inches. You can also change the number of divisions per unit.*

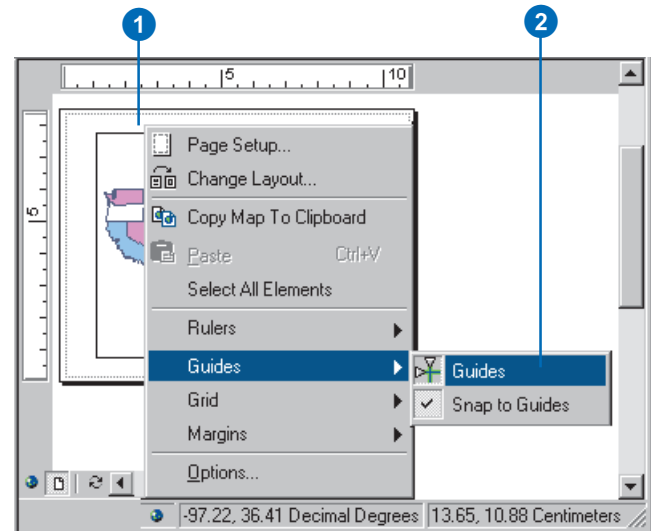
## Setting the units and divisions on rulers

1. Right-click the ruler.
2. Click Options.
3. Click the Units dropdown arrow and click a unit of measure.
4. Click the Smallest Division dropdown arrow and click the size of the smallest division.
5. Click OK.



## Turning guides on and off

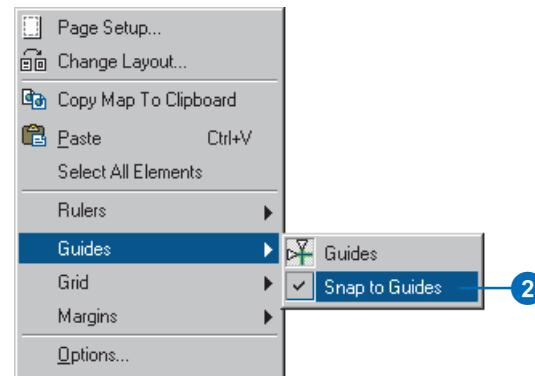
1. Right-click the page.
2. Point to Guides and click Guides.



## Snapping to guides

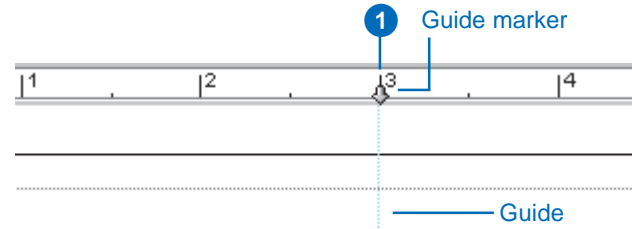
1. Right-click the page.
2. Point to Guides and click Snap to Guides.

When you move map elements to the vicinity of a guide, the map element will snap to the guide.



## Adding a guide

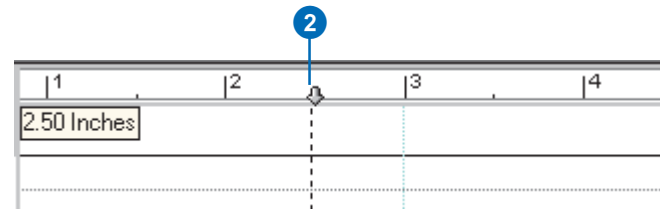
1. Click the ruler at the place where you want a guide.



## Moving a guide

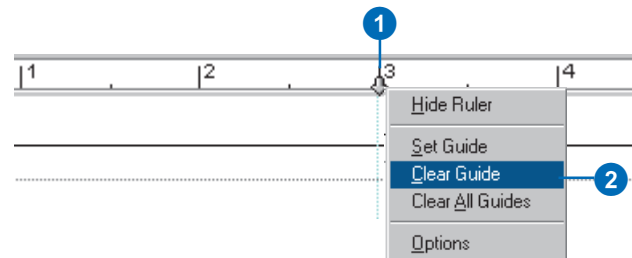
1. Point to a guide marker on the ruler.
2. Click and drag the guide marker to a new location on the ruler.

The guide appears with a dotted line until you release the mouse button.



## Removing a guide

1. Point to a guide marker on the ruler.
2. Right-click the guide marker and click Clear Guide.





## Tip

### Using guides to set margins on the page

You can use guides to set margins for a map that is not the same size as your printer's page size.

The guides provide a visual indication of the map's margins to help you avoid positioning map elements in the margins.

Turning on snapping to guides will provide an additional cue that an element is near a margin.

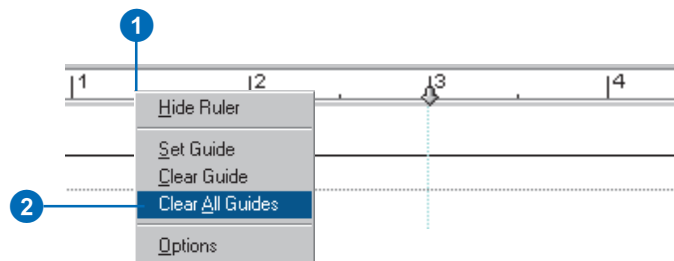
## See Also

For more information on margins, see 'Showing or hiding printer margins' in this chapter.

### Removing all guides from a ruler

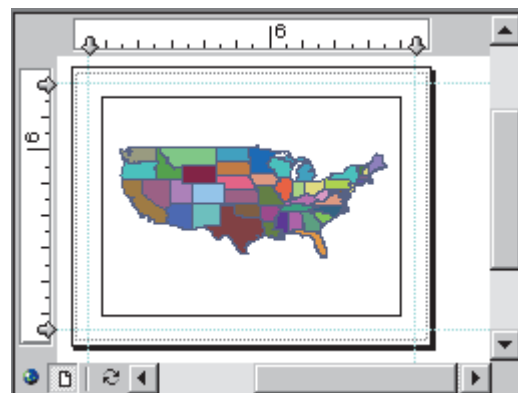
1. Right-click the ruler.
2. Click Clear All Guides.

All of the guides are removed from the ruler.



### Using guides to define a map's margins

1. Click the rulers to add guides where you want the map's margins to be.
2. Optionally, move the guides to fine-tune their position.



## Tip

### Snapping to the grid

The snapping grid appears as a grid of dots on the virtual page. You can use the grid as a purely visual reference in placing map elements, or you can turn on snapping to grid. If you turn on snapping, the position of elements on the page will be constrained by the vertices of the snapping grid.

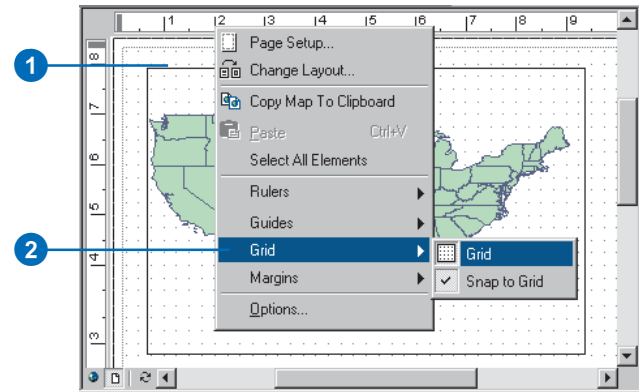
## Tip

### Why change the grid size?

You can change the size of the grid to allow more or less freedom in positioning map elements when snapping to grid is enabled.

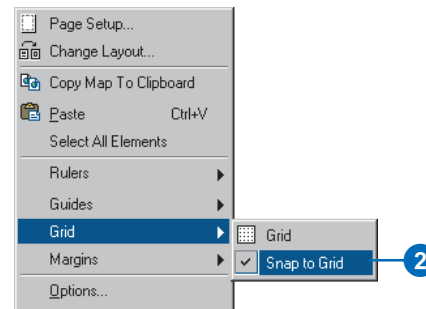
## Turning the grid on and off

1. Right-click the page.
2. Point to Grid and click Grid.



## Snapping to the grid

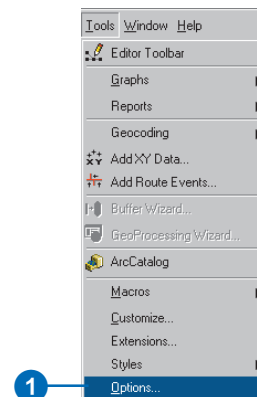
1. Right-click the page.
2. Point to Grid and click Snap to Grid.



## Changing the grid size

1. Click Tools and click Options.
2. Click the Layout View tab on the Options dialog box.

The Options dialog box appears. ►



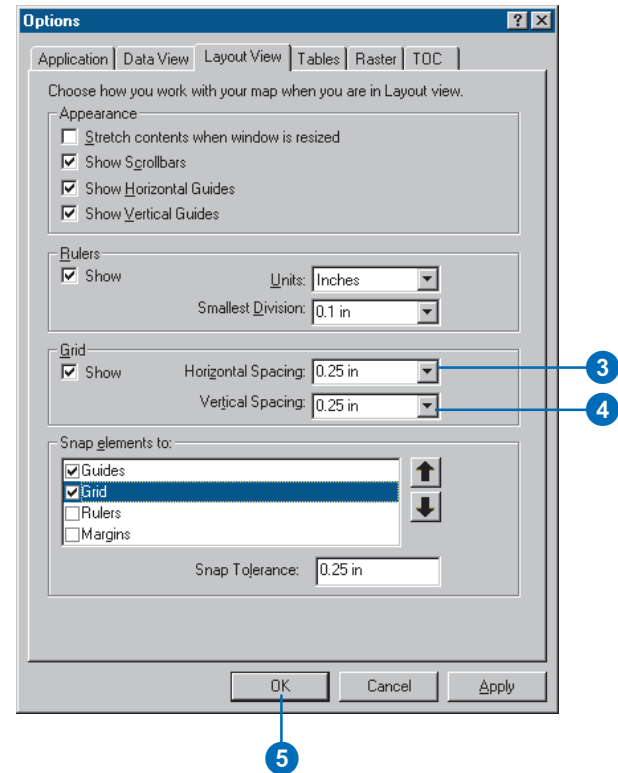
## Tip

### Changing the snapping order

The order in which guides, grids, and rulers appear in the Snap elements to list determines which one an element will snap to. For example, in the event that the element is within the snapping tolerance of both a guide and a grid point, it will snap to whichever is on top—the guide or the grid point.

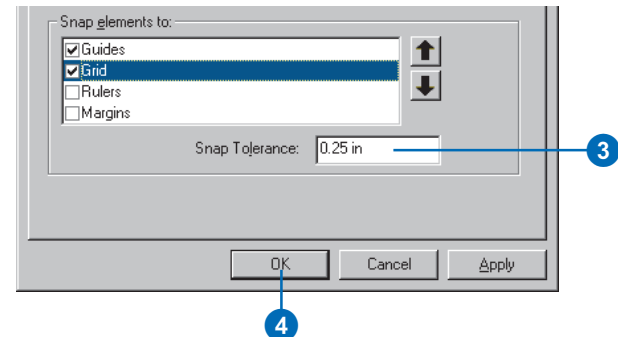
You can use the up and down arrow keys to change the snapping order.

3. Click the Horizontal Spacing dropdown arrow and click a number of units to specify the horizontal spacing of the snapping grid.
4. Click the Vertical Spacing dropdown arrow and click a number of units to specify the vertical spacing of the snapping grid.
5. Click OK.



### Changing the snapping tolerance

1. Right-click the page.
2. Click Options.
3. Type a number of units for the snapping tolerance.
4. Click OK.



## Adding data frames

A map is composed of one or more data frames (and data) arranged on the page, plus one or more other map elements.

Simple maps usually have only a single data frame. Sometimes you want to show more data than a single frame can conveniently hold. If that's the case, you may decide to add another data frame to the map.

You can use additional data frames in different ways, for example, to show insets and overviews or to allow map readers to compare different representations of the same area.

### Tip

#### Choosing how to add a data frame

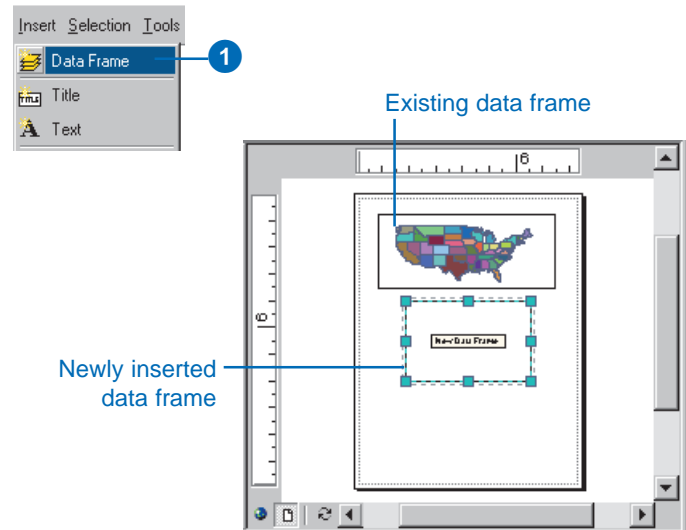
*If you want to show two different layers of data in two data frames, it may be quicker to add a new data frame to the map than to copy an existing data frame.*

*If your data frames have layers in common, it may be more convenient to add the common layers to a single data frame than to duplicate the data frame.*

## Adding a new data frame to a map

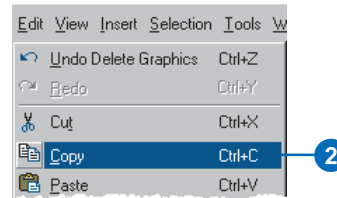
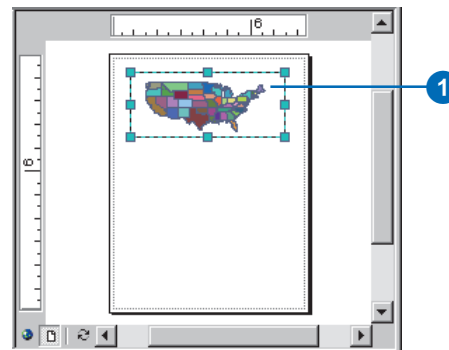
1. Click Insert and click Data Frame.

You can add any data to the new data frame.

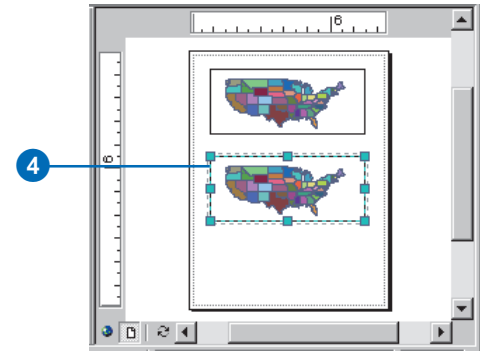
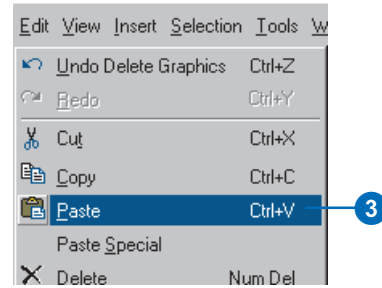


## Duplicating a data frame

1. Click the data frame to select it.
2. Click Edit and click Copy. ▶

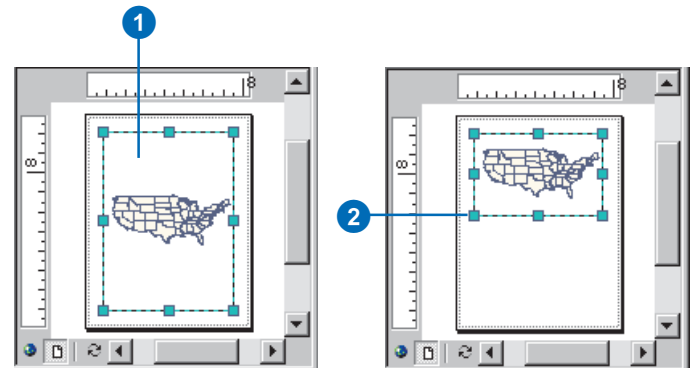


3. Click Edit and click Paste.
4. Click the copy, located on top of the original data frame, and drag it to a new place on the page.



## Resizing a data frame

1. Click the data frame to select it.
2. Click a selection handle and drag it to change the size of the data frame.



## Tip

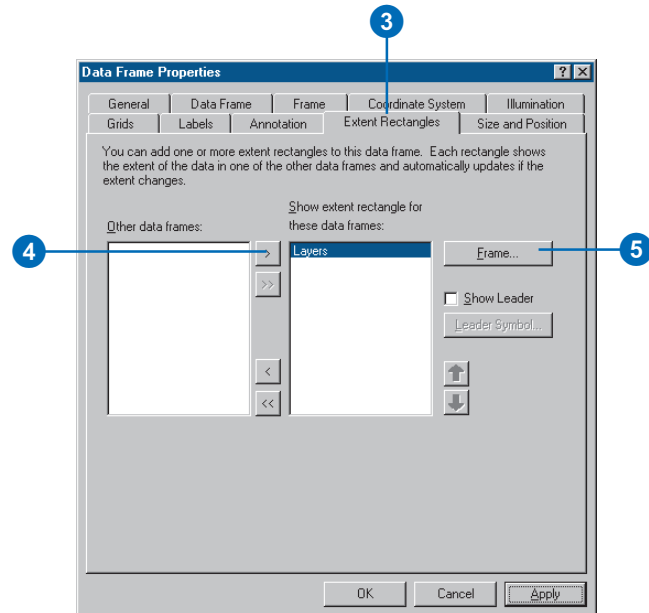
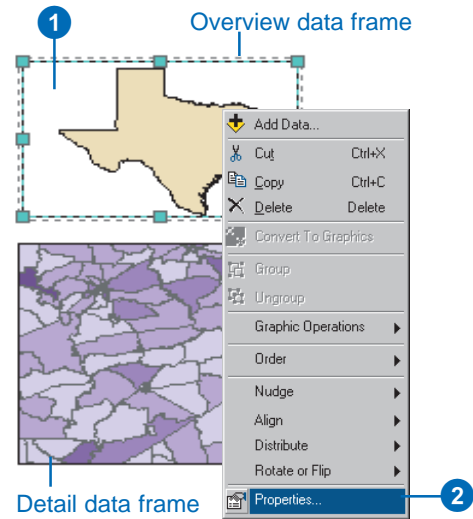
### Showing a data frame's position with an extent rectangle

You can use a data frame with a large extent to provide context for another data frame—for example, showing the location of a state within a country. If the area on the map is familiar to your audience, it may not be necessary to add any more information.

Sometimes, the area that you show in the detail data frame does not have a commonly recognized outline. In this case, it may be useful to show its position with an extent rectangle.

### Using one data frame to show the location of another

1. Click the overview data frame to select it.
2. Right-click the overview data frame and click Properties.
3. Click the Extent Rectangles tab.
4. Click the detail data frame (in this case called Layers) in the Other data frames list and click the right arrow button to send it to the Show extent rectangle for these data frames list.
5. Click Frame to choose a border for the extent rectangle. ▶



## Tip

### Showing multiple extents

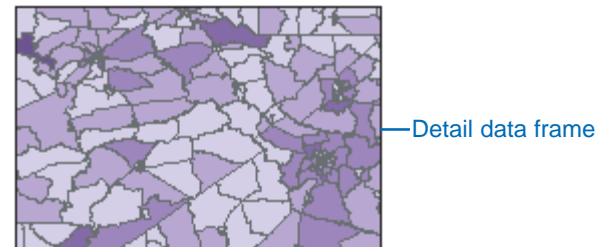
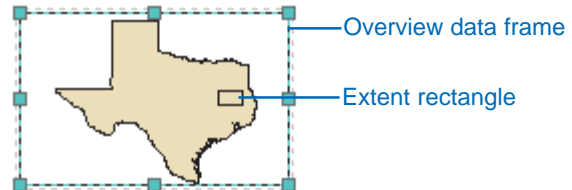
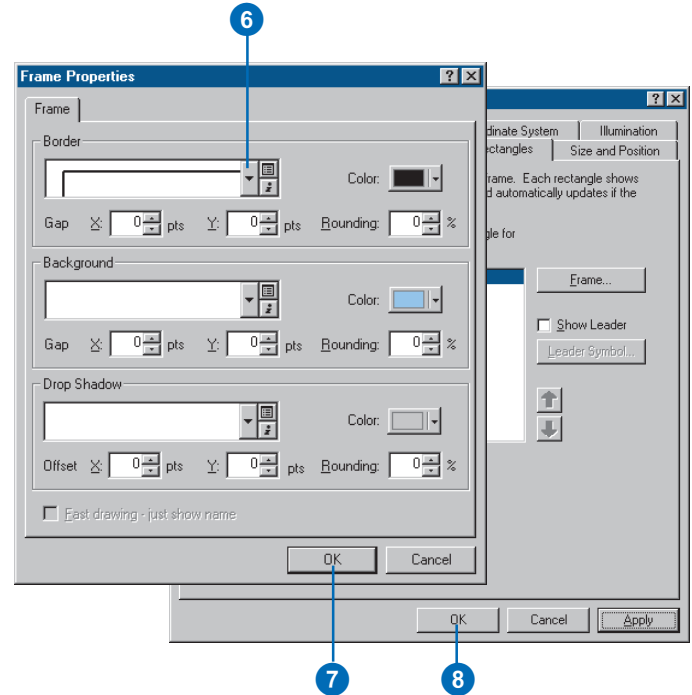
You can use extent rectangles to show the positions of several different data frames on a single data frame.

## Tip

### Changing extents after you add an extent rectangle

You can change the extent of either data frame when you have an extent rectangle—the rectangle will automatically be updated to reflect the new relationship of the data frames.

6. Click the Border dropdown arrow and click a border.
7. Click OK on the Frame Properties dialog box.
8. Click OK on the Data Frame Properties dialog box.



## Adding map elements related to data frames

Some map elements—such as North arrows, scale bars, scale text, and legends—are related to the data in data frames. North arrows indicate the orientation of the map. Scale bars provide a visual indication of the sizes of features and distances between features shown on the map. Scale text indicates the scale of the map and features on the map. A legend tells a map reader what the symbols used to represent features on the map mean. ►

### Tip

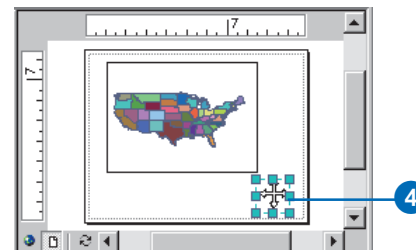
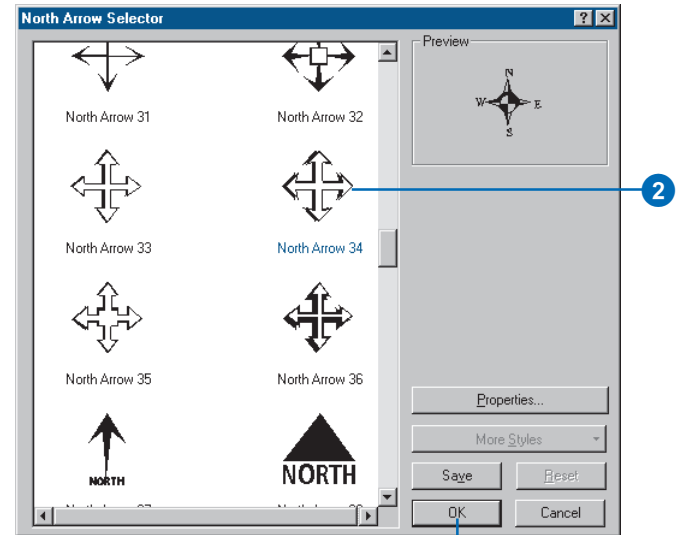
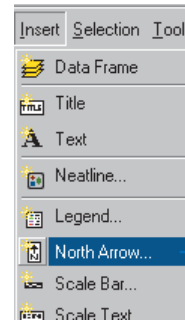
#### Resizing a map element

*Map elements aren't always the size you want when they're added to a map. You can change the size of map elements by selecting them and dragging the selection handles.*

*Dragging a handle away from an element enlarges it. Dragging a handle toward an element reduces it.*

## Adding a North arrow

1. Click Insert and click North Arrow.
2. Click a North arrow.
3. Click OK.
4. Click and drag the North arrow into place on your map.
5. Optionally, resize the North arrow by clicking and dragging a selection handle.





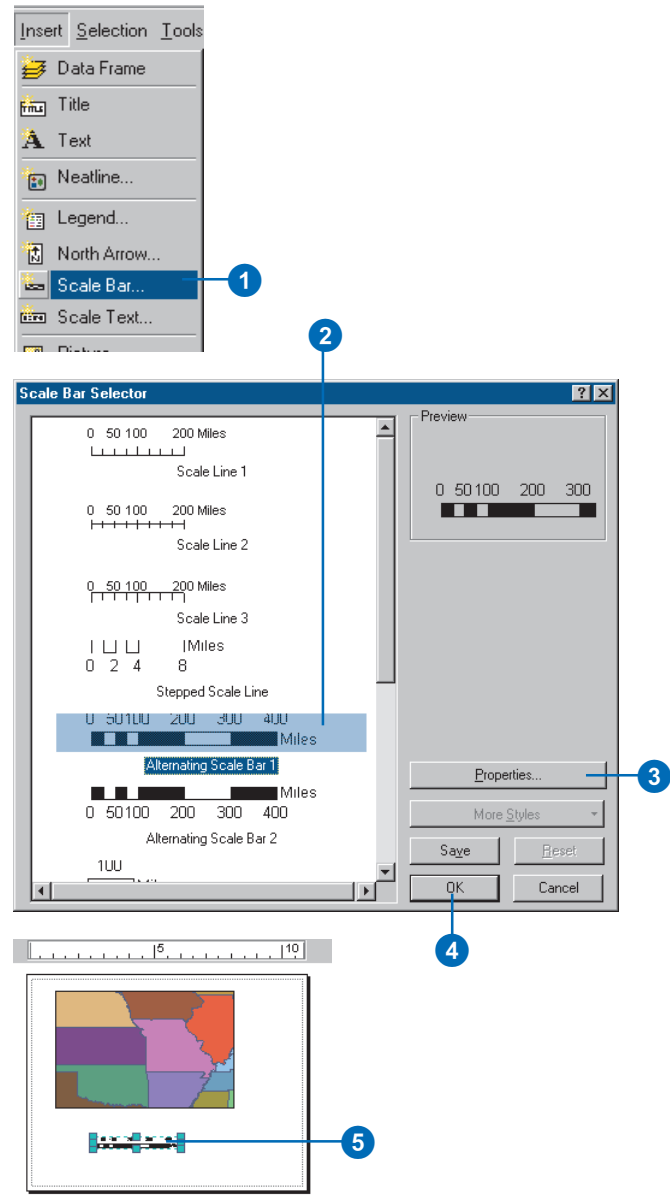
You can use a scale bar to represent the scale of your map.

A scale bar is a line or bar divided into parts and labeled with its ground length, usually in multiples of map units such as tens of kilometers or hundreds of miles.

If the map is enlarged or reduced, the scale bar remains correct. ►

## Adding a scale bar

1. Click Insert and click Scale Bar.
2. Click a scale bar.
3. Optionally, click Properties to modify the scale bar's properties.
4. Click OK.
5. Click and drag the scale bar into place on your map.
6. Optionally, resize the scale bar by clicking and dragging a selection handle.



When you add a scale bar to a map, the number and size of the divisions might not be exactly as you would like them. For example, you might want to show four divisions rather than three or show 100 meters per division instead of 200.

You might also want to change the units that the scale bar shows or adjust how those units are represented.

You can adjust many characteristics of a scale bar from the Scale Bar properties dialog box. ►

### Tip

#### Changing the units label

By default, the units label on a scale bar is the same as the scale bar units. Sometimes you might want to change the label of the scale bar; for example, from Kilometers to km. Just type the new scale bar label in the Label text box.

### Tip

#### Why can't I see the Size and Position tab or the Frame tab?

You can only change the size and position and frame of an element after it has been placed on the map. If you click Properties while inserting a map element, you won't see these tabs.

## Customizing a scale bar's scale and units

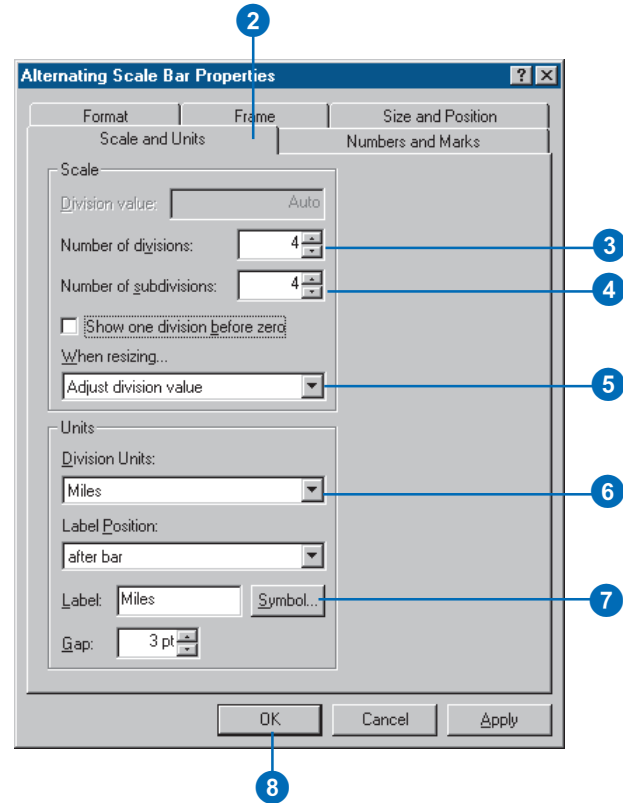
1. Right-click the scale bar and click Properties.
2. Click the Scale and Units tab.
3. Click the arrow buttons to set the number of divisions.
4. Click the arrow buttons to set the number of subdivisions.
5. Click the When resizing dropdown arrow and click how you want the scale bar to respond when the map scale changes.

Adjust division value—the division value will vary with the map scale. The number of divisions and the width of the scale bar remain constant.

Adjust number of divisions—the number of divisions will vary with the map scale. The division value and the width of the scale bar remain constant.

Adjust width—the width of the scale bar will vary with the map scale. The division value and number of divisions remain constant.

6. Choose the units for the scale bar.
7. Click Symbol and choose a text style for the scale bar labels.
8. Click OK.

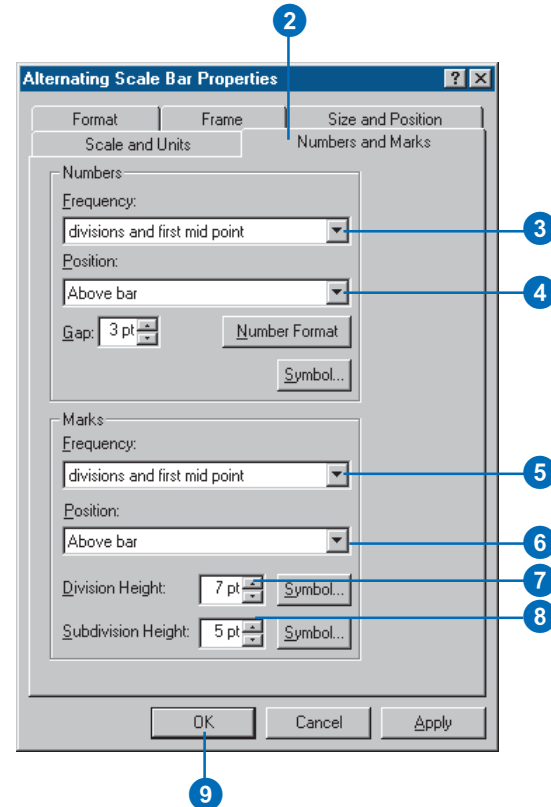


When you add a scale bar to a map, the number labels and tic marks might not be exactly as you would like them. For example, you might want to label the endpoints of the scale bar but not the divisions, or you might want larger tic marks at the major divisions of the bar than at the minor ones.

You might also want to change the size or color of the font that the numbers are drawn in. ►

## Customizing a scale bar's numbers and marks

1. Right-click the scale bar and click Properties.
2. Click the Numbers and Marks tab.
3. Click the Numbers Frequency dropdown arrow to choose where along the bar to place the numbers.
4. Click the Numbers Position dropdown arrow to choose where along the bar to place the numbers.
5. Click the Marks Frequency dropdown arrow to choose where along the bar to place tic marks.
6. Click the Marks Position dropdown arrow to choose where to place tic marks relative to the bar.
7. Click the Division Height arrow buttons to increase or decrease the height of division tic marks.
8. Click the Subdivision Height arrow buttons to increase or decrease the height of subdivision tic marks.
9. Click OK.



You can also represent the scale of your map with scale text.

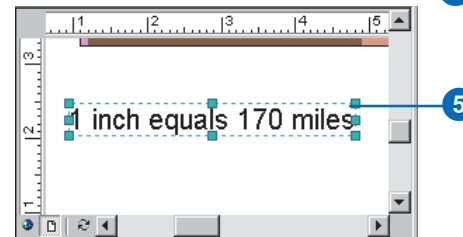
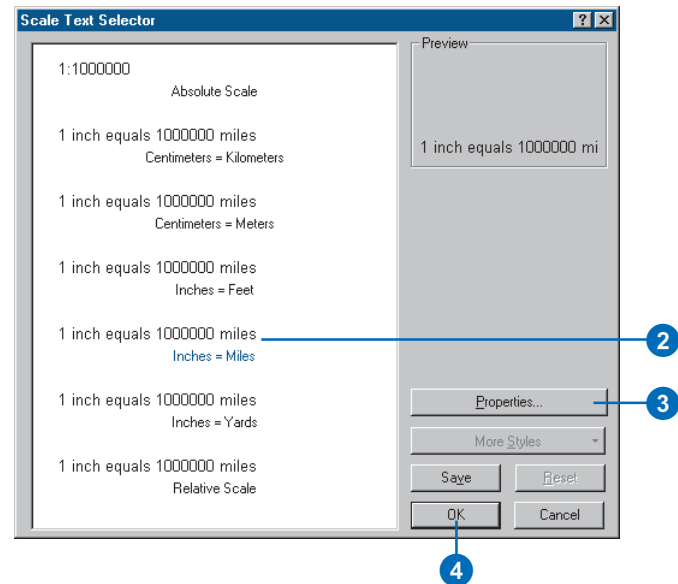
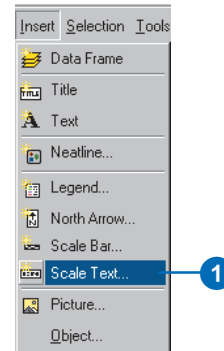
Scale text tells a map reader how many ground units are represented by a map unit—for example, “one centimeter equals 100,000 meters”.

One drawback of scale text is that if a printed copy of the map is duplicated at another scale (enlarged or reduced), the scale text will be in error. Scale bars do not suffer this limitation.

Many maps have both scale text and a scale bar to indicate the map scale. ►

## Adding scale text

1. Click Insert and click Scale Text.
2. Click a sample of the style of scale text to add to the map.
3. Optionally, click Properties to customize the scale text.
4. Click OK.
5. Click and drag the scale text into position on your map.
6. Optionally, resize the scale text by clicking and dragging a selection handle.



You can use a legend to tell map readers the meaning of the symbols you've used on the map.

Legends consist of examples of the symbols on the map with a label containing some explanatory text.

When you use a single symbol for the features in a layer, the layer is labeled with the layer's name in the legend.

When you use multiple symbols to represent features in a single layer, the field you used to classify the features becomes a heading in the legend, and each category is labeled with its value.

## Tip

### Enable the Legend Wizard

You can insert legends with the help of the Legend Wizard. To enable the wizard, click the Tools menu and click Options. Click the Application tab and check Show Wizards when available.

## Tip

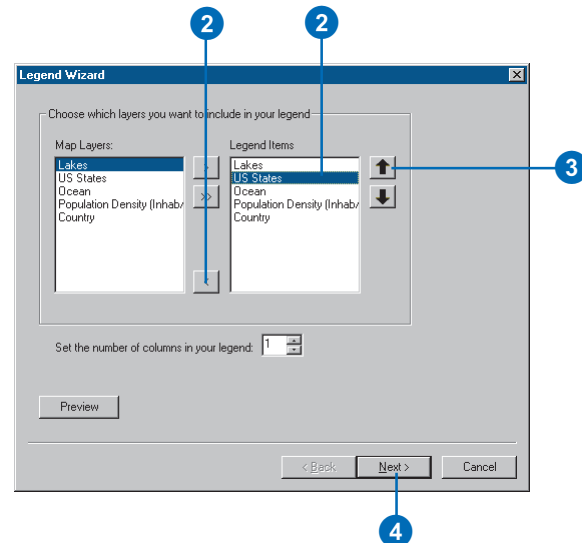
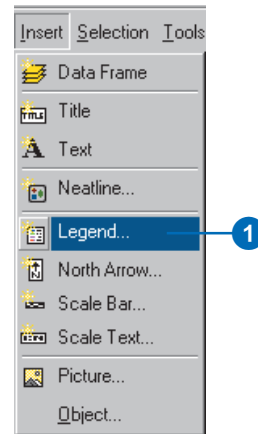
### Legends on maps with multiple data frames

When you have more than one data frame, inserting a legend adds a legend for the selected data frame.

Each legend corresponds to a single data frame, although you can arrange multiple legends together as a single legend for a complex map.

## Adding a legend

1. Click Insert and click Legend.  
The Legend Wizard appears. If you don't see it, enable the Legend Wizard as described in the tip to the left.
2. By default, all the layers on the map will appear as legend items in the legend. To remove a legend item, click it, then click the left arrow button.
3. Use the Up and Down arrow buttons to order the legend items.
4. Click Next. ▶

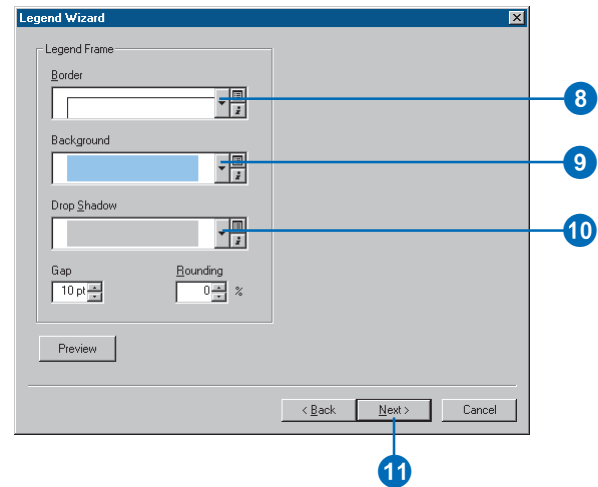
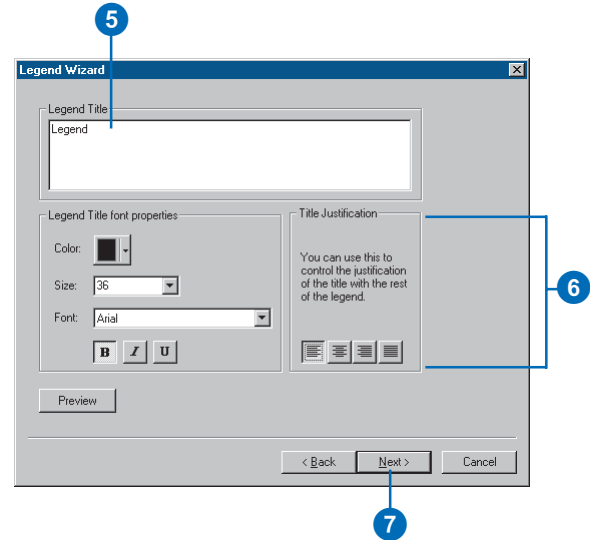


## Tip

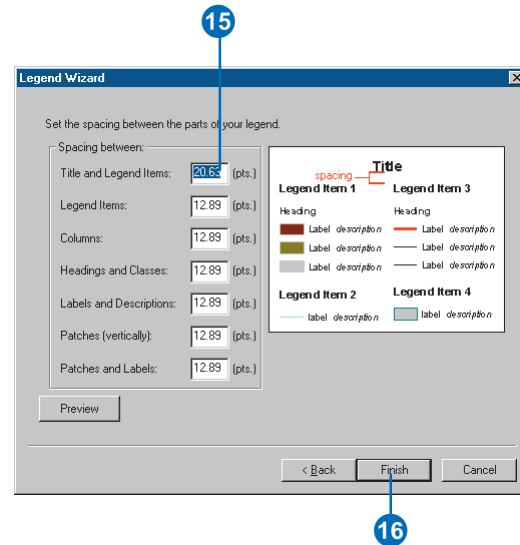
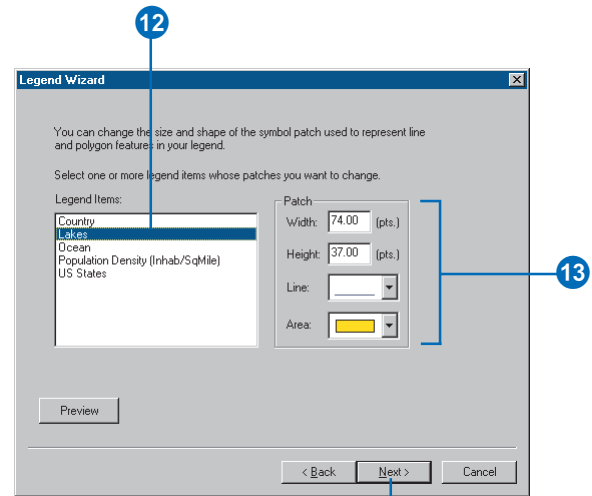
### Changing legend labels

You can edit the text of the labels that appear in the legend by changing the text in the ArcMap table of contents or on the Symbology tab of the Layer Properties dialog box.

5. Type a title for the legend.
6. Set the text color, size, and font as desired.
7. Click Next.
8. Click the Border dropdown arrow and click a border.
9. Click the Background dropdown arrow and click a background.
10. Click the Drop Shadow dropdown arrow and click a drop shadow.
11. Click Next. ►



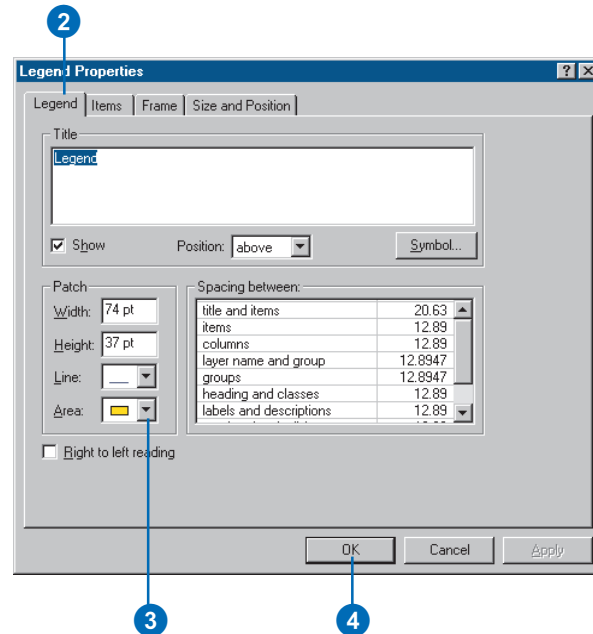
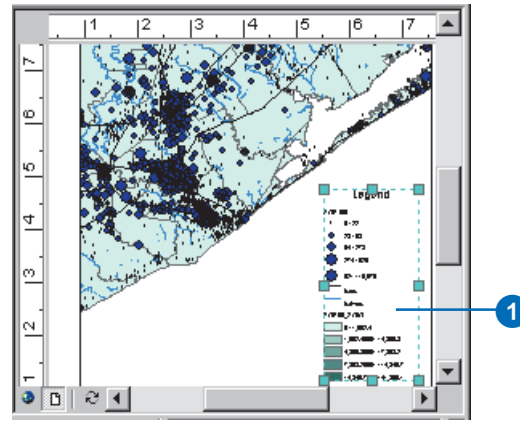
12. Click a Legend Item in the list to modify the symbol patch.
13. Set the Patch properties as desired.
14. Click Next.
15. Set the spacing between legend elements by typing a value into the appropriate box.
16. Click Finish.



Legends have patches that show examples of the map symbols. By default, the legend patches are points, straight lines, or rectangles that match the map symbols. You can customize the legend patches so areas are represented with patches of another shape or so rivers are drawn with a sinuous rather than straight line.

## Changing the patches in a legend

1. Double-click the legend on the map and click Properties.
2. Click the Legend tab.
3. Click the dropdown arrow to select a new patch shape.
4. Click OK.





## Tip

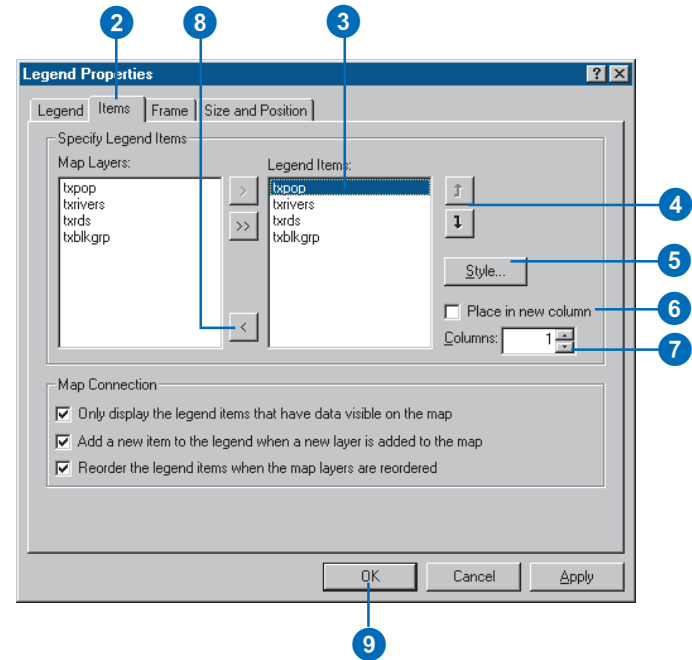
### Changing a single layer's legend patch

If you have two layers with the same geometry in a data frame—for example, a layer of roads and a layer of streams—you can set their legend patches independently, so roads are shown with a straight line and rivers with a sinuous line.

In the Legend Items list, click the Item for the layer you want to change. Right-click and click Properties. Click the General tab and check the Override default patch box. Click the Patch dropdown arrow and click a new patch.

### Changing the items in a legend

1. Right-click the legend on the map and click Properties.
2. Click the Items tab.
3. Click a legend item in the Legend Items list.
4. Click the up and down arrows to move the item up or down in the legend.
5. Optionally, click Style and change the Item's style in the legend.
6. Optionally, check Place in new column to place the highlighted item in a new column.
7. Optionally, change the number of columns in the legend for the highlighted legend item by clicking the up and down arrow keys.
8. Optionally, remove an item from the legend by clicking it and clicking the left arrow key.
9. Click OK.



Certain map elements—including scale bars, scale text, North arrows, legends, and data frames—can have frames.

You can use frames to set map elements apart from other elements or from the background of the map.

You can also use frames to visually link map elements to other parts of the map by using similar frames for related elements.

### Tip

#### Why can't I see the Frame tab?

*You can only set the frame properties after an element has been placed on the map.*

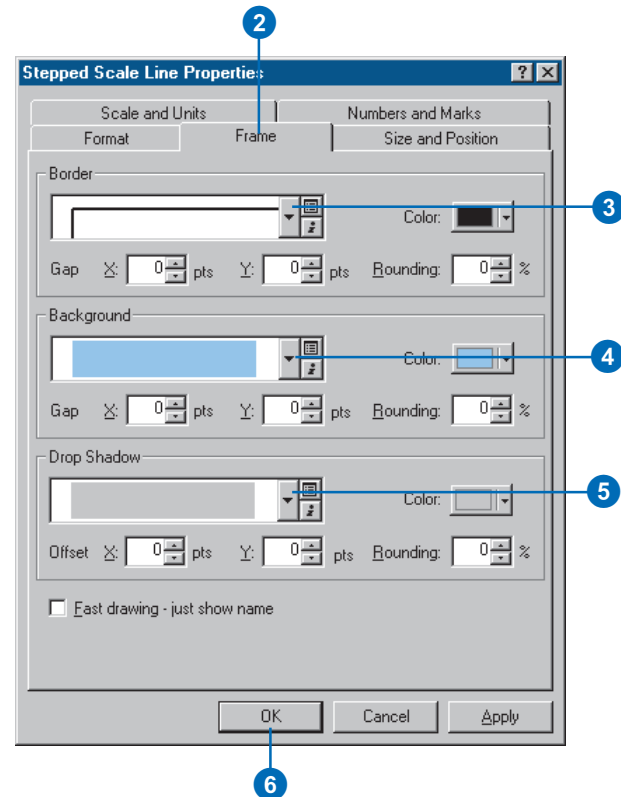
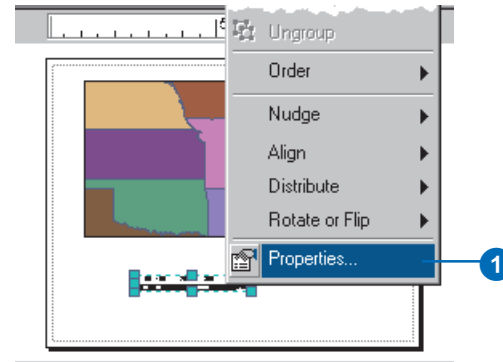
### Tip

#### Framing grouped elements

*If you group some elements together, you can right-click the group and set a frame for the group.*

## Framing a map element

1. Right-click the element on the map and click Properties.
2. Click the Frame tab.
3. Click the Border dropdown arrow and click a border.
4. Click the Background dropdown arrow and click a background.
5. Click the Drop Shadow dropdown arrow and click a drop shadow.
6. Click OK.



## Tip

### Why convert a map element to graphics?

*You might want to convert a map element, such as a legend, to graphics if you want more precise control over each element that comprises the element. Once you convert a map element to graphics, you can't reconstruct the map element from the individual pieces.*

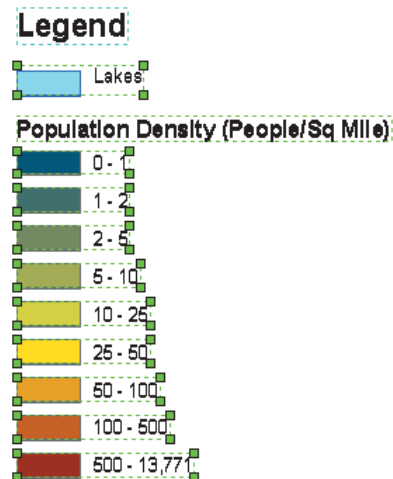
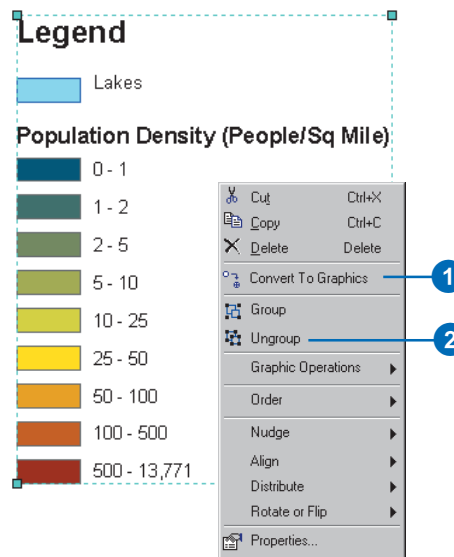
## Converting map elements to simple graphics

1. Right-click an element, such as a legend, and click Convert To Graphics.

The element is now a grouped graphic.

2. Right-click the graphic and click Ungroup.

The individual graphics that comprise the map element can now be edited separately.



*After ungrouping, you can edit the individual graphic elements.*

## Adding other map elements

In addition to those elements that are related to data frames, there are elements that provide additional information, frame or group the elements of the map, or ornament the map.

Most maps have a title. A title communicates the topic of the map to a casual viewer and provides a way to refer to a map.

Many maps have graphic elements in addition to the geographic data on the map.

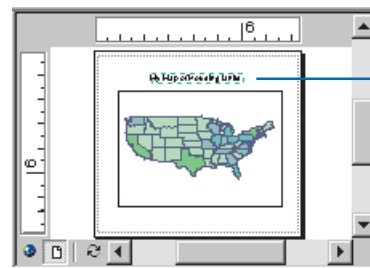
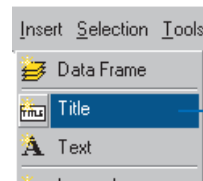
Graphics can be used to ornament a map, group related parts of a map together, identify a map with an organization, or emphasize a part of the map. You can use graphic rectangles to frame a group of other map elements.

If you want to frame an individual map element, right-click it, click properties, and click the Frame tab—you can use this method to choose borders and backgrounds for legends, North arrows, data frames, scale bars, scale text, and data frames.

Maps can have pictures or graphic images in addition to the geographic data on the map. ►

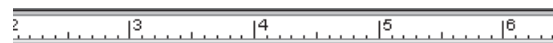
## Adding a title

1. Click Insert and click Title.
2. Type a title for the map.
3. Click and drag the title into place on your map.
4. Optionally, modify the appearance of the title text.

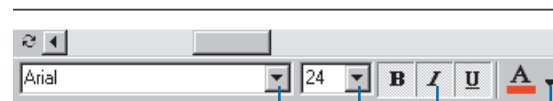


## Modifying a title

1. With the title selected, click the Font dropdown arrow and click a font.
2. Click the font size dropdown arrow and click a font size.
3. Click Bold, Italic, or Underline to change the style of the text.
4. Click the Text Color dropdown arrow and click a color.



***My Map of Housing Units***



You might add a graphic image of your company's logo to indicate the source of a map or add a nation's flag to a map to indicate its subject.

You can also ornament a map by placing representative images of places, people, or objects found in an area on a map.

While most of the data on a map is usually geographic data presented in data frames, maps can also contain reports and graphs that support or complement the geographic data. Reports and graphs are two alternative ways of presenting complex tabular information; they can make your map more informative or persuasive.

## Tip

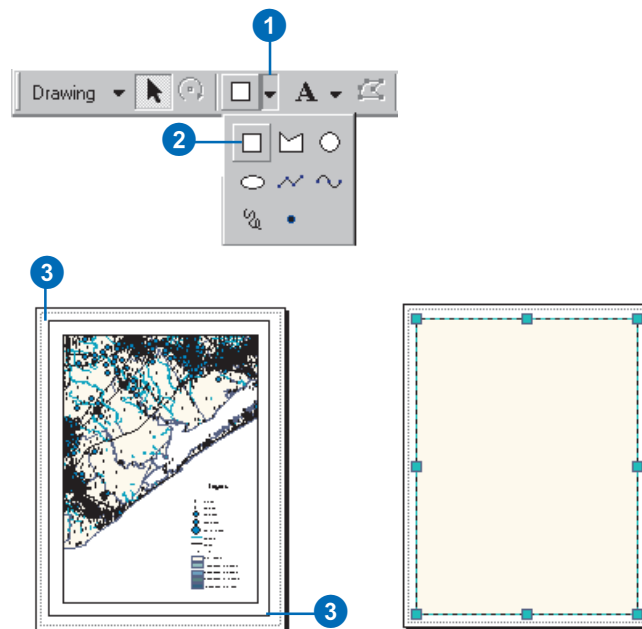
### Mixing your own colors

*If you don't find the exact color you want in the array of colors on the Fill Color dropdown menu, you can mix your own. Click the dropdown arrow and click More Colors.*

## Adding a graphic element

1. Click the graphics dropdown arrow on the Drawing toolbar.
2. Click the New Rectangle button.
3. Click on the map and drag a box where you want the rectangle.

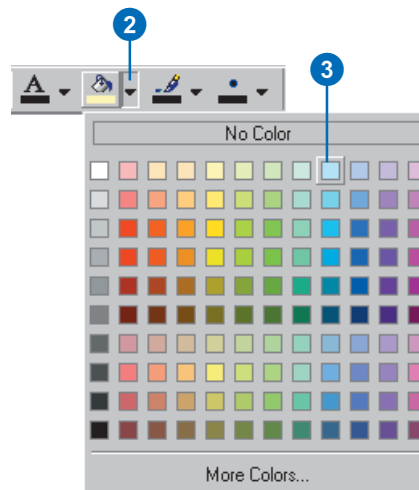
The graphic element appears on the map.



## Applying color to a graphic element

1. Click a graphic element to select it.
2. Click the Fill Color dropdown arrow.
3. Click a color.

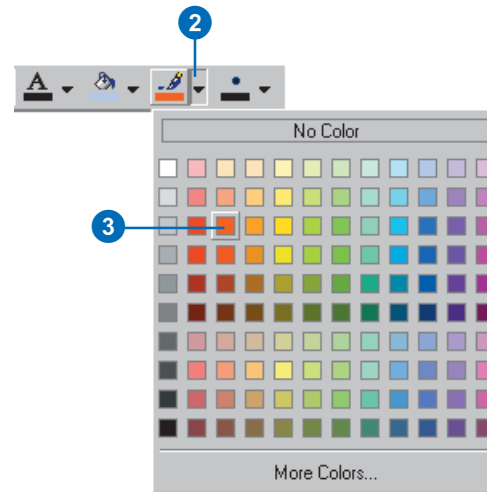
The fill color is applied to the graphic element.



## Applying a line color to a graphic element

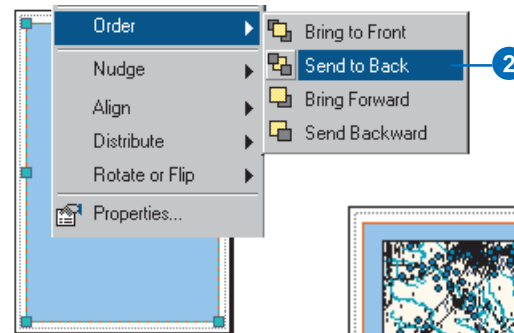
1. Click a graphic element to select it.
2. Click the Line Color drop-down arrow.
3. Click a color.

The line color is applied to the graphic element.

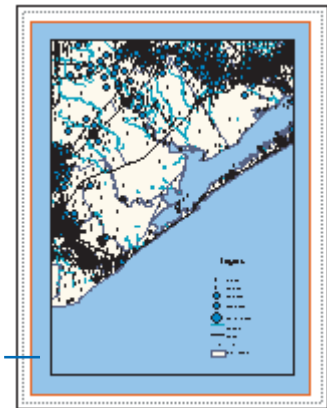


## Placing a graphic element behind other elements

1. Click the graphic element to select it.
2. Right-click on the graphic element, point to Order, and click Send to Back.

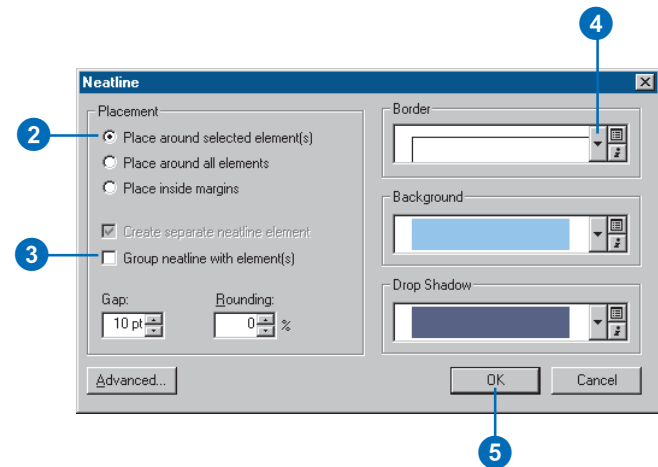
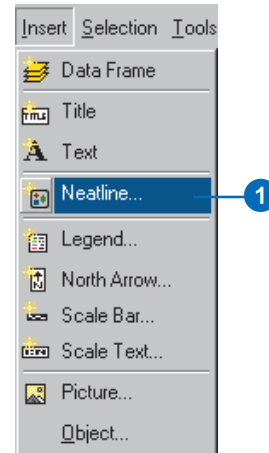


Graphic rectangle behind map elements



## Adding a neatline

1. Click the Insert menu and click Neatline.
2. Click the Placement option you want.
3. Check Group neatline with elements if you want to group the elements with the neatline.
4. Click the Border dropdown arrow and click the type of neatline you want.
5. Click OK.



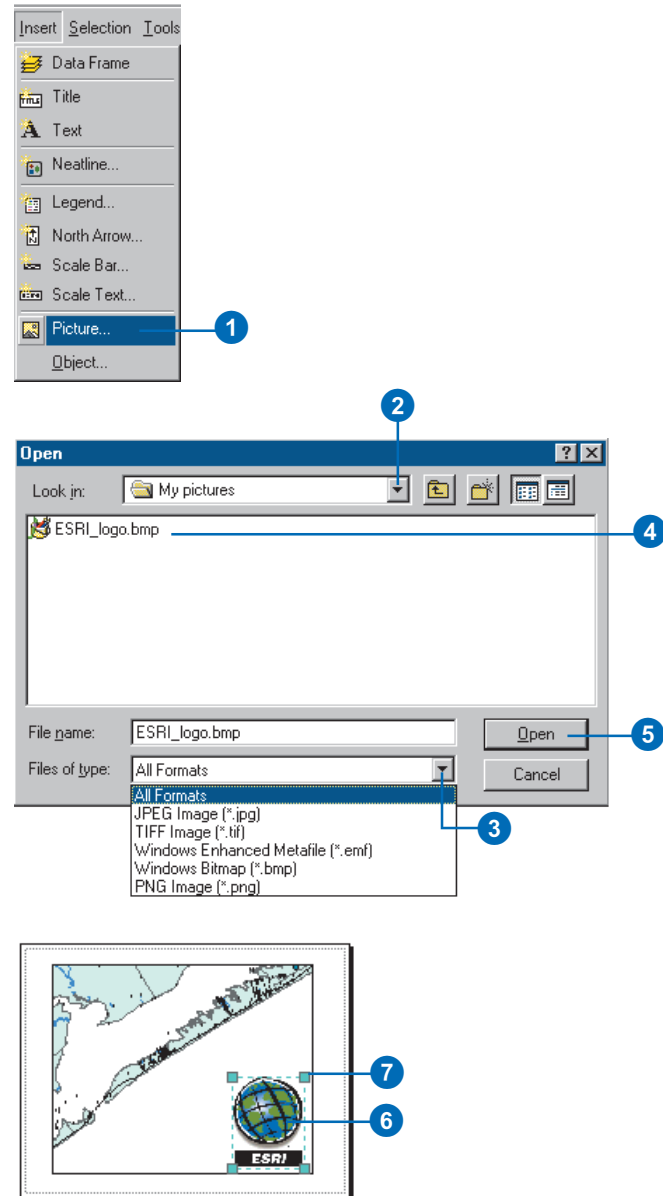
## Tip

### Stretching picture graphics

*ArcMap keeps the same ratio of width to height (the aspect ratio) when you resize picture graphics, so they won't be distorted when you change their size. If you want to make a graphic wider or taller without changing its other dimension, right-click the graphic, click properties, then uncheck 'Maintain aspect ratio' on the Picture tab. You can then stretch the graphic.*

## Adding a picture

1. Click Insert and click Picture.
2. Navigate to the folder that contains the picture.
3. Optionally, select the type of picture that you want to add.
4. Click the picture that you want to add.
5. Click Open.
6. Click and drag the picture into position on your map.
7. Optionally, resize the picture by clicking a selection handle and dragging it.





## Aligning and grouping map elements

Sometimes you'll have multiple elements that you want aligned on the map. For example, you might want the left edges of two legends to be aligned. You can quickly align map elements by using the Align tools.

If you have multiple elements that you've placed relative to each other and you want them to maintain the same relationship when they're moved, you can group them together. The map elements will be treated as a single element until you ungroup them.

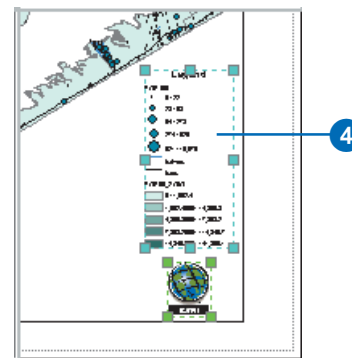
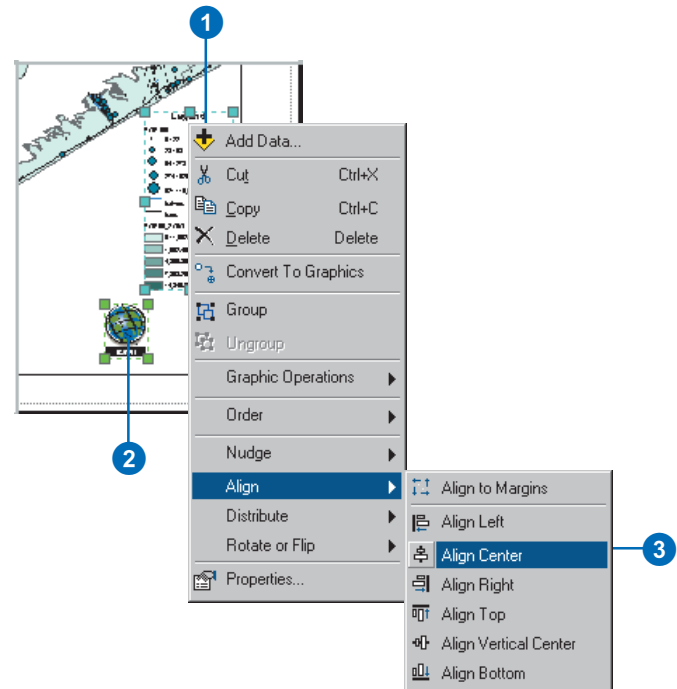
### Tip

#### Snapping to the map's margins when you align elements

*The Align tools can either align selected map elements with each other or with the margin of the map. If you click Align to Margins, the Align tools will snap selected elements to the margins of the map. Click Align to Margins again to make the Align tools align selected elements with each other.*

## Aligning map elements

1. Click one of the map elements to select it.
2. Hold the Shift key and click the other map element.  
Now both elements are selected.
3. Right-click on one of the selected elements, point to Align, and click Align Center.
4. Click the aligned map elements and drag them into position on your map.



## Tip

### Ungrouping map elements

To ungroup map elements, select the group, right-click it, and click *Ungroup*.

## Tip

### Resizing groups of elements

If you group some elements, you can click on the group and drag a selection handle to resize the group, just as you would a graphic.

The font size of text in a group will be scaled to match the new size of the group.

## See Also

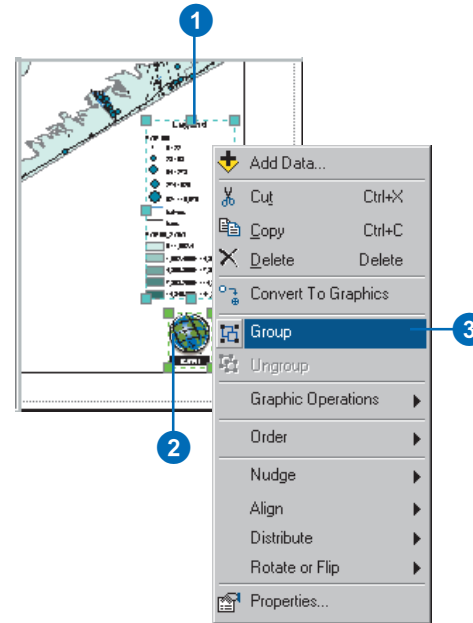
For more information on aligning, distributing, positioning, and ordering map elements, see Chapter 7, 'Labeling maps with text and graphics'.

## Grouping map elements

1. Click one of the map elements to select it.
2. Hold the Shift key and click the other map element.

Now both elements are selected.

3. Right-click on one of the selected elements and click *Group*.



## Printing a map

Once you've created a map, you'll probably want to print it.

It's a good idea to preview your map before you print it to make sure that the map page and printer page sizes are correctly matched.

If you want to print a map that is not set to be the same as the printer page size, there are several scenarios.

If the map is smaller than your printer page size, go ahead and print or choose a smaller page size on your printer.

If the map is larger than the printer's default page size, you have several options. You can change the page size of the printer, change the printer that you're using, or change the page size of the map. ►

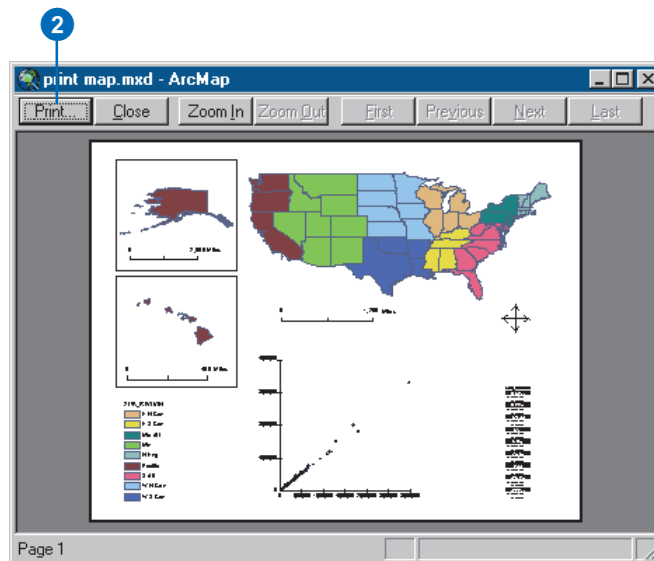
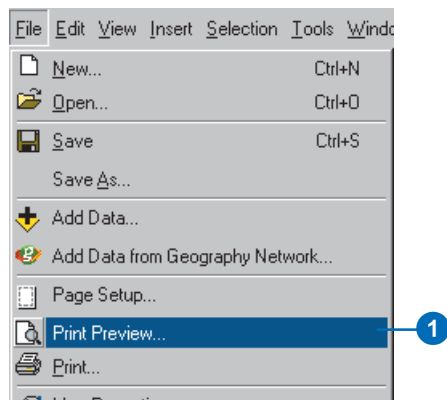
### Tip

#### Previews of maps with raster data layers

*Large maps with raster layers may look excessively dark in the small print preview window. This is because rasters are not resampled for the preview. This will not affect the way your map appears when it is printed at full scale.*

## Previewing and printing a map

1. Click File and click Print Preview.
2. Examine the preview. If it looks right, click Print. ►



If your printer will accommodate a large page but its default page size is smaller than your map, change the Printer Page size on the Page Setup dialog box.

If your printer cannot accommodate a page the size of the map, you can print the map as tiles on separate pages, scale the map to the printer page size, or simply proceed with printing and clip the map to the printer's page size.

If you have another printer on the network that will print your large map on a single page, you can switch to that printer. Just choose the new printer and the correct page size on the Page Setup dialog.

You can also change the page size of the map on the Page Setup dialog box. See 'Setting the page' in this chapter.

### Tip

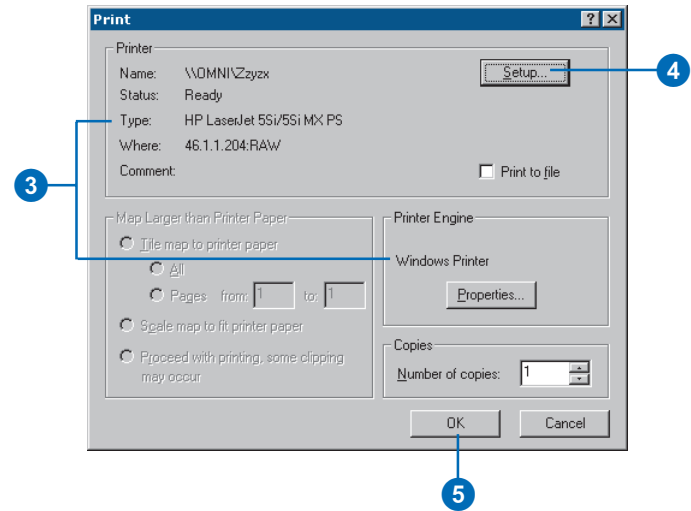
#### Set page size the same as printer

*If you have the page size set to be the same as the printer page, printing your map will be very simple—just click File, click Print, then click OK.*

### See Also

*For more information on setting the page size for a map, see 'Setting the page' in this chapter.*

3. Verify that you're printing to the correct printer with the printer engine you want.
4. Optionally, click the Setup button to display the Page Setup dialog and choose another printer engine. Click OK.
5. Click OK.

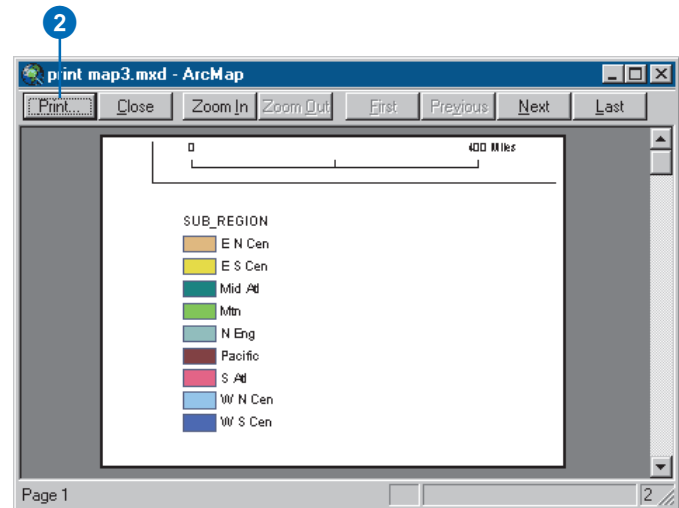


## Tiling a map that's bigger than your printer page

1. Click File and click Print Preview.

If the map page size is larger than the printer page size, you will see a portion of the map in the preview.

2. Click Print. ▶



## Tip

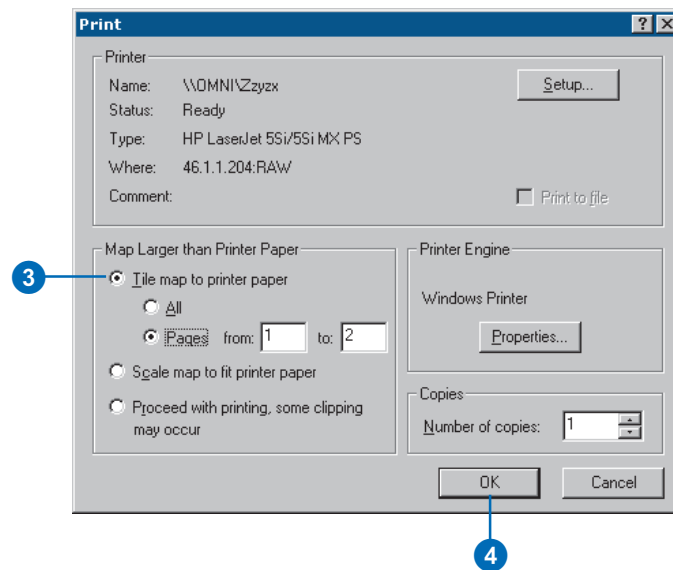
### ArcPress

For large or very complex maps or maps with rasters or transparent layers, the Windows® and PostScript® printer engines may produce print files that are larger and more complex than your printer can handle.

If your printer is unable to print your map, you should purchase the ArcPress™ printer engine to use with ArcMap.

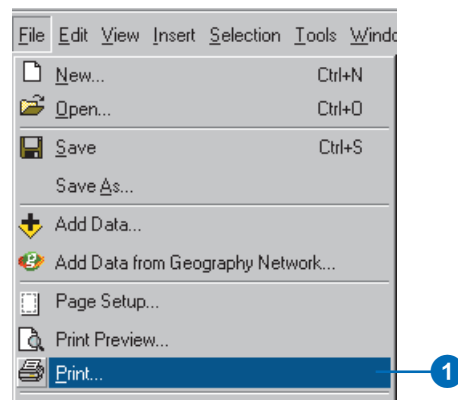
3. Click Tile map to printer paper.

4. Click OK.



## Printing multiple copies

1. Click File and click Print. ►



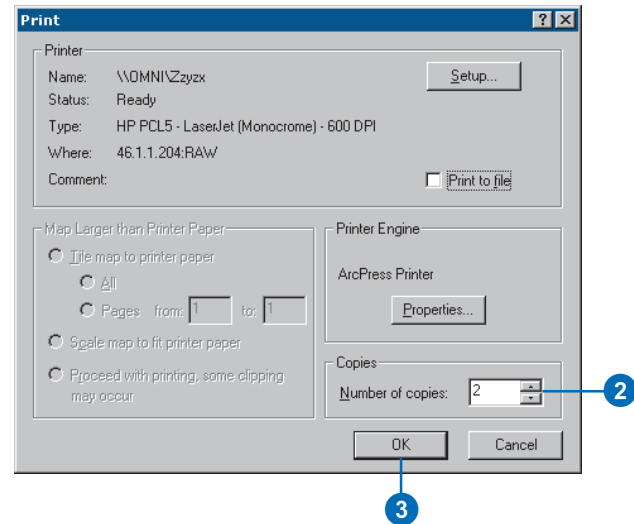
## Tip

### Page orientation

If you have the page size set to be the same as the printer page, the page orientation will match the best fit for the selected printer and printer engine.

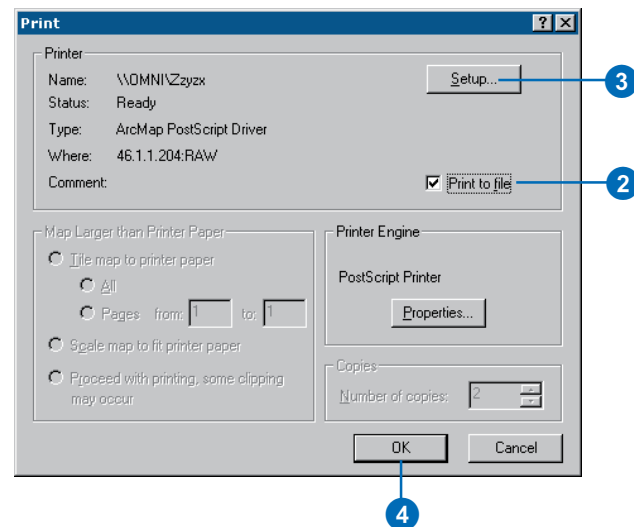
If you have a custom page size, the map's page orientation will be rotated according to the width and height of your map page. It's best to set the printer page orientation to match, or your map may be clipped.

2. Type the number of copies you want to print.
3. Click OK.



### Printing to a file

1. Click File and click Print.
2. Check Print to file.
3. Optionally, click the Setup button to display the Page Setup dialog and choose another printer engine. Click OK.
4. Click OK. ►

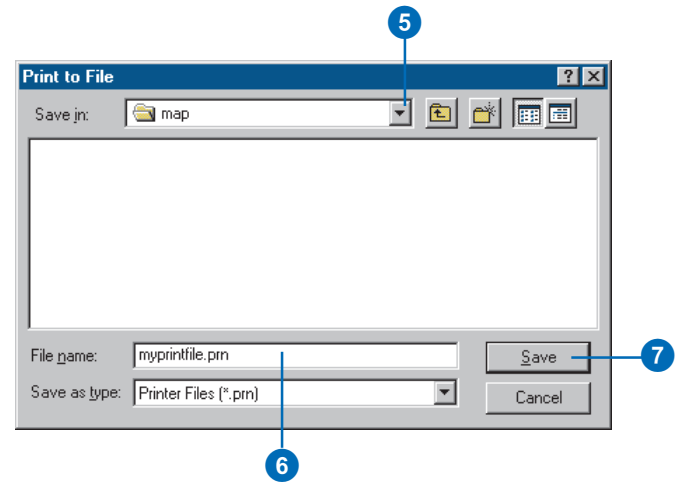


## Tip

### Print filename extensions

If you choose the Windows printer engine, you'll create a Windows printer file, \*.prn. If you choose the PostScript printer engine, you'll create a PostScript file, \*.ps. If you choose the ArcPress printer engine, you'll create a raster file with the extension of the ArcPress driver you've selected.

5. Navigate to where you want to save the output printer file.
6. Type a name for your print file.
7. Click Save.



## Changing the layout

A quick way to change the way your map looks is to change the layout so that it matches the layout of a template. To change the layout, use the Change Layout tool. This tool is ideally suited for maps that you haven't spent much time arranging and adding map elements to. For example, suppose you created an empty map, added a few layers to it, and symbolized the layers the way you wanted them to look. You could then use the Change Layout tool to arrange the map elements as defined in a layout.

When you change the layout, the resulting map will contain only those map elements that are defined in the template. For instance, if your original map has a legend but the template you want to use doesn't, the new layout will not contain a legend. Additionally, any map elements will be formatted as they are defined on the template, not on the original map. Thus, if you've spent a long time setting the properties of the map elements, you probably won't want to use the Change Layout tool as the settings will not carry over to the new layout.

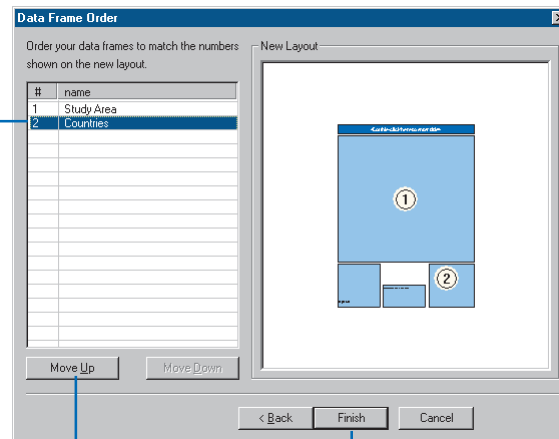
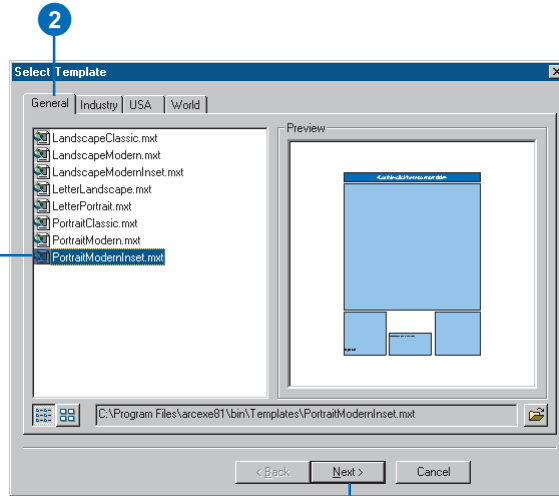
## Changing the layout

1. Click the Change Layout tool on the Layout toolbar.
2. Click the tab containing the template you want to use to change the layout.
3. Click the template you want to use to use.
4. Click Finish if the number of data frames on the map matches the number of data frames in the template.

Click Next if the number of data frames on the map doesn't match the number of data frames in the template and proceed to the next step to arrange the data frames on the map.

5. Click the data frame you want to position on the map.
6. Click Move Up or Move Down to change its position in the list.
7. Click Finish.

Order the data frames to position them appropriately on the layout. If your map has more data frames than the template provides space for, the extra data frames will be positioned at the lower-left corner of the map.





## Exporting a map

Once you've created a map, you may want to export it from a map document to another file type.

You can export maps as several types of image files. These include EMF, BMP, EPS, PDF, and JPEG (and several more types if you have ArcPress).

EMF (Enhanced Windows Metafiles) are Windows native vector, or vector and raster, graphics. They are useful for embedding in Windows documents because they can be resized without distortion.

BMP (Windows Bitmap) files are simple, native Windows raster images. They do not scale as well as EMF files.

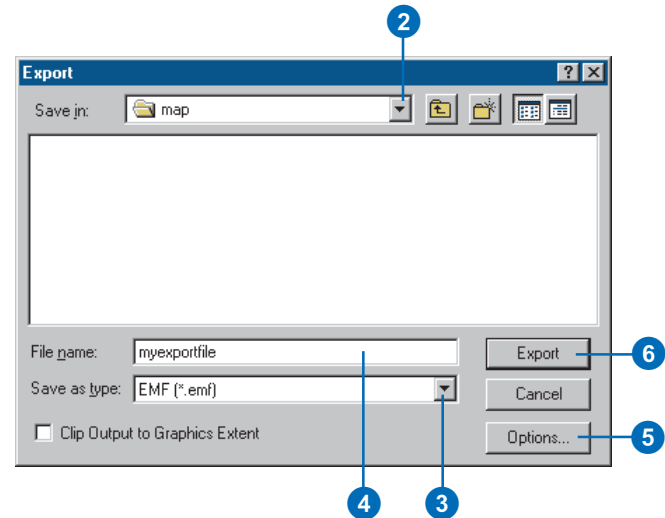
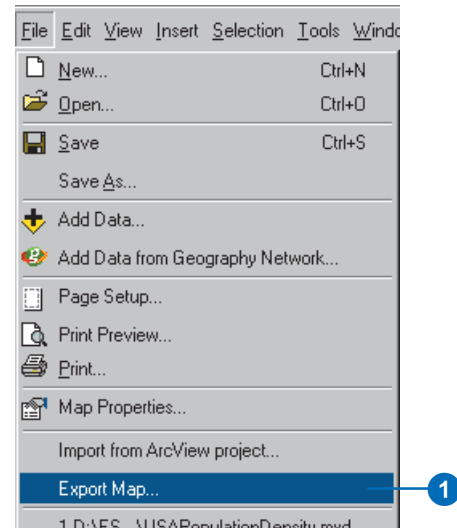
EPS (Encapsulated PostScript) files are primarily used for vector graphics and printing.

PDF (Portable Document Format) files are designed to be consistently viewable across different platforms. They are commonly used for distributing documents on the Web.

JPEG (Joint Photographic Experts Group) files are compressed image files. They are commonly used for images on the Web because they are more compact than many other file types.

## Exporting a map

1. Click File and click Export Map.
2. Navigate to where you want to save the export file.
3. Click the Save as type dropdown arrow and click the type of file that you want to export.
4. Type a name for the export file.
5. Optionally, click Options and set parameters for the file type that you chose.
6. Click Export.





# Working with styles and symbols

# 9

## IN THIS CHAPTER

- Using styles to create maps
- Finding the styles you need
- Modifying and saving symbols
- Modifying and saving map elements
- Saving the current styles
- The Style Manager
- Organizing style contents
- Creating new symbols and map elements
- Creating line symbols
- Creating fill symbols
- Creating marker symbols
- Creating text symbols
- Working with color

Styles provide a complete set of tools to help you create a map. Each style contains a suite of symbols and map elements that provide information about symbol properties, label specifications, color schemes, legend and scale bar characteristics, coordinate reference systems, and much more.

Styles help to describe not only how data is drawn, but also the appearance and placement of map elements, symbols, and other cartographic additions on your map. Every time you select and apply a particular map element or symbol, you are using the contents of a style.

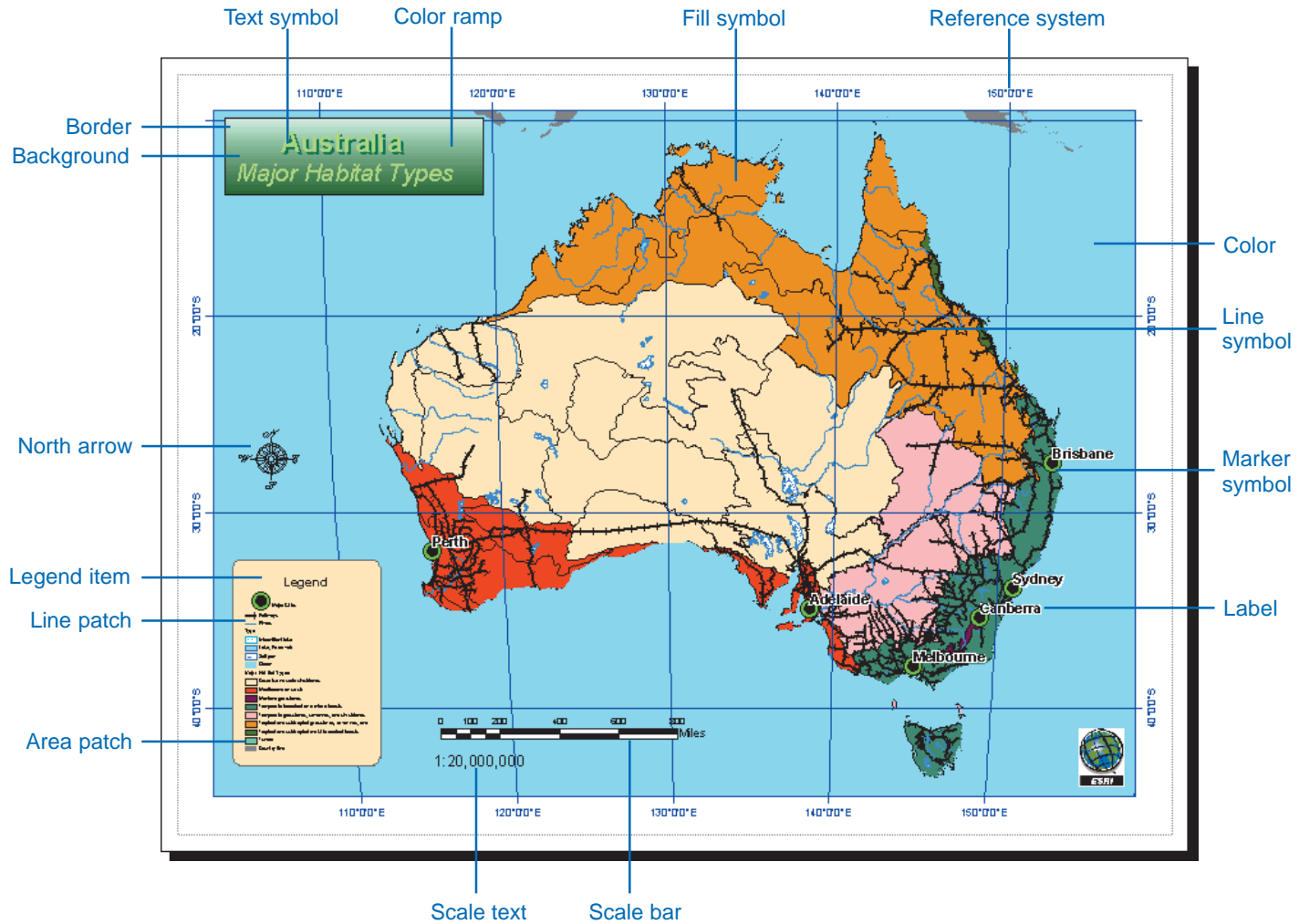
Styles are designed to be used with map templates and feature layers. A style or group of styles can be referenced with a map template to help you create a map for a specific purpose or a map series.

Styles can help you maintain standards for symbols, colors, patterns, and methods of rendering distributions, relationships, and trends. Using familiar styles lets your map communicate in the most effective way. Styles enable people to easily explore, understand, and analyze a map. ArcMap comes with a wide variety of styles to help you create maps that convey the right message for a specific application and audience.

In the previous chapters, you have learned how to symbolize data and how to draw map elements and graphics. You are probably already familiar with most of the symbol and map element dialog boxes.

In this chapter, you will learn how to create the symbols you want and save them in styles you can reuse to produce maps that meet the needs of your organization.

# Using styles to create maps



## Finding the styles you need

By default, ArcMap displays a robust set of generic symbols and map elements from the style of ESRI. It also comes with a wide range of industry-specific styles. To create maps for your application, you may need to use components from one or more styles. When a style is *referenced*, its map elements and symbols are available throughout ArcMap.

As you compose your map, you will see these symbols throughout the user interface.

You can add more styles or remove styles at any time during an ArcMap session.

### Tip

#### Are there other ways to reference styles?

You can reference styles in the Style Manager dialog box and in the Symbol Selector dialog boxes. However, the Symbol Selector dialog boxes only list the styles that contain the same symbols.

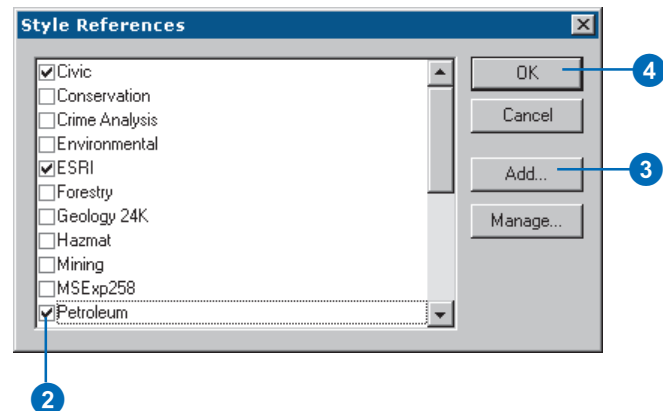
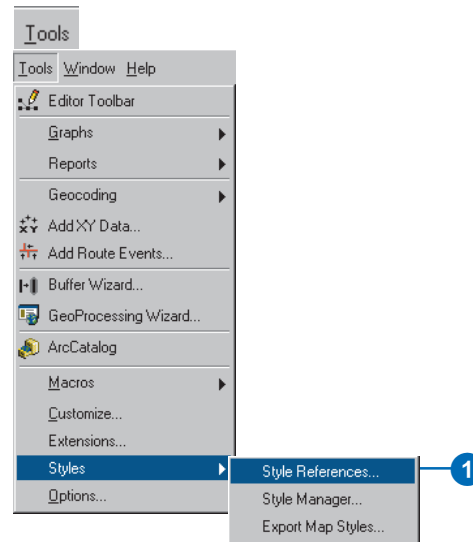
### Tip

#### Can I install just the styles I need?

You can use the custom ArcMap installation to load only the styles you want to have accessible in ArcMap.

1. Click Tools, point to Styles, and click Style References.  
Your personal style and the ESRI style are referenced by default.
2. Check the additional styles you want to use.
3. Click the Add button to load more styles.
4. Click OK.

Navigate to and click the styles you need.



## Modifying and saving symbols

As you compose your map, you may want to modify the symbols you've used to draw data and graphics.

You may also want to open a saved map document and make modifications.

When you save your changes from the Symbol Selector dialog box, the new symbols are stored in your personal style. Later, you can use the Style Manager to move them into another style.

### Tip

#### Why can't I modify the color of a symbol?

*Sometimes a symbol layer or layers are locked. In this case, you can click Properties and use the Symbol Editor dialog to modify the colors you want.*

### Tip

#### What's a symbol category?

*When you save a symbol, you can specify a name and a category for class distinction. The category can be used to differentiate drawing methods and other criteria. It can be viewed in the Style Manager dialog box.*

## Modifying and saving symbols used to draw feature layers

1. In the Table of Contents, click the symbol you want to modify.

The Symbol Selector dialog box is displayed.

2. Double-click on a symbol.

3. If you want to make further simple modifications, use the Color and Width Options to set specific properties.

4. If you want to make further advanced modifications, click Properties to access the Symbol Editor dialog box and make the changes you want.

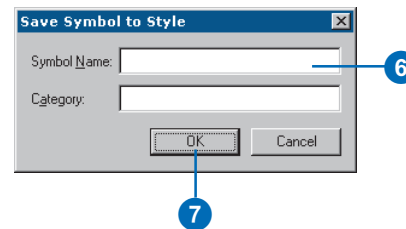
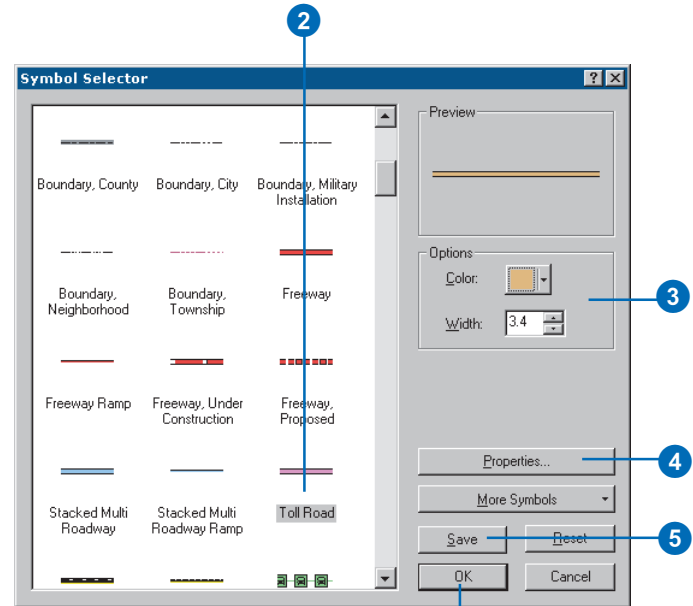
5. Click Save.

6. Type a Symbol Name.

Your new symbol is saved in your personal style and appears at the top of the Style contents window.

7. Click OK.

8. Click OK.



## Tip

**What's the difference between modifying symbols used to draw data and symbols used to draw graphics?**

*Graphics have an additional property tab for size and position in relation to the page.*

## Tip

**Shortcut to the Symbol Property Editor dialog box**

*Instead of clicking the Properties button on the Symbol Selector dialog box, you can click on the Preview window.*

## Tip

**Can I modify my data with the Draw toolbar shortcuts?**

*Only if you have exported your data to a graphics layer. The Draw toolbar is only for graphics.*

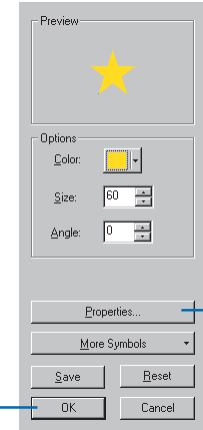
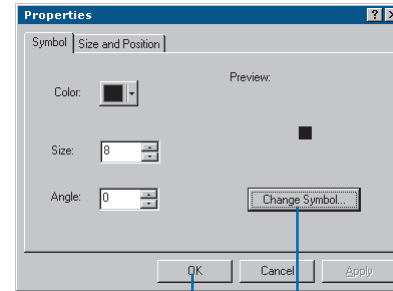
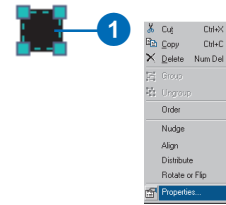
## Tip

**What units are used in the symbol dialog menus?**

*The Symbol Selector dialog menus and map element Properties dialog menus use points. The Symbol Property Editors can be set to use points, inches, centimeters, or millimeters.*

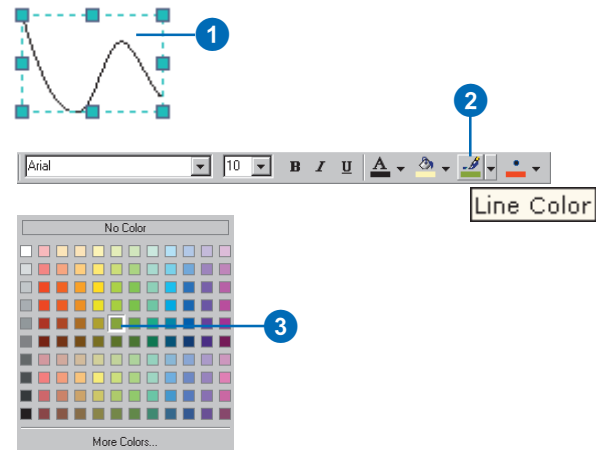
## Modifying symbols used to draw graphics

1. In layout view, double-click a graphic element on the map or click the context menu and click Properties.
2. Change the Color, Size, and Angle options as needed or click Change Symbol and choose another symbol.
3. If you want to make further advanced modifications, click Properties to access the Symbol Editor dialog box and make the changes you want.
4. Click OK.



## Using the Draw toolbar to make quick symbol changes

1. In layout view, click to select the graphic element you want to modify.
  2. Click the appropriate shortcut button on the Draw toolbar.
  3. Click the new property.
- Your changes are immediately applied.



# Modifying and saving map elements

When you insert a map element on the map layout, you can modify its properties. Later, you may decide to make more changes and save them to use in another map.

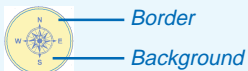
Most map elements are composed of a mix of symbols and map elements. For example, the North arrow's graphic comes from a marker that is created from a font, and its frame comes from a border and background that are created from other symbols.

The graphic example here shows you how to modify this element.

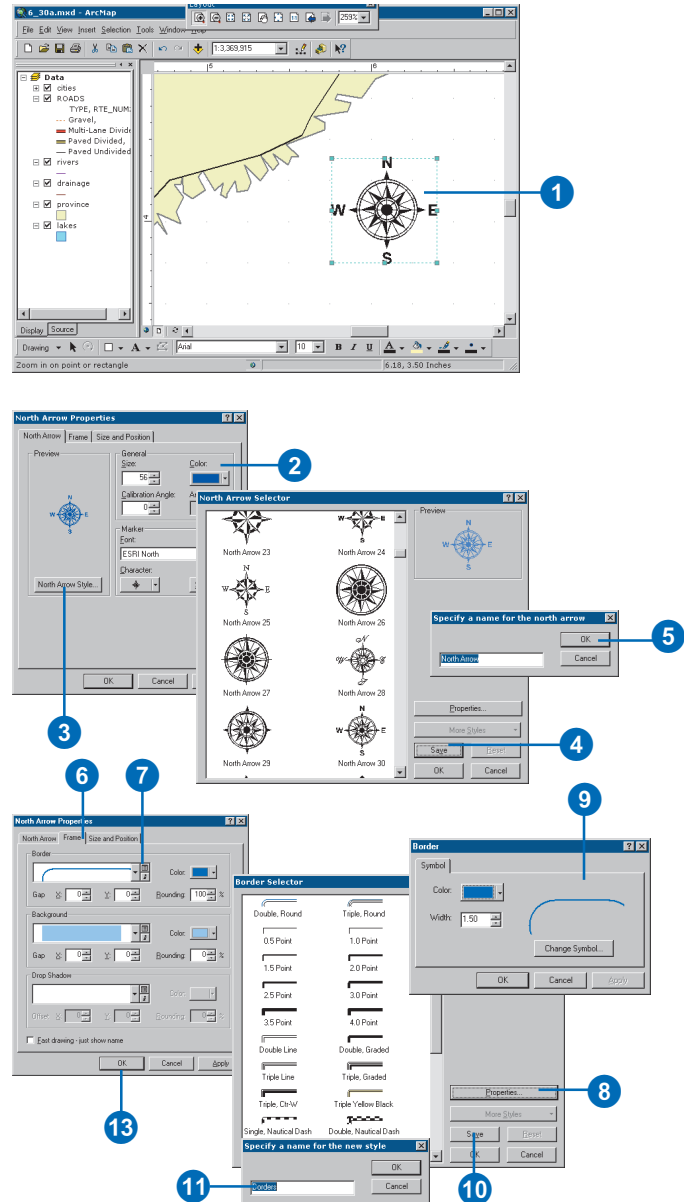
## Tip

### What's the difference between modifying symbols and map elements?

Map elements have an additional *Frame* tab for background and border properties.



1. In layout view, double-click on the element you want to modify.
2. Click the Color dropdown arrow and click a new color.
3. Click the Style button.
4. Click Save.
5. Type a name and click OK.
6. Click the Frame tab.
7. Click the Style button to change the border style.
8. Click Properties.
9. In the Symbol Border dialog box, click the properties you want.
10. Click Save.
11. Type a name and click OK.
12. Repeat steps 7 through 11 to set the background style and properties.
13. Click OK.





## Saving the current styles

Saving your current map styles is an easy way to generate a style containing all the elements and symbols used in your map.

You can create and modify map elements and symbols as you design your map and then save everything into a style.

Exporting map styles also allows you to save map elements and symbols from many styles into a single style.

### Tip

#### How are symbols stored in a map document?

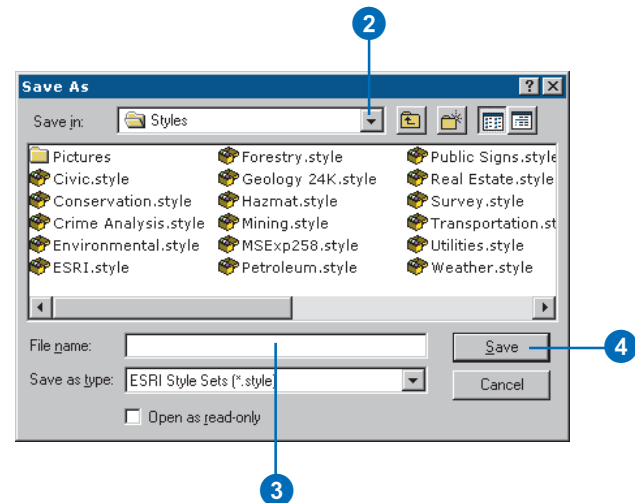
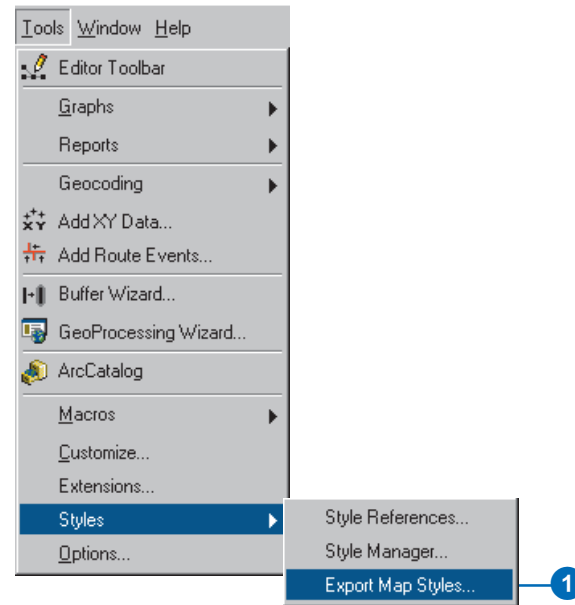
*When you draw anything in ArcMap—symbols, map elements, and graphics—it's copied into the map document. Therefore, you don't need the original referenced styles to open and draw the map again.*

### Tip

#### Can I create a style from any map without any referenced styles?

*If you need to modify the symbols in a map and don't have the original styles, you can easily create a style of the existing map elements and symbols.*

1. Click Tools, point to Styles, and click Export Map Styles.
2. Navigate to where you want to save the new style.  
By default, the browser is set to your Styles folder.
3. Type a style name.
4. Click Save.



# The Style Manager

The image shows the Style Manager window in ArcMap. It is divided into several sections:

- Left Panel (Style Tree):** A tree view showing the folder structure of styles. The 'Color Ramps' folder is selected. Callout: "Style tree. Open the map element or symbol folder you want to view."
- Top Panel (Name and Category):** A table listing styles. Callouts point to the 'Name' and 'Category' columns.
 

Name	Category
Precipitation	Default Ramps
Temperature	Default Ramps
Elevation #1	Default Ramps
Elevation #2	Default Ramps
Red to Blue Divergi...	Dichromatic Ramps
Red to Blue Divergi...	Dichromatic Ramps
Purple to Green Di...	Dichromatic Ramps
Purple to Green Di...	Dichromatic Ramps
Brown to Blue Gree...	Dichromatic Ramps
Brown to Blue Gree...	Dichromatic Ramps
Partial Spectrum 1 ...	Dichromatic Ramps
Partial Spectrum 2 ...	Dichromatic Ramps
Pink to YellowC...	mps
Pink to YellowC...	mps
Red to Green C...	mps
Red to Green C...	mps
Pastels	Default Schemes
Muted Pastels	Default Schemes
Enamel	Default Schemes
Dark Glazes	Default Schemes
Cool Tones	Default Schemes
- Right Panel (Style Contents):** A list of styles. A context menu is open over the list. Callouts include:
  - "Style contents."
  - "Category of the element or symbol."
  - "Referenced styles."
  - "Load more styles."
  - "Create new styles."
- Bottom Panel:** Callout: "Resize the left and right panels."
- Bottom Right:** Callout: "Style Contents view modes."

Other callouts on the left side of the window:

- "Your personal style contains all your saved symbol and map element modifications."
- "ESRI style contains a default set of map elements and symbols."

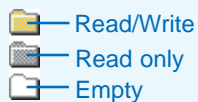
## Organizing style contents

The Style Manager dialog box lets you organize styles and their contents—symbols and map elements. You can cut, copy, paste, rename, and modify any style contents. You can also create new styles, symbols, and map elements.

You can create a new style and copy in your personal style contents as well as symbols and map elements from other existing styles.

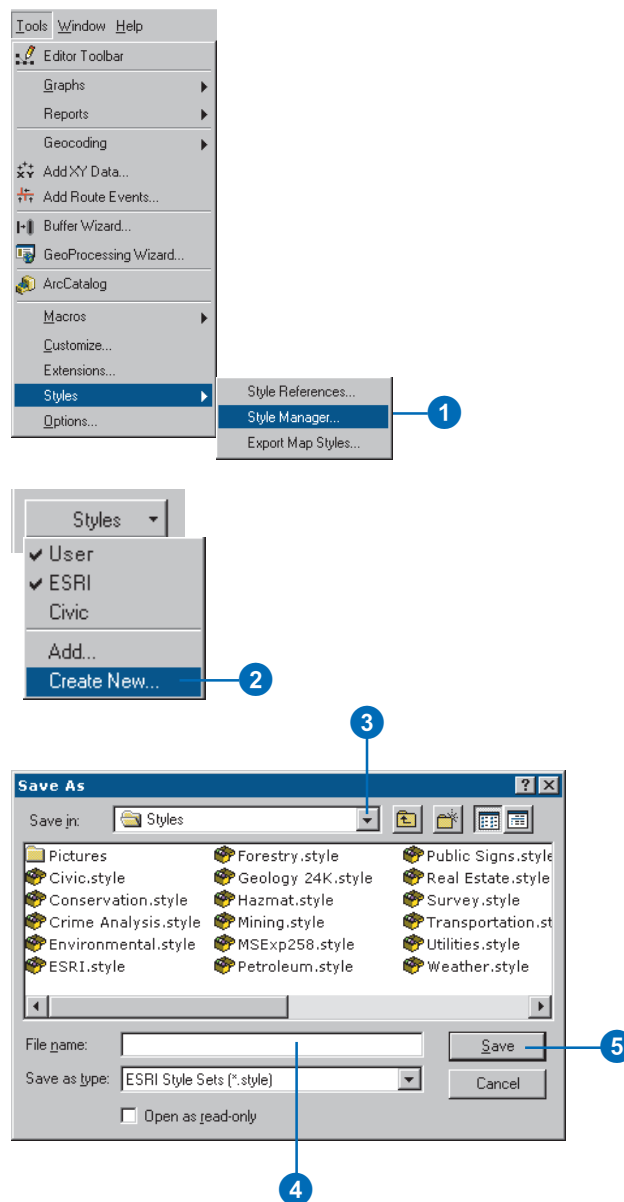
You may want to customize some of the ArcMap-provided styles by deleting the symbols and map elements you don't need.

You can easily distinguish which style folders contain map elements and symbols, which can be modified, and which are empty.



## Creating a new style

1. Click Tools, point to Styles, and click Style Manager.
2. Click Styles and click Create New.
3. Navigate to the Styles folder.
4. Type the name for the new style you're creating.
5. Click Save.



## Tip

### Where is the Styles folder installed?

By default, the Styles folder is installed \bin\Styles folder where ArcGIS is installed.

## Tip

### Where is my personal style folder installed?

Your personal style folder is installed under the Windows install location, for example, C:\WINNT\Profiles\

## Tip

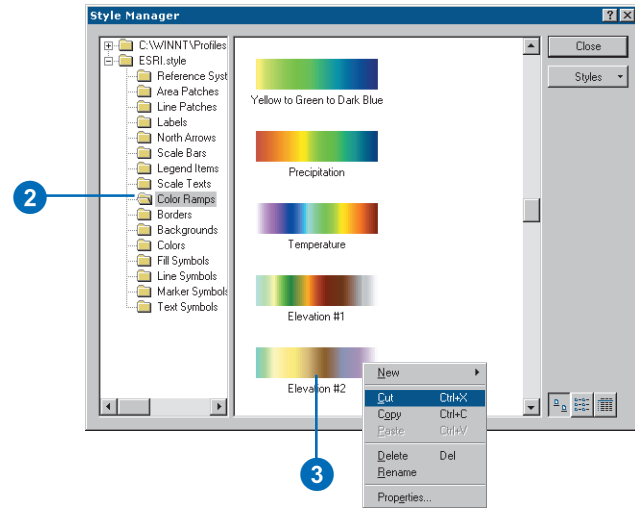
### Using shortcut keys

You can use keyboard shortcuts to cut, copy, paste, and delete styles.

## Copying and pasting style contents

1. Click Tools, point to Styles, and click Style Manager.
2. Click the style folder whose contents you want to view.
3. Click an element and click Cut or Copy.
4. Click another style folder of the same kind.
5. Right-click in the contents window and click Paste.
6. Type a new name for the style.

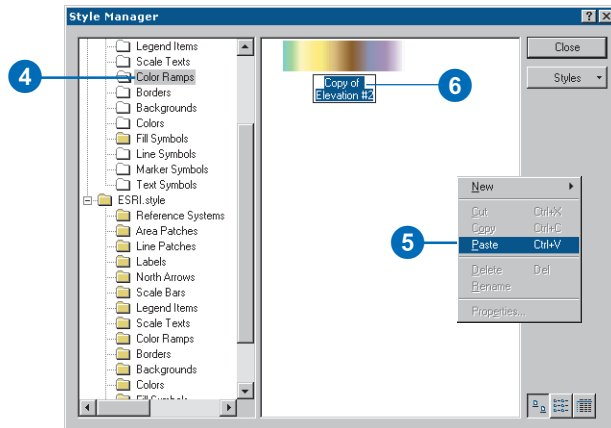
You can change the name later by using Rename on the context menu.



## Deleting style contents

Click on any map element or symbol and click Delete from the context menu.

There is no undo for delete, so you may want to move something to another folder for later use rather than deleting it.



## Creating new symbols and map elements

When you're creating symbols and map elements from scratch, use the Style Manager dialog box. You can create new symbols to add to the style contents, or you can modify an existing symbol.

### Tip

#### Why should I lock or unlock a symbol layer?

The locking property controls whether or not the color option can be modified in the Symbol Selector dialog box. A locked layer can't be modified.

### Tip

#### Why should I turn off drawing for a symbol layer?

You might want to modify the symbol for a particular application but not want to lose the original symbol definition.

### See Also

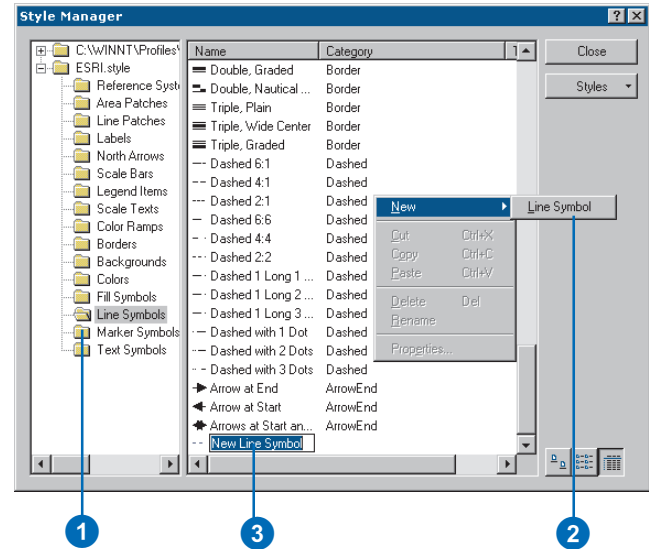
To learn how to automate map production by matching symbol names to data attributes, see Chapter 6, 'Symbolizing your data'.

## Creating a new symbol in the Style Manager

1. In the style tree, click the symbol folder where you want to create more symbols.
2. Right-click in the open space in the Symbol contents window, point to New, and click Line Symbol.

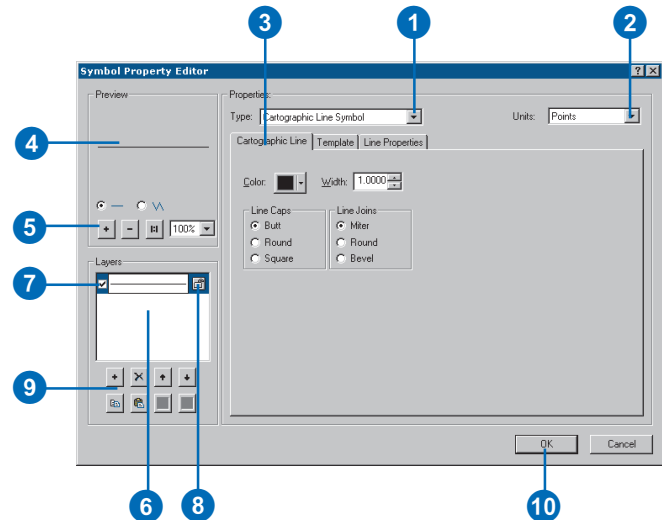
Use the properties in the Symbol Property Editor dialog boxes to create the symbol you want and click OK.

3. Name the new symbol.



## Using common symbol properties

1. Set the symbol type.
2. Set the units of measure.
3. Click tabs for applicable properties.
4. Preview all layers.
5. Preview mode options.
6. Preview each layer.
7. Set layer drawing on or off.
8. Set color locking on or off.
9. Select layer options to add, delete, move up, move down, copy, and paste.
10. Click OK.



## Creating line symbols

Line symbols are used to draw linear data such as transportation networks, water systems, boundaries, zonings, and other connective networks. Lines are also used to outline other features such as polygons, points, and labels. As graphics, lines can be used as borders, leaders for arrows and other annotation, and freehand drawing.

The examples here show you how to create some common line symbols: an encased road, a railroad, a touring route, and arrowhead leaders.

The four line types are as follows:

- Simple—fast-drawing, one-pixel lines with predefined pattern; or solid, wide lines
- Cartographic—straight line template patterns and marker decorations
- Hash—hashures, template patterns, and marker decorations
- Marker—markers, template patterns, and other marker decorations

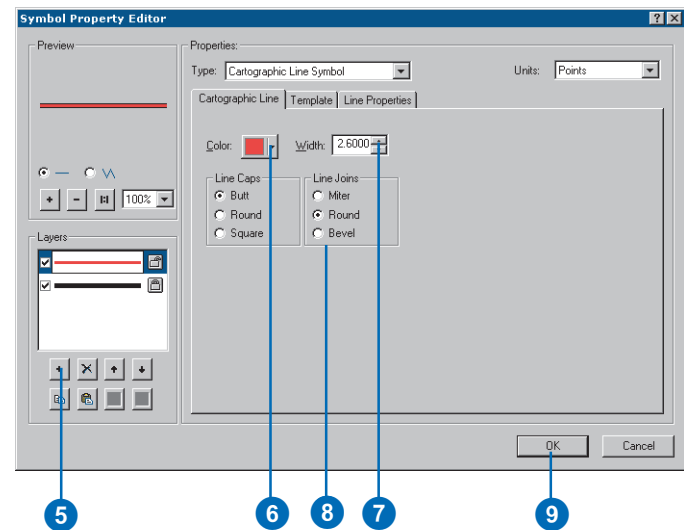
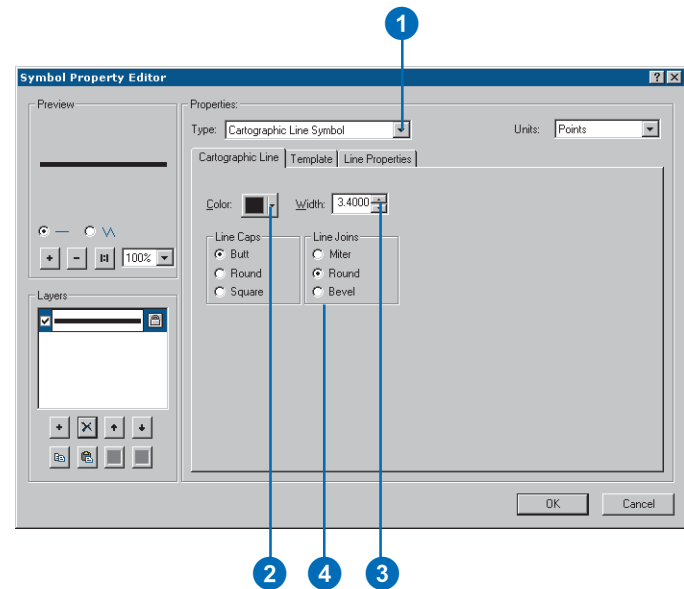
Any number of layers can be combined in a single line.

## Creating an encased road

1. In the Line Symbol Property Editor dialog, click the Type dropdown arrow and click Cartographic Line Symbol.
2. Click the Color dropdown arrow and click black.
3. Set the Width to 3.4 points.
4. Click Butt for Line Caps and Round for Line Joins.
5. Click the Add a New Layer button.

Cartographic Line Symbol should already be selected as the Type.

6. Click red from the Color palette.
7. Set the Width to 2.6 points.
8. Click Butt for Line Caps and Round for Line Joins.
9. Click OK.



## Tip

### How do I modify a hash?

*The hash mark uses a line symbol to set the color, width, caps, and joins.*

## Tip

### How do I get intersecting road networks and other features to draw realistically?

*You can reorder any feature layer by using the Advanced Drawing Options menu accessed by right-clicking on a layer.*

*For more control, it is also helpful to symbolize features using the drawing method to depict unique values.*

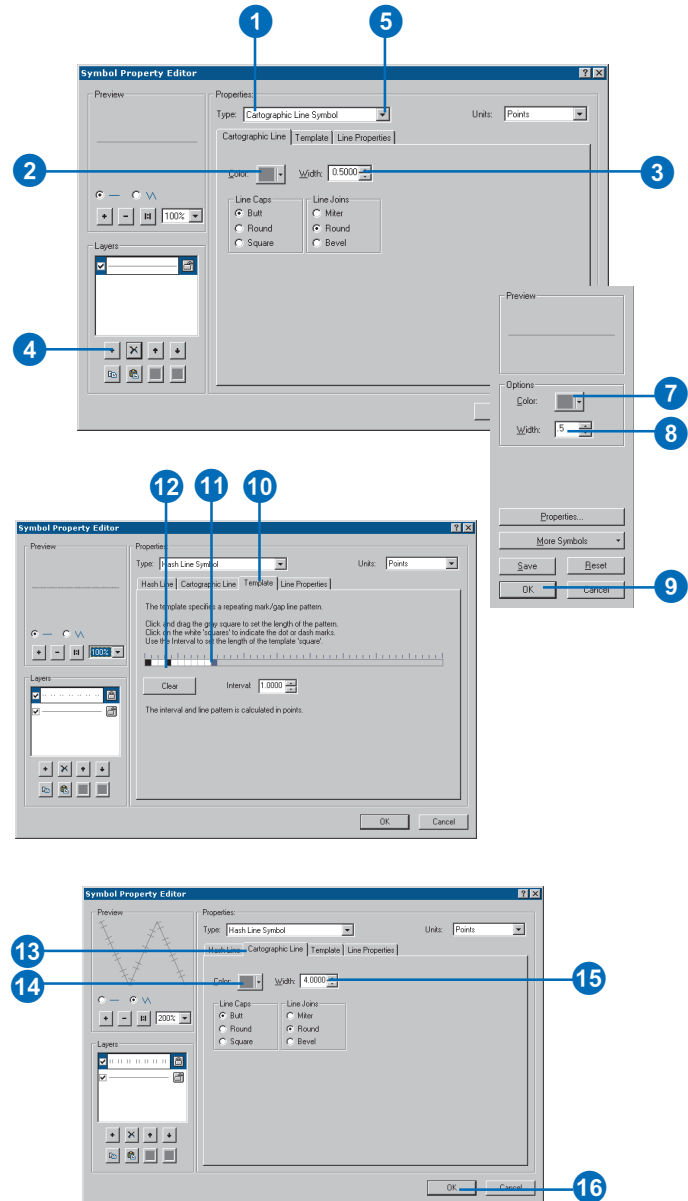
## Tip

### Why shouldn't I use two parallel lines for road encasements?

*Using a single wide layer produces more realistic symbology where roads intersect and merge.*

## Creating a railroad

1. In the Line Symbol Property Editor dialog, click the Type dropdown arrow and click Cartographic Line Symbol.
2. Click the Color dropdown arrow and click a gray shade.
3. Adjust the Width to 0.5000 points.
4. Click the Add Layer button.
5. Click the Type dropdown arrow and click Hash Line Symbol.
6. Click the Hash Line tab and click Hash Symbol.
7. Click the Color dropdown arrow and click a gray shade.
8. Adjust the Width to 0.5000 points.
9. Click OK.
10. Click the Template tab.
11. Slide the dark gray square to the 11th position to create a pattern length of 10 units.
12. Click the 4th position to add another hash.
13. Click the Cartographic Line tab.
14. Click the Color dropdown arrow and click a gray shade.
15. Adjust the Width to 4.0000 points.
16. Click OK.



## Tip

### How do I align multilayer symbols using the Template tab?

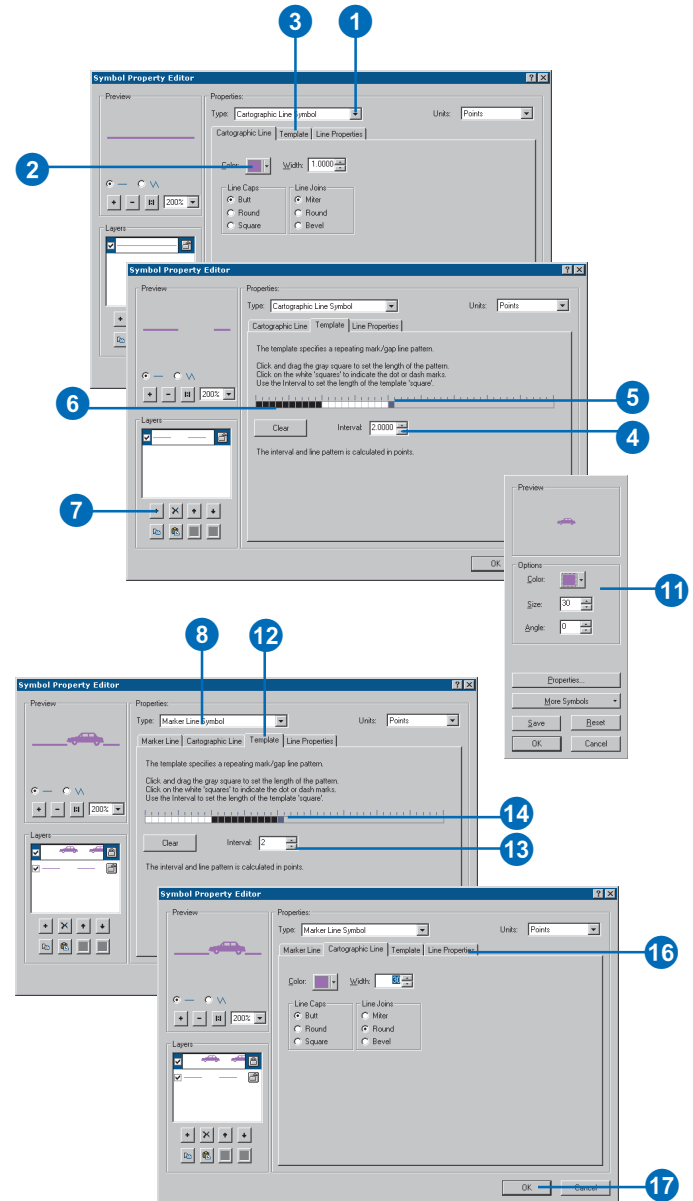
The *Template* tab lets you design a common template for the symbol layers that need to be synchronized. You can use the same template to stack and center line dashes with markers, or you can reverse the template pattern to center the marker in the gap as shown in the touring route example.

For hash lines, the template mark indicates how many dashes will occur in the pattern segment.

You can create a wide variety of effects with multiple line layers. Aligning the layer patterns is achieved by having a common denominator for the template and interval settings.

## Creating a tour route

1. In the Line Symbol Property Editor dialog, click the Type dropdown arrow and click Cartographic Line Symbol.
2. Click the Color dropdown arrow and click a color.
3. Click the Template tab.
4. Adjust the Interval to 2 points.
5. Slide the dark gray square to the 21st position to create a pattern length of 20 units.
6. Click positions 1–10 to create a dash.
7. Click the Add Layer button.
8. Click the Type dropdown and click Marker Line Symbol.
9. Click Marker.
10. Click More Symbols and click Civic.
11. Click the Car-Generic symbol, set the Color, set the Size to 30, and click OK.
12. Click the Template tab.
13. Adjust the Interval to 2.
14. Slide the dark gray square to the 21st position to create a pattern length of 20 units.
15. Click positions 11–20.
16. Click the Line Properties tab and set the Offset to 3.
17. Click OK.





## Tip

### Can I create leaders with markers other than arrows?

You can use any marker you want to create start or end decorations. The default arrow lets you adjust its length and height. The ESRI Arrowhead font contains additional arrow styles, but you can also use any marker for line decorations.

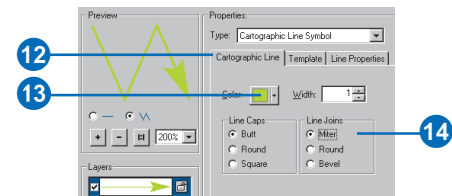
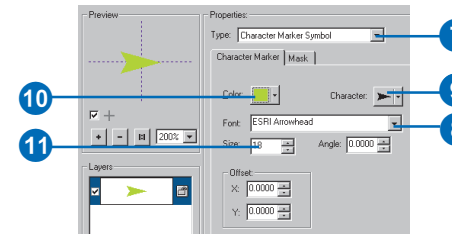
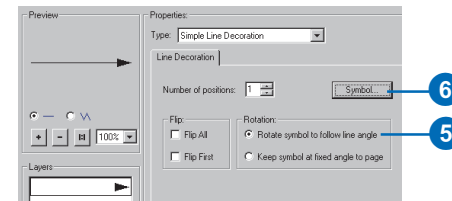
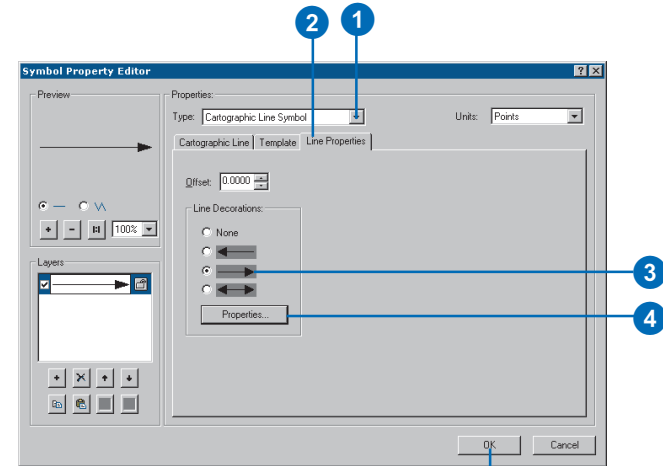
## Tip

### Why do my line arrows sometimes appear horizontal to the map?

You can toggle the arrowheads to follow the line orientation or stay at a fixed angle to the map. See step 5 in the task on this page.

## Creating arrowhead leaders

1. In the Line Symbol Property Editor dialog, click the Type dropdown arrow and click Cartographic Line Symbol.
2. Click the Line Properties tab.
3. Click the right-facing arrow.
4. Click Properties.
5. Click Rotate symbol to follow line angle.
6. Click Symbol and click Properties.
7. Click the Type dropdown arrow and click Character Marker Symbol.
8. Click the Font dropdown arrow and click ESRI Arrowhead.
9. Click the Character dropdown arrow and click 37.
10. Click the Color dropdown arrow and click a green shade.
11. Set the Size to 18 points and click OK on all dialog boxes.
12. Click the Color dropdown arrow and click a green shade.
13. Click Butt for Line Caps and Miter for Line Joins.
15. Click OK.



## Creating fill symbols

Use fill symbols to draw polygonal features like countries, provinces, land uses, habitats, parcels, and footprints. Fills can be solid, gradients, hatched overlays, random markers, and transparent or opaque pictures. In addition, a polygonal data layer can be given a percentage of transparency. Fills are also used to draw graphic shapes and backgrounds, data frames, map elements, graphics, and text.

The five fill types are:

- Simple—fast-drawing solid fill with optional outline
- Gradient—linear, rectangular, and circular color ramp fills
- Line—hatched lines at any angle, separation, or offset
- Marker—marker symbols drawn randomly or ordered
- Picture—continuous tiling of a .bmp (Windows bitmap) or .emf (Windows enhanced metafile) graphic

Any number of layers can be combined in a single fill.

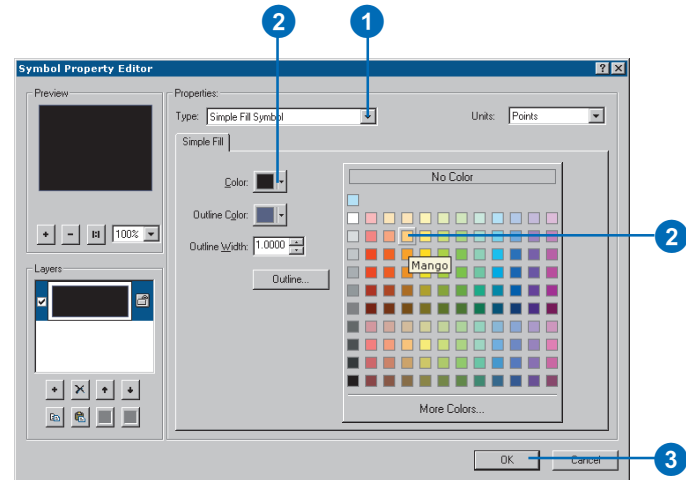
### Tip

#### Creating custom outlines

Click Properties and use the Line Symbol Editor dialog to design a custom outline.

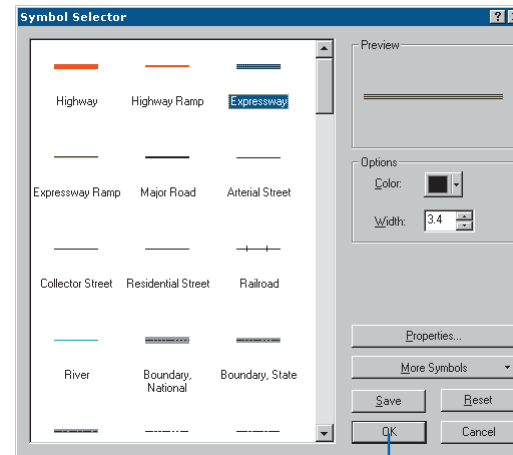
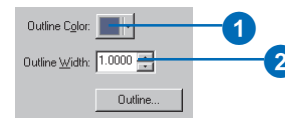
## Creating a solid fill

1. In the Fill Symbol Property Editor dialog, click the Type dropdown arrow and click Simple Fill Symbol.
2. Click the Color dropdown arrow and click the color you want.  
  
Or click More Colors and use the Color Selector dialog box to mix a new color.
3. Click OK.



## Adding a fill outline

1. Click on Outline Color and click the color you want to use.
2. Set the Outline Width or click Outline to choose a predefined line symbol.  
  
Alternatively, use the line properties menu to create a new outline.
3. Click OK.



## Tip

### Do I have to use a predefined color ramp to create a gradient fill?

You can modify an existing color ramp or create a new one as you create the gradient symbol. See steps 5 through 9 in the task on this page.

## Tip

### Are there different kinds of color ramps to use with gradient fills?

There are four types of color ramps designed to communicate quantitative data, temperature, and elevation and to draw polygonal fills.

The four color ramp types are:

- Algorithmic—linear stretch between one or two specified end colors
- Random—alternating bands of random colors
- Multipart—combines other color ramp elements in a continuous band
- Preset—a ramp of individually specified colors

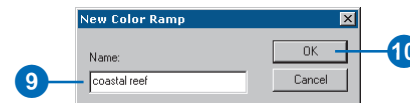
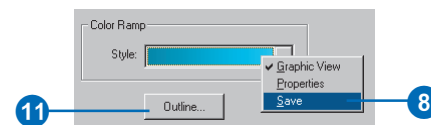
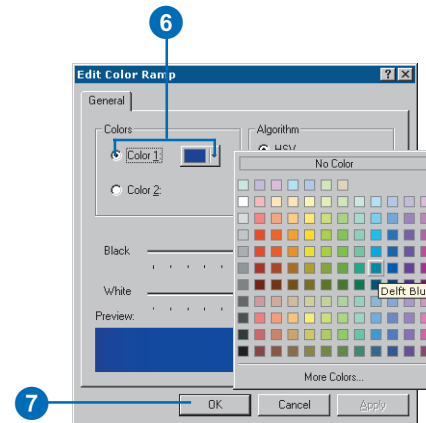
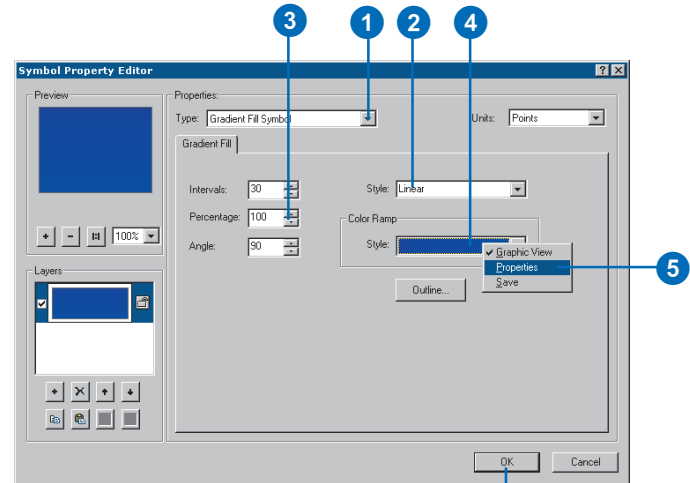
## See also

For more information on color, see the section 'Working with color' in this chapter.

## Creating a gradient fill

1. In the Fill Symbol Property Editor dialog, click the Type dropdown arrow and click Gradient Fill Symbol.
2. Click the Style dropdown arrow and click Linear.
3. Adjust the number of color Intervals and the color stretch Percentage from start to end.
4. Click the Color Ramp Style dropdown arrow and click another fill.
5. To modify the ramp, right-click Style and click Properties.
6. Click Color 1, click the dropdown arrow, and choose a new color hue.
7. Click OK.
8. Right-click Style and click Save.
9. Type the new color ramp name.
10. Click OK.
11. Click Outline and set the Width to 0 for no outline.
12. Click OK.

The color ramp is stored in your personal style.



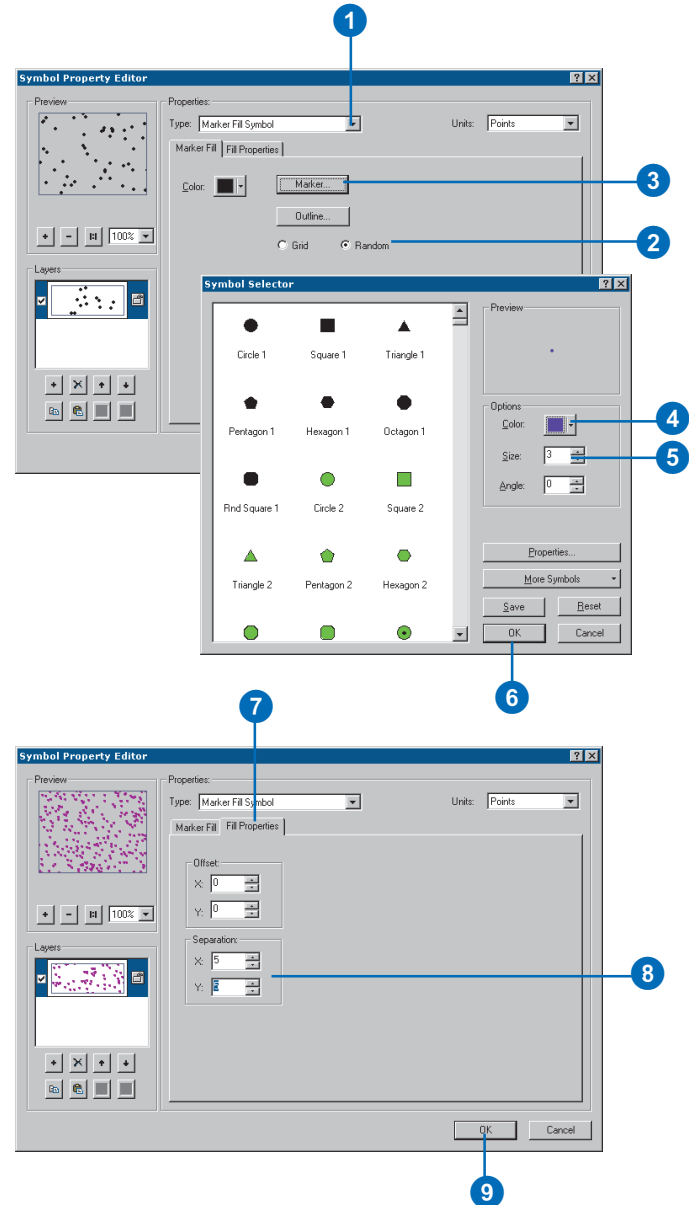
## Tip

### What's the difference in using marker fills, line fills, and picture fills?

Marker and line fills are vector based. The more dense the fill is, the more drawing-intensive it is. Picture fills can be .emf (vector) or .bmp (images).

## Creating a random dot fill

1. In the Fill Symbol Property Editor dialog, click the Type dropdown arrow and click Marker Fill Symbol.
2. Click Random.
3. Click Marker.
4. Change the Color.
5. Change the Size to 3.
6. Click OK.
7. Click the Fill Properties tab.
8. Adjust the X and Y Separation to 5, 5 for a denser distribution.
9. Click OK.



## Tip

### Is there more than one way to create a transparent overlay fill?

You can create a hatched line fill with alternating opaque and transparent hatches. You can also set the entire feature layer to a percentage of transparency. Combining these can achieve a variety of effects.

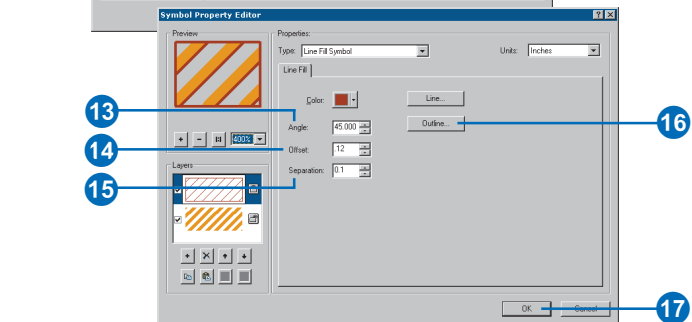
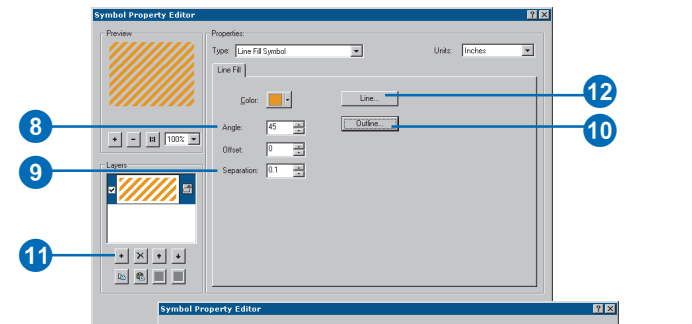
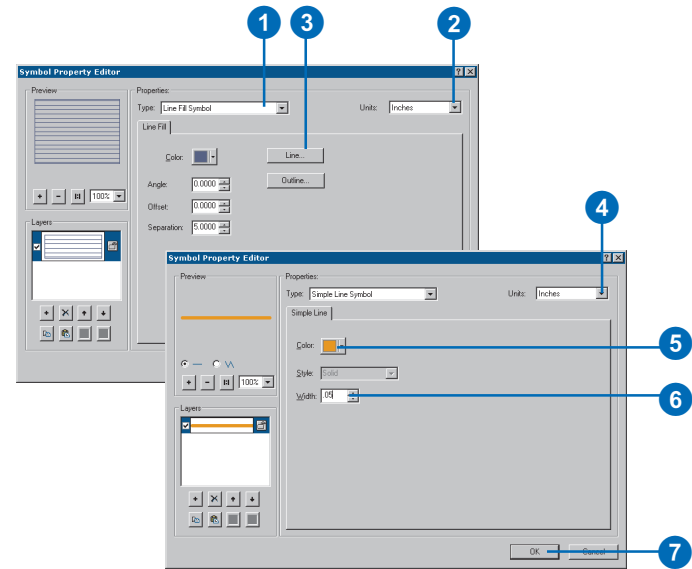
## Tip

### Can I mix symbols with different units in the same style?

You can use any units you prefer.

## Creating an overlay fill

1. In the Fill Symbol Property Editor dialog, click the Type dropdown arrow and click Line Fill Symbol.
2. Click the Units dropdown arrow and click Inches.
3. Click Line and click Properties.
4. Click the Units dropdown arrow and click Inches.
5. Click the Color dropdown arrow and click an orange shade.
6. Set the Width to 0.05.
7. Click OK twice.
8. Adjust the Angle to 45.
9. Set the Separation to 0.1.
10. Click Outline and set it to 0. Click OK.
11. Click the Add Layer button.
12. Repeat steps 3 through 5. Set the Width to 0.01. Click OK twice.
13. Adjust the Angle to 45.
14. Set the Offset to 0.12.
15. Set the Separation to 0.1.
16. Click Outline and set it to 0. Click OK.
17. Click OK.



## Tip

### Is there a significant difference between a .bmp and an .emf picture?

A .bmp is a raster image. An .emf is a vector graphic. You can modify both foreground and background colors on 1-bit .bmp pictures. You can only modify the background color on multibyte .bmp and .emf pictures.

## Tip

### How do I create a transparent picture fill?

You can set the background or foreground color to “no color” to create a transparent picture.

## Tip

### Why would I want to swap the foreground and background color?

Swapping the color properties of a 1-bit .bmp image toggles which color can be modified with the Symbol Selector Options. Only the foreground color can be modified.

## Tip

### Why does a .bmp look worse than an .emf when I scale it?

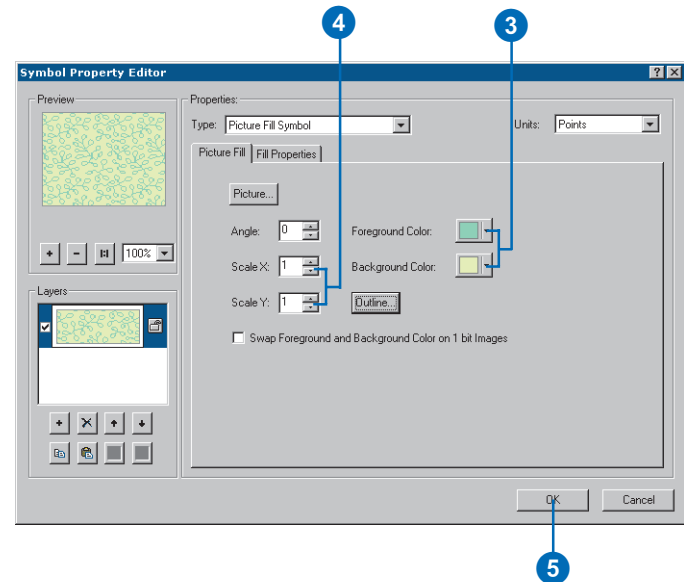
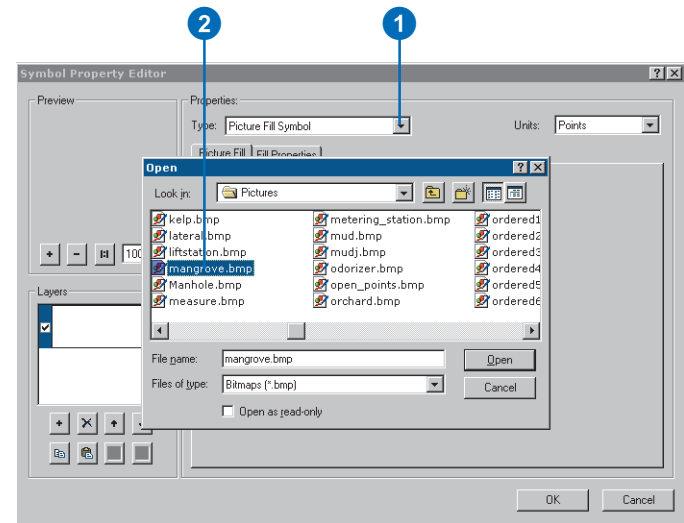
A .bmp is an image, or a grid of pixels; therefore, only the individual pixels can be scaled. If it is scaled too large it can look jagged, rough, or blurry. If it is scaled too small, it can lose detail.

.emf vectors scale proportionately.

## Creating picture fills

1. In the Fill Symbol Property Editor dialog, click the Type dropdown arrow and click Picture Fill Symbol.
2. Navigate to a .bmp or .emf file.
3. Click the Foreground and Background Color dropdown arrows and set the new colors.
4. Adjust the Scale of the picture.
5. Click OK.

You can choose “no color” to create a transparent background or foreground.



# Creating marker symbols

Marker symbols are used to draw point features, labels, and other map annotations. They can be used in conjunction with other symbols to decorate line symbols and create fill patterns and text backgrounds. As graphics, they can add special cartographic elements.

The four marker types are:

- Simple—fast-drawing set of basic glyph patterns with optional mask
- Character—a glyph from a TrueType font
- Arrow—a glyph from a TrueType font
- Picture—a single .bmp (Windows bitmap) or .emf (Windows enhanced metafile) graphic

Any number of layers can be combined in a single marker.

## Tip

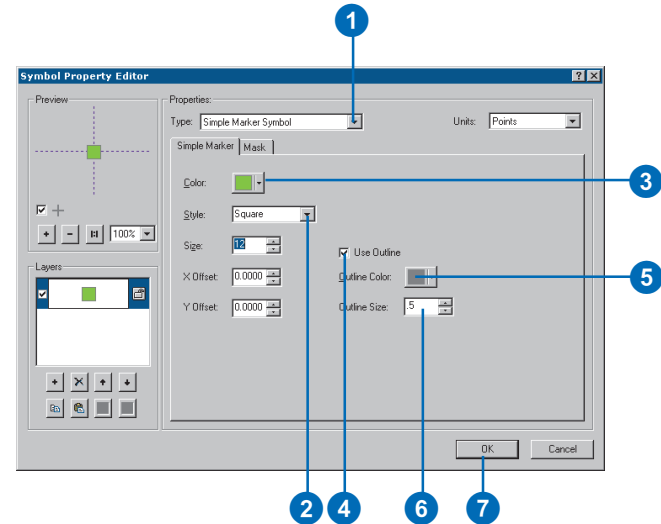
### What's the difference between an outline and a mask?

*An outline uses a line symbol to surround the layer graphic.*

*A mask uses a fill symbol to draw a halo around all layers of the symbol.*

## Creating a simple marker shape

1. In the Marker Symbol Property Editor dialog, click the Type dropdown arrow and click Simple Marker Symbol.
2. Click the Style dropdown arrow and click Square.
3. Click the Color dropdown arrow and click a color.
4. Check Use Outline.
5. Click the Outline Color dropdown arrow and click a color.
6. Set the Outline Size to 0.5.
7. Click OK.



## Tip

### Can I use any TrueType font to create symbols?

You can use any text or display font that's loaded in your system's fonts folder.

ArcMap installs a wide range of fonts with hundreds of glyphs used to create the provided styles.

## Tip

### Can I create my own TrueType fonts?

You can create your own TrueType® fonts using third-party font-creation software and copy them to your system's font folder.

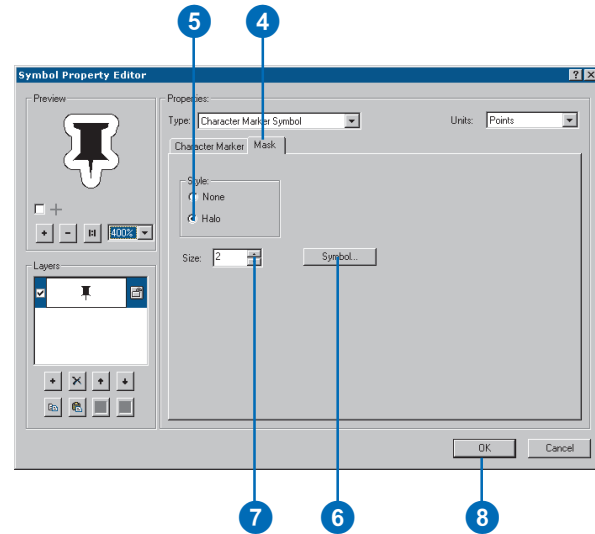
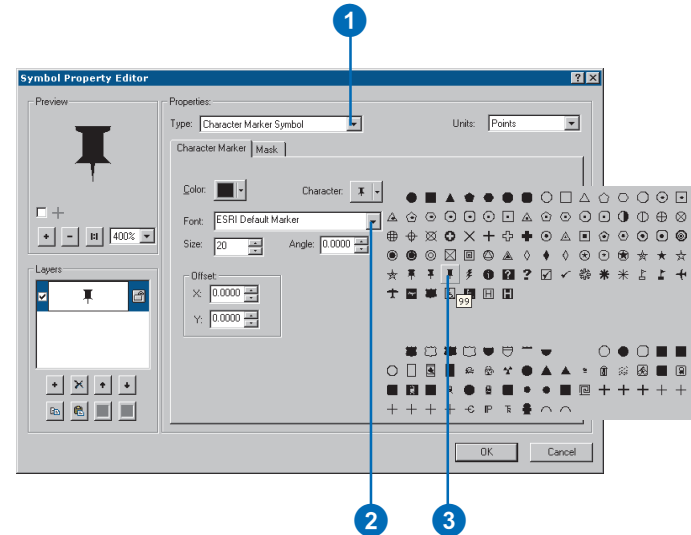
## Tip

### Isn't a North arrow just a character marker?

A North arrow is created from a TrueType font. It also has unique properties that link it to its source data frame, and it can have a background and border.

## Creating a marker from a TrueType font

1. In the Marker Symbol Property Editor dialog, click the Type dropdown arrow and click Character Marker Symbol.
2. Click the Font dropdown arrow and click ESRI Default Marker.
3. Click the Character dropdown arrow and click the pushpin button (99).
4. Click the Mask tab.
5. Click Halo.
6. Click Symbol and create a white fill with a black outline width of 0.5.
7. Adjust the Size to 2 points.
8. Click OK.





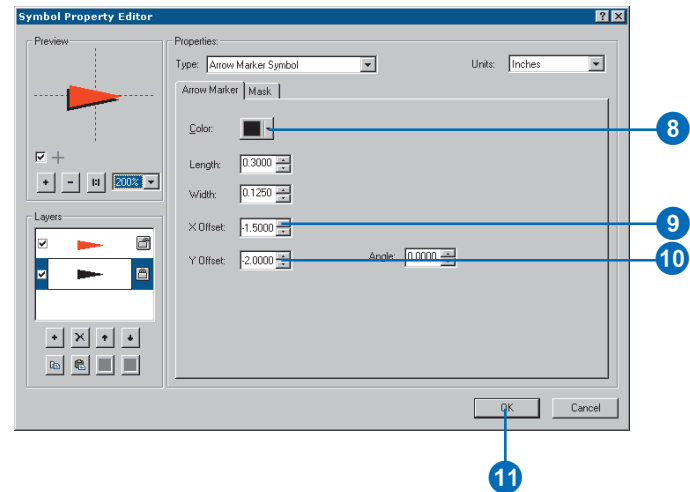
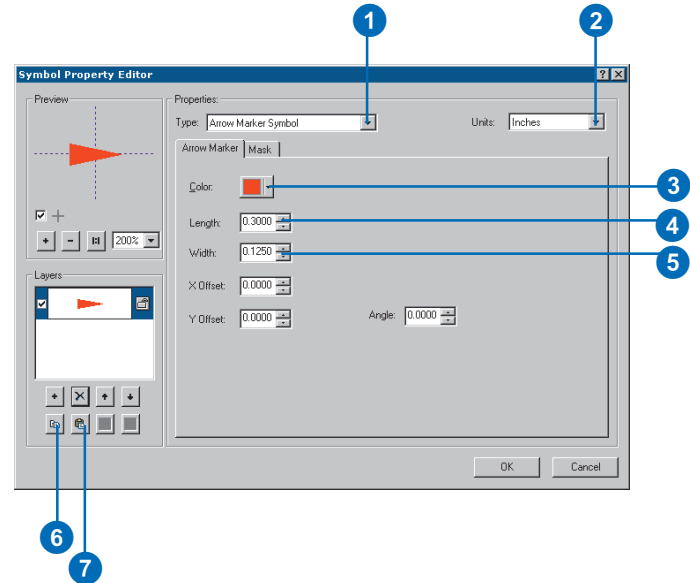
## Tip

### Does ArcMap come with any existing arrowheads?

An ESRI Arrowhead font contains a variety of arrow shapes. For more information on how to access the font, see the section 'Creating a marker from a TrueType font' in this chapter.

## Creating an arrow marker

1. In the Marker Symbol Property Editor dialog, click the Type dropdown arrow and click Arrow Marker Symbol.
2. Click the Units dropdown arrow and click Inches.
3. Click the Color dropdown arrow and click a red shade.
4. Set the Length to 0.3.
5. Set the Width to 0.125.
6. Click the Copy Layer button.
7. Click the Paste Layer button.
8. Click the Color dropdown arrow and click black.
9. Set the X Offset to -1.5.
10. Set the Y Offset to -2.0.
11. Click OK.



## Tip

### Does ArcMap come with any pictures?

The pictures used in the styles that come with ArcMap are stored in the `\bin\styles\pictures` folder where ArcGIS is installed.

## Tip

### How can I create my own pictures?

You can create pictures using any graphics software package that supports export to Windows bitmaps or Windows enhanced metafiles.

Using a graphics package to design artwork allows you to create a single image with several colors as well as combine graphics and text.

You can scan graphics and use an editing package to clean them up and then save them as a .bmp or .emf file.

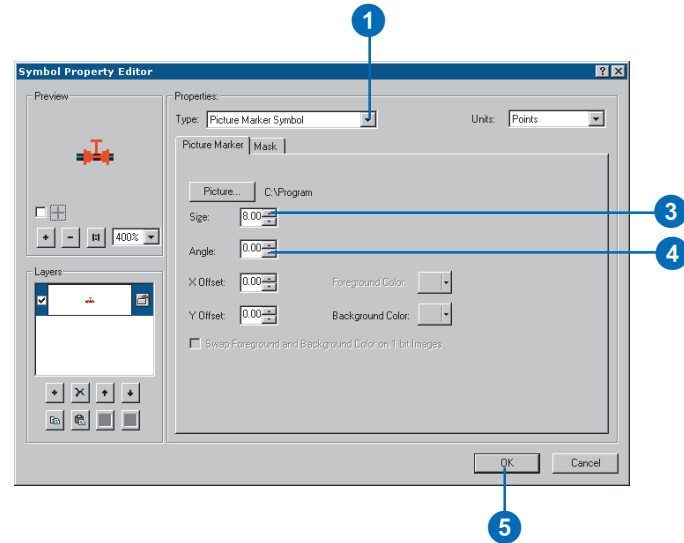
## Tip

### Is there a difference between using a .bmp or an .emf format?

.bmp is a raster format and .emf is a vector format; therefore, the .emf format has better clarity and scaling abilities.

## Creating a marker from a picture graphic

1. In the Marker Symbol Property Editor dialog, click the Type dropdown arrow, and click Picture Marker Symbol.
2. Click a .bmp or .emf.
3. Set the Size.
4. Set the Angle.
5. Click OK.



# Creating text symbols

Text symbols are used to draw labels and annotation that identify and add meaning to your data. Text is also used for titles, descriptions, callouts, legends, scale bars, graticule labels, tables, and other textual and tabular information conveyed on your map.

You can create simple text symbols or add advanced formatting, backgrounds, fills, shadows, and halos.

Text symbols consist of a single layer.

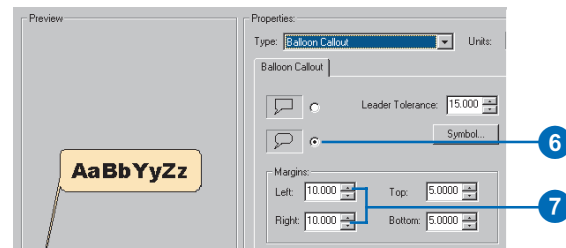
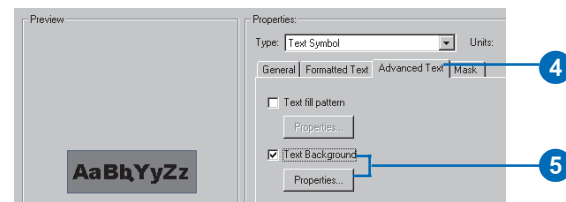
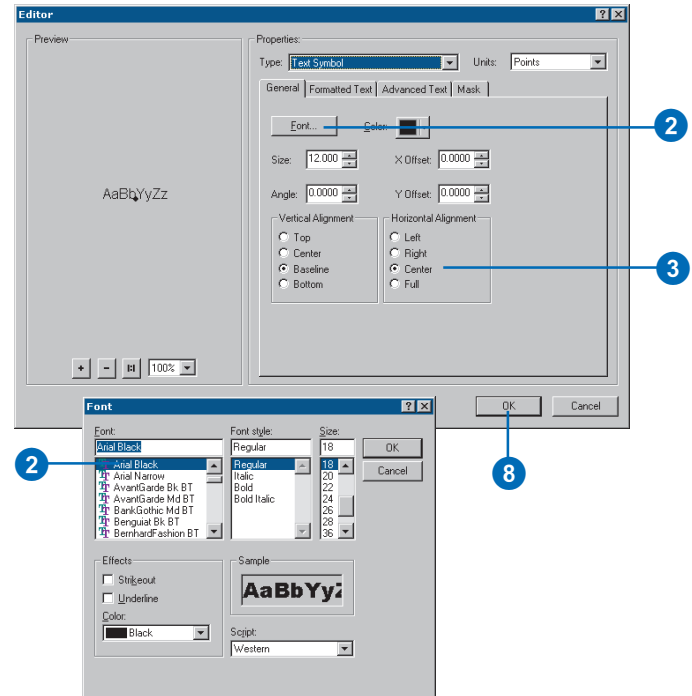
## Tip

### What's the difference between text and labels?

*Text describes the font, style, formatting, and effects. Labels are drawn with text symbols and have additional properties for placement and conflict detection.*

# Creating text backgrounds

1. In the Text Symbol Property Editor dialog, click the General tab.
2. Click the Font dropdown arrow and choose a Font, Font style, and Size and click OK.
3. Set the Vertical and Horizontal Alignment.
4. Click the Advanced Text tab.
5. Check Text Background and click Properties.
6. Click the rounded style balloon callout.
7. Set the Right and Left Margins.
8. Click OK in all dialog boxes.



## Tip

### What if I don't want leaders and accent bars?

You can use the Line Callout option to draw text backgrounds only.

A wide variety of effects can be achieved with different styles and by toggling the leaders, accent bars, and borders.

## Tip

### What if the background outline is too close to the accent bar?

You can enlarge the Gap.

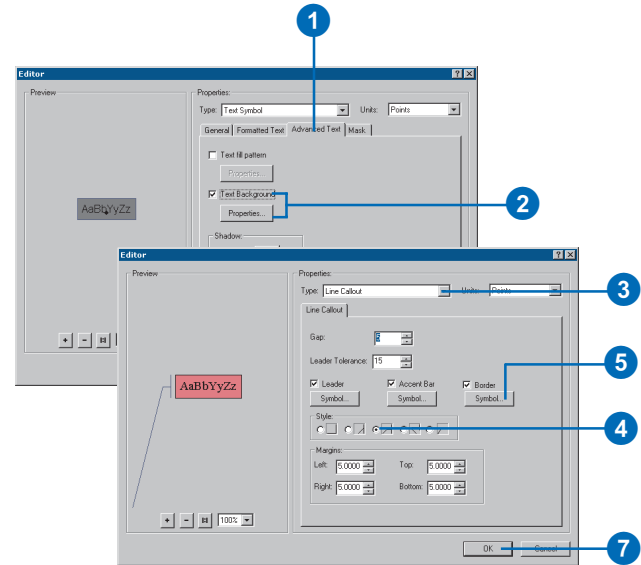
## Tip

### Crowded text in the background?

Fix this problem by adjusting the Margins.

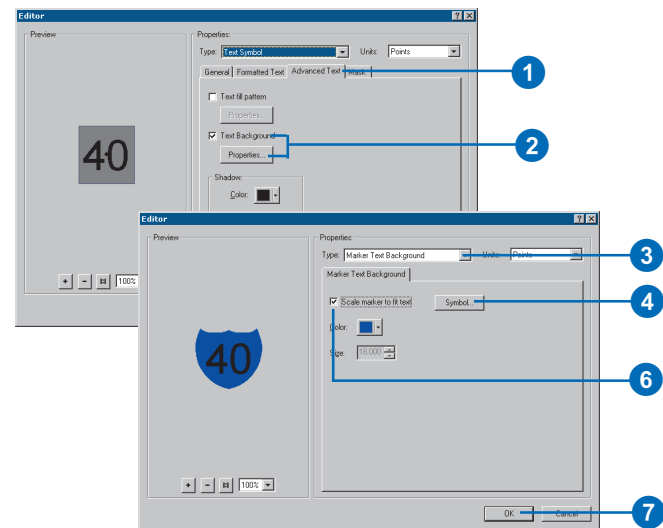
## Creating text callouts

1. In the Text Symbol Property Editor dialog, click the Advanced Text tab.
2. Check Text Background and click Properties.
3. Click the Type dropdown arrow and click Line Callout.
4. Click the third Style option.
5. Check Border and click Symbol underneath.
6. Click the Color dropdown arrow and click the color and outline you want. Click OK.
7. Click OK.



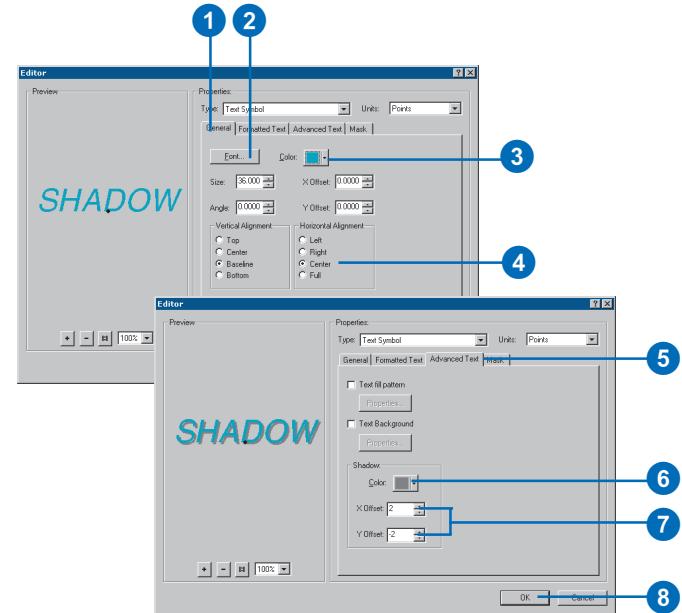
## Creating text inside markers

1. In the Text Symbol Property Editor dialog, click the Advanced Text tab.
2. Check Text Background and click Properties.
3. Click the Type dropdown arrow and click Marker Text Background.
4. Click Symbol.
5. Choose a marker and click OK.
6. Check Scale marker to fit text.
7. Click OK.



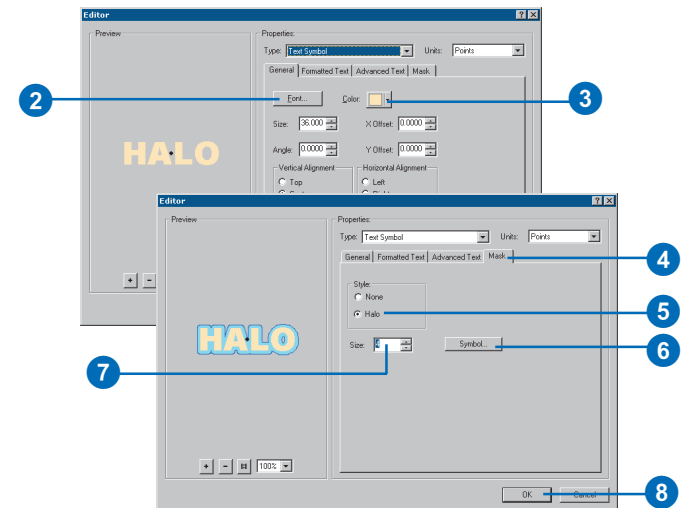
## Creating text with a drop shadow

1. In the Text Symbol Property Editor dialog, click the General tab.
2. Click Font and choose a font.
3. Click the Color dropdown arrow and choose a color.
4. Set the Vertical and Horizontal Alignment.
5. Click the Advanced Text tab.
6. Click Color and click gray.
7. Set the X Offset to 2 and the Y Offset to -2.
8. Click OK.



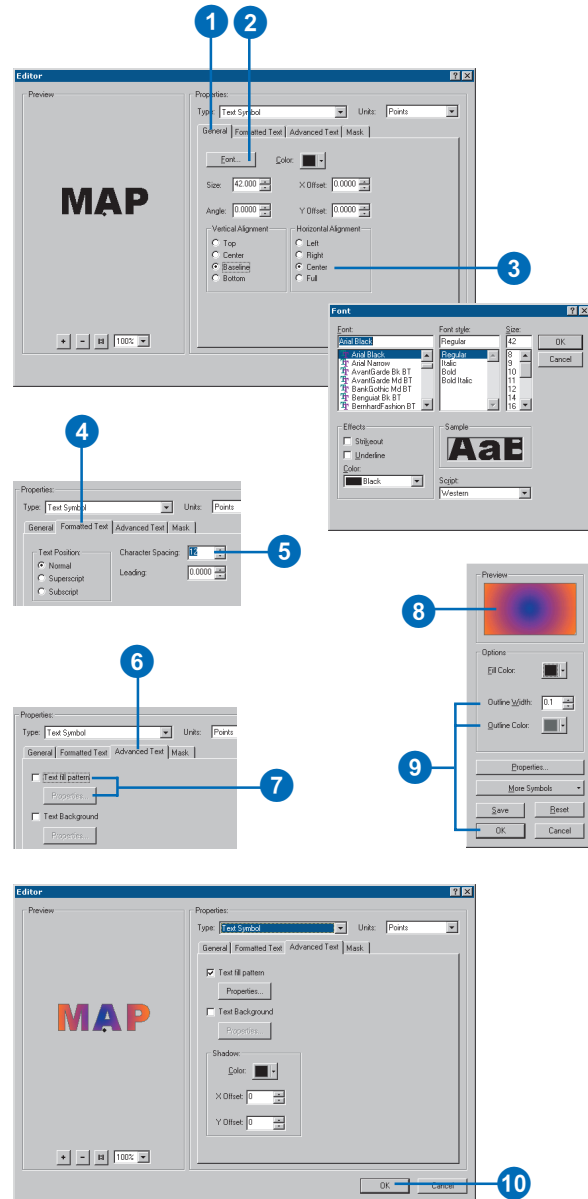
## Creating text with a halo

1. In the Text Symbol Property Editor dialog, click the General tab.
2. Click Font and choose a font.
3. Click the Color dropdown arrow and choose a color.
4. Click the Mask tab.
5. Click Halo.
6. Click Symbol and click a fill. Click OK.
7. Set a Size.
8. Click OK.



## Creating filled text

1. In the Text Symbol Property Editor dialog, click the General tab.
2. Click Font and choose a font.
3. Set the Vertical and Horizontal Alignment.
4. Click the Formatted Text tab.
5. Set the Character Spacing.
6. Click the Advanced Text tab.
7. Check Text fill pattern and click Properties.
8. Select a fill.
9. Set the Outline Width and Color and click OK.
10. Click OK.



## Working with color

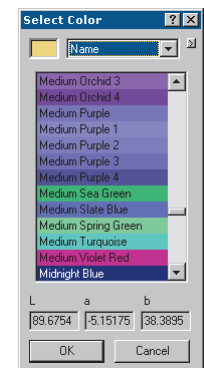
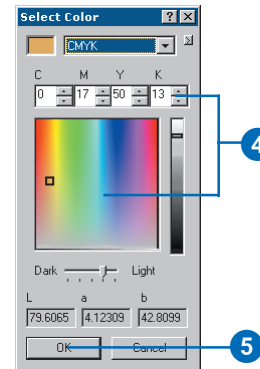
Color is one of the fundamental properties of all symbols and map elements. The color palette on each dialog box shows the color contents of all the referenced styles. Your personal modifications are also shown at the top of the palette. You can use a variety of dialog boxes to create the colors you want. The Selector dialog boxes are accessed from the color palette. The Property dialog boxes are accessed from the Selector dialog boxes and the Style Manager.

Color can be defined in five ways:

- RGB—red, green, blue
- CMYK—cyan, magenta, yellow, black
- HLS—hue, lightness, saturation
- Gray—gray shade ramp
- Names—ArcInfo color names

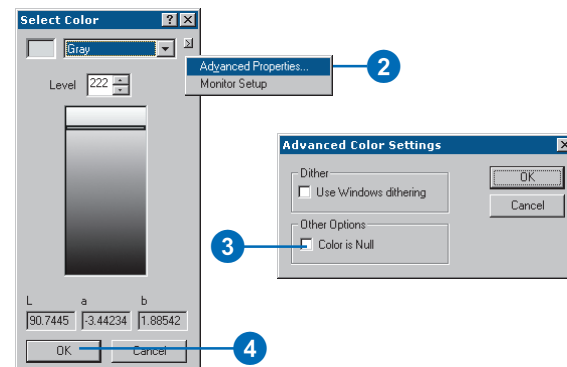
## Defining the colors you want to use on your map

1. Click Tools, point to Styles, and click Style Manager.
2. Click the Color Style folder to view its contents.
3. Right-click in the Contents window. Click New and choose a color model.
4. Click on a color in the Color window or use the color model spinners to mix a color.
5. Click OK.
6. Type the name of the new color in the Contents window.



## Defining a null color

1. Right-click in the Contents window. Click New and click Gray.
2. Click the Arrow button and click Advanced Properties.
3. Check Color is Null.
4. Click OK.



## Tip

### Identifying the colors on the palette

You can right-click the color to see its name as a tip.

## Tip

### Does the color palette come from a style?

Yes, it is a combination of all the referenced styles. As you create custom colors, they are displayed at the top of the palette.

## Tip

### Why would I use a null color?

A null color lets you create transparent areas in your symbols. It also lets you turn off outline drawing.

However, a null color can't be used to knock out or block other colors.

## Redefining colors as you work

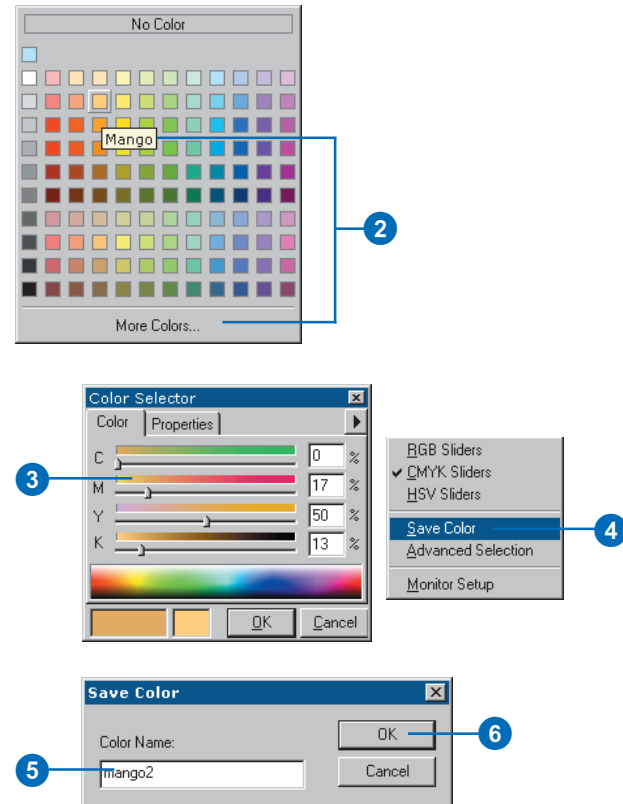
1. Click the Color dropdown arrow on a dialog box or right-click on a symbol in the table of contents.
2. Click on a new color or click More Colors to view additional colors.
3. Use the Color Selector dialog box to mix a new color.

You can toggle the color model with the Arrow button menu choices or click on the color preview to display the Property dialog boxes.

4. Click the Arrow button and click Save Color.
5. Type a name for the new color.

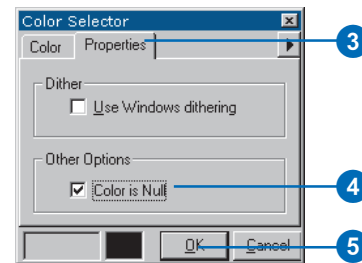
The color is saved in your personal style.

6. Click OK.



## Defining a null color

1. Click the Color dropdown arrow on a dialog box.
2. Click More Colors.
3. Click the Properties tab.
4. Check Color is Null.
5. Click OK.





# Querying data

**Section 3**



# Working with tables

# 10

## IN THIS CHAPTER

- Elements of a table
- Opening a layer's attribute table
- Loading existing tabular data onto a map
- Arranging columns
- Controlling a table's appearance
- Locating and viewing records
- Sorting records
- Selecting records
- Summarizing data
- Adding and deleting fields
- Editing attributes
- Making field calculations
- About joining attribute tables
- Joining attribute tables

A table is a database component that contains a series of rows and columns, where each row, or record, represents a geographic feature—such as a parcel, power pole, highway, or lake—and each column, or field, describes a particular attribute of the feature—such as its length, depth, cost, and so on. Tables are stored in a database—for example, INFO™, Microsoft® Access, dBASE®, FoxPro®, Oracle®, and SQL Server™.

You'll typically use tables in ArcMap to inspect the attributes of geographic features. From a table, you can identify features with particular attributes and select them on the map. Over time, you might also update the attributes to reflect changes to geographic features—for example, a new subdivision extends your parcel database, or the construction of a dam alters a river network.

Tables can also store information related to features such as warehouse inventories, monthly sales figures, and maintenance records. By joining this information to your spatial data, you can uncover new patterns and relationships that were not apparent before. For example, you might see which stores have the top monthly sales figures, what roads require maintenance in the near future, or where the largest number of endangered species are located.

# Elements of a table

Columns or fields

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Darhan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365592	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyala	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Dornod	Mongolia	Asia	91911	118099.500

Rows or records

Record: 16 Show:  All  Selected Records (0 out of 842 Selected.)

Move to first record

Previous record

Current record

Next record

Move to last record

Number of records. An \* indicates total not yet determined.

Click to find and replace records, select records by attributes, change the highlight color, add the table to the layout, export the table, and open related tables.

## Opening a layer's attribute table

To explore the attributes of a layer on a map, open its attribute table. Once open, you can select features and find features with particular attributes.

You can open more than one table at a time. For example, you can view an attribute table for administrative boundaries and, at the same, view the attribute table for cities.

### Tip

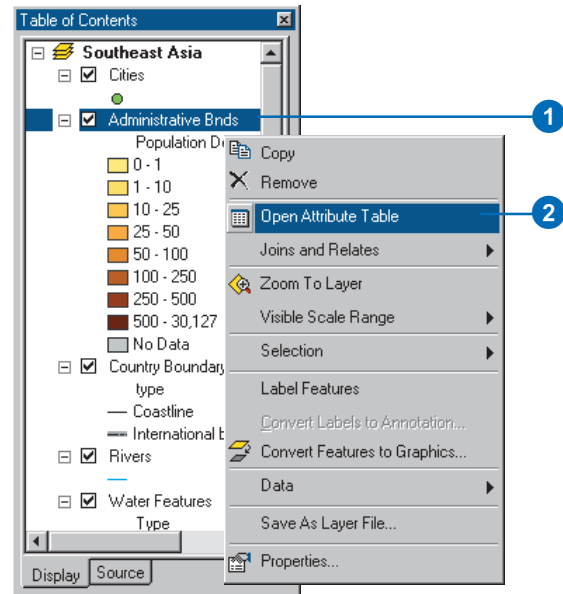
#### Closing a table

You can close a table by clicking the Close button in the upper-right corner of the table window.

1. In the table of contents, right-click the layer for which you want to display a table.

2. Click Open Attribute Table.

The layer's attribute table opens.



The screenshot shows the 'Attributes of Administrative Bnds' table window. The table has the following columns: NAME, COUNTRY, CONTINENT, POPULATION, and SQKM\_ADMIN. The table contains 20 rows of data. The bottom of the window shows a record count of 16 and a 'Show: All Selected' dropdown menu.

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Darhan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365592	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyala	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Domod	Mongolia	Asia	91911	118099.500

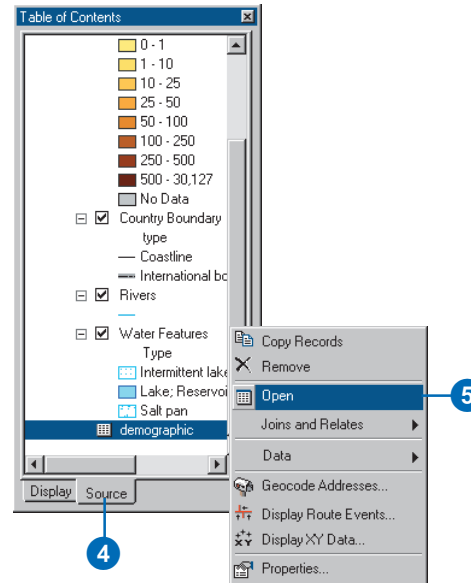
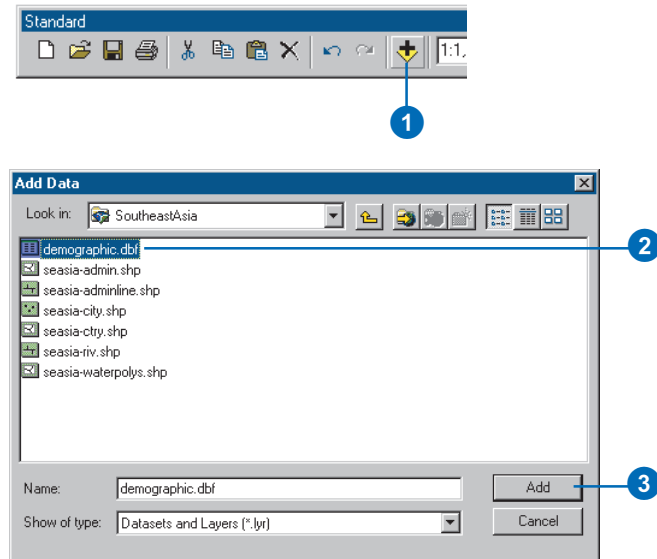
## Loading existing tabular data onto a map

Not all the tabular data associated with a layer has to be stored in its attribute table. Some data you may choose to store in separate tables—for instance, data that changes frequently such as monthly sales figures. You can add this tabular data directly to your map as a table and use it in conjunction with the layers on your map. These tables don't display on your map, but they are listed in the table of contents on the Source tab. You work with these tables as you would any table based on geographic features. For example, you can view the table, add new fields, create graphs, and join the table to other tables.

### See Also

*Joining a table to a layer allows you to visualize the information contained in a table. For more information, see 'Joining attribute tables' in this chapter.*

1. Click the Add Data button.
2. Navigate to the table you want to add and click it.
3. Click Add.
4. Click the Source tab at the bottom of the table of contents.
5. Right-click the table and click Open.



## Arranging columns

When you open a table, you can rearrange its appearance. For example, you may want to widen or reduce the width of the visible columns, move a column, hide a column from being displayed at all, sort the table based on a selected field or fields, or freeze a field so that you always see it as you scroll across the table.

Freezing a column is helpful when a table has many columns. It is often very useful to see how the values in a certain column relate to the data in the rest of a table.

Freezing a column locks a column as the leftmost column in the table view. You can then use the horizontal scroll bar to see the other columns in the table. When you scroll, the frozen column remains in place while all other columns move. A frozen column is easily identified because it has a thick black line separating it from the other columns in the table.

## Changing a column's width

1. Position the mouse pointer at the edge of the column you want to resize.

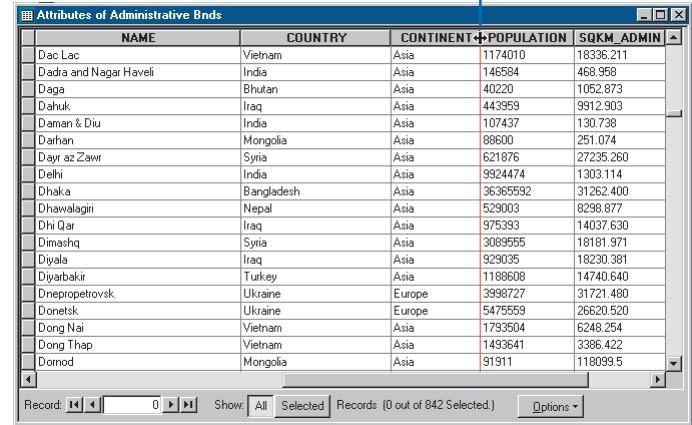
The pointer's icon changes.

2. Click and drag the column's edge to the desired width.

A black line indicates where the edge of the column will be located.

3. Drop the edge of the column.

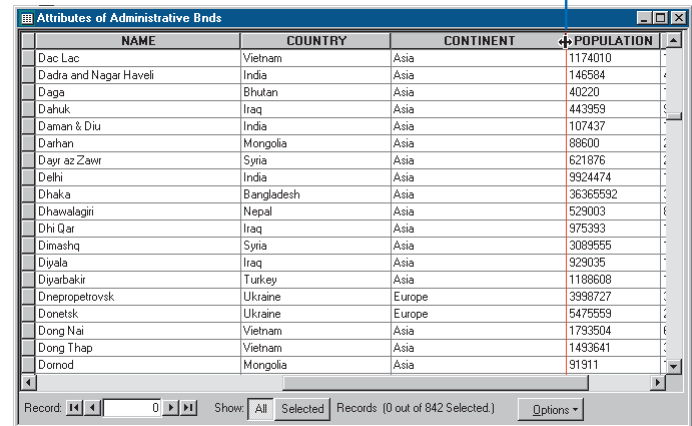
The column is resized.



Attributes of Administrative Bnds

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Daifan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365592	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyala	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Domod	Mongolia	Asia	91911	118099.5

Record: 0 | Show: All Selected | Records: (0 out of 842 Selected) | Options



Attributes of Administrative Bnds

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Daifan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365592	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyala	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Domod	Mongolia	Asia	91911	118099.5

Record: 0 | Show: All Selected | Records: (0 out of 842 Selected) | Options

## Tip

### Deselecting a column

To deselect all columns in the table, click *Options* and click *Clear Selection* or simply click on a cell in the table.

## Tip

### Changing the selection color

By default, selected columns are highlighted in cyan. To change the selection color, click the *Options* button on the table, click *Appearance*, then click the color you prefer.

## Rearranging a table's columns

1. Click the heading of the column you want to move.

2. Click and drag the column's heading.

A red line indicates where the column will be positioned.

3. Drop the column.

After you drop it, the column appears in the new position.

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Darhan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365592	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyala	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Domod	Mongolia	Asia	91911	118099.5

NAME	CONTINENT	COUNTRY	POPULATION	SQKM_ADMIN
Dac Lac	Asia	Vietnam	1174010	18336.211
Dadra and Nagar Haveli	Asia	India	146584	468.958
Daga	Asia	Bhutan	40220	1052.873
Dahuk	Asia	Iraq	443959	9912.903
Daman & Diu	Asia	India	107437	130.738
Darhan	Asia	Mongolia	88600	251.074
Dayr az Zawr	Asia	Syria	621876	27235.260
Delhi	Asia	India	9924474	1303.114
Dhaka	Asia	Bangladesh	36365592	31262.400
Dhawalagiri	Asia	Nepal	529003	8298.877
Dhi Qar	Asia	Iraq	975393	14037.630
Dimashq	Asia	Syria	3089555	18181.971
Diyala	Asia	Iraq	929035	18230.381
Diyarbakir	Asia	Turkey	1188608	14740.640
Dnepropetrovsk	Europe	Ukraine	3998727	31721.480
Donetsk	Europe	Ukraine	5475559	26620.520
Dong Nai	Asia	Vietnam	1793504	6248.254
Dong Thap	Asia	Vietnam	1493641	3386.422
Domod	Asia	Mongolia	91911	118099.5



## Tip

### Unfreezing a column

Right-click the column heading and click Freeze/Unfreeze Column to unfreeze the column.

## Tip

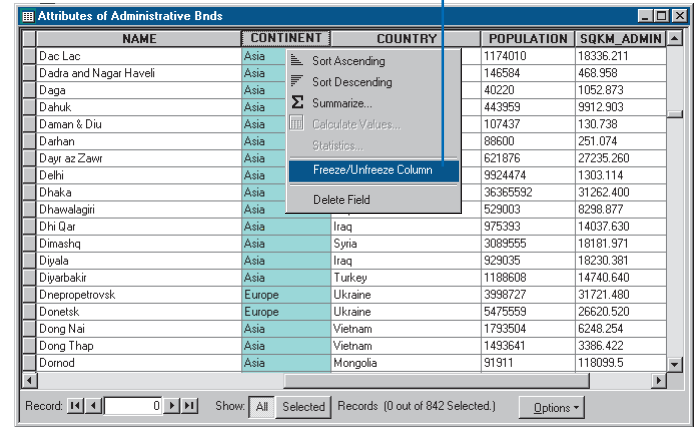
### Hiding a column

Right-click the layer or table in the table of contents and click Properties. Click the Fields tab. Here you can set whether a field is visible or not.

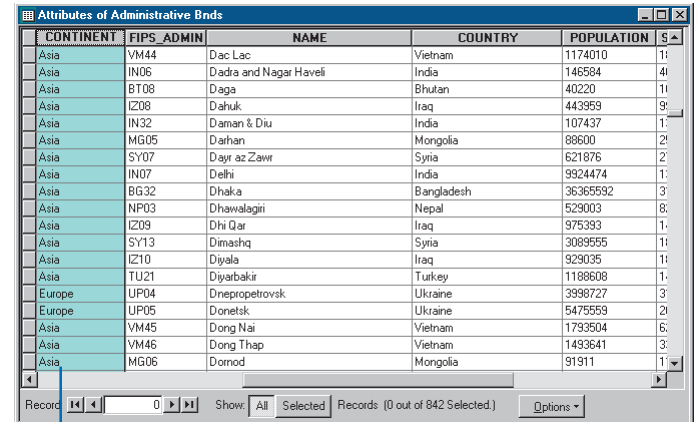
## Freezing a column

1. Click the heading of the column(s) you want to freeze.
2. Right-click the selected column's heading and click Freeze/Unfreeze Column to freeze the column.

The column is now frozen.



NAME	CONTINENT	COUNTRY	POPULATION	SQKM_ADMIN
Dac Lac	Asia		1174010	18336.211
Dadra and Nagar Haveli	Asia		146584	468.988
Daga	Asia		40220	1052.873
Dahuk	Asia		443959	9912.903
Daman & Diu	Asia		107437	130.738
Darhan	Asia		88600	251.074
Dayr az Zawr	Asia		621876	27235.260
Delhi	Asia		9924474	1303.114
Dhaka	Asia		36365592	31262.400
Dhawalagiri	Asia		529003	8298.877
Dhi Qar	Asia	Iraq	975393	14037.630
Dimashq	Asia	Syria	3089555	18181.971
Diyala	Asia	Iraq	929035	18230.381
Diyarbakir	Asia	Turkey	1188608	14740.640
Dnepropetrovsk	Europe	Ukraine	3998727	31721.480
Donetsk	Europe	Ukraine	5475559	26620.520
Dong Nai	Asia	Vietnam	1793504	6248.254
Dong Thap	Asia	Vietnam	1493641	3386.422
Dornod	Asia	Mongolia	91911	118099.5



CONTINENT	FIPS_ADMIN	NAME	COUNTRY	POPULATION	S
Asia	VM44	Dac Lac	Vietnam	1174010	1
Asia	IN06	Dadra and Nagar Haveli	India	146584	4
Asia	BT08	Daga	Bhutan	40220	1
Asia	IZ08	Dahuk	Iraq	443959	9
Asia	IN32	Daman & Diu	India	107437	1
Asia	MG05	Darhan	Mongolia	88600	2
Asia	SY07	Dayr az Zawr	Syria	621876	2
Asia	IN07	Delhi	India	9924474	1
Asia	BG32	Dhaka	Bangladesh	36365592	3
Asia	NP03	Dhawalagiri	Nepal	529003	8
Asia	IZ09	Dhi Qar	Iraq	975393	1
Asia	SY13	Dimashq	Syria	3089555	1
Asia	IZ10	Diyala	Iraq	929035	1
Asia	TU21	Diyarbakir	Turkey	1188608	1
Europe	UP04	Dnepropetrovsk	Ukraine	3998727	3
Europe	UP05	Donetsk	Ukraine	5475559	2
Asia	VM45	Dong Nai	Vietnam	1793504	6
Asia	VM46	Dong Thap	Vietnam	1493641	3
Asia	MG06	Dornod	Mongolia	91911	1

The column has been frozen.

## Controlling a table's appearance

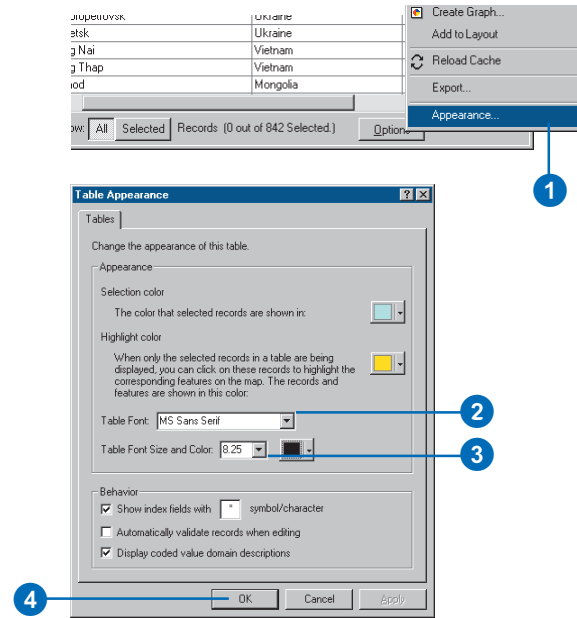
You can tailor the look of the table window to suit your needs. For example, if you don't like the default table font, you can change it to another one and set the font size as well. Make changes for all tables or just one—each table can have its own individual settings.

You can also set the selection and highlight color for records in a table. Selected records are displayed with the selection color; the highlight color identifies a record when you're only viewing the selected records in the table.

Formatting a field can also enhance the look of a table. For example, you might set the number digits to display to the right of a decimal point or use scientific notation.

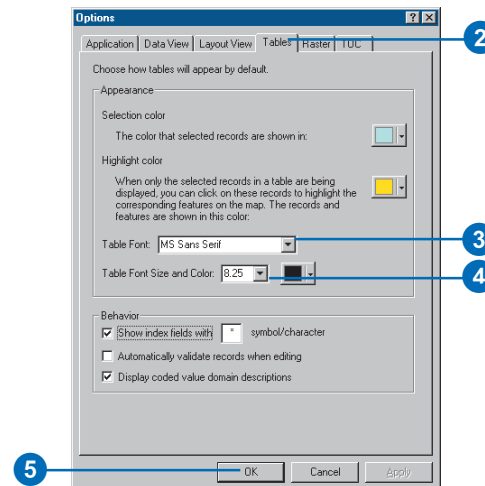
## Setting the text font and size for a table

1. On the table window, click Options and click Appearance.
2. Click the Table Font dropdown arrow and click the font you want to use.
3. Click the Table Font Size dropdown arrow and click a point size.
4. Click OK.



## Setting the default text font and size for all tables

1. Click the Tools menu and click Options.
2. Click the Tables tab.
3. Click the Table Font dropdown arrow and click the font you want to use.
4. Click the Table Font Size dropdown arrow and click a point size.
5. Click OK.



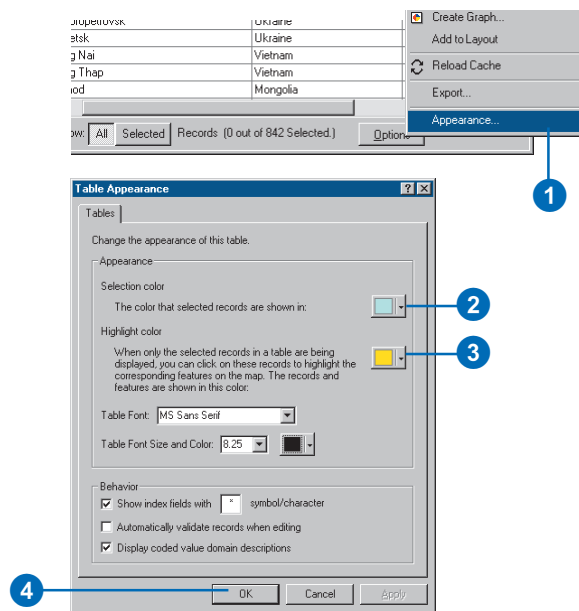
## Tip

### Selection vs. highlight color

The selection color shows the selected records in a table. When you're only viewing the selected records, clicking one highlights the feature with the highlight color.

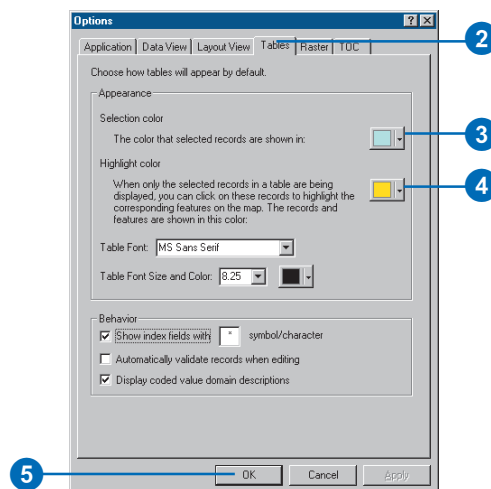
## Setting the selection and highlight color for a table

1. On the table window, click Options and click Appearance.
2. Click the Selection color dropdown arrow and click the color you want to use.
3. Click the Highlight color dropdown arrow and click the color you want to use.
4. Click OK.



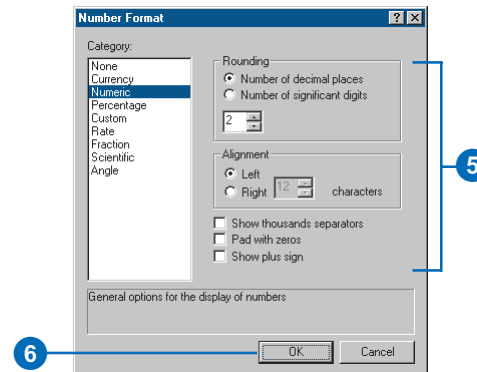
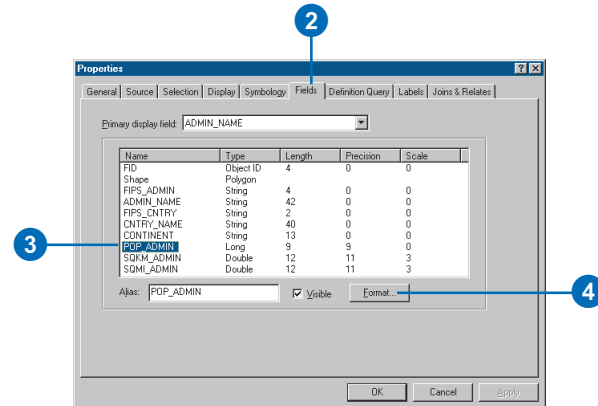
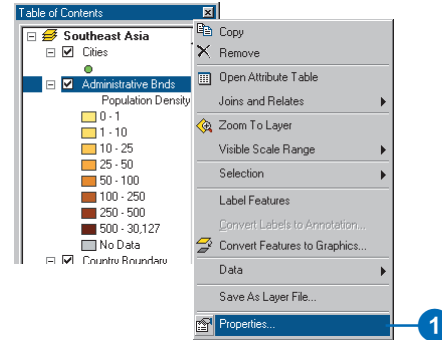
## Setting the default selection and highlight color for all tables

1. Click the Tools menu and click Options.
2. Click the Tables tab.
3. Click the Selection color dropdown arrow and click the color you want to use.
4. Click the Highlight color dropdown arrow and click the color you want to use.
5. Click OK.



## Formatting numeric fields

1. Right-click the layer or table in the table of contents and click Properties.
2. Click the Fields tab.
3. Click a numeric field in the list.
4. Click Format.
5. Set the number of decimal places, alignment, and so on.
6. Click OK when finished.



## Locating and viewing records

You can use the navigation buttons at the bottom of the table window to quickly move to the next, previous, first, or last record in the table. If you know the specific record number, you can type that in as well.

When you want to find a record in a table that matches some numeric value or text string, you can search the table for that value in the selected fields or the entire table. Depending on the type of field—text or numeric—you have three different types of searches:

- Any part
- Whole field
- Start of field

Numeric fields are always searched using the whole field. If you're searching a text field, you can search for any part of the text string or the start of the field that matches the text you enter into the Find dialog box. The Find dialog box also gives you the option of searching up, down, or in all directions from the current position in the table.

## Moving to a specific record number

1. Open the table.
2. Type the number of the record you want to move to and press Enter.

The table scrolls to the record.

NAME	COUNTRY	
Dac Lac	Vietnam	Asia
Dadra and Nagar Haveli	India	Asia
Daga	Bhutan	Asia
Dahuk	Iraq	Asia
Daman & Diu	India	Asia
Darhan	Mongolia	Asia
Dayr az Zawr	Syria	Asia
Delhi	India	Asia
Dhaka	Bangladesh	Asia
Dornod	Mongolia	Asia

Move to first record

Previous record

2

Next record

Move to last record

## Viewing all or only the selected records

1. Open the table.
2. Click Show All to view all records or click Show Selected to view only the selected ones.

Darhan	Mongolia	Asia
Dayr az Zawr	Syria	Asia
Delhi	India	Asia
Dhaka	Bangladesh	Asia
Dornod	Mongolia	Asia

## Tip

### Matching the case

To match the capitalization of the text you type, check Match Case in the Find dialog box.

## Tip

### Search the whole table or just one field

To constrain the search to specific fields, check the box next to Search Only Selected Field(s).

## Tip

### Replacing text you find

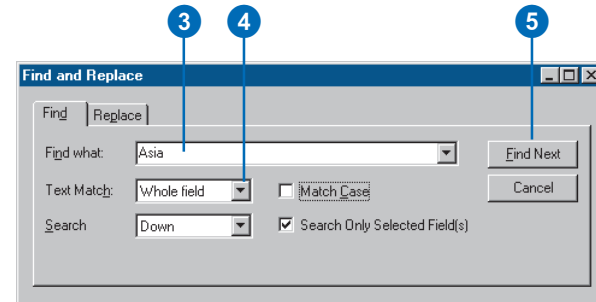
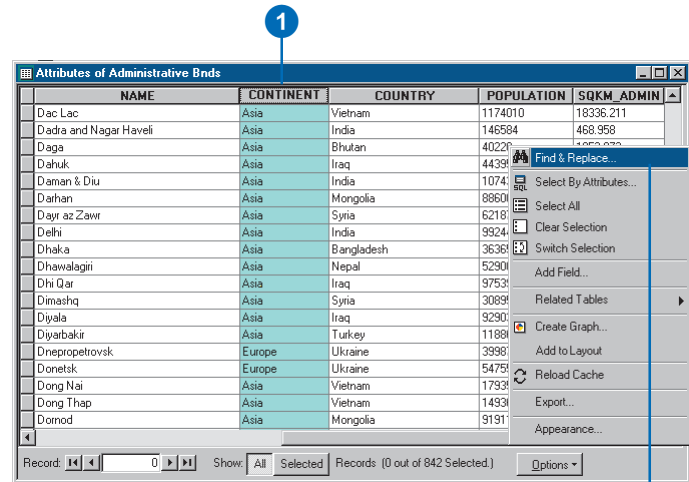
In order to replace the text you find, you must be editing the table. For more information, see 'Editing attributes' in this chapter.

## Finding records with particular attribute values

1. Click the heading of the column that contains the text for which you want to search.
2. Click Options and click Find & Replace.
3. Type the text you want to find in the Find what text box.
4. Click the Text Match dropdown arrow and click the type of search you want.
5. Click Find Next.

The first record found containing your text is selected.

6. If you want to find another record containing the same text, click Find Next again.



## Sorting records

Sorting the records or rows in a table lets you derive information about its contents. For example, you could find the city with the largest population in Southeast Asia. After you sort a column's values in ascending order, the values appear ordered from A to Z or from 1 to n, where n is the largest number. Descending order arranges a column's values from Z to A or from n to 1.

Sometimes it's helpful to sort a table's rows by more than one column. For example, it might be more useful to sort the cities by country and by population—the effect is similar to producing a report. To sort by more than one column, you must first arrange the columns that you'll use for sorting. The sorting columns must be arranged in order from left to right, where the values in the column farthest to the left will be sorted first and the values in the column farthest to the right will be sorted last. The sorting columns are not required to be adjacent to each other; however, if they are the order of the records is more obvious.

## Sorting records by one column

1. Click the heading of the column whose values you want to use to sort the records.
2. Right-click the selected column's heading and click Sort Ascending or Sort Descending.

The table's records are sorted.

Attributes of Administrative Bnds

NAME	COUNTRY	CONTINENT	POPULATION	SQKM ADMIN
Dac Lac	Vietnam	Asia	1174010	
Dadria and Nagar Haveli	India	Asia	146584	
Daga	Bhutan	Asia	40220	
Dahuk	Iraq	Asia	443959	
Daman & Diu	India	Asia	107437	
Darhan	Mongolia	Asia	88600	
Dayr az Zawr	Syria	Asia	621876	
Delhi	India	Asia	9824474	
Dhaka	Bangladesh	Asia	36365592	
Dhawalagiri	Nepal	Asia	529003	
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyyala	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1783504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Dornod	Mongolia	Asia	91911	118099.5

Record: 0 | Show: All Selected | Records: (0 out of 842 Selected.)

Attributes of Administrative Bnds

NAME	COUNTRY	CONTINENT	POPULATION	SQKM ADMIN
Bagmati	Nepal	Asia	2425622	10119.830
Samarkand	Uzbekistan	Asia	2396775	16484.820
Cagayan Valley	Philippines	Asia	2341000	26293.721
Johor	Malaysia	Asia	2328434	19354.980
Southern	Sri Lanka	Asia	2323388	5586.203
Ha Bac	Vietnam	Asia	2311062	4741.386
Hamgyongbukto	North Korea	Asia	2284713	16949.359
Ha Tay	Vietnam	Asia	2268431	1994.277
Vinh Pthu	Vietnam	Asia	2250245	4698.150
Fergana	Uzbekistan	Asia	2243964	6721.420
Orenburgskaya oblast'	Russia	Europe	2238836	93978.258
Taegu'gkhalsi	South Korea	Asia	2229040	454.359
Janakpur	Nepal	Asia	2221955	9708.168
Omskaya oblast'	Russia	Asia	2206018	117327.203
Alma-Ata	Kazakhstan	Asia	2192685	104087.102
Ha Noi	Vietnam	Asia	2187289	1307.030
Hwanghae-namdo	North Korea	Asia	2183196	8231.063
Lumbini	Nepal	Asia	2170072	8609.160
Jambi	Indonesia	Asia	2166717	46381.898

Record: 0 | Show: All Selected | Records: (0 out of 842 Selected.)

The records are sorted according to the selected column's values.

## Tip

### Selecting adjacent columns

Hold down the *Ctrl* key while selecting columns to select more than one.

## Sorting records by more than one column

1. Rearrange the table's columns so the column whose values will be sorted first appears to the left of the column whose values will be sorted second.
2. Click the heading of the first column you want to use to sort the records.
3. Press the *Ctrl* key on the keyboard and click the second column's heading.
4. Repeat step 3 until you've selected all columns that will be used to sort the table's records.
5. Right-click a selected column heading and click Sort Ascending or Sort Descending.

The table's records are sorted.

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	40220
Daga	Bhutan	Asia	443959	107437
Dahuk	Iraq	Asia	88600	621876
Daman & Diu	India	Asia	9924474	36365932
Darhan	Mongolia	Asia	529003	975393
Dayr az Zawr	Syria	Asia	3089555	10191.971
Delhi	India	Asia	923035	18230.361
Dhaka	Bangladesh	Asia	1188608	14740.640
Dhawalagiri	Nepal	Asia	3998727	31721.480
Diri Qar	Iraq	Asia	5479559	26220.520
Dimashq	Syria	Asia	1793504	6248.254
Diyala	Iraq	Asia	1493641	3386.422
Diyarbakir	Turkey	Asia	91911	118099.5
Dnepropetrovsk	Ukraine	Europe		
Donetsk	Ukraine	Europe		
Dong Nai	Vietnam	Asia		
Dong Thap	Vietnam	Asia		
Dornod	Mongolia	Asia		

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Baisai	Bangladesh	Asia	9021761	9330.440
Chittagong	Bangladesh	Asia	14746629	41989.570
Rajshahi	Bangladesh	Asia	29285383	34153.789
Khulna	Bangladesh	Asia	31312653	21771.020
Dhaka	Bangladesh	Asia	36365932	21262.400
Chhukha	Bhutan	Asia	18969	1796.559
Ha	Bhutan	Asia	23711	1729.475
Bumthang	Bhutan	Asia	33822	2773.234
Tongsa	Bhutan	Asia	36307	1836.534
Daga	Bhutan	Asia	40220	1052.873
Punakha	Bhutan	Asia	47675	4436.861
Pemagatse	Bhutan	Asia	52688	523.437
Lhunthsi	Bhutan	Asia	56226	2867.930
Paro	Bhutan	Asia	59804	1717.870
Shemgang	Bhutan	Asia	63150	2381.352
Wangdi Phodrang	Bhutan	Asia	66890	4364.049
Thimphu	Bhutan	Asia	76891	1830.109
Samdrup Jongkhar	Bhutan	Asia	103620	2087.843
Mongar	Bhutan	Asia	103897	1830.243

The records are sorted first by the left column's values and then by the right column's values.



## Selecting records

There are various ways to select features in ArcMap. One way is to select features through an attribute table. From a table, you can interactively select records by pointing at them or select those records that meet some criteria—for example, find all cities with a population greater than one million.

Once you've defined a selection, you'll see those features highlighted on your map. For example, suppose you wanted to find the locations of the five cities with the largest population. You would sort the records in the table in descending order based upon population and then select the top five records in the table to see them highlighted on the map.

You can add to your selected set using any other ArcMap selection methods.

### See Also

*For more information on selecting map features, see Chapter 13, 'Querying maps'.*

## Interactively selecting records

1. Open the attribute table for a layer on your map.
2. Click the leftmost column in the table adjacent to the record you want to select.

To select consecutive records, you can click and drag the mouse.

3. Press and hold the Ctrl key while clicking additional records.

2

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Darhan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365932	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyalah	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Dornod	Mongolia	Asia	91911	118099.5

NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146584	468.958
Daga	Bhutan	Asia	40220	1052.873
Dahuk	Iraq	Asia	443959	9912.903
Daman & Diu	India	Asia	107437	130.738
Darhan	Mongolia	Asia	88600	251.074
Dayr az Zawr	Syria	Asia	621876	27235.260
Delhi	India	Asia	9924474	1303.114
Dhaka	Bangladesh	Asia	36365932	31262.400
Dhawalagiri	Nepal	Asia	529003	8298.877
Dhi Qar	Iraq	Asia	975393	14037.630
Dimashq	Syria	Asia	3089555	18181.971
Diyalah	Iraq	Asia	929035	18230.381
Diyarbakir	Turkey	Asia	1188608	14740.640
Dnepropetrovsk	Ukraine	Europe	3998727	31721.480
Donetsk	Ukraine	Europe	5475559	26620.520
Dong Nai	Vietnam	Asia	1793504	6248.254
Dong Thap	Vietnam	Asia	1493641	3386.422
Dornod	Mongolia	Asia	91911	118099.5

3

Selected records are highlighted in the table and on the map.

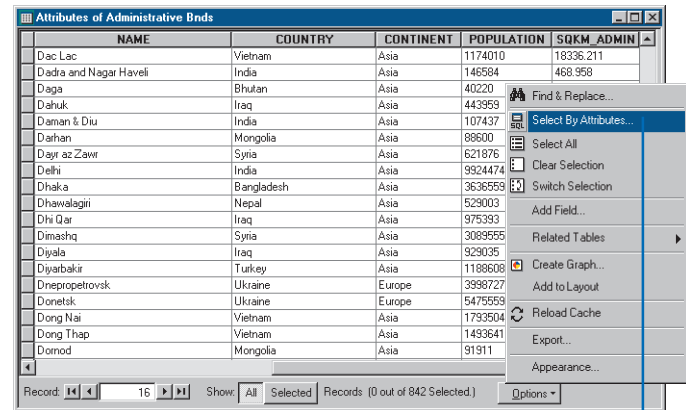
## Tip

### Saving and reusing selection expressions

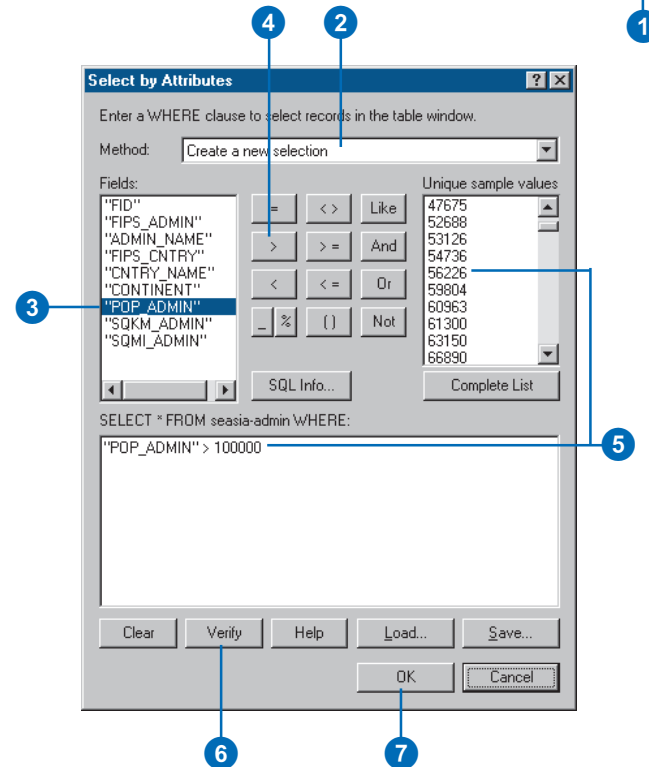
You can save and reload selection expressions using the Save and Load buttons at the bottom of the Select By Attributes dialog box. This lets you quickly re-create a selected set of records by loading in a saved expression.

### Selecting records by attributes

1. Click Options in the table you want to query and click Select By Attributes.
2. Click the Method dropdown arrow and click the selection procedure you want to use.
3. Double-click the field from which you want to select.
4. Click the logical operator you wish to use.
5. Scroll to and double-click the value in the Unique sample values list you wish to select. Alternatively, you can type a value directly into the text box.
6. Click Verify to verify your selection.
7. Click OK.  
Your selection is highlighted in the table.



NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Dac Lac	Vietnam	Asia	1174010	18336.211
Dadra and Nagar Haveli	India	Asia	146594	468.958
Daga	Bhutan	Asia	40220	
Dahuk	Iraq	Asia	443959	
Daman & Diu	India	Asia	107437	
Dashan	Mongolia	Asia	88600	
Dayr az Zawr	Syria	Asia	621876	
Delhi	India	Asia	9924474	
Dhaka	Bangladesh	Asia	3636559	
Dhawalagiri	Nepal	Asia	529003	
Dhri Qar	Iraq	Asia	975393	
Dimashq	Syria	Asia	3083555	
Diyala	Iraq	Asia	923035	
Diyarbakir	Turkey	Asia	1188608	
Dnepropetrovsk	Ukraine	Europe	3998727	
Donetsk	Ukraine	Europe	5475559	
Dong Nai	Vietnam	Asia	1793504	
Dong Thap	Vietnam	Asia	1493641	
Dornod	Mongolia	Asia	91911	



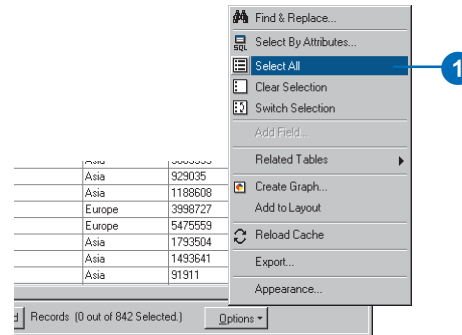
## Tip

### Selecting features

The Selection menu on the Standard toolbar contains additional tools for selecting features.

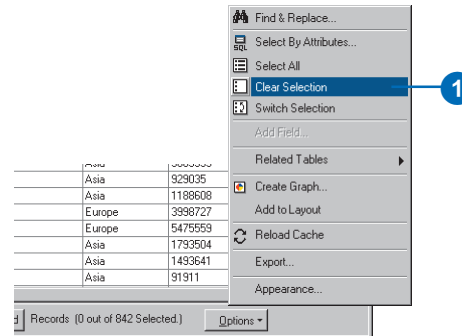
## Selecting all records

1. Click Options in the table and click Select All.



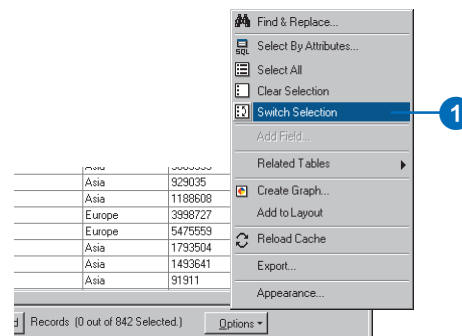
## Clearing the selected set

1. Click Options in the table and click Clear Selection.



## Switching the selected set

1. Click Options in the table and click Switch Selection.



## Summarizing data

Sometimes the attribute information you have about map features is not organized in the way you want—for instance, you have population data by county when you want it by state. By summarizing the data in a table, you can derive various summary statistics—including the count, average, minimum, and maximum value—and get exactly the information you want. ArcMap creates a new table containing the summary statistics. You can then join this table to the attribute table of a layer. Doing so lets you symbolize, label, or query the layer's features based on their values for the summary statistics.

### See Also

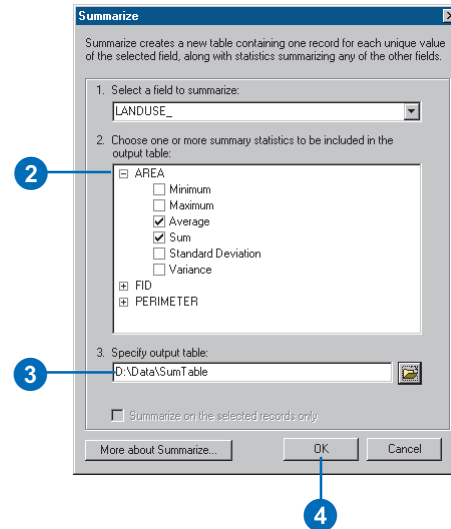
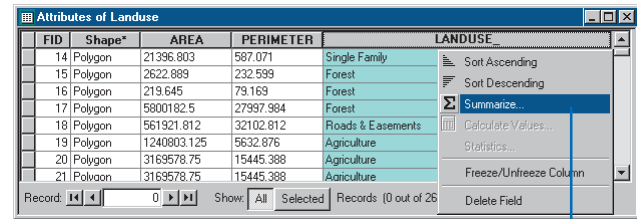
For more information on joining tables, see 'Joining attribute tables' in this chapter.

### See Also

If you want to summarize features by dissolving the boundaries between similar features, see the topic on the GeoProcessing Wizard in Chapter 13, 'Querying maps'.

## Summarizing data in a field

1. Right-click the field heading of the field you want to summarize and click Summarize.
2. Check the box next to the summary statistics you want to include in the output table.
3. Type the name and location of the output table you want to create or click the Browse button and navigate to a workspace.
4. Click OK.
5. Click Yes when prompted to add the new table to your map.



OID	LANDUSE	Count_LANDUSE	Avg_AREA	Sum_AREA
0	Agriculture	267	514882.282914	137473569.538
1	Assessed as unused	690	26524.913062	18302190.013
2	Brush	111	121435.193604	13479306.49
3	Duplex	11	41621.761364	457893.375
4	Forest	303	349895.691657	106015364.572
5	Freeway	5	72977.3028	364886.514
6	Heavy Industry	14	132352.375	1852933.25
7	Highway	19	64335.508842	1222374.668
8	Light Industry	8	119771.519125	958172.153

The new output table contains one record for each unique land use value and a field for each summary statistic you selected.

## Adding and deleting fields

You can easily add or remove fields from a table in ArcMap as necessary. Most likely, you'll add or remove fields from data that you personally manage. Large organizations typically have large databases with well-defined database schemas that outline the contents—including fields—of the database. Unless you manage the database, it is unlikely that you'll be able to add or remove fields.

You can add or remove fields from a table as long as the following conditions are met:

- You have write access to the data.
- You're not currently editing the data in ArcMap.
- No other users or applications are accessing the data including other ArcMap or ArcCatalog sessions.

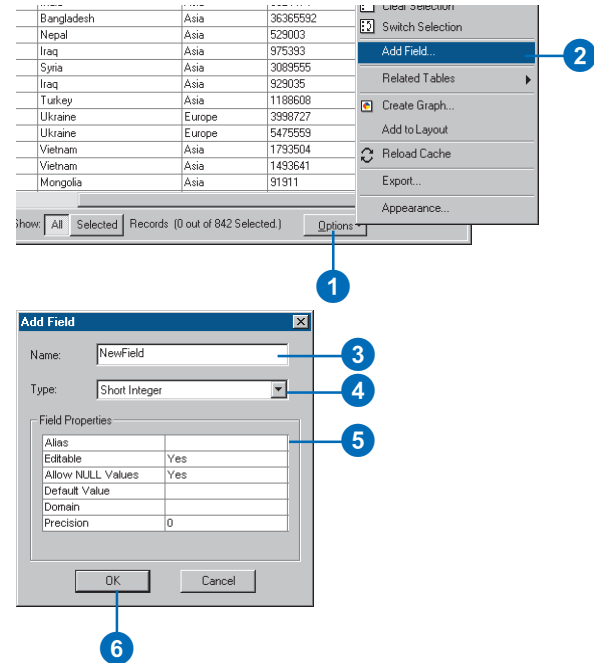
### Tip

#### Why is Add Field unavailable?

*The Add and Delete Field options are grayed out when you're editing the table.*

## Adding a field to a table

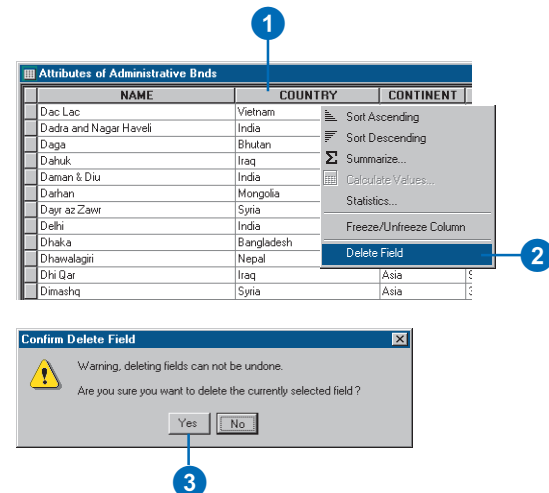
1. Click Options in the table you want to add a field to.
2. Click Add Field.
3. Type the name of the field.
4. Click the Type dropdown arrow and click the field type.
5. Set any other field properties, such as a field alias, as necessary.
6. Click OK.



## Deleting a field from a table


1. In the table window, right-click over the field header of the field you want to delete.
2. Click Delete Field.
3. Click Yes to confirm the deletion.

Deleting a field cannot be undone.



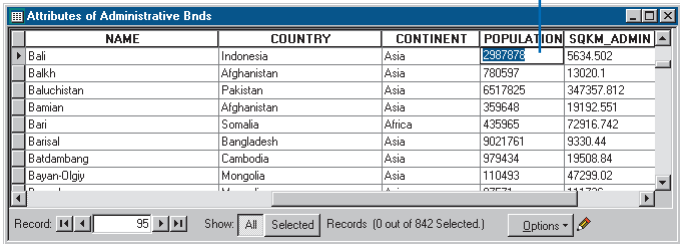
## Editing attributes

Your database is only as good as the information it contains. Over time, you'll need to edit the information in your database to keep it accurate and up-to-date. ArcMap lets you edit the attributes of features displayed on your map and also the attributes contained in other database tables (for example, a table of monthly sales figures) that are not represented geographically on the map. You can edit any of the attribute values that appear in a table as well as add new records and delete records. You can also use the field calculator to change the attribute value of a field for several records at once.

As with editing map features in ArcMap, editing the attributes of features takes place within an *edit session*. You start an edit session by clicking Start Editing from the Editor menu on the Editor toolbar. Once you begin an edit session, you'll notice this icon  next to the Options button on the table window, indicating that the table can be edited. Additionally, those fields that you can edit will have a white background color to the field heading. ▶

## Editing text in records

1. If you haven't started an edit session, click the Editor menu on the Editor toolbar and click Start Editing.
2. Open the table you want to edit.
3. Click the cell containing the attribute value you want to change.
4. Type the values and press Enter.  
The table is updated.

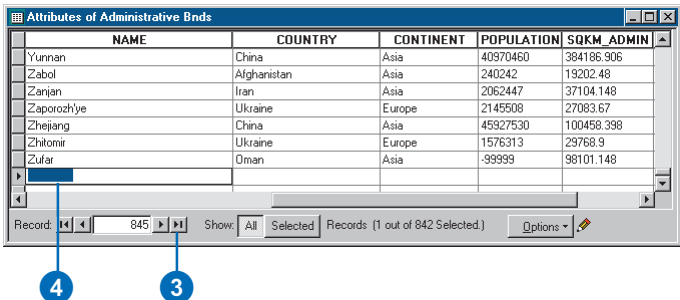


NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Bali	Indonesia	Asia	8937878	5634.502
Balkh	Afghanistan	Asia	780597	13020.1
Baluchistan	Pakistan	Asia	6517825	347357.812
Bamian	Afghanistan	Asia	359648	19192.551
Bari	Somalia	Africa	435965	72916.742
Bairisal	Bangladesh	Asia	9021761	9330.44
Baldambang	Cambodia	Asia	979434	19508.84
Bayan-Olgii	Mongolia	Asia	110493	47299.02

## Adding new records

1. If you haven't started an edit session, click the Editor menu on the Editor toolbar and click Start Editing.
2. Open the table you want to edit.
3. Click Move to end of table.
4. Click a cell in the last, empty record and type in a new value.

Note: Use these steps to add new records to tables that don't have associated geographic features. If you want to add features to your coverage, shapefile, or geodatabase, use the Create New Feature task on the Editor toolbar.



NAME	COUNTRY	CONTINENT	POPULATION	SQKM_ADMIN
Yunnan	China	Asia	40970460	384186.906
Zabol	Afghanistan	Asia	240242	19202.48
Zarjan	Iran	Asia	2062447	37104.148
Zaporozh'ye	Ukraine	Europe	2145508	27083.67
Zhejiang	China	Asia	45927530	100458.398
Zhitomir	Ukraine	Europe	1576313	29768.9
Zufar	Oman	Asia	-99999	98101.148

Now, you can make any of the attribute changes you need by clicking on a cell and typing a new attribute value. If you make a mistake, you can easily undo the edit by clicking Undo from the Edit menu.

Editing attributes through the table allows you to quickly make changes to several features (records) at once. When you're editing the attributes of specific map features, you may find it more convenient to do so using the Attribute dialog box, accessed from the Editor toolbar. This dialog is tailored to updating the attributes of specific map features that you first point at with the mouse.

When you've completed your edits, you can save them and end the edit session.

### Tip

#### Adding the Editor toolbar

To display the Editor toolbar, click Tools, then click Editor Toolbar.

### Tip

#### Navigating the cells in a table

You can navigate the cells in a table by pressing the Tab or arrow keys on your keyboard.

## Deleting records

1. If you haven't started an edit session, click the Editor menu on the Editor toolbar and click Start Editing.
2. Open the table you want to edit.
3. Select the records you want to delete. Press and hold the Ctrl key while clicking to select more than one record.
4. Press the Delete key on the keyboard.

Any geographic features associated with the records are also deleted.

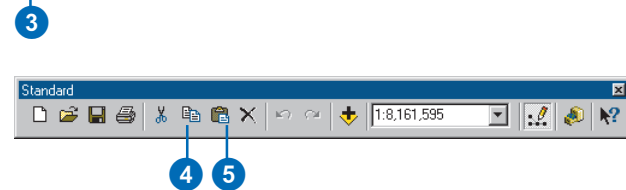
NAME	COUNTRY	CONTINENT	POPULATION	SQKM ADMIN
Yunnan	China	Asia	40970460	384186.906
Zabol	Afghanistan	Asia	240242	19202.48
Zarjan	Iran	Asia	2062447	37104.148
Zaporozhye	Ukraine	Europe	2145508	27083.67
Zhejiang	China	Asia	45927530	100458.398
Zhlotmir	Ukraine	Europe	1576313	29768.9
Zufar	Oman	Asia	-99999	98101.148

- 3 To select a record, click in the first column adjacent to the record you want to select.

## Copying and pasting records

1. If you haven't started an edit session, click the Editor menu on the Editor toolbar and click Start Editing.
2. Open the table you want to edit.
3. Select the records you want to copy. Press and hold the Ctrl key while clicking to select more than one record.
4. Click Copy on the Standard toolbar.
5. Click Paste on the Standard toolbar. The new records are added at the end of the table.

NAME	COUNTRY	CONTINENT	POPULATION	SQKM ADMIN
Yunnan	China	Asia	40970460	384186.906
Zabol	Afghanistan	Asia	240242	19202.48
Zarjan	Iran	Asia	2062447	37104.148
Zaporozhye	Ukraine	Europe	2145508	27083.67
Zhejiang	China	Asia	45927530	100458.398
Zhlotmir	Ukraine	Europe	1576313	29768.9
Zufar	Oman	Asia	-99999	98101.148



## Making field calculations

Entering values with the keyboard is not the only way you can edit tables. In some cases, you might want to perform a mathematical calculation to set a field value for a single record or even all records. The ArcMap field calculator lets you perform simple as well as advanced calculations on any selected record.

The field calculator also lets you perform advanced calculations using VBA statements that process the data before calculations are made on the selected field. For example, using demographic data, you might want to find out the largest age group by percentage of the population for each county in the United States. You can create a script that preprocesses your data using logical constructs such as If...Then statements and Select Case blocks. This lets you perform sophisticated calculations quickly and easily.

### Tip

#### Calculating fields outside an edit session

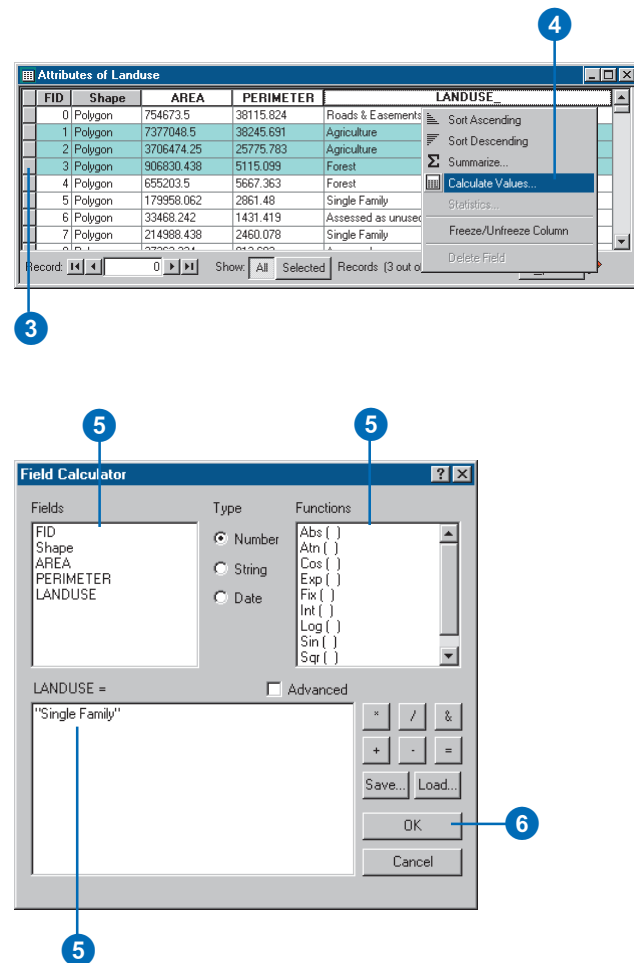
*You can't undo a field calculation when performed outside of an edit session.*

## Making simple field calculations

1. If you haven't started an edit session, click the Editor menu on the Editor toolbar and click Start Editing.
2. Open the table you want to edit.
3. Select the records you want to update. If you don't select any, the calculation will be applied to all records.
4. Right-click the field heading for which you want to make a calculation and click Calculate Values.
5. Use the Fields list and Functions to build a calculation expression. You can also edit the expression in the text area below. Alternatively, you can just type in a value to set the field to. In this example, the string "Single Family" is used.

Note: Use single or double quotes when calculating strings. Which one you use will depend on the database your data is stored in.

6. Click OK.





## Tip

### Reusing calculation expressions

After entering VBA statements, click **Save** to write them out to a file. The **Load** button will prompt you to find and select an existing calculation file.

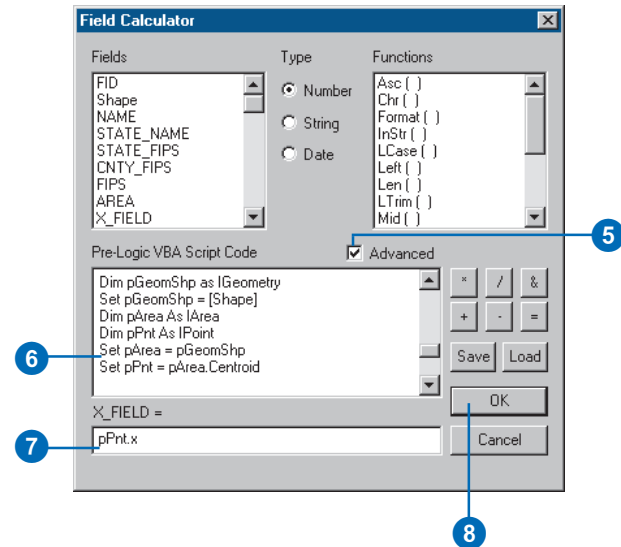
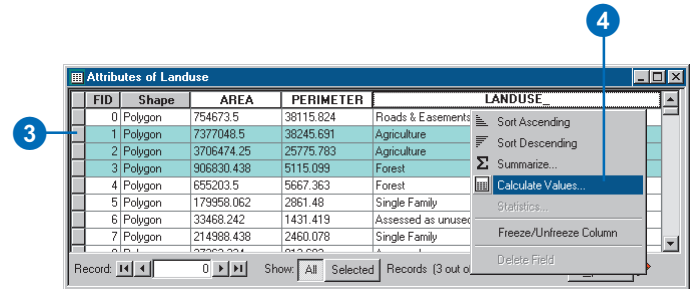
## See Also

For more information on VBA, consult any Visual Basic reference. *The Visual Basic Editor*—accessed by clicking the **Tools** menu, pointing to **Macros**, and clicking *Visual Basic Editor*—also contains an online reference to Visual Basic commands.

## Making advanced field calculations

1. If you haven't started an edit session, click the **Editor** menu on the Editor toolbar and click **Start Editing**.
2. Open the table you want to edit.
3. Select the records you want to update. If you don't select any, the calculation will be applied to all records.
4. Right-click the field heading for which you want to make a calculation and click **Calculate Values**.
5. Check **Advanced**.
6. Type VBA statements in the first text box.
7. Type the variable or value that is to be written to the selected records.
8. Click **OK**.

The VBA statements can include ArcMap methods. The VBA code shown in the figure gets the x-coordinate of the centroid of each polygon in the layer and writes it out to a field called **X\_FIELD**.



# About joining attribute tables

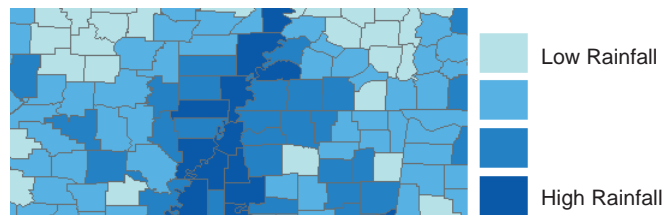
Most database design guidelines promote organizing your database into multiple tables—each focused on a specific topic—instead of one large table containing all the necessary fields. This scheme prevents duplicate information in the database because you store the information only once in one table. When you need information that isn't in the current table, you can link the two tables together. In ArcMap, you can establish this kind of link by either *joining* or *relating* two tables together.

## Joining the attributes from a table

Typically, you'll join a table of data to a layer's attribute table, extending the information you have about your geographic features. Joins are based on the value of a field that can be found in both tables. The name of the field does not have to be the same, but the data type has to be the same; you join numbers to numbers, strings to strings, and so on.

Suppose you obtain daily weather forecasts by county and generate weather maps based on this information. As long as the

Shape	FID	County	County	Rain	Total
Polygon	1	Atoka	Atoka	1.80	10.16
Polygon	2	Kiowa	Kiowa	2.34	13.67
Polygon	3	Nowata	Nowata	1.62	11.90



Symbolizing features based on joined rainfall data.

weather data is stored in a table in your database and shares a common field with your layer, you can join it to your geographic features and use any of the additional fields to symbolize, label, query, or analyze the layer's features.

When you join tables in ArcMap, you establish a *one-to-one* or *many-to-one* relationship between the layer's attribute table and the table containing the information you wish to join. The example above illustrates a one-to-one relationship between each county and the weather data. In other words, there's one record of weather data for each county.

Here's an example of a many-to-one relationship. Suppose you have a layer where each polygon is classified according to its land use type. The layer's attribute table only stores a land use code; a separate table stores the full description of each land use type. Joining these two tables together establishes a many-to-one relationship because many records in the layer's attribute table join to the same record in the table of land use descriptions. You might then use the more descriptive text when generating the legend for your map.

Shape	FID	LU_Code	LU-Code	Description
Polygon	1	2	1	Single Family
Polygon	2	1	2	Agriculture
Polygon	3	1	3	Commercial



Many polygons share the same land use description.

## Summarizing your data before joining it

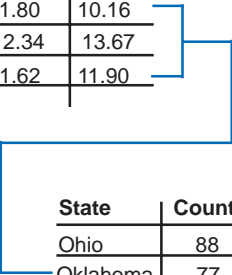
Depending on how your data is organized, you may have to start by summarizing the data in your table before you join it to a layer. When you summarize a table, ArcMap creates a new table containing summary statistics derived from your table. You can create various summary statistics including count, average, sum, minimum, and maximum.

For example, suppose you want to create weather maps by state instead of by county, but the weather information you have is organized by county. You could summarize the county data by state—for instance, finding the average rainfall for all counties within a state—and then join the newly created output table to a state layer to create a weather map of rainfall by state.

State	County	Rain	Total
Oklahoma	Atoka	1.80	10.16
Oklahoma	Kiowa	2.34	13.67
Oklahoma	Nowata	1.62	11.90

State	Count	Avg_Rain	Max_Rain
Ohio	88	3.21	4.50
Oklahoma	77	2.56	3.86
Oregon	36	5.66	7.92



*Sometimes it may be necessary to summarize your tabular data so that it can be joined to your geographic data.*

## When to relate tables instead of joining them

You've seen how joining tables establishes a one-to-one or many-to-one relationship between a layer and a table. However, in some situations, you may want to establish a *one-to-many* or a *many-to-many* relationship between a layer and a table.

An example of a one-to-many relationship is building occupancy. One building, such as a shopping center, may be occupied by many tenants. You may want to join a table of tenants to the attribute table of a layer representing buildings. However, if you perform a join, ArcMap will only find the first tenant belonging to each building, ignoring additional tenants. In this case, you should *relate* the tables instead of joining them.

Unlike joining tables, relating tables simply defines a relationship between two tables. The associated data isn't appended to the layer's attribute table like it is with a join. Instead, you can access the related data when you work with the layer's attributes. For example, if you select a building, you can find all the tenants that occupy that building. Similarly, if you select a tenant, you can find what building they reside in (or several buildings, in the case of a chain of stores in multiple shopping centers—a many-to-many relationship).

Relates defined in ArcMap are essentially the same as simple relationship classes defined in a geodatabase, except that they are saved with the map instead of in a geodatabase. For more information on creating relationship classes, see Chapter 6, 'Defining relationship classes', in *Building a Geodatabase*.

## Joining data spatially

When the layers on your map don't share a common attribute field, you can instead join them using a *spatial join*. A spatial join joins the attributes of two layers based on the location of the features in the layers. With a spatial join, you can:

- Find the closest feature to another feature.
- Find what's inside a feature.
- Find what intersects a feature.

For example, you might want to tell a customer where they can find the nearest retail store and how far away it is from them. Or a biologist might summarize information about endangered species sightings based on what region in a national park the observations were made.

For information on how to perform a spatial join, see Chapter 13, 'Querying maps'.

## How are joins and relates saved in your map?

When you save a map containing joins and relates, ArcMap saves the definition of how the two attribute tables are linked rather than saving the linked data itself. The next time you open your map, ArcMap reestablishes the relationship (whether a join or relate) between the tables by reading the tables from the database. In this way, any changes to the source tables that have taken place since they were last viewed on the map are automatically included and reflected on the map.

If you want, you can make a permanent disk copy of a layer with joined data; simply export the layer. To export the layer, right-click it in the table of contents, point to Data, and click Export Data. This creates a new feature class with all of the attributes, including the joined fields, written out.

## Joining attribute tables

Data comes from a variety of sources. Often, the data you want to display on your map is not directly stored with your geographic data. For instance, you might obtain data from other departments in your organization, purchase commercially available data, or download data from the Internet. If this information is stored in a table, such as a dBASE, INFO, or geodatabase table, you can associate it with your geographic features and display the data on your map.

ArcMap provides two methods to associate data stored in tables with geographic features: *joins* and *relates*. When you join two tables, you append the attributes from one onto the other, based on a field common to both tables. Relating tables defines a relationship between two ►

### See Also

For information on spatial joins, see Chapter 13, 'Querying maps'.

### Tip

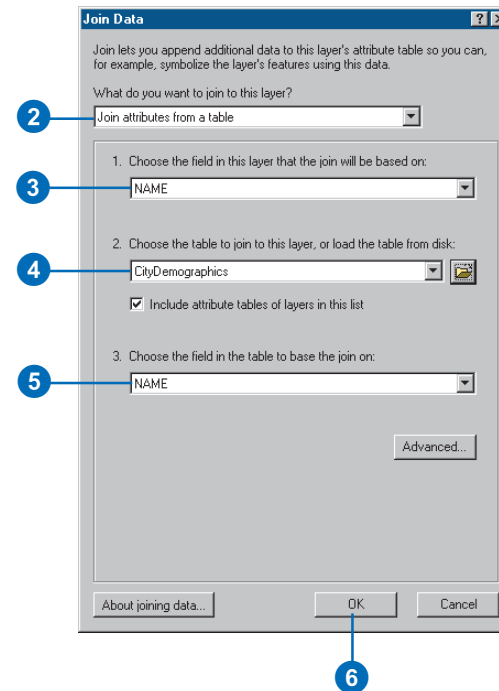
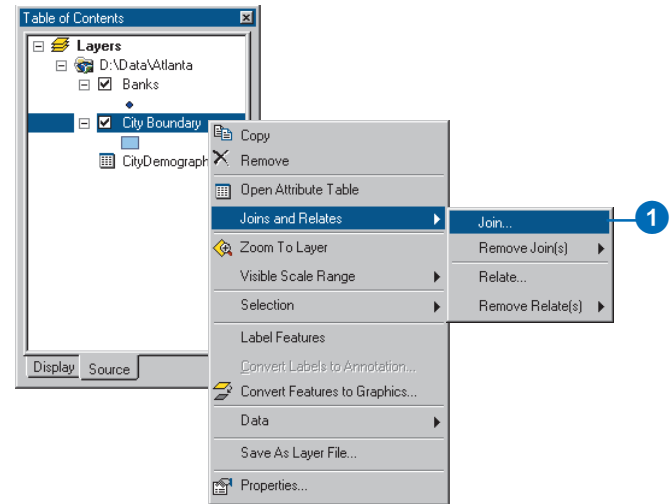
#### Joining by relationship class

You can also join two tables using a predefined relationship class.

## Joining the attributes in one table to another

1. Right-click the layer or table you want to join, point to Joins and Relates, and click Join.
2. Click the first dropdown arrow and click Join attributes from a table.
3. Click the dropdown arrow and click the field name in the layer that the join will be based on.
4. Click the dropdown to choose the table to join to the layer. If the table is not currently part of the map, click the browse button to search for it on disk.
5. Click the dropdown arrow and click the field in the table to base the join on.
6. Click OK.

The attributes of the table are appended to the layer's attribute table.



tables—also based on a common field—but doesn't appended the attributes of one to the other. Instead, you can access the related data when necessary.

You'll want to join two tables when the data in the tables has a *one-to-one* or a *many-to-one* relationship—for example, you have a layer showing store locations and you want to join a table of the latest monthly sales figures to it.

You'll want to relate two tables when the data in the tables has a *one-to-many* or *many-to-many* relationship—for example, your map displays a parcel database, and you have a table of owners. A parcel may have more than one owner and an owner may own more than one parcel.

Joins and relates are reconnected whenever you open the map. This way, if the underlying data in your tables changes, it will be reflected in the join or relate.

When you're through using a join or relate, you can remove it.

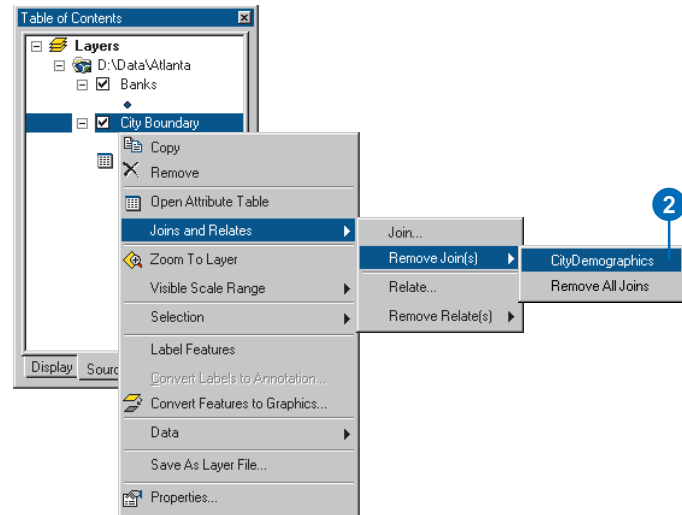
## Tip

### Creating a new dataset from joined data

If you want to permanently save joined data with your geographic features, export the data to a new dataset (e.g., shapefile). Right-click the layer in the table of contents, point to *Data*, and click *Export data*.

## Removing a joined table

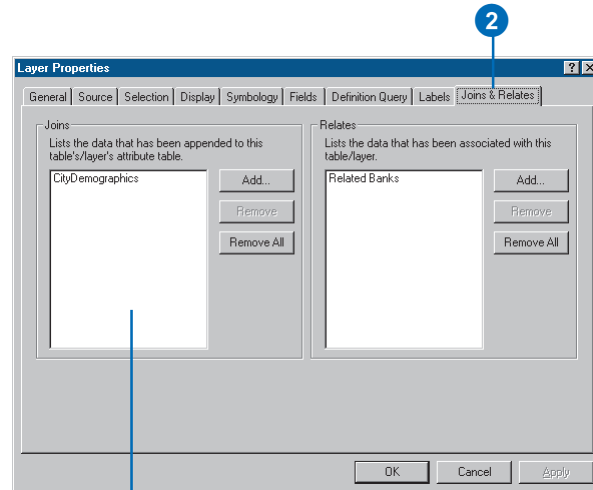
1. Right-click the layer containing a join you want to remove and point to *Joins and Relates*.
2. Point to *Remove Join(s)* and click the join you want to remove.



## Managing joined tables

1. Right-click a layer or table in the table of contents and click *Properties*.
2. Click the *Joins & Relates* tab.

All the joins for the layer or table are listed on the left side of the dialog. You can add new joins or remove existing ones.



All joins for the layer or table are listed here.

## Tip

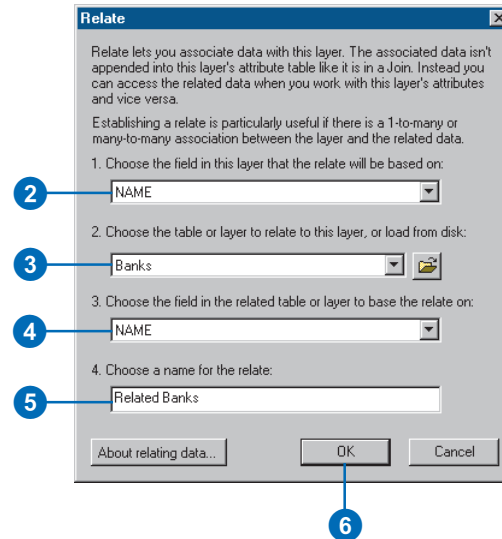
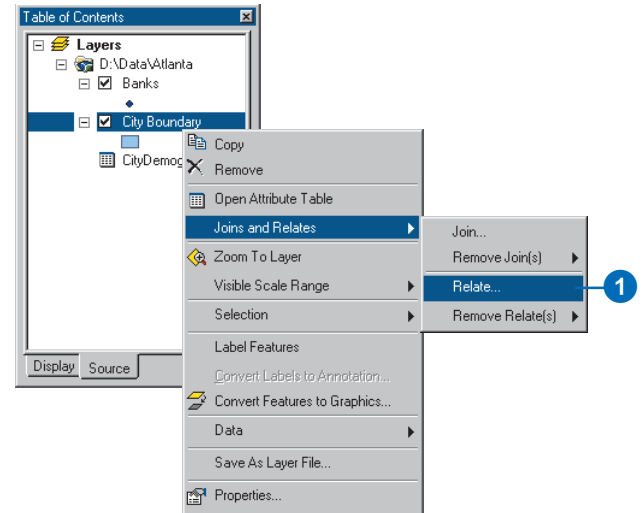
### You may not need to relate feature classes in geodatabases

If a feature class in a geodatabase participates in a relationship class, that relationship class will be immediately available for use. You don't need to relate the tables in ArcMap.

## Relating the attributes in one table to another

1. Right-click the layer you want to relate, point to Joins and Relates, and click Relate.
2. Click the first dropdown arrow and click the field in the layer the relate will be based on.
3. Click the second dropdown arrow and click the table or layer to relate to, or load the table from disk.
4. Click the third dropdown arrow and click the field in the related table to base the relate on.
5. Type a name for the relate. You'll use this name to access the related data.
6. Click OK.

The relate is now established between the two tables. The next topic discusses how to access records using the relate.



## Tip

### Relates work both ways

Once you define a relate, you can access the related records from either table participating in the relationship.

## Tip

### Accessing relationship classes

If your map contains layers from a geodatabase that participate in relationship classes, those relationship classes will be listed automatically along with any relates you define.

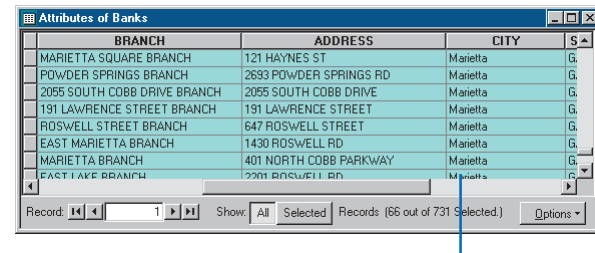
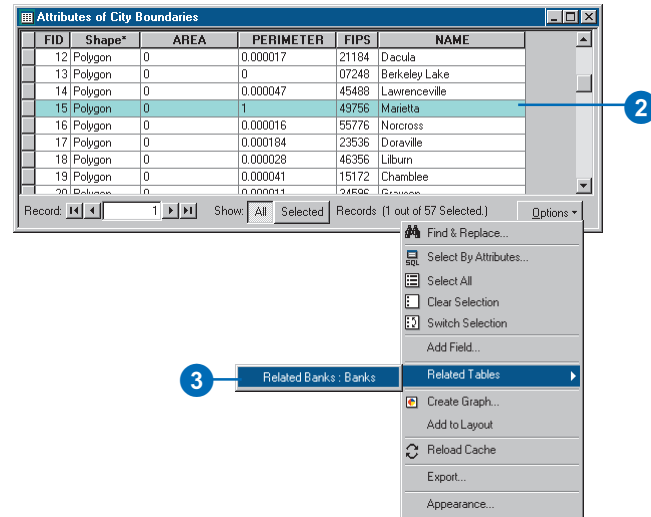
## See Also

You must set up a relationship before you can access related records. For information on relating tables, see 'Relating the attributes in one table to another' on the previous page.

## Accessing related records

1. Open the attribute table for which you've set up a relate.
2. Select the records in the table for which you want to display related records.
3. Click Options, point to Related Tables, and click the name of the relate you want to access.

The related table displays with the related records selected.

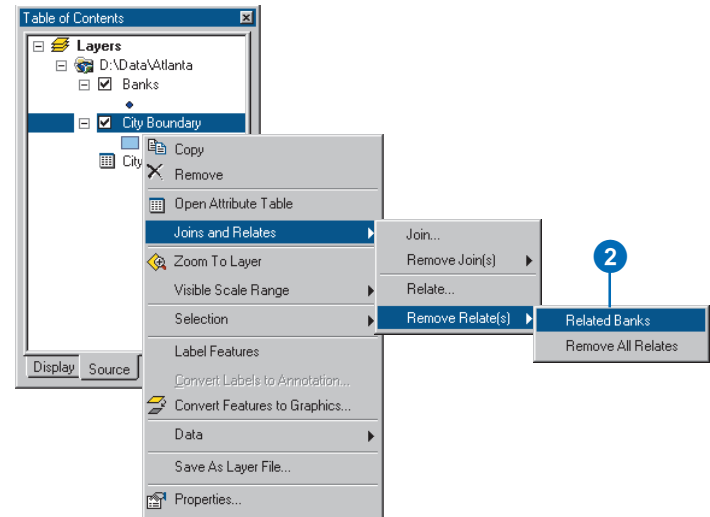


All banks in the City of Marietta are selected.



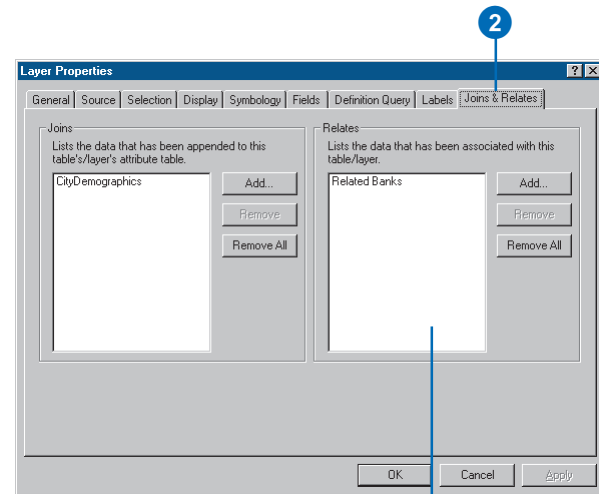
## Removing a related table

1. Right-click the layer containing a relate you want to remove and point to Joins and Relates.
2. Point to Remove Relate(s) and click the relate you want to remove.



## Managing related tables

1. Right-click a layer or table in the table of contents and click Properties.
2. Click the Joins & Relates tab.  
All the relates for the layer or table are listed on the right side of the dialog. You can add new relates or remove existing ones.



All relates for the layer or table are listed here.

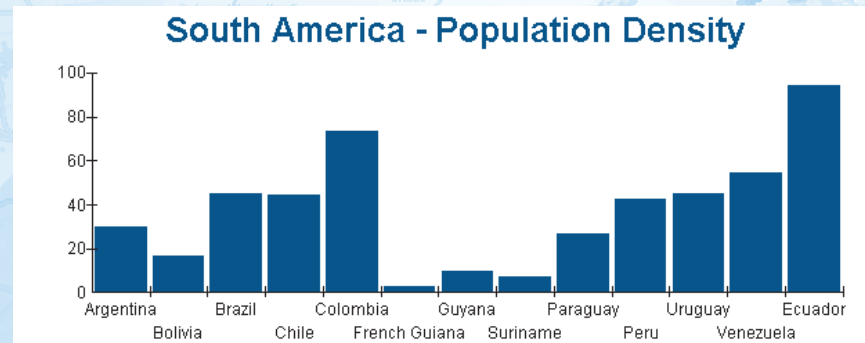


# Looking at data with graphs

## IN THIS CHAPTER

- Choosing which type of graph to make
- Creating a graph
- Displaying a graph
- Modifying a graph
- Creating a static copy of a graph
- Managing graphs
- Saving and loading a graph
- Exporting a graph

Graphs present information about map features—and the relationship between them—in an attractive, easy-to-understand manner. They can show additional information about the features on the map or show the same information in a different way. Graphs complement a map because they convey information that would otherwise take some time to summarize and understand—for instance, you can quickly compare features to see which have more or less of a particular attribute.



*You can quickly see which countries have a high population density in this column graph.*

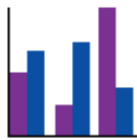
The information displayed on a graph comes directly from the attribute information stored with your geographic data. Once created, you can easily add a graph to your map and print it out.

# Choosing which type of graph to make

You can choose from several different types of graphs—both two- and three-dimensional. Some graphs are better than others at presenting certain kinds of information. Each graph has display properties that you can adjust to suit your needs. You can experiment with the various graph types and display properties to see what works best for you.



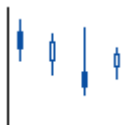
**Area**—An area graph consists of one or more lines drawn on an x,y grid with the area between the lines and the x-axis shaded. Like line graphs, area graphs show trends in values, but shading gives greater emphasis to differences in quantities. An area graph can be two- or three-dimensional.



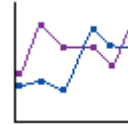
**Bar and Column**—Bar and column graphs consist of two or more parallel bars, each representing a particular attribute value. Use either of these graphs to compare amounts or to show trends—for example, monthly sales figures. Bar and column graphs can be two- or three-dimensional.



**Bubble**—The bubble graph lets you chart three variables in two dimensions. It's a variation of the scatter graph, where the size of the bubble represents a particular data value. For example, the size of the bubble might represent total population; the position along the y-axis, birth rate; and the position along the x-axis, death rate.



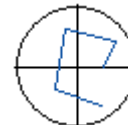
**High-Low-Close**—The high-low-close graph lets you chart a range of values on an x,y grid. The range is shown as a vertical bar, with a horizontal crossbar for the high, the low, and a normative value usually called the close. An alternate version, the open-high-low-close, adds a fourth crossbar for another value called the open.



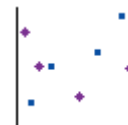
**Line**—A line graph consists of one or more lines, or sequences of symbols, drawn on an x,y grid. Line graphs show trends in value along a continuous scale. The three-dimensional version of the line graph is also available.



**Pie**—The pie chart consists of a circle, or pie, divided into two or more sections, or slices. Pie charts show relationships between parts and the whole and are particularly useful for showing proportions and ratios. You can highlight a pie slice by “exploding” it—moving it slightly away from the center. A pie chart can be two- or three-dimensional.



**Polar**—A polar graph is essentially a line graph drawn on a circular grid. The line relates values to angles. Polar graphs are useful primarily in mathematical and statistical applications.



**Scatter**—A scatter graph plots x,y coordinates based on attribute values. The pattern may reveal a relationship between the values plotted on the grid. A scatter graph may also be three-dimensional, with data plotted along a z-axis.

## Creating a graph

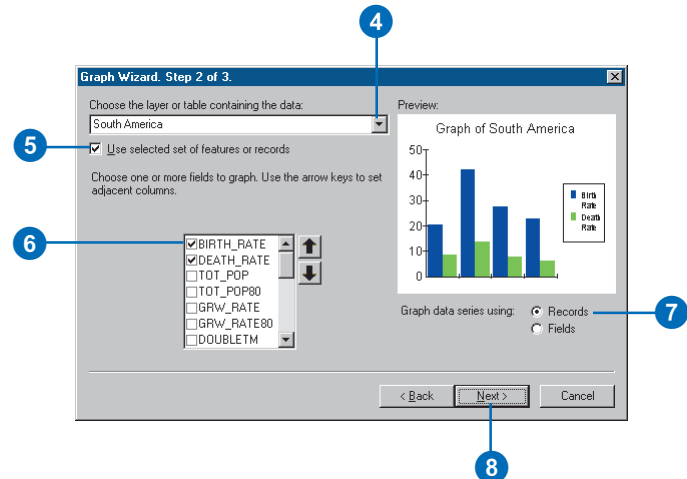
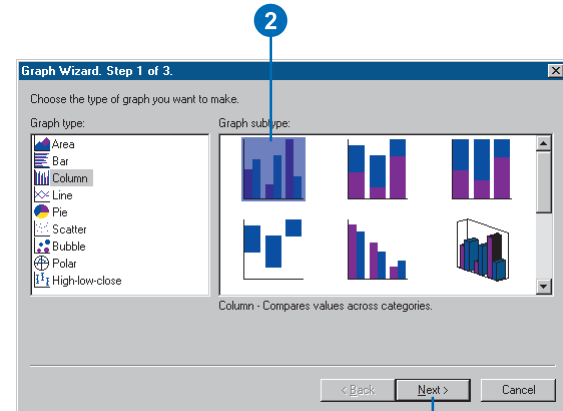
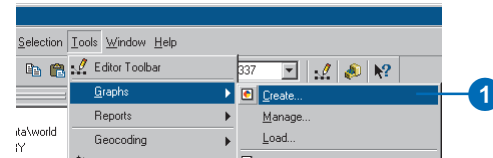
Before you create a graph, you should determine what you want to graph. You can graph all features or just the selected ones. Some graphs can effectively display only a limited amount of data, so choose your graph type appropriately. Alternatively, you might consider making more than one graph.

Most graphs are drawn on a grid whose scales are shown by two or three axes: x, y, and z. A data point displayed on the graph is defined by the intersection of two or more field values—for instance, birth rate plotted along the x-axis and death rate plotted along the y-axis on a scatter graph. Keep in mind that a data point doesn't necessarily appear as a point (or dot) on a graph. Depending on the type of graph, a single data point may be represented by a dot, a bar, a pie slice, or some other graphic.

For most graphs, you can choose more than one field value to plot along the axes. You can order the fields as necessary. For example, you can choose which bar in a bar graph represents which field. The order also defines how fields pair up for plotting data points on the graph. For example, suppose you want to graph two attribute fields for the x-axis and two for ►

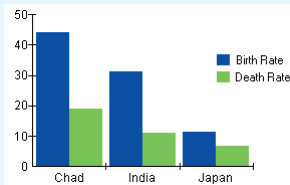
## Creating a graph and adding it to a layout

1. Click the Tools menu, point to Graphs, and click Create.
2. Click the Graph type and subtype you want.
3. Click Next.
4. Click the dropdown arrow and click the layer or table you want to graph.
5. Check to graph only the selected features or records.
6. Check the fields you want to graph.
7. Click an option to graph data series using Records or Fields.
8. Click Next. ►

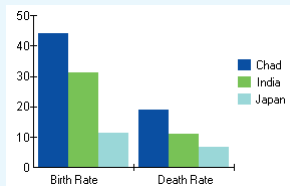


the y-axis on a scatter graph. The first field in the list for the x-axis pairs up with the first field in the list for the y-axis, and so on, to determine the location of the data points on the graph.

With some graph types, you can graph data using either records or fields. For instance, suppose you have data on birth and death rates by country. Graphing by record allows you to easily compare the birth and death rates for individual countries.

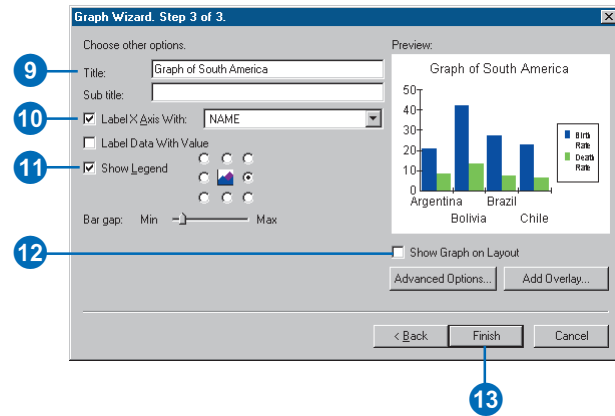


Graphing by field plots all birth and death rates together for all countries.



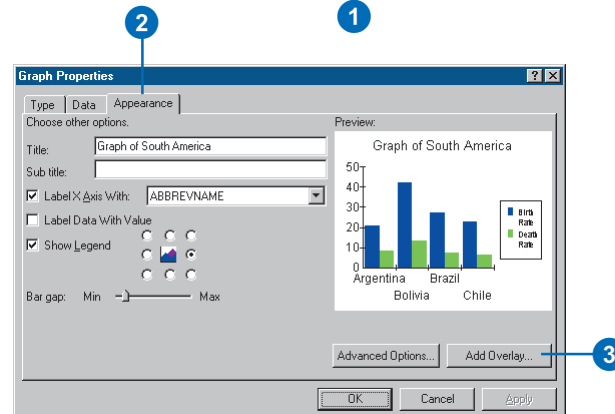
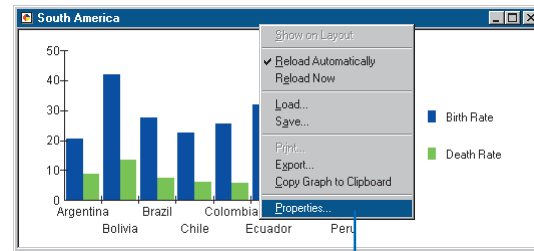
In some cases, you can also plot a secondary graph, called an overlay graph, over the primary one. An overlay graph is a line graph that uses the same x-axis as the primary graph.

9. Type a title for the graph.
10. Check Label X Axis With, then click the dropdown arrow and click a field.
11. Check Show Legend.
12. Check Show Graph on Layout.  
You can add the graph to the layout later if necessary.
13. Click Finish.



## Adding an overlay graph

1. Right-click the title bar of the graph window and click Properties.
2. Click the Appearance tab.
3. Click Add Overlay. ▶

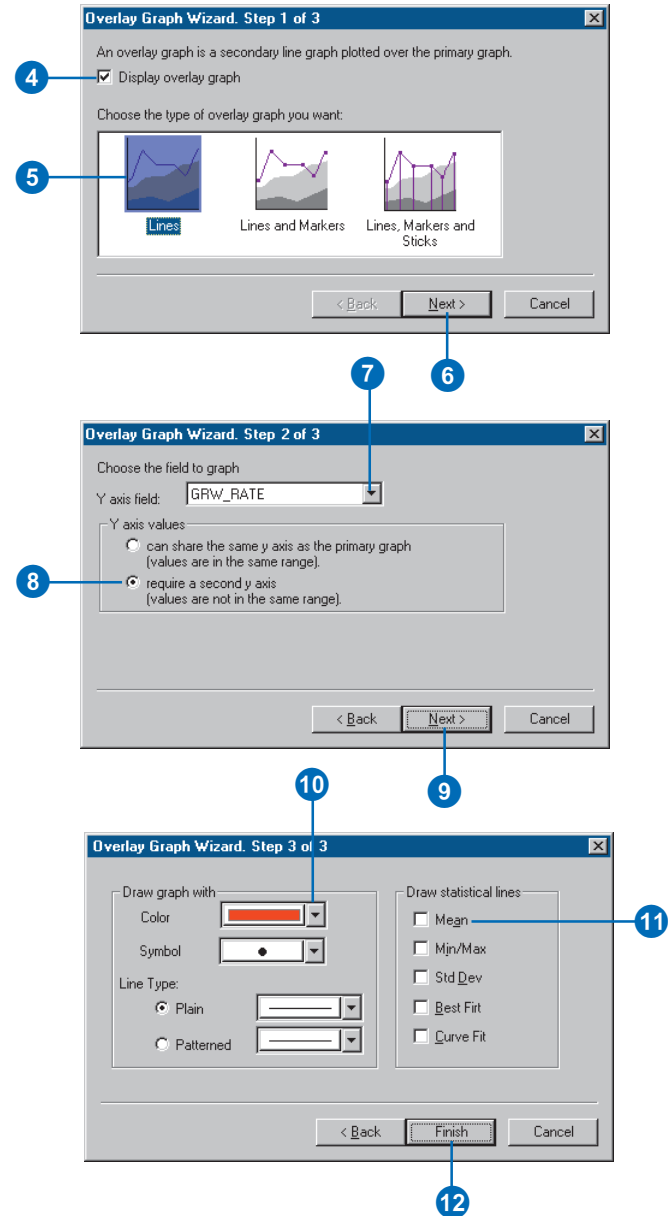


## Tip

### Why is the Add Overlay button unavailable?

*You can only add an overlay graph to column, area, high–low–close, and scatter graphs.*

4. Check Display overlay graph.
5. Click the type of overlay graph you want to add.
6. Click Next.
7. Click the Y axis field dropdown arrow and click the field you want to graph.
8. Click the option to add a second y-axis if the data values in the field you chose are not in the same range as the primary graph.
9. Click Next.
10. Click the Color dropdown arrow and set a line color for the graph.
11. Optionally, you can add statistical lines to the overlay. Check those you want to add.
12. Click Finish.



## Displaying a graph

While working with the graphs on your map, you can choose to view them in separate windows alongside the ArcMap window, as map elements on the layout ready to be printed, or both.

Graphs are dynamic; they can update automatically as you change the selected set of features in a layer. Thus, as you browse a map selecting new features, the graph will update to reflect the new selected features.

### Tip

#### Updating a graph on the layout

*Graphs shown on the layout will automatically update as you change the selected set of features the graph is based on. If you want to create a static copy on the layout, copy and paste the graph on the layout.*

### Tip

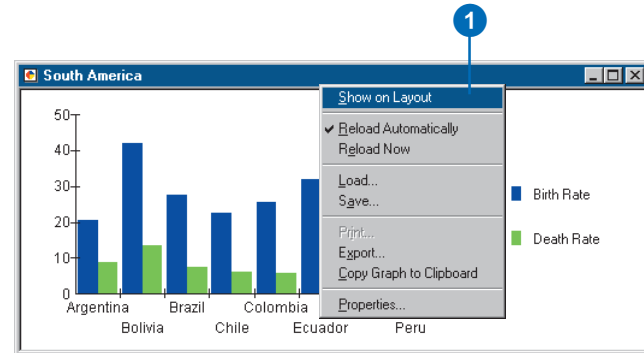
#### You can only display a graph once on a layout

*If you want to show different sets of data graphed the same way, you need to create multiple graphs. You can copy and paste a graph on a layout to create a static copy.*

## Adding a graph to the layout

1. Right-click the title bar of the graph window and click Show on Layout.

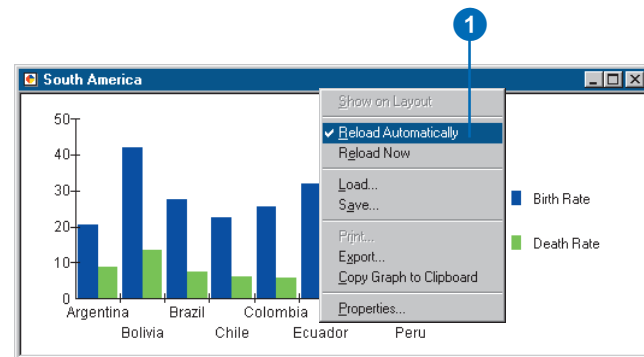
If the graph is already on the layout, this option will be unavailable.



## Updating a graph when the selection changes

1. Right-click the title bar of the graph window and click Reload Automatically.

When Reload Automatically is checked, the graph will update whenever the selected set of features changes. Disabling this feature creates a static graph. This option works only when you create a graph using the selected features.





## Modifying a graph

You can control most visual aspects of a graph to create an effective display of your data. For example, you can choose what type of graph you want to use, add titles, label axes, and change the color of graph markers—such as the bars in a bar graph.

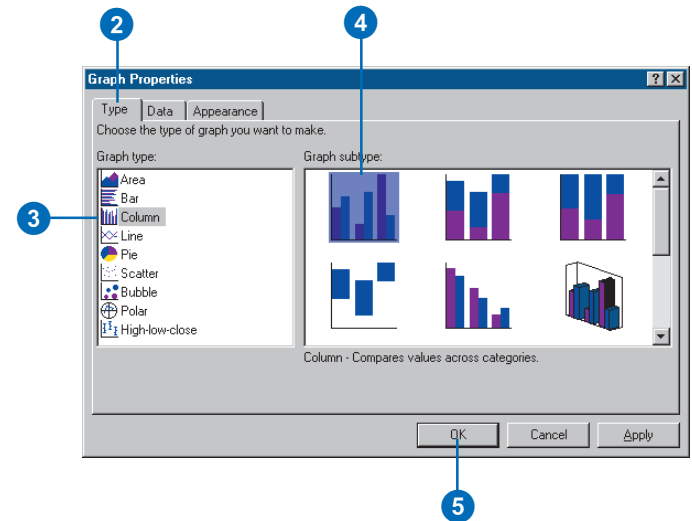
### Tip

#### Identifying features on a graph

*Clicking on a data point on a graph—whether a bar on a bar graph or a point on a line graph—identifies the associated feature on the layer.*

## Changing the graph type

1. Right-click the title bar of the graph window and click Properties.
2. Click the Type tab.
3. Click the graph type you want to use.
4. Click the Graph subtype you want to use.
5. Click OK.



## Tip

### Changing the font and size of the title

To change the text font or text size of the graph title, click the *Advanced Options* button on the *Appearance* tab. Then, click the *Fonts* tab on the dialog box that appears.

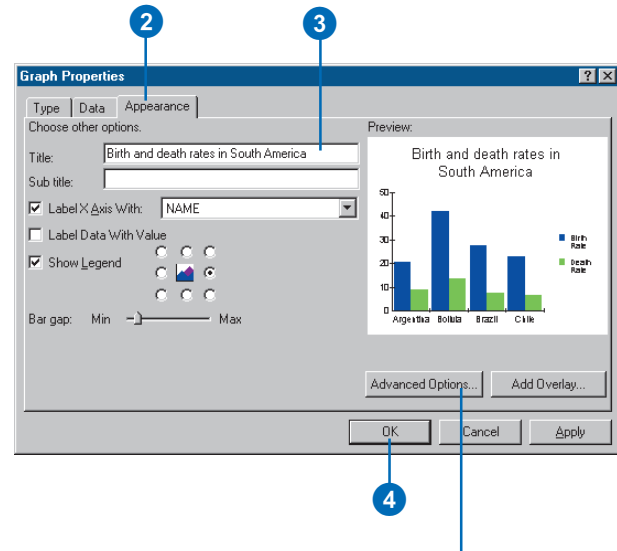
## Tip

### Changing the text color of the title

To set the text color of the title, click the *Advanced Options* button on the *Appearance* tab. On the dialog box that appears, click the *Background* tab and change the text color.

## Adding a title to a graph

1. Right-click the title bar of the graph window and click *Properties*.
2. Click the *Appearance* tab.
3. Type a title.
4. Click *OK*.



Click *Advanced Options* to set the text font, size, and color. Set the text font and size from the *Font* tab. Set the text color from the *Background* tab.

## Tip

### Why don't I see the color I want?

Click the *Background* tab on the *Advanced Options* dialog box and change the palette.

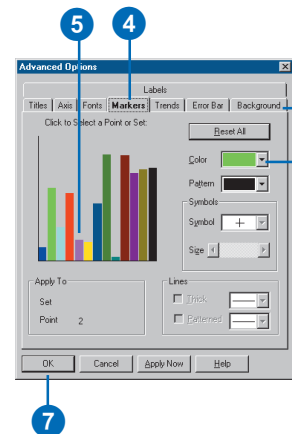
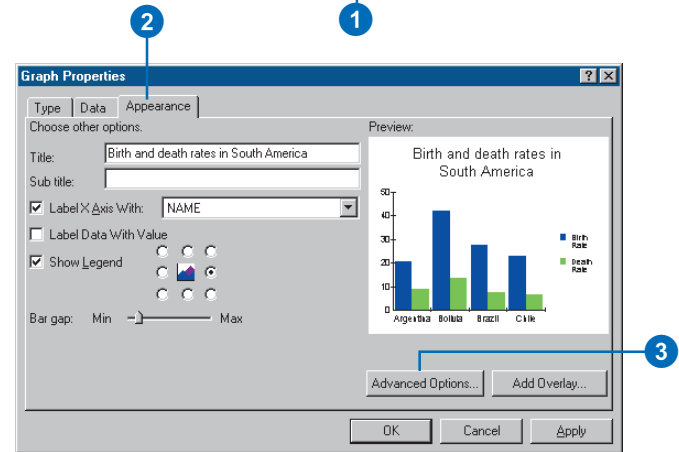
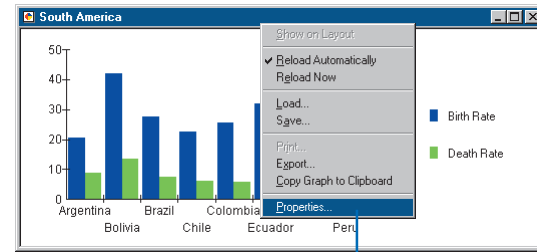
## Tip

### Setting point symbols

For graphs that plot points—for example, the scatter graph—you can also choose the symbol to plot points with. Click the *Markers* tab on the *Advanced Options* dialog box.

## Changing graph marker colors

1. Right-click the title bar of the graph window and click *Properties*.
2. Click the *Appearance* tab.
3. Click *Advanced Options*.
4. Click the *Markers* tab.
5. Click the marker you want to change.
6. Click the *Color* dropdown arrow and click a color.
7. Click *OK*.



If you don't see the colors you want, click the *Background* tab and change the palette.

## Tip

### Changing the font of the legend

To change the text font or text size of the text in the legend, click the **Fonts** tab on the **Advanced Options** dialog box.

## Tip

### Changing the text color of the legend

The option for setting the text color of the legend is located on the **Background** tab on the **Advanced Options** dialog box.

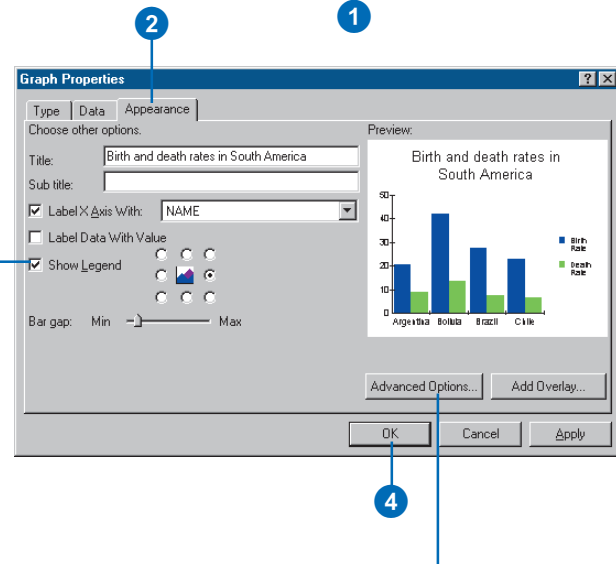
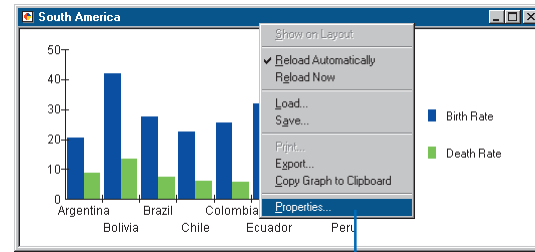
## Tip

### Placing a border around a legend

You'll find the option to add or remove the border around a legend on the **Background** tab on the **Advanced Options** dialog box.

## Adding a legend to a graph

1. Right-click the title bar of the graph window and click **Properties**.
2. Click the **Appearance** tab.
3. Check **Show Legend** and click a legend position.
4. Click **OK**.



Click **Advanced Options** to set the text size, font, and color for the legend, as well as to add and remove borders. The text font and size controls are found on the **Fonts** tab. The text color and border controls are found on the **Background** tab.

## Tip

### Setting the text font for labeling axes

Click the **Fonts** tab on the **Advanced Options** dialog box. In **Apply to**, click **Labels**, then in **Typeface**, choose the font you want your labels displayed with.

## Tip

### Why don't I see the color I want?

Click the **Background** tab on the **Advanced Options** dialog box and change the palette.

## Controlling the x-, y-, and z-axes of the graph

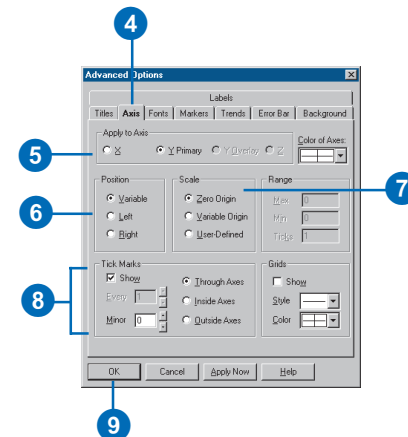
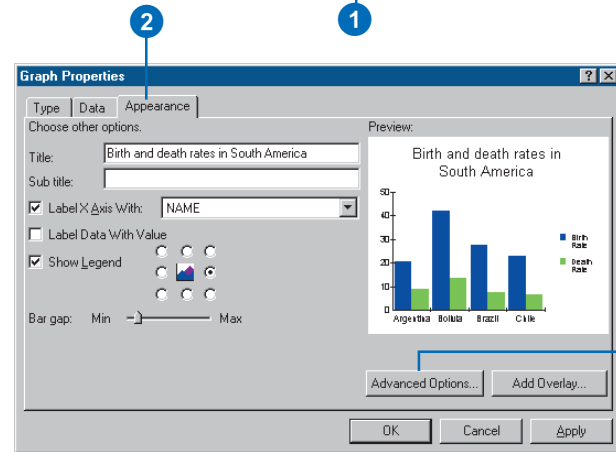
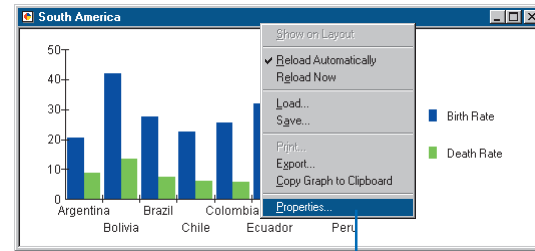
1. Right-click the title bar of the graph window and click **Properties**.
2. Click the **Appearance** tab.
3. Click **Advanced Options**.
4. Click the **Axis** tab.
5. Click the axis you want to modify.
6. Set the position of the axis. For example, click **variable**, **left**, or **right** for the y-axis.
7. Set the scale, or numeric range, for the axis.

**Zero Origin:** axis coordinates range from zero to maximum data value.

**Variable Origin:** axis coordinates range is set to the actual data value range.

**User-Defined:** you specify the coordinate range for the axis.

8. Optionally, check the boxes to show **Tick Marks** and **Grids** on your graph.
9. Click **OK**.



## Tip

### What are trend lines?

Trend lines are additional lines you can draw on top of your graph. A trend line can represent a statistical value, such as the mean or standard deviation, or it might be a limit line you define to highlight data values that fall outside a prescribed limit.

## Drawing trend lines on a graph

1. Right-click the title bar of the graph window and click Properties.

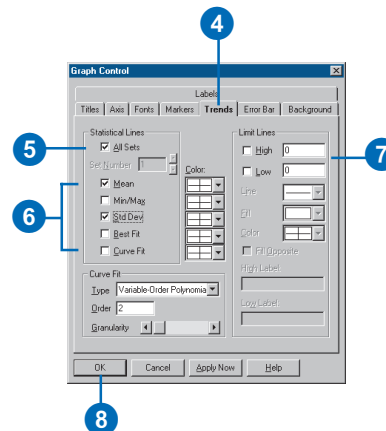
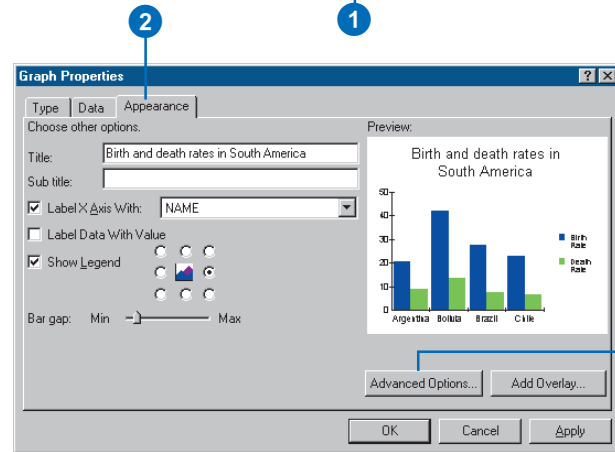
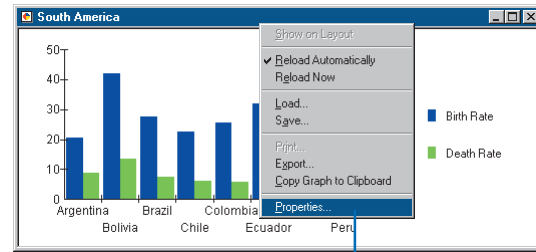
2. Click the Appearance tab.
3. Click Advanced Options.
4. Click the Trends tab.

Not all graph types support trend lines. If the tab is not available, the graph type does not support it.

5. Check All Sets to draw trend lines for each attribute value you're graphing.

For example, if you're graphing birth and death rates, you can draw a mean line for both values or just one of them.

6. Check the line types you want to add to the graph.
7. Type a value to add your own limit lines (drawn along a specified y-axis value).
8. Click OK.



## Creating a static copy of a graph

Graphs shown on a layout update automatically as you change the selected features in the layer the graph is based on. Sometimes you may want to create a static version of a graph to show how different features compare. To do this, you can copy and paste the graph on the layout.

Copying a graph on the layout creates a static version for display only. Although it looks just like the original graph, it is not listed in the Graph Manager and you can only change certain appearance properties.

### Tip

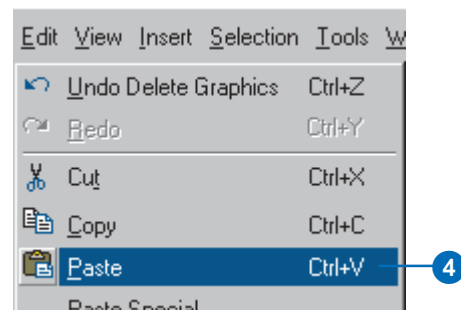
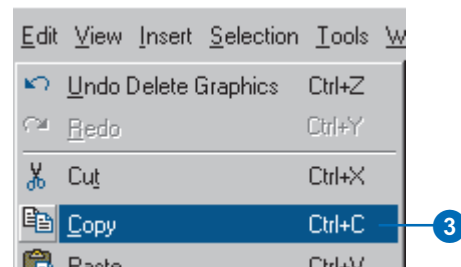
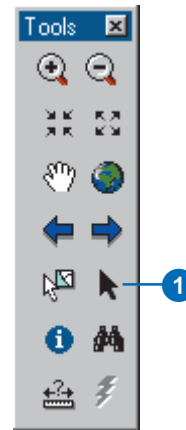
#### Copying a graph to the clipboard

*From the graph window, you can copy a graph to the clipboard. This creates a bitmap image of the graph that you can then paste into other applications.*

## Copying and pasting a graph

1. Click the Select Elements tool on the Tools toolbar.
2. Click the graph on the layout you want to copy.
3. Click the Edit menu and click Copy.
4. Click the Edit menu and click Paste.

The static copy of the graph appears on the layout.




## Managing graphs

Your maps may contain several graphs. To help you manage them, you'll use the Graph Manager. From this dialog box, you can open a graph, add it to the layout, rename it, and delete it.

If you remove the layer a graph is based on, the graph will still remain on the map. You need to explicitly remove the graph if you no longer want it. You can associate the graph with a new layer by displaying the Graph Properties and assigning a new layer.

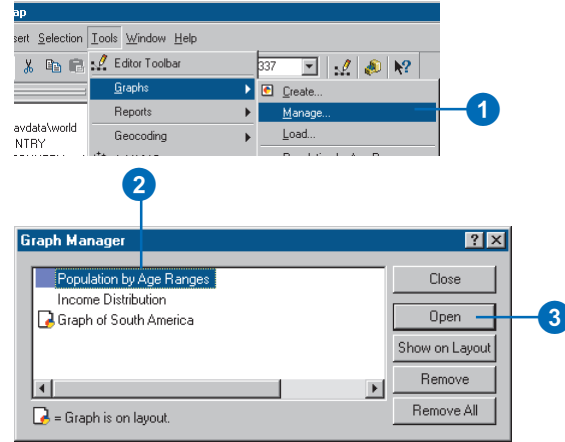
### Tip

#### How can I tell if a graph is on the layout?

If you see this icon  next to the graph name in the Graph Manager, the graph is on the layout.

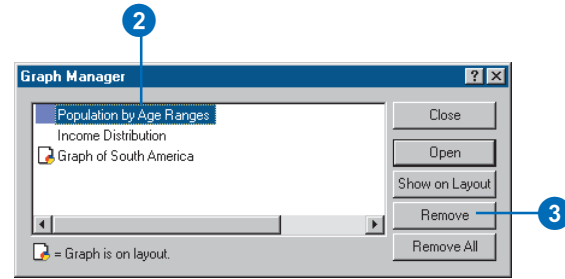
## Opening a graph

1. Click the Tools menu, point to Graphs, and click Manage.
2. Click the graph you want to open.
3. Click Open.



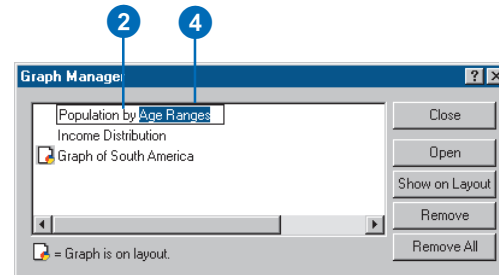
## Removing a graph

1. Click the Tools menu, point to Graphs, and click Manage.
2. Click the graph you want to remove.
3. Click Remove.



## Renaming a graph

1. Click the Tools menu, point to Graphs, and click Manage.
2. Click the graph you want to rename.
3. Click again over the name.  
This will allow you to type a new name.
4. Type the new name.





## Saving and loading a graph

If you want to copy a graph that you've made on one map and put it on another, save it to a file on disk. That way, you can load the graph onto another map and place it as appropriate.

All the properties you've set on a graph are maintained when you save it to disk, including the type of graph, data the graph is based on, whether there's a selected set, what fields are being graphed, and so on. While you can preview a saved graph in ArcCatalog, you can only change the properties in ArcMap.

When you load a graph on a map that doesn't contain the layer the graph is based on, ArcMap will prompt you to add that layer to the map. If you choose not to, the graph will still display, but you won't be able to change the features shown on the graph.

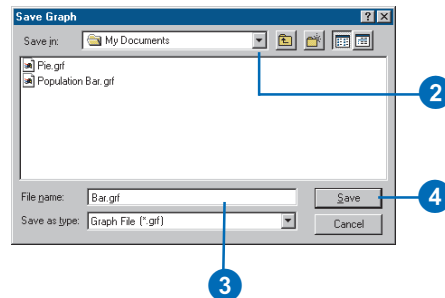
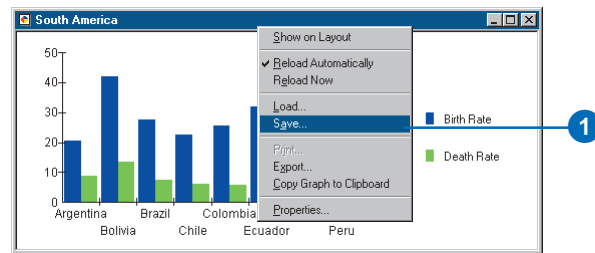
### Tip

#### Using a graph in another application

If you want to include a graph in another application, you can export the graph to these formats: Windows bitmap, JPEG, Windows metafile, and GIF.

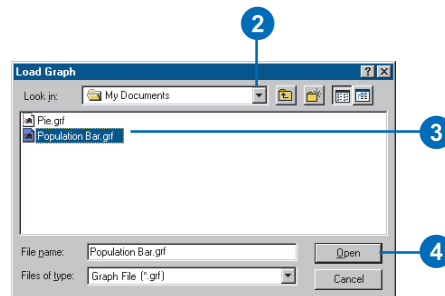
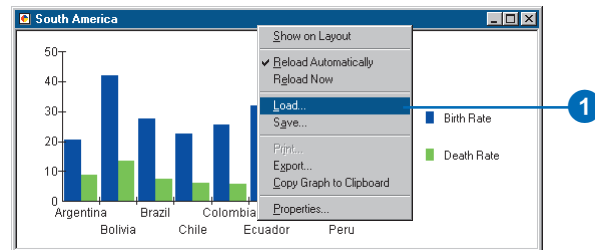
## Saving a graph

1. Right-click the title bar of the graph window and click Save.
2. Click the Save in dropdown arrow and navigate to the location you want to save the graph to.
3. Type a name for the graph.
4. Click Save.



## Loading a graph

1. Right-click the title bar of the graph window and click Load.
2. Click the Look in dropdown arrow and navigate to the location where the graph is stored.
3. Click the graph.
4. Click Open.



## Exporting a graph

When you want to use a graph in another application, you can export it to one of these formats: bitmap (.bmp), JPEG (.jpg), GIF (.gif), and Windows metafile (.wmf). For example, you might want to include a graph in a document you're distributing with your map.

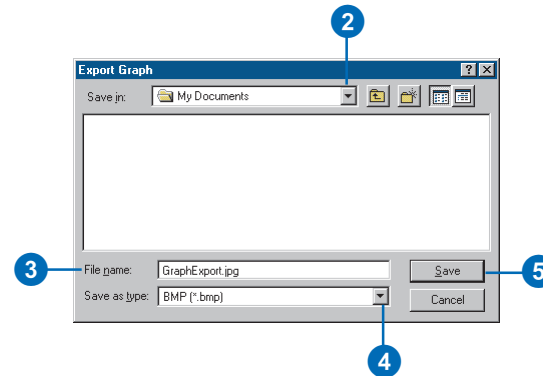
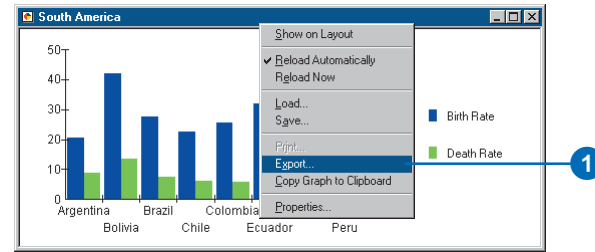
### Tip

#### Copying a graph to the clipboard

*You can also copy a graph to the clipboard and paste it into another application. The graph is copied as a bitmap file (.bmp).*

## Exporting a graph

1. Right-click the title bar of the graph window and click Export.
2. Click the Save in dropdown arrow and navigate to the location where you want to save the exported graph.
3. Type a name for the graph.
4. Click the Save as type dropdown arrow and click the type of file you want to export.
5. Click Save.



# 12

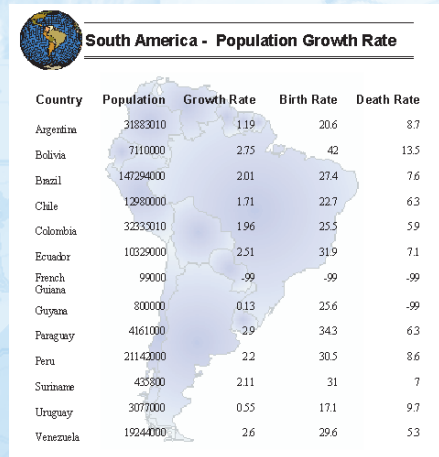
## Creating reports

### IN THIS CHAPTER

- About reports
- Creating a simple report
- Setting the report type and size
- Working with fields
- Organizing report data
- Adding report elements
- Controlling the presentation
- Saving and loading a report
- Using Crystal Reports

Reports present the facts and figures behind your analysis and are invaluable companions to the maps you're creating. Reports let you effectively display attribute information about map features in a tabular format that you control.

The information displayed in a report comes directly from the attribute information stored with your geographic data.



The report displays a map of South America with a table of data. The table has five columns: Country, Population, Growth Rate, Birth Rate, and Death Rate. The data is as follows:

Country	Population	Growth Rate	Birth Rate	Death Rate
Argentina	31823010	1.19	20.6	8.7
Bolivia	7110000	2.75	42	13.5
Brazil	147294000	2.01	27.4	7.6
Chile	12980000	1.71	22.7	6.3
Colombia	32333010	1.96	25.5	5.9
Ecuador	10329000	2.51	31.9	7.1
French Guiana	99000	-.99	-.99	-.99
Guyana	800000	0.13	25.6	-.99
Paraguay	4161000	2.9	34.3	6.3
Peru	21142000	2.2	30.5	8.6
Suriname	433800	2.11	31	7
Uruguay	3077000	0.55	17.1	9.7
Venezuela	19244000	2.6	29.6	5.3

*A report created in ArcMap*

a graphical interface for controlling the look of your report. (Note: Crystal Reports 8 Standard Edition is distributed with ArcMap. In order to access the reporting tools, you must have installed Crystal Reports.) Which one should you use? For a simple report, try ArcMap's built-in reporting tool. When you need a full-functioned graphical report building tool, try Crystal Reports.

# About reports

## What is a report?

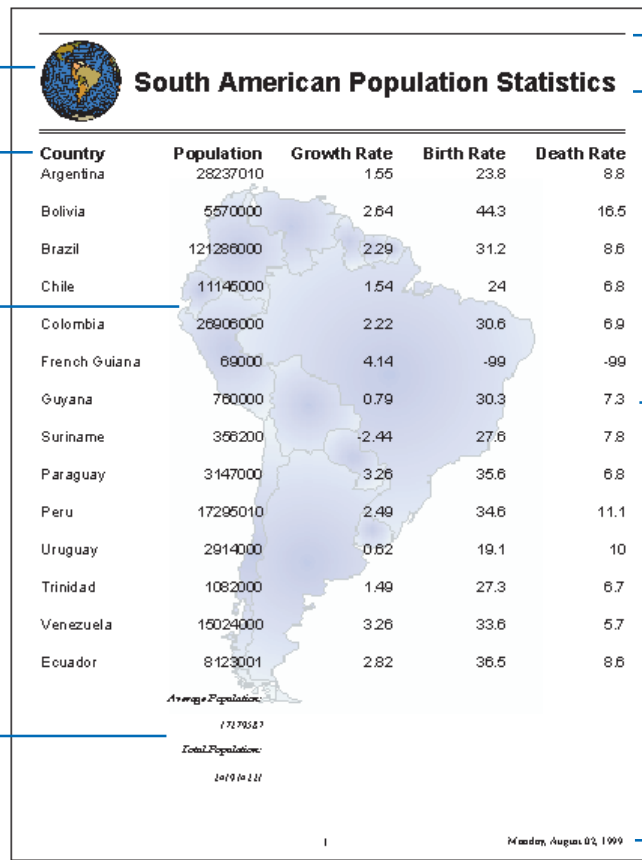
A report presents tabular information about features on the map formatted in an attractive manner. Reports are derived from an attribute table on your map. You can choose which fields from your table you want to display and how you want to display them. Once you've created a report, you can place it on your map layout next to your geographic data or save it as a file—for example, a PDF file—for distribution. The figures below show a few examples of the kinds of reports you can create. This report displays records in a tabular form, where each record is represented by a row in the display. You can include a title, page numbers, the current date, summary statistics, and images.

Display an image such as a company logo.

Choose the fields to display.

Display an image behind the data.

Calculate statistics about attribute values.



Draw borders around report elements.

Put a title on the report.

Display records in tabular form.

Display the current date and page numbers.

This report organizes the data in a single column, displaying field names and values vertically. The report groups cities by what country they're in and displays them alphabetically by name. By controlling the text font, size, and color and shading certain elements, you can create a report that highlights the information you want to convey.

**Cities of the World**

**Afghanistan**

Name: Herat  
Population: 160000  
Name: Kabul  
Population: 1179000  
Name: Qandahar  
Population: 203000

**Albania**

Name: Tirane  
Population: 210800

**Algeria**

Name: Algiers  
Population: 2547983  
Name: In Salah  
Population: 18800  
Name: Oran  
Population: 628558  
Name: Tamanrasset  
Population: -99  
Name: Tindouf  
Population: -99

Control the font, size, and color of text.

Shade report elements with various colors.

Group values by a field; here, the cities are grouped by what country they're in.

Display records in one or more columns.

The cities are sorted alphabetically by name; alternatively, they could be sorted by population.

## Report sections

Reports are divided into a series of sections; each one identifies a particular area on the report. You control how a report looks by manipulating the contents of a section and by setting properties such as its size and color. For example, the section at the top of the report typically contains the title and subtitle of the report; however, you don't have to include either of these report elements if you don't need them. The following figure highlights the various sections in a report with different colors.

<b>Report Title</b>		
<i>Report Subtitle</i>		
Name	Population	Wednesday, August 04, 1999
<b>Top of Group Argentina</b>		
Buenos Aires	10750000	
Cordoba	1070000	
Mendoza	650000	
Rosario	1045000	
<i>Average Population in Group</i>		
3873760		
<b>Top of Group Bolivia</b>		
La Paz	562552	
Santa Cruz de la Sierra	441717	
<i>Average Population in Group</i>		
717166		
<b>Top of Group Brazil</b>		
Belo Horizonte	2550000	
Recife	2525000	
Rio de Janeiro	10150000	
Sao Paulo	15175000	
<i>Average Population in Group</i>		
7726000		
<b>Top of Group Chile</b>		
Concepcion	675000	
Santiago	4100000	
Valparaiso	675000	
<i>Average Population in Group</i>		
1318087		
<b>Top of Group Colombia</b>		
Bogota	4250000	
Medellin	2055000	
<i>Average Population in Group</i>		
3177600		
<b>Top of Group Ecuador</b>		
Quetzacul	1255000	
Quito	1080000	
<i>Average Population in Group</i>		
1162600		
<b>Top of Group Fr Guiana</b>		
Cayenne	23001	
<i>Average Population in Group</i>		
23001		
<i>Average Population</i>		
2784008		
<b>Bottom of Report</b>		
Sources of Page Footnote		
		1

Top of report—Prints once at the beginning of the report and can contain the title, subtitle, image, and field names.

Top of page—Prints once at the top of each page. Commonly contains field names, the current date, and the page number.

Top of group—Prints once at the beginning of each group that you've defined. Typically, the name of the group appears here. This section appears only when you've defined groups.

Records—Prints the data for each record.

Bottom of group—Prints after the records in the group and may contain group summary statistics. This section appears only when you've defined groups.

Bottom of report—Prints once at the end of the report. Primarily used to print a summary of the report, such as grand totals, and report footnotes.

Bottom of page—Prints once at the bottom of the page. Typically contains page summaries, page footnotes, and the page number.

## Working with sections

ArcMap automatically calculates the height of each section based on the height of the elements in it. An element can be a title, subtitle, column header, page number, and so on. For example, if you use a large point size for the title, ArcMap enlarges the section at the top of the report to accommodate the text.



*Using a larger point size increases the height of the title and subsequently increases the height of the top of the report section.*

If you want to manually control the height of a section, you can turn off the automatic sizing of the section and set the height explicitly. You will also need to make sure that the height of elements, such as the title, within a section are sized accordingly. Otherwise, they may be truncated.



*By turning off the Autosize property, you can explicitly set the height of the section. Elements in that section, however, can become truncated.*

The width is the same for all sections and is determined by the width you specify for the report.

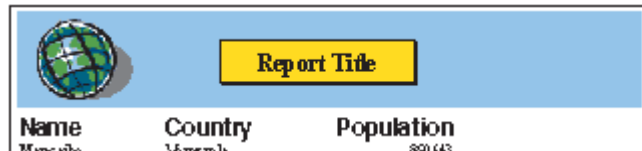
## Working with elements in a section

Within each section, you can control the size and position of an element within it. As with sections, you can let ArcMap automatically size elements or size them explicitly yourself. In the figure below, the title has an explicit height, width, and position set. It also has a border around it and a background color that's different from the background color of the section.



*You can set the size, position, and color of an element.*

Once the title is the right size, you can position it relative to other elements such as an image representing a company logo.



## Creating a simple report

A report lets you organize and display the tabular data that's associated with your geographic features. Sometimes you'll want to print out a report to distribute with your map or, alternatively, you might put the report right on the map.

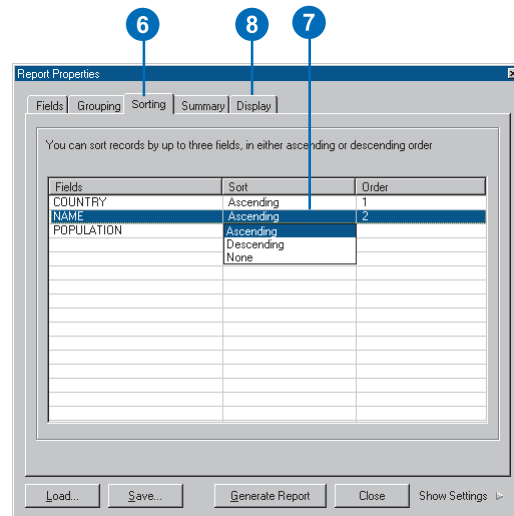
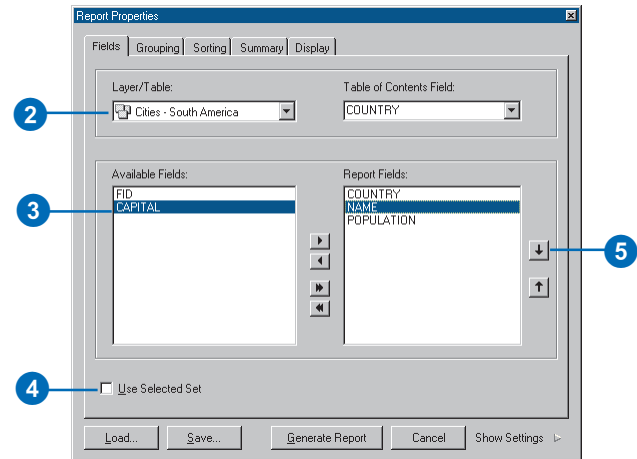
When you create your report, you choose what fields to display and whether you want to generate a report listing all features in a layer or only the selected ones. Once you've created your report, you can put it on the layout next to your map display or print it out.

A report has many properties that you set when you create it. For example, you can set a property to define what type of report you want—tabular or columnar. You can also set a particular page size and use a particular text font and color for the text on your report.

The set of steps to the right show you how to make a simple tabular report. Subsequent sections in this chapter focus on how to set report properties to achieve a particular result.

## Creating a simple tabular report

1. Click the Tools menu, point to Reports, and click Create Report.
2. On the Fields tab, click the Layer/Table dropdown arrow and click the layer or table you want to base the report on.
3. In the Available Fields list, double-click the fields you want to include in the report.
4. Check Use Selected Set if you want to create a report with only the selected features.
5. Click the arrow buttons to order the report fields.
6. Click the Sorting tab.
7. Click a field to sort in the Sort column.
8. Click the Display tab. ▶





## Tip

### Adding a report to the map layout

Once you've created a report, you can display it on your map layout. By creating a report with a particular page size, you can ensure that it fits exactly where you want it on the layout.

## Tip

### Adding titles, subtitles, and page numbers to your report

You can add additional elements to your report—such as a title, page numbers, an image, and footnotes—to enhance the display. The Elements setting on the Display tab lists all the additional things you can add.

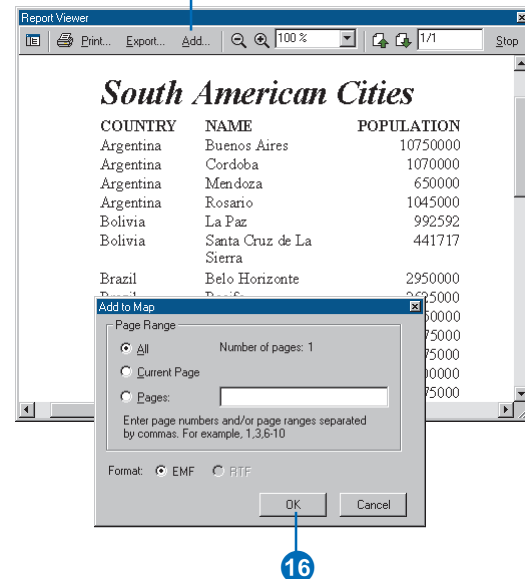
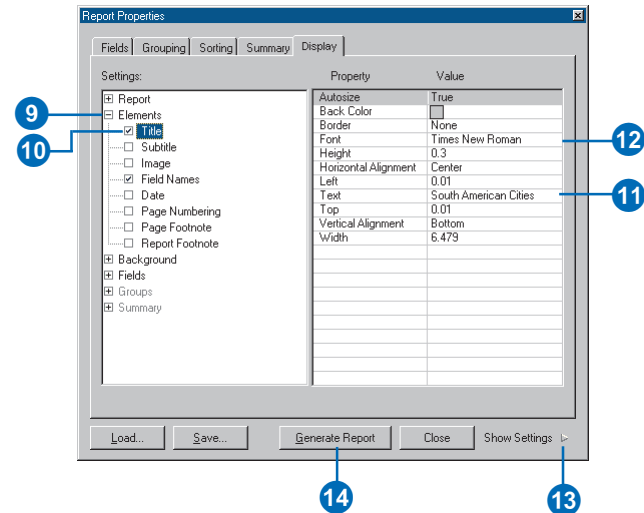
## Tip

### Shading records

To make the data in your reports easier to read, you can shade every other record with a color. On the Report Properties dialog, click the Display tab. Click Report and click Records. Then set the Shade Records and Shade Color properties.

- Under Settings, click Elements.
- Check Title to add a title to the report.
- Locate the Text property and type a title for the report.
- Click the Font property and set the font and size of the title.
- Click Show Settings to preview the report.
- Click Generate Report.
- At the top of the Report Viewer, click Add to add the report to the map layout.
- Click OK.

The report is added to the layout as a graphic element. Each page of the report is added as a separate graphic element on the layout.



## Setting the report type and size

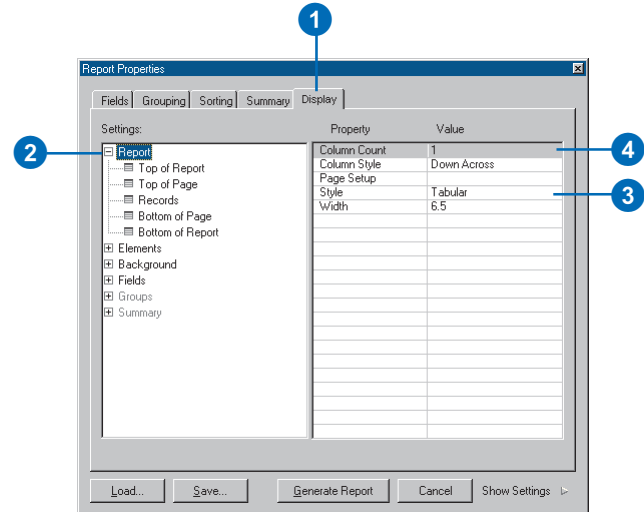
You can make two different types of reports—tabular or columnar. A tabular report organizes data in rows and columns, much like a spreadsheet. Each row represents one record of data, and each column represents one field. A columnar report displays fields and their values vertically in columns, much like a newspaper column layout. With a columnar report, you can specify the number of columns you want to display.

When creating a report, you can specify the size you want. The size you choose will depend on how you plan to use the report. If you plan to print it out on paper, you'll typically use common paper sizes. If you plan to incorporate it onto your map layout, you'll want to set a page size that's as close to the actual size of the space available on the layout. That way, the text sizes you specify in the report will be the same on the map layout.

The page size you set initially determines the height and width of the report. You can, however, increase the width to accommodate the data you want to display. If the width exceeds the printer page size, the report will print on additional pages.

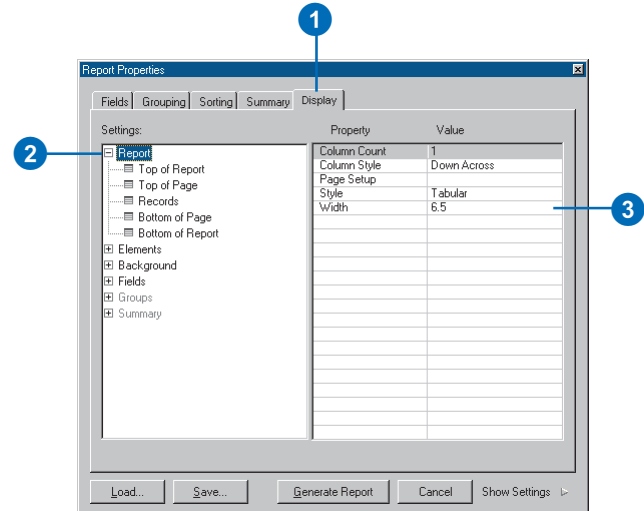
## Setting the report type

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Click the Style property, then click the dropdown arrow, and click Tabular or Columnar.
4. Optionally, for a columnar report, set the Column Count and Column Style properties.



## Setting the report width

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Double-click the Width property and type a width in inches.



## Tip

### Setting the report height

While you can set the report width independently, the report height is determined by the paper size. However, by adjusting the page margins, you can precisely control the report size.

## Tip

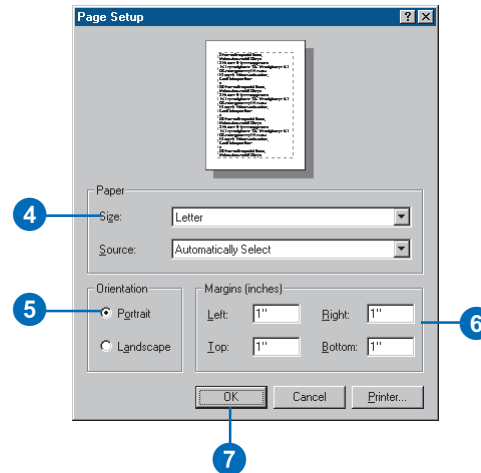
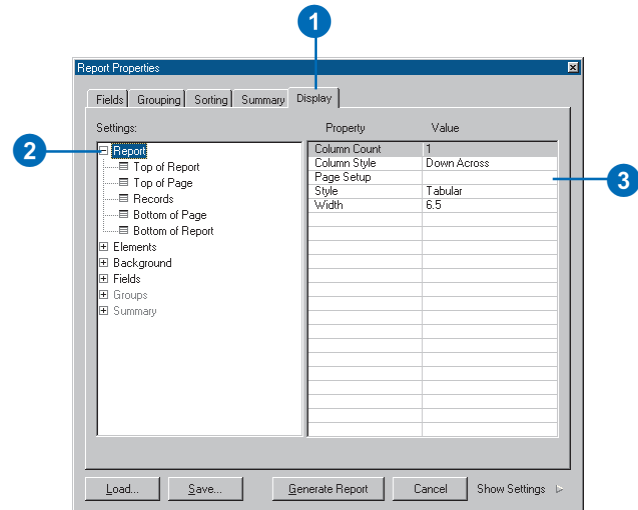
### Composing the report for a layout

Compose your report at the size you want it to be on your layout. Choose the paper size so that the report will fit in the available space. Then, you can adjust the margins of the page to get the exact size you need. This will ensure that the text on the report is sized correctly. You can still reduce or enlarge the report as it appears on the layout.

## Setting the page size, orientation, and margin

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Click the Page Setup property and click the button to display the Page Setup dialog.
4. Click the Paper Size dropdown arrow and click the size you want.
5. Click Portrait or Landscape.
6. Type the Left, Right, Top, and Bottom margins.
7. Click OK.

If you're incorporating the report on a layout, choose a size that's close to the available space on the layout.



## Working with fields

The information displayed on your report is based on the fields you choose to include. When you choose the fields, you can also set the order that they will appear in the report. That way, you can have certain fields appear before others.

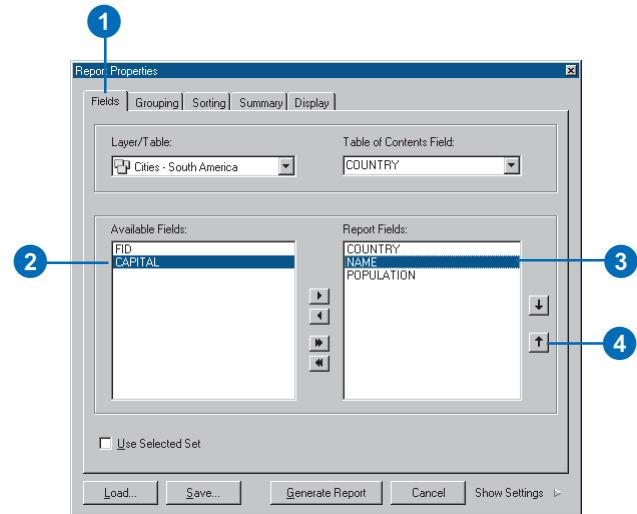
The field name displayed on the report is the same as its name in the database. However, as field names in a database are often abbreviations or cryptic descriptions of the attribute stored in the field, you can replace the names with your own descriptive text to help clarify their meaning.

ArcMap automatically sets the display width of a field to accommodate the width of the data. However, you can set a width explicitly. You may also want to increase the width of the report to prevent the fields from wrapping on the page.

## Ordering fields

1. Click the Fields tab on the Report Properties dialog.
2. In the Available Fields list, double-click the fields you want to include in the report if you haven't done so already.
3. In the Report Fields list, click the field you want to move.
4. Click the Up or Down Arrow buttons to move the field.

The report displays the fields in the order you've specified.

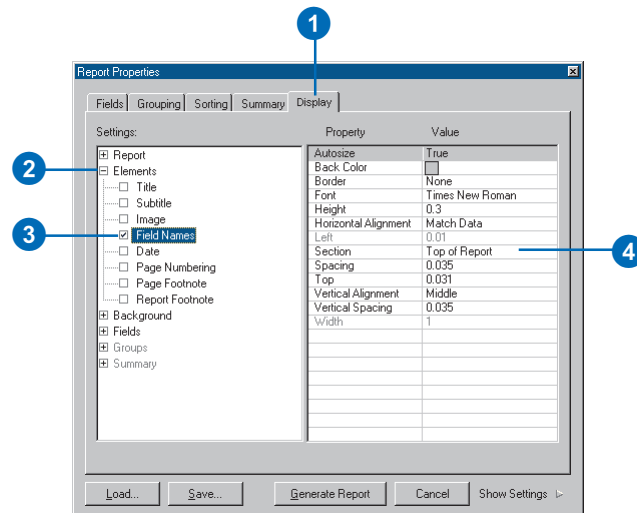


## Displaying field names

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Field Names to display field names on the report.

Field names appear as column headers in a tabular report and to the left of values in a columnar report.

4. Click the Section property and click the dropdown arrow. Click Top of Report or Top of Each Page. Top of Report displays the names once on the first page. This property is for tabular reports only.



## Tip

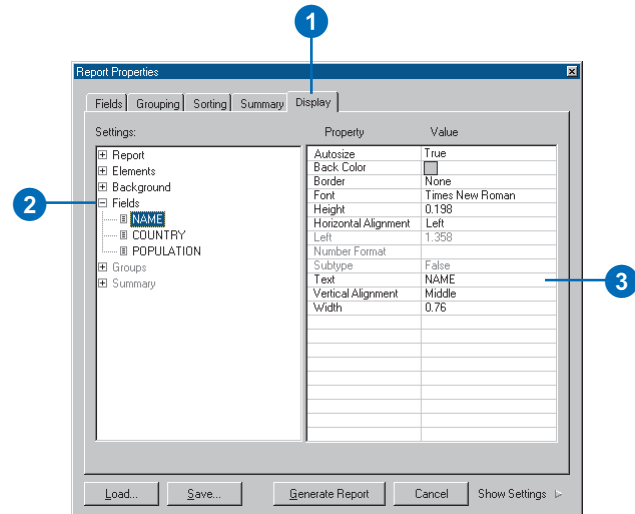
### Setting field aliases

*The field aliases you set while creating a report will only apply to the report.*

## Setting a field alias

1. Click the Display tab on the Report Properties dialog.
2. Click Fields and click the name field you want to set an alias for.
3. Double-click the Text property and type the text you want to display.

This field alias only displays on the report.



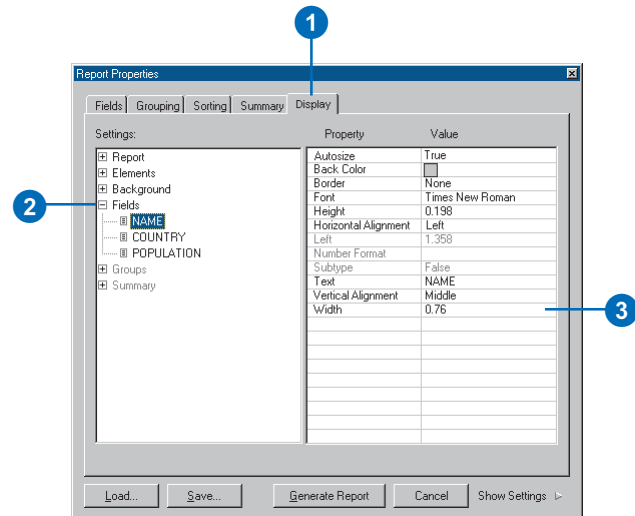
## Tip

### Setting your own field widths

*ArcMap automatically determines how wide to display a field to accommodate the data. However, you can increase or decrease the width. If the width of all fields exceeds the width of the report, the fields will wrap.*

## Setting the display width of a field

1. Click the Display tab on the Report Properties dialog.
2. Click Fields and click the name field you want to set the width of.
3. Double-click the Width property and type the width you want.



## Tip

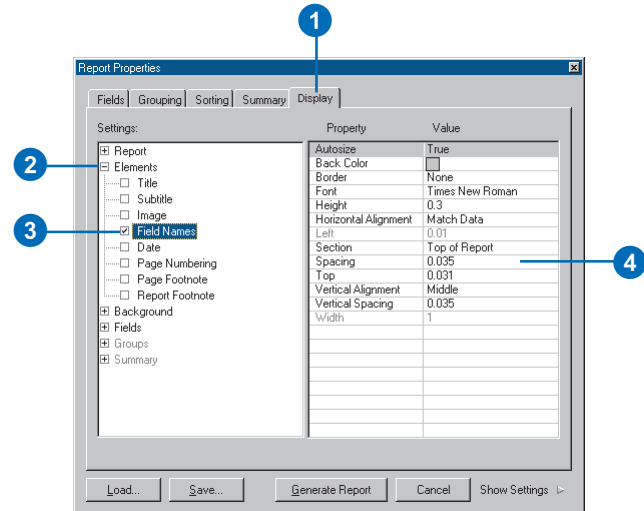
### When to adjust the column spacing

Adjust the column spacing when you want to increase or decrease the horizontal distance between fields in a tabular report or between the field name and its value in a columnar report.

## Increasing the space between columns in the report

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Field Names if it isn't already checked.
4. Double-click Spacing and type a horizontal distance in inches.

The value you type sets the distance between the fields in a tabular report or the field name and its value in a columnar report.



## Tip

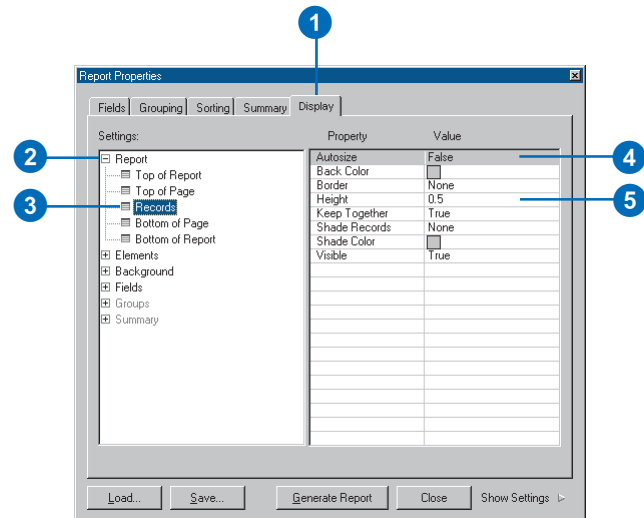
### When to adjust the row spacing

Adjust the row spacing when you want to increase or decrease the vertical distance between records in the report.

## Increasing the space between rows in the report

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Click Records.
4. Click Autosize, click the dropdown arrow, and then click False.
5. Double-click Height and type a height in inches for the row.

Increasing the height increases the space between rows in the report.



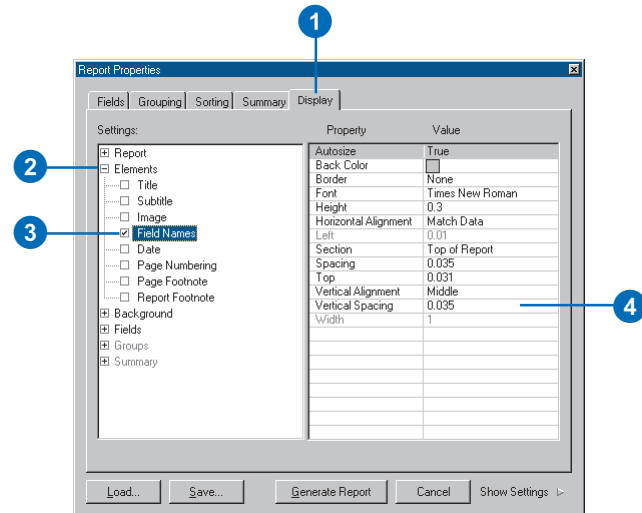
## Tip

### When to adjust the vertical spacing between fields in a columnar report

Field names and values stack on top of each other in a columnar report. Thus, a given record of data may occupy several rows in the report. When you want to increase or decrease the space between these fields, adjust the Vertical Spacing property.

### Changing the vertical spacing between fields in a columnar report

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Field Names if it isn't already checked.
4. Double-click Vertical Spacing and type a distance in inches.



## Organizing report data

One advantage of displaying your data in a report is that a report allows you to organize your data. For example, you can sort records based on the values in one or more fields—given a list of cities, you could sort them by total population. You can also group records together and calculate summary statistics. For example, you could group cities by what country they're in. This lets you easily see which city has the largest population in a given country. You can further calculate summary statistics—for example, compute the sum, average, count, standard deviation, and minimum and maximum values.

### Tip

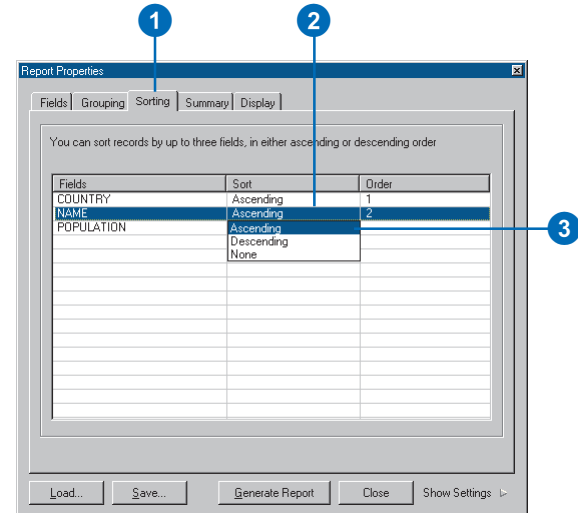
#### Sorting records using up to three fields

*You can sort records using up to three fields in ascending or descending order.*

## Sorting records

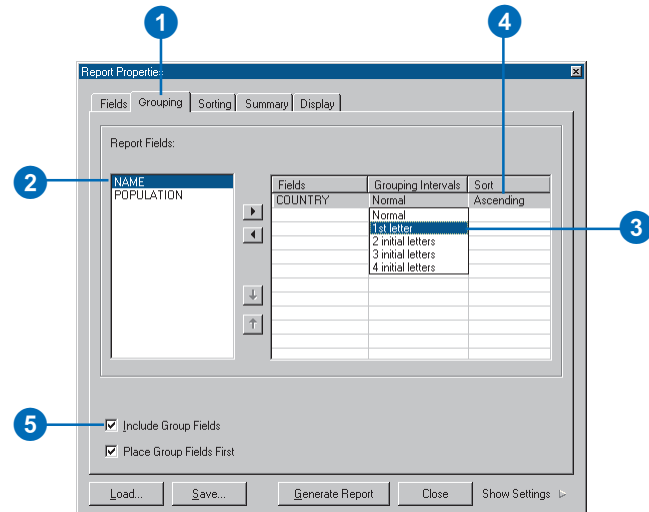
1. Click the Sorting tab on the Report Properties dialog.
2. Click a field to sort in the Sort column.
3. Click Ascending, Descending, or None.
4. If you want to sort other fields, click them and then click the sorting method.

ArcMap sorts the fields based on the sort order. The figure to the right sorts cities alphabetically by country and then by their name.



## Grouping records

1. Click the Grouping tab on the Report Properties dialog.
2. Double-click the field you want to use to group data.
3. Click Grouping Intervals and click the method for grouping data.
4. Click Ascending or Descending for the sort method.
5. Check Include Group Fields to repeat the group value in the report display.





## Tip

### What summary statistics are available?

*You can compute the average, count, minimum, maximum, standard deviation, and sum for any numeric fields on your report.*

## Tip

### Where can you display summary statistics?

*You can display summary statistics for a field at the end of the report, at the end of each page, and at the end of each group you've defined.*

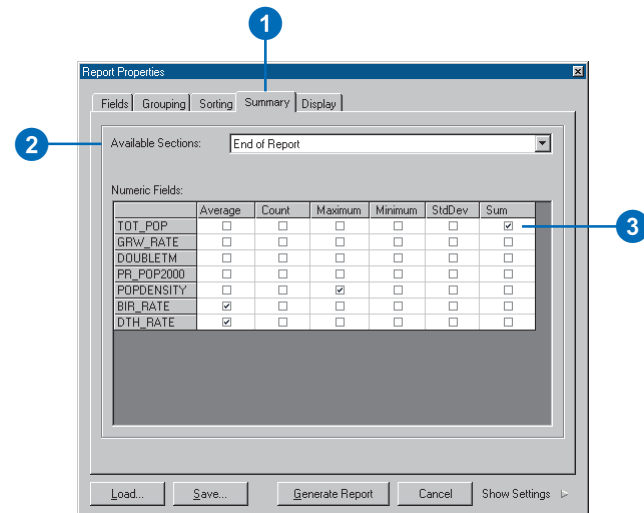
## Tip

### Shading records

*To make the data in your reports easier to read, you can shade every other record with a color. On the Display tab, click Report and click Records. Then set the Shade Records and Shade Color properties.*

## Calculating summary statistics

1. Click the Summary tab on the Report Properties dialog.
2. Click the Available Sections dropdown arrow and click the section you want the statistics to appear in.
3. For each numeric field, check the box that corresponds to the statistic you want to display.
4. To display statistics in each available section, repeat steps 2 and 3 for each section.



# Adding report elements

To help you create attractive-looking reports, you can add these additional elements to your reports:

- A title
- A subtitle
- Page numbers
- The current date
- Images (e.g., a company logo)
- Footnotes

Once you've added an element, you can control the way it looks. For example, you might change the text font and size of the title and center it on the page.

This section describes how to add the particular element you want to your report while you're creating it.

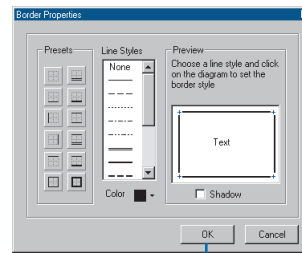
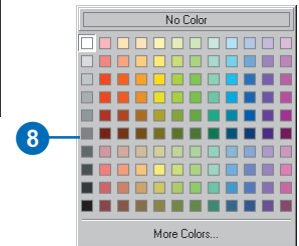
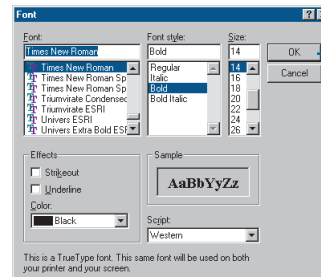
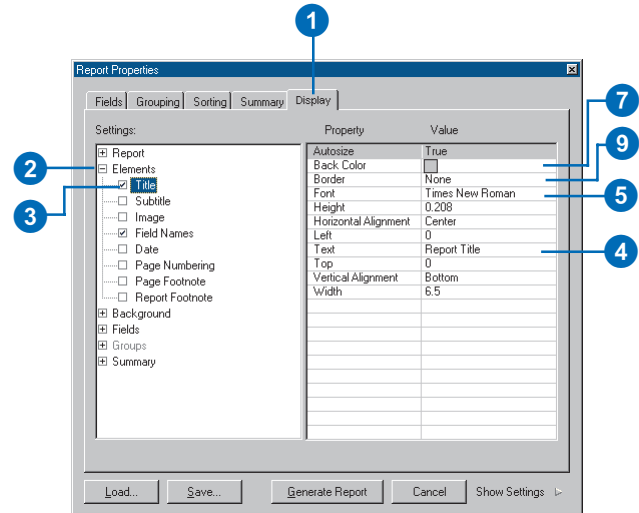
## Tip

### Borders and shading

*Accent report elements with borders and background colors.*

## Adding a title

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Title.
4. Double-click Text and type the text for the title.
5. Click Font and click the button to display the Font dialog.
6. Set the font, size, style, and color as desired and click OK.
7. Click Back Color and click the button to display the Color dialog.
8. Click the color you want.
9. Click Border and click the button to display the Border Properties dialog.
10. Click the border style you want and click OK.



## Tip

### Setting the height of an element

In general, ArcMap automatically calculates the height of an element. For example, the height of the title is based on the font size you choose. However, you can also set the height explicitly. This is useful when you want to add additional space around the element. To set the height, set the Autosize property to False and then set the Height property to a height in inches.

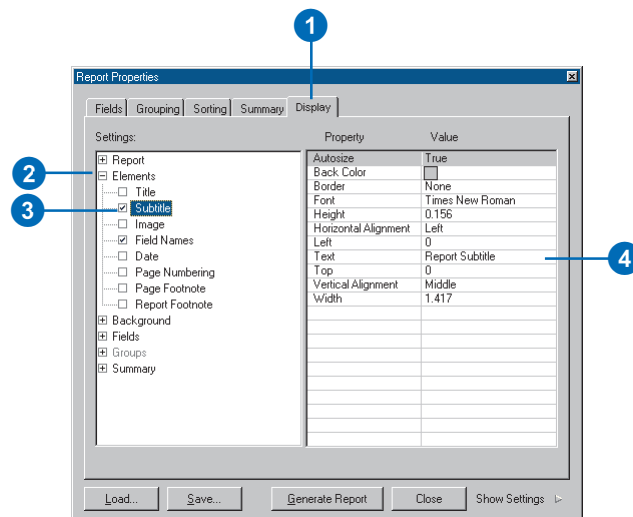
## Tip

### Why isn't the element centered on the page properly?

Probably because you need to adjust the width of the element. The horizontal alignment of an element is based on its width, not the width of the report.

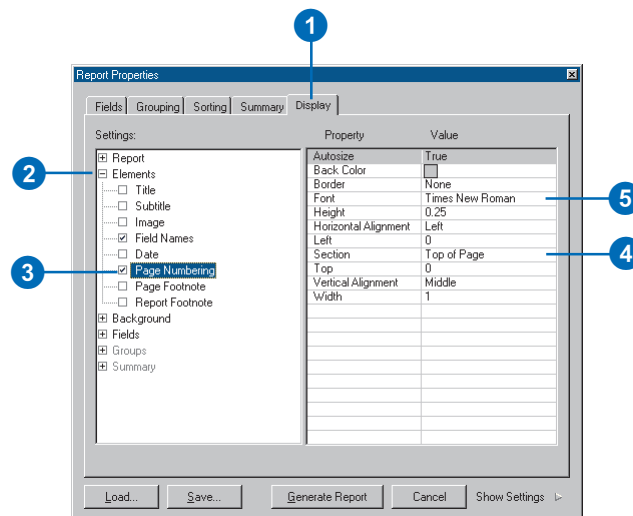
## Adding a subtitle

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Subtitle.
4. Double-click Text and type the text for the subtitle.



## Adding page numbers

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Page Numbering.
4. Click Section, click the dropdown arrow, and then click Top of Page or Bottom of Page.
5. Click Font and click the button to open the Font dialog.
6. In the Font dialog, set the font, size, style, and color as desired and click OK.



## Tip

### Positioning an element

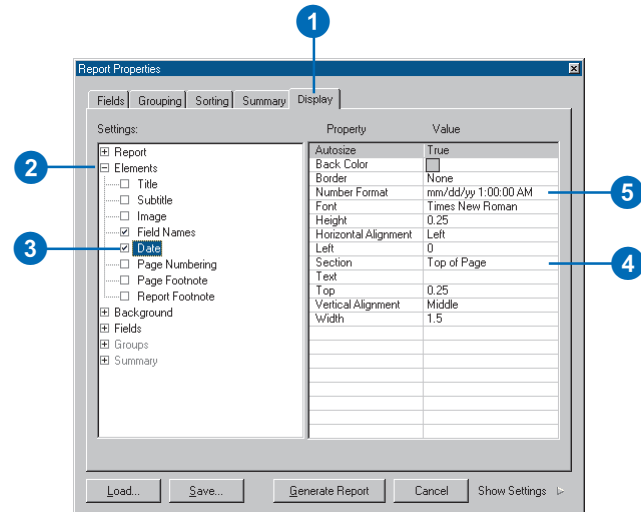
Each element has its own height and width. An element, such as a title, is located in the section at the top of the report. You can position the upper-left corner of an element by adjusting the Top and Left properties of the element.

## Adding the date

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Date.
4. Click Section, click the dropdown arrow, and click Top of Page or Bottom of Page.
5. Click Number Format, click the dropdown arrow, and click the date format you want.

Dates can be represented as:

- mm/dd/yy 1:00:00 AM
- Monday, July 26, 1999
- mm/dd/yy



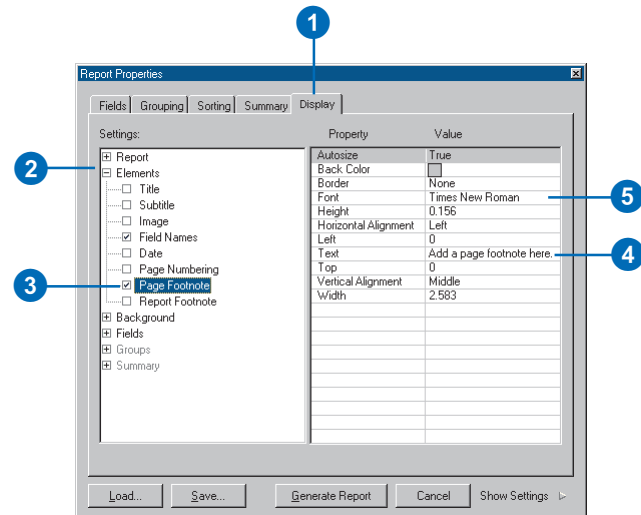
## Tip

### Adding footnotes

You can add footnotes to the bottom of each page or once at the end of the report.

## Adding footnotes

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Page Footnote or Report Footnote.
4. Double-click Text and type the text for the footnote.
5. Click Font and click the button to open the Font dialog.
6. In the Font dialog, set the font, size, style, and color as desired and click OK.



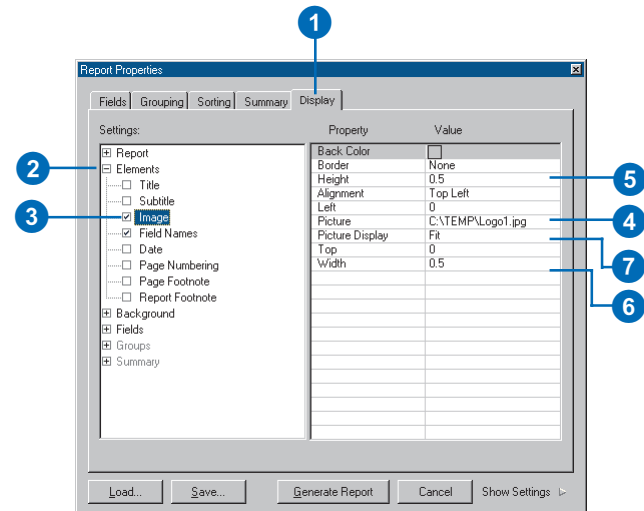
## Tip

### Getting an image to fit

*Images aren't always sized exactly as you'd like them to be. Fortunately, when you add an image to your report, you can adjust its appearance to fit the available space. If it's too large, you can shrink it or crop it. If it's too small, you might stretch it instead.*

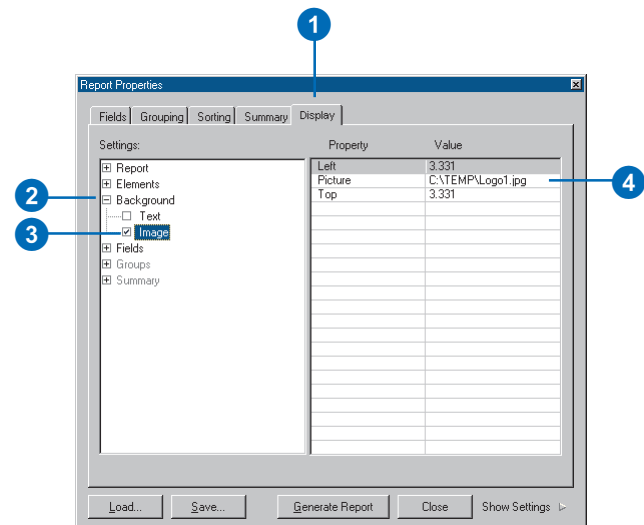
## Adding an image at the top of the report

1. Click the Display tab on the Report Properties dialog.
2. Click Elements.
3. Check Image.
4. Click Picture, click the button to display the Open Image dialog, and click the image you want to display.
5. Double-click Height and type a height in inches.
6. Double-click Width and type a width in inches.
7. Click Picture Display; click the dropdown arrow; and click Fit, Clip, or Stretch.



## Adding an image in the background

1. Click the Display tab on the Report Properties dialog.
  2. Click Background.
  3. Check Image.
  4. Click Picture, click the button to display the Open Image dialog, and click the image you want to display.
- The image will now appear behind the report data on all pages.



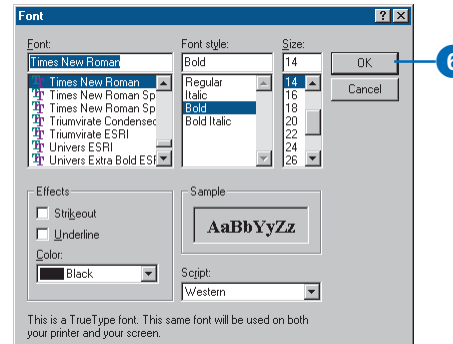
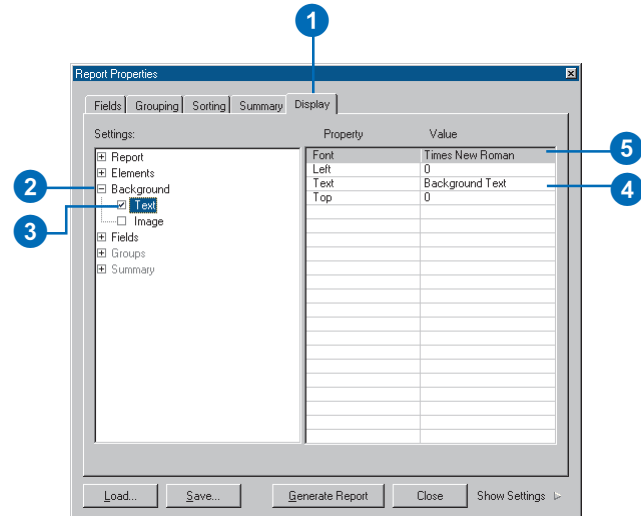
## Tip

### Positioning the background text and image

Use the *Top* and *Left* properties to position the upper-left corner of the background text or image on the report page.

## Adding text in the background

1. Click the Display tab on the Report Properties dialog.
2. Click Background.
3. Check Text.
4. Double-click the Text property and type the text string you want to appear in the background.  
  
The text displays behind the report data on all pages.
5. Click Font and click the button to open the Font dialog.
6. In the Font dialog, set the font, size, style, and color as desired and click OK.



# Controlling the presentation

As described earlier in this chapter, a report is made up of several sections, each of which defines a particular area on the report. For example, the section at the top of the report contains the title of the report; another section displays the records in the report.

Each section has properties that you can modify such as its color and whether or not it is displayed. A section also contains certain elements with their own properties that you can modify to change the visual appearance of the report. For example, you might choose to shade the records in your report.

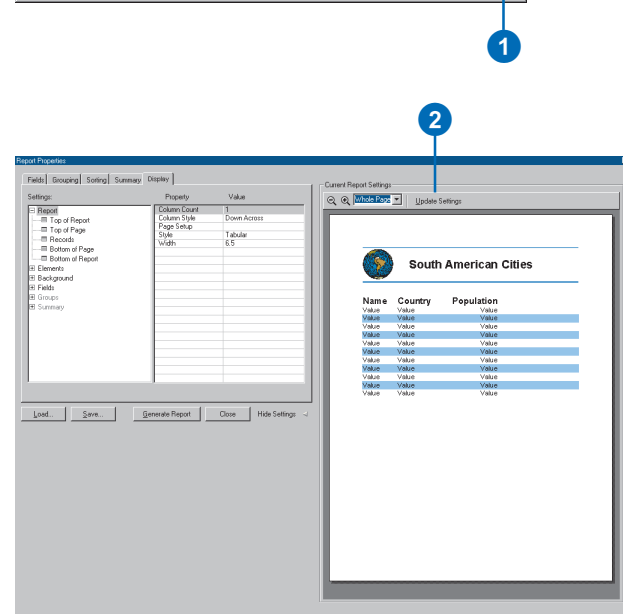
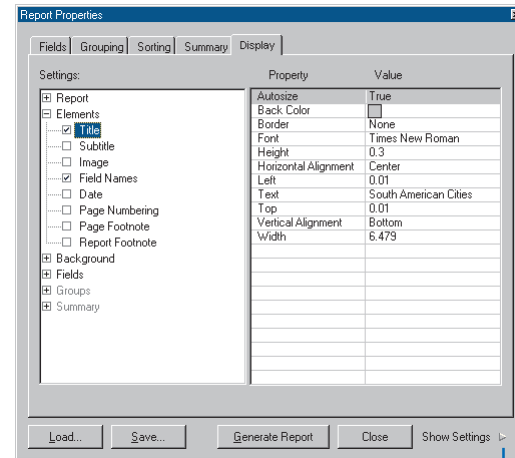
By setting the properties of a section and the elements within it, you can create your own individual look. As you create your report, you can preview your settings to see what your report will look like.

## Previewing a report

1. Click the Show Settings on the Report Properties dialog.

The dialog expands to show you a preview of the report.

2. As you modify the report properties, click Update Settings to see the changes reflected on the preview.



## Tip

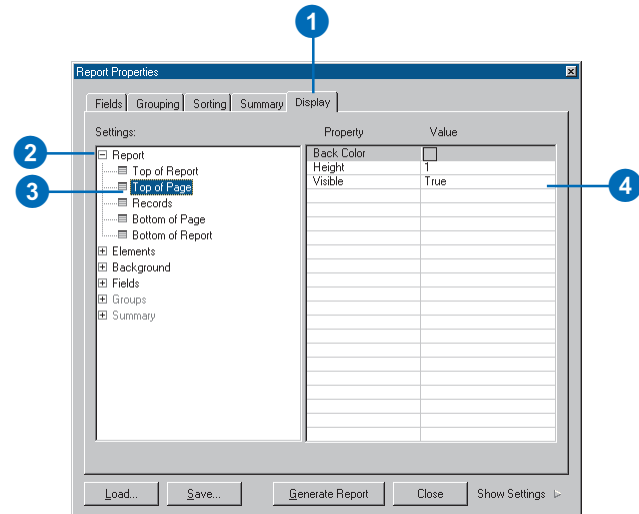
### How to display more data on your report page

If you're not using a report section, such as the top or bottom of the page, you can hide it, thereby increasing the space available to display data on the report page.

## Hiding a section

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Click the report section you want to hide, for example, Top of Page.
4. Click Visible, click the dropdown arrow, and click False.

The report section will not appear in the report.



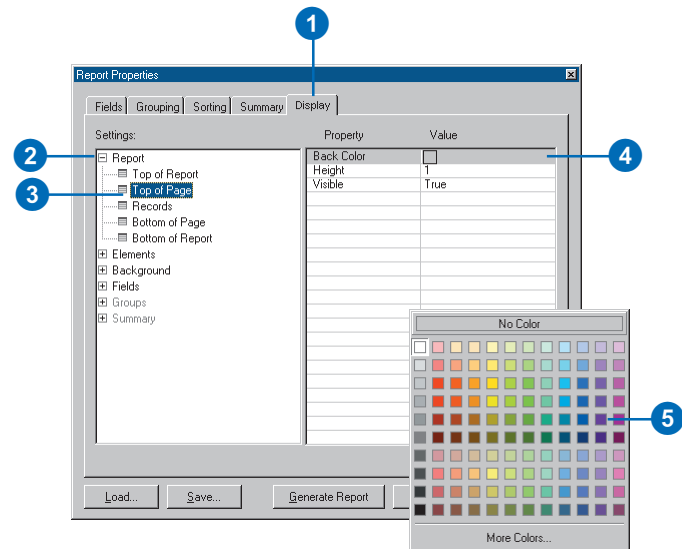
## Tip

### Using background colors

Each report element, such as the title, has its own background color. By using background colors, you can enhance the display of your report. Additionally, you can apply a background color to report sections.

## Setting the background color of a section

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Click the report section you want to set a background color of, for example, Top of Page.
4. Click Back Color and click the button to open the Color dialog.
5. Click the background color you want.





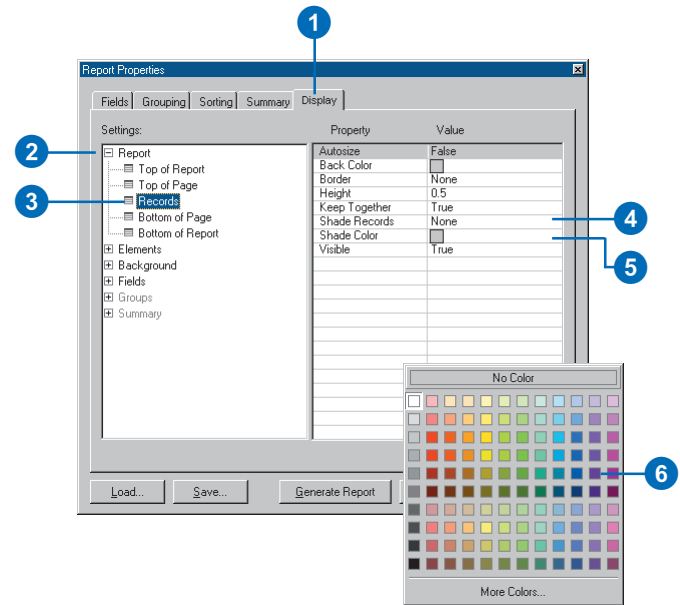
## Tip

### Making your data easier to read

*You can enhance the readability of your report by shading records. This helps the reader to visually separate data in adjacent records. You can choose to alternately shade every other, every two, or every three records.*

## Shading records in the report

1. Click the Display tab on the Report Properties dialog.
2. Click Report.
3. Click Records.
4. Click Shade Records, click the dropdown arrow, and click the option you want.
5. Click Shade Color and click the button to open the Color dialog.
6. Click the color you want to shade records with.



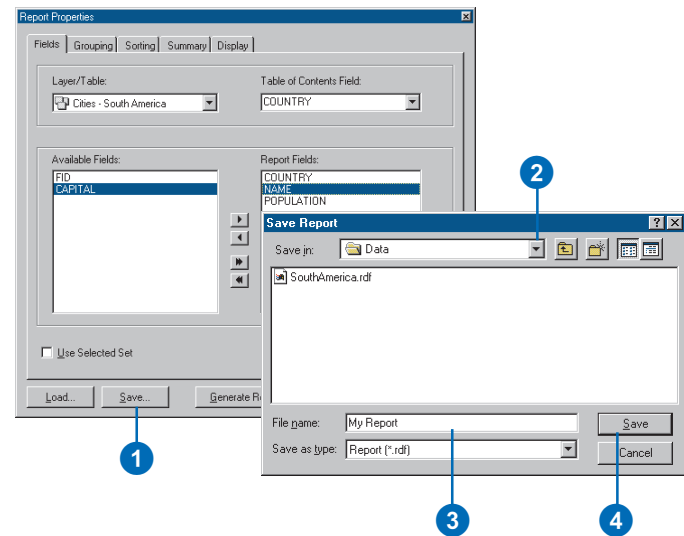
## Saving and loading a report

If you want to copy a report that you've made on one map and put it on another, save it to a file on disk. Then you can load the report in another map and place it as appropriate. When you save a report to a file, you're creating a static copy that is not linked to the actual data you created the report from. Thus, you won't be able to modify the report in any way.

You can also export a report to a different file type. Export to Adobe® Portable Document Format (PDF), Rich Text Format (RTF), or plain text (TXT).

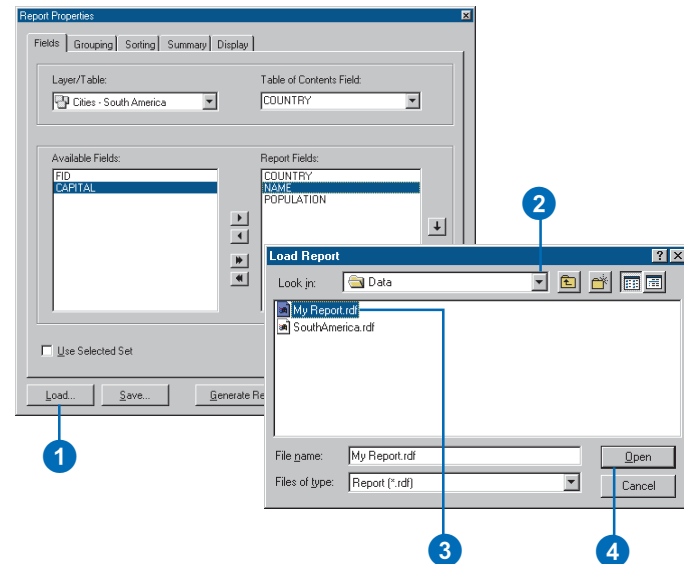
### Saving a report

1. Click Save on the Report Properties dialog.
2. Click the Save in dropdown arrow and navigate to the location where you want to save the report.
3. Type a name for the report.
4. Click Save.



### Loading a report

1. Click Load in the Report Properties dialog.
2. Click the Look in dropdown arrow and navigate to the location where the report is stored.
3. Click the report.
4. Click Open.



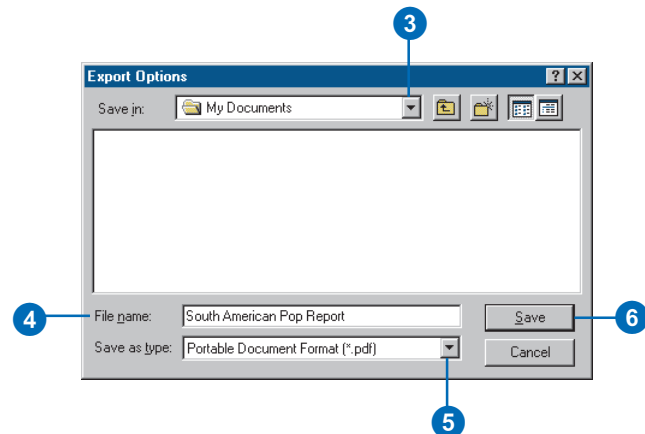
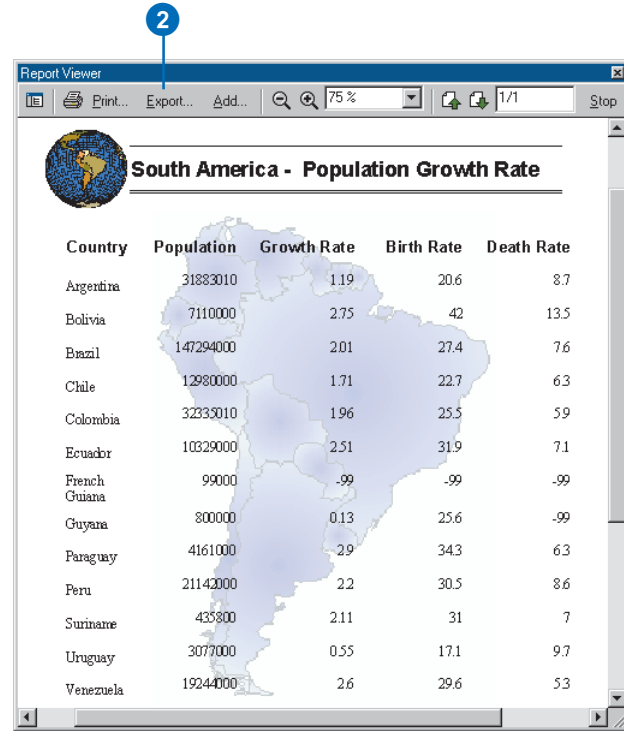
## Tip

### Export reports to PDF, RTF, or plain text

Once you create your report, you can include it on your map and also export it to several different file formats. Export to Adobe PDF, RTF, or plain text.

## Exporting a report

1. Click Generate Report on the Report Properties dialog.
2. Click Export on the Report Viewer window.
3. Click the Save in dropdown arrow and navigate to the location where you want to save the exported report.
4. Type a name for the report.
5. Click the Save as type dropdown arrow and click the type of file you want to export.
6. Click Save.



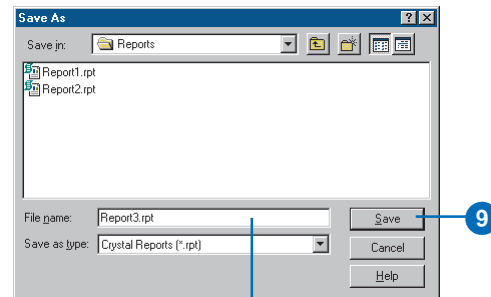
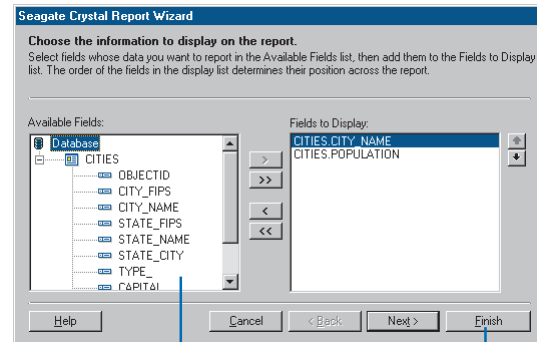
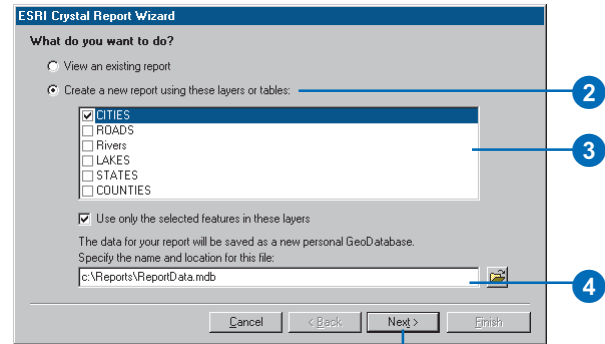
# Using Crystal Reports

To help you create the reports you need, ArcMap has integrated with industry-leading Seagate Crystal Reports. When you install ArcMap, you can optionally install Crystal Reports. Once installed, you'll have access to the Crystal Reports Wizard that lets you create and view reports.

The reports you create with Crystal Reports are managed as files outside ArcMap. ArcMap simply passes the tabular information from the layers on your map to Crystal Reports. While you can access the reports you create from within ArcMap and display them in a separate window, you can't add them to your map layout. If you need to do this, use ArcMap's built-in reporting tool instead.

## Creating a report

1. Click the Tools menu, point to Reports, and click Crystal Reports Wizard.
2. Click Create a new report using these layers or tables.
3. Check the layers and tables you want to include in the report.
4. Type the name of the output geodatabase.
5. Click Next.
6. Double-click the fields you want to include in the report.
7. Click Finish to create the report.  
Optionally, click Next to set other report parameters.
8. Type a name for the report.
9. Click Save.



## Tip

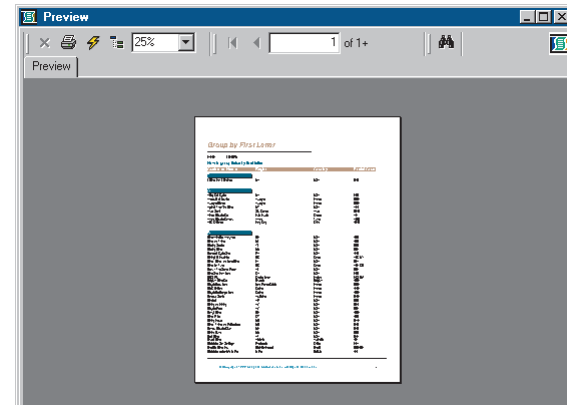
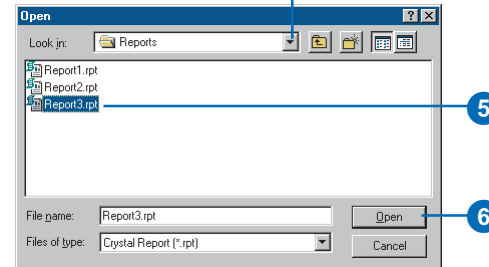
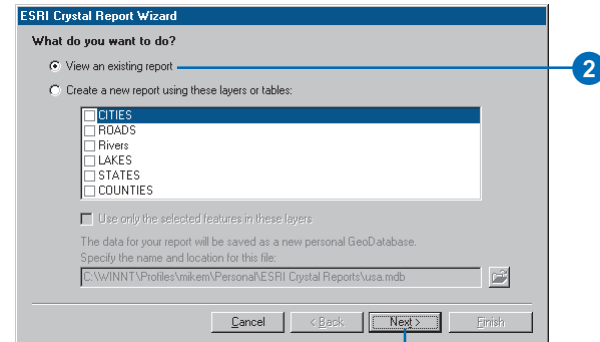
### Can I add a Crystal Report to my map layout?

No. Instead, use ArcMap's built-in reporting tool to create your report and add it to the layout.

## Viewing an existing report

1. Click the Tools menu, point to Reports, and click Crystal Reports Wizard.
2. Click View an existing report.
3. Click Next.
4. Click the Look in dropdown arrow and navigate to the location of the report.
5. Click the Report.
6. Click Open.

The report appears in its own window.





# Querying maps

## IN THIS CHAPTER

- **Identifying features**
- **Displaying a Web page or document about a feature**
- **Selecting features interactively**
- **Selecting features by searching with a SQL expression**
- **Selecting features by their location**
- **Specifying how selected features highlight**
- **Displaying information about selected features**
- **Exporting selected features**
- **Creating buffers around features**
- **Aggregating data with the GeoProcessing Wizard**
- **Joining the attributes of features by their location**

Maps convey a great deal of information. You can learn much about an area just by looking at a map. Yet, sometimes it's those things that aren't immediately apparent by looking at a map that are most interesting and revealing. You can begin to discover new spatial relationships when you start asking questions like: Where is...?, Where's the closest?, What's inside?, and What intersects?

ArcMap provides a number of tools to help you find answers to these types of questions. With ArcMap, you can:

- Find out what a feature is by pointing at it. This may display additional information such as a picture or Web page.
- Find features with particular attributes such as cities with a population greater than one million.
- Find features with a particular spatial relationship. For instance, you can find the wildlife habitats within 50 kilometers of an oil spill or find all traffic accidents that occurred along a particular stretch of road.
- Aggregate features in a layer (by removing the boundary between similar features), merge layers together, and clip the boundary of a layer with another layer such as a study area.

Once you've found features, you can display their attributes and statistics, create reports and graphs, or export them to a new feature class.

## Identifying features

When you view a map online, there's lots of information you can get directly from it. If you want to know what a feature is, just pause your mouse over it to display a Map Tip. A Map Tip pops up on the screen providing a quick description such as a city name. If you want to know more about the feature, use the Identify tool to display all the attributes of the feature.

### Tip

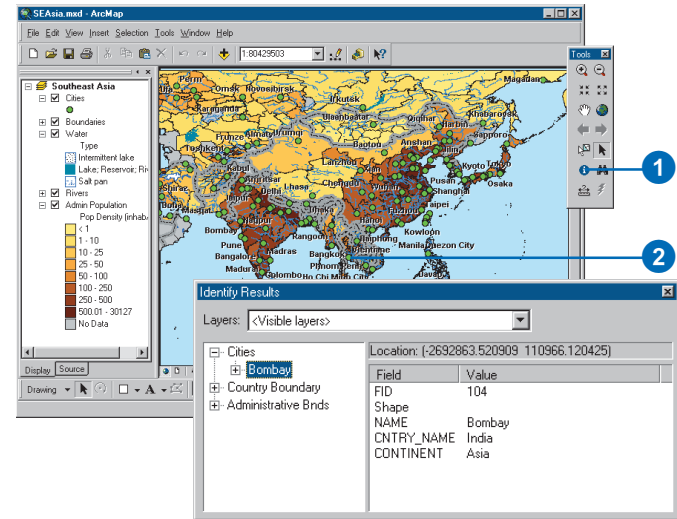
#### I can't see the Map Tips

*If you can't see Map Tips even after you've enabled them, make sure that the layer is turned on and the features in the layer are not being hidden by features in overlapping layers.*

## Identifying features by pointing at them

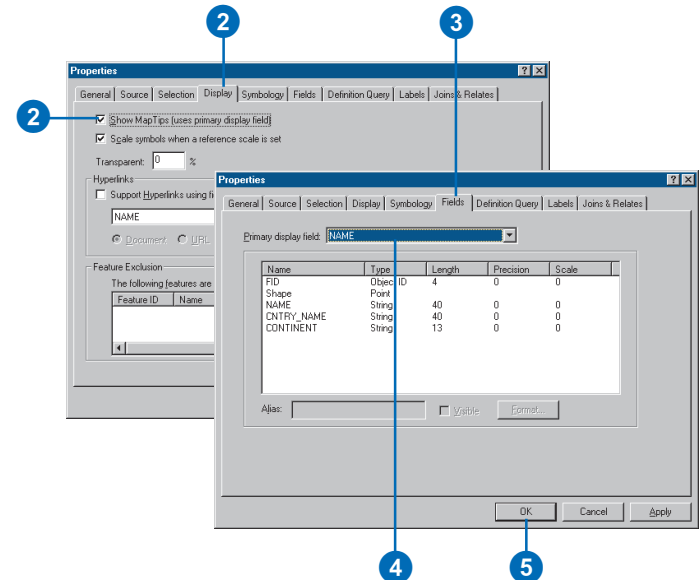
1. Click the Identify button on the Tools toolbar.
2. Click the mouse pointer over the map feature you want to identify.

The features in all visible layers under the pointer will be identified.



## Displaying Map Tips

1. In the table of contents, right-click the layer for which you want to display Map Tips and click Properties.
2. Click the Display tab and check Show Map Tips.
3. Click the Fields tab.
4. Click the Primary display field dropdown arrow and click the attribute field you want to display as the Map Tip.
5. Click OK.
6. Move the mouse pointer over a feature to see the Map Tip.





## Displaying a Web page or document about a feature

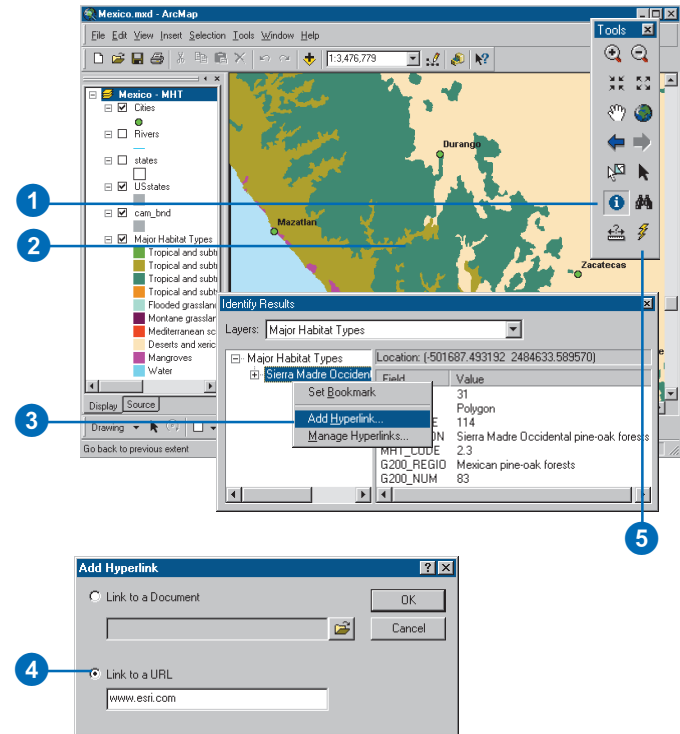
You can display a Web page or text document about a feature by clicking the feature in the map. However, before you can do this, you must create a hyperlink. A hyperlink is a document path and name or a Web page address stored with the feature.

You can create hyperlinks easily and save them to the current ArcMap document or write them to a layer file by clicking features in the map and typing the hyperlinks.

If you would like to store the hyperlinks in the layer's attribute table, create a field in the feature attribute table and enter the hyperlinks for each feature. You must then instruct ArcMap to access the hyperlinks from this field.

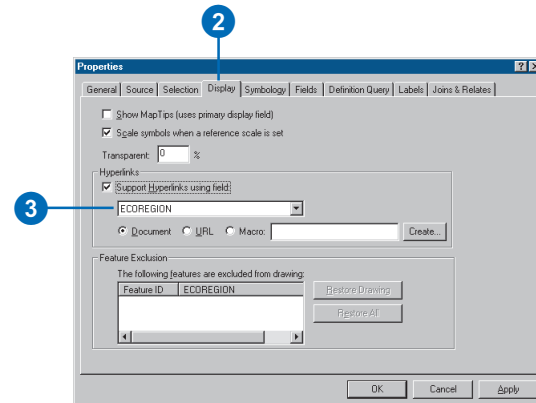
## Creating and accessing hyperlinks stored in a layer file or ArcMap document

1. Click the Identify Features button on the Tools toolbar.
2. Click a feature.
3. In the Identify Results window, right-click the feature you want to set a hyperlink for and click Add Hyperlink.
4. To add a hyperlink to a Web page, click Link to a URL and type a URL. To link to a document, click Link to a Document and type a pathname to the document.
5. Click the Hyperlink tool on the Tools toolbar and click a feature.



## Accessing hyperlinks stored in an attribute table

1. Double-click the layer in the table of contents you want to display a Web page or document for.
2. Click the Display tab.
3. Check Support Hyperlinks using field, click the dropdown arrow, and click a field.
4. Click OK.
5. Click the Hyperlink button and click a feature. The document or Web page displays.



## Selecting features interactively

You can select features with your mouse by clicking them one at a time or by dragging a box around them.

Before you select features with one of these methods, you can specify the layers you want to select from. Do this when the features you want to select overlap or are very close to features from other layers. For example, if you have a layer of cities where many of the cities are on rivers, you can avoid selecting rivers by specifying that you want to select from the cities layer only.

You can also select features in the map by selecting their records in the attribute table. When you select feature records in a table, the feature highlights on the map.

### Tip

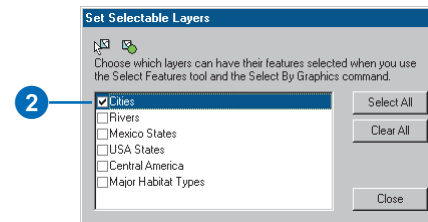
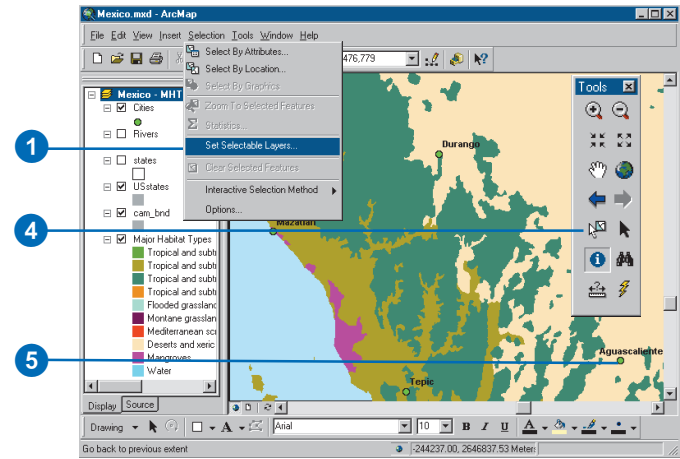
#### Setting selectable layers

*When you're setting selectable layers, you can check or uncheck all layers by holding down the Ctrl key while clicking one of the check boxes.*

## Selecting a feature by clicking it in the map

1. Click Selection and click Set Selectable Layers.
2. Click the layers you want to select from.
3. Click Selection, point to Interactive Selection Method, then click Create New Selection.
4. Click the Select Features tool.
5. Click the feature you want to select.
6. To select additional features, hold down the Shift key while clicking the features.

To remove a feature from the selected set, click the Selection menu, point to Interactive Selection Method, and click Remove From Current Selection. Click a selected feature and it deselects.



## Tip

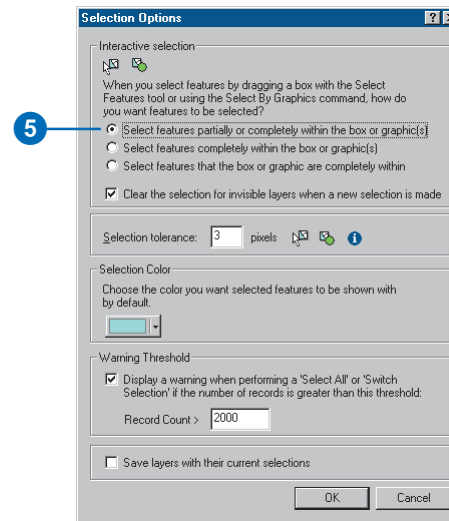
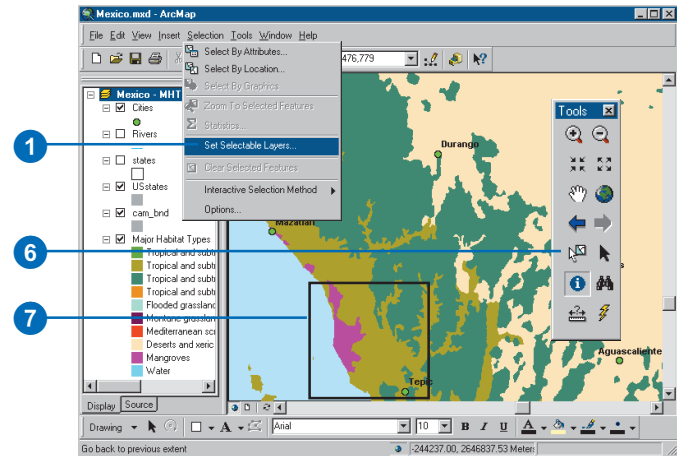
### Deselecting all features

To deselect all selected features at once, click the map where there are no features or click a feature of a layer that is not selectable. If you are unable to do this, click the Selection menu and click Clear Selected Features.

## Select features by dragging a box

1. Click Selection and click Set Selectable Layers.
2. Click the layers you want to select from.
3. Click Selection, point to Interactive Selection Method, then click Create New Selection.
4. Click Selection and click Options.
5. Specify how you'd like to select features with the box and click OK.
6. Click the Select Features button.
7. Click and drag a box around the features you want to select.
8. To select additional features, hold down the Shift key as you drag the box.

To remove a feature from the selected set, click the Selection menu, point to Interactive Selection Method, and click Remove From Current Selection. Drag a box around the features you want to deselect.



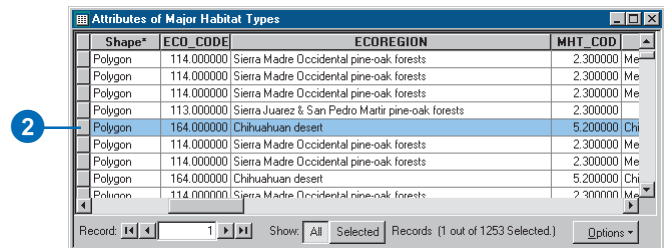
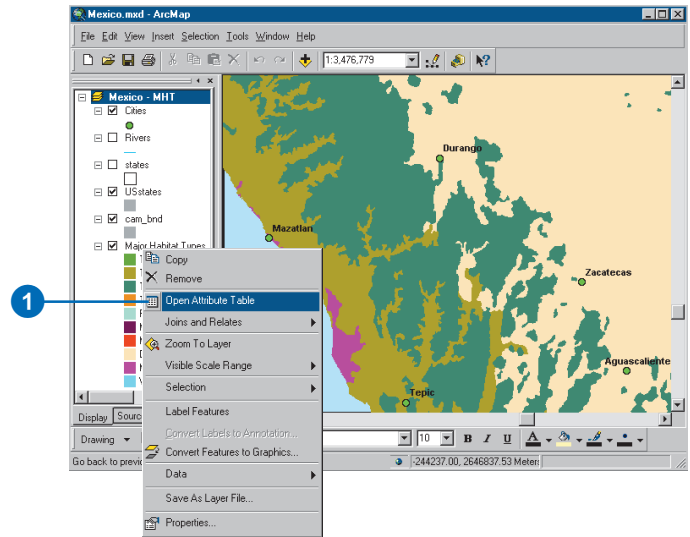
## Tip

### Selecting consecutive records in a table

To select consecutive records in a table, click and drag the mouse up or down.

## Selecting a feature by clicking it in the table

1. Right-click a layer in the table of contents and click Open Attribute Table.
2. Select a feature in the table by clicking to the left of a record.
3. To select additional features, hold down the Ctrl key and click on the features. To deselect a feature, hold down the Ctrl key and click the feature.



## Selecting features by searching with an SQL expression

Structured Query Language (SQL) is a powerful language you use to define one or more criteria that can consist of attributes, operators, and calculations. For example, imagine you have a map of customers and want to find those who spent more than \$50,000 with you last year and whose business type is 'Restaurant'. You would select the customers with this expression: `Sales > 50000 AND Business_type = 'Restaurant'`.

When you search with SQL expressions, you can select features or table records in any data format supported by ArcMap. However, you format expressions differently depending on the format of the data you're querying. The following pages contain guidelines on how to build SQL expressions for different data formats.

### Tip

#### Try the Query Wizard

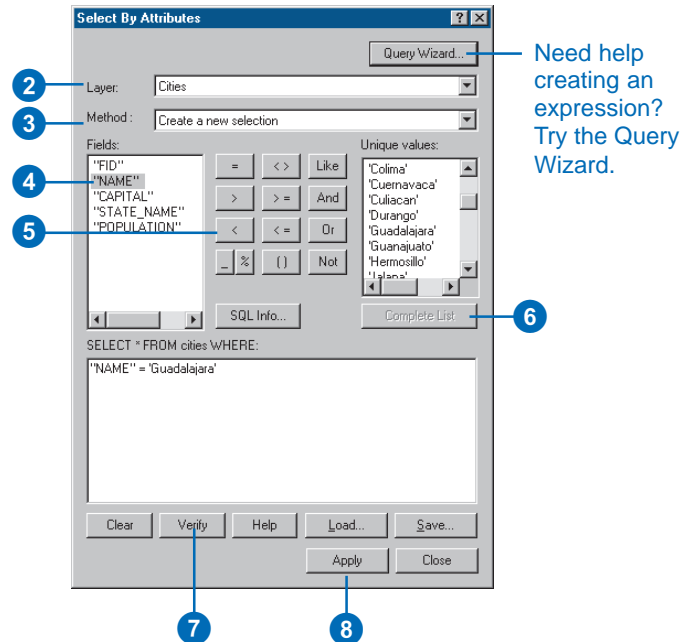
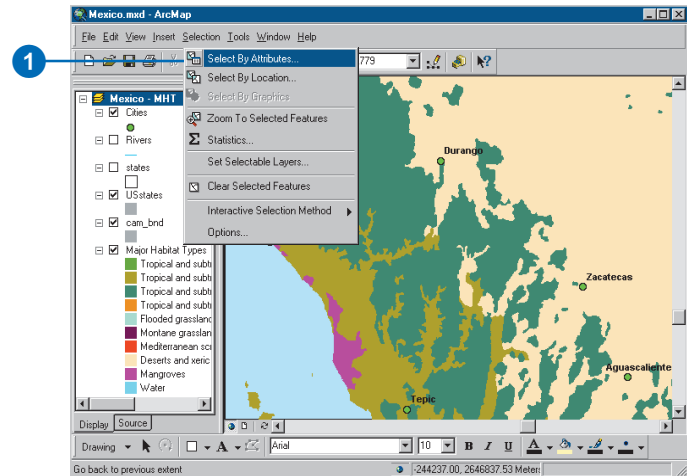
*If you've never selected features by their attributes, try clicking the Query Wizard button to generate the selection expression.*

1. Click Selections and click Select By Attributes.
2. Click the Layer dropdown arrow and click the layer containing the features you want to select.
3. Click the Method dropdown arrow and click a selection method.
4. Double-click a field to add the field name to the expression box.
5. Click an operator to add it to the expression.
6. If you have a very large number of values, click the Complete List button to see them all.

Double-click a value to add it to the expression.

7. To see if you're using proper syntax or if the criteria you've entered will select any features, click the Verify button.
8. Click OK.

The status bar at the bottom of the ArcMap window tells you how many features are selected.



## Building an SQL expression

When you create an expression in the Select By Attributes dialog box, you create it in a version of SQL; the one you use depends on the format of the data you're querying.

You use ANSI SQL with shared geodatabase data and Jet SQL with personal geodatabase data. These two versions of SQL are similar; however, each supports features and functions the other doesn't.

When you query coverages, shapefiles, INFO tables, and dBASE tables, you use a limited version of SQL that doesn't support functions or the many features of ANSI and Jet SQL.

The following shows you how to build simple expressions. For information on how to build more complex expressions, please consult your SQL reference manual.

### Specifying fields

- If you're querying ArcInfo coverages, shapefiles, INFO tables, or dBASE tables, enclose fields in double quotes:  
"AREA"
- If you're querying personal geodatabase data, enclose fields in square brackets:  
[AREA]
- If you're querying shared geodatabase data, don't enclose fields:  
AREA

### Searching for strings

Regardless of the data you're querying, always enclose strings such as names in single quotes. For example, this query will select California in a layer based on personal geodatabase data:

```
[STATE_NAME] = 'California'
```

Strings are case-sensitive for coverages, shapefiles, INFO tables, dBASE tables, and shared geodatabases. If you are unsure of case, use the operator LIKE, not '='. For example, "STATE\_NAME" = 'rhode island' will not find a feature with "Rhode Island" in its attribute record, but "STATE\_NAME" LIKE 'rhode island' will.

Strings are not case-sensitive for personal geodatabases. For example, [STATE\_NAME] = 'rhode island' will select a feature with "Rhode Island" in its attribute record.

If you are uncertain of spelling or just want to use a shorter string in your expression, use LIKE with wild cards. If you are querying a coverage, shapefile, INFO table, dBASE table, or a shared geodatabase:

'\_' represents any one character and '%' any group of characters.

If you are querying a personal geodatabase:

'?' represents any one character and '\*' any group of characters.

For example, this query will select Mississippi in a shared geodatabase:

```
STATE_NAME LIKE 'Miss%'
```

This query will find Catherine Smith and Katherine Smith in a layer based on personal geodatabase data:

```
[OWNER_NAME] LIKE '?atherine smith'
```

If you use a wild card character in a string with the = operator, the character is considered part of the string, not a wild card.

### Searching for values

To search for a specific value, use the = operator. To compare values use the <, >, <=, >=, and <> operators. For example, this query will select all houses greater than or equal to 1,500 square feet in a coverage:

“AREA” >= 1500

You can include calculations in expressions. Mathematical operators you can use include +, \*, and /. For example, to find the counties with a population density of less than or equal to 25 people per square kilometer, you could use the query:

“POP2000” / Area <= 25

Longer calculations first evaluate \* and / operators from left to right and then the + and - operators. For example, this query would multiply PRICE by AREA and then add TAX:

“NETVALUE” > “TAX” + “PRICE” \* AREA

To control the order calculations evaluate, use parentheses. Calculations within parentheses evaluate first. For example, to add TAX to PRICE and then multiply by AREA, use:

“NETVALUE” > (“TAX” + “PRICE”) \* “AREA”

## Building expressions with more than one criteria

To search for several strings or values in a field, use the IN operator. For example, this expression will search for four different state names in a shared geodatabase:

STATE\_NAME IN (‘Alabama’, ‘Alaska’, ‘California’, ‘Florida’)

To build an expression with more than one criteria when both criteria must be true, use the AND operator. For example, to find areas of pine forest larger than 100 square kilometers, use this expression:

VEGETATION = ‘Pine Forest’ AND AREA > 100

When at least one of the criteria must be true, use the OR operator. For example, this expression will select any feature with at least one of the following conditions:

SALES > 20000 OR ORDERS > 20000

To exclude, use the NOT operator. For example, to select all the Pacific states except California, use:

SUB\_REGION = ‘Pacific’ AND NOT STATE\_NAME = ‘California’



# Ways to find features by their location

With the Select By Location dialog box, you can select features based on their location relative to other features. You can use a variety of methods to select the point, line, or polygon features in one layer that are near or overlap the features in the same or another layer.

## **Are crossed by the outline of**

This method selects the features that are overlapped by the features of another layer. For example, selecting wilderness areas crossed by the outline of roads will select any wilderness area with a road crossing its boundaries.

## **Intersect**

This method is similar to the Are crossed by the outline of method but also selects any features bordered by the reference features. For example, selecting wilderness areas intersected by roads will select any wilderness area with a road running within its boundaries or alongside it.

## **Are within a distance of**

This method selects features near or adjacent to features in the same layer or in a different layer. For example, if you have a layer of clean and polluted wells, you can find all the clean wells within 500 meters of the polluted ones. Or, you could find the reservoirs and farms in other layers that are within this distance of the polluted wells. You can also use this option to find features adjacent to other features. For example, you may have already selected land parcels that your company might purchase, and now you want to get information about adjacent parcels. In this case you would select the parcels within zero distance of the ones you've already selected.

## **Have their center in**

This method selects the features in one layer that have their center in the features of another layer.

## **Are completely within**

This method selects features in one layer that fall completely inside the polygons of another. For example, you can select lakes completely within a forested area. To select features that are a distance from the edges of the polygon they fall inside, specify a buffer distance. For example, you can select lakes that are at least 500 meters within a forested area.

## **Completely contain**

You can select polygons in one layer that completely contain the features in another layer. For example, select forested areas that have lakes completely within them. To select polygons that completely contain features a certain distance within them, specify a buffer distance. For example, you can select forested areas with lakes at least 500 meters within them by buffering the lakes.

## **Share a line segment with**

This method selects features that share line segments, vertices, or nodes with other features.

## **Are identical to**

This method selects any feature having the same geometry as a feature of another layer. The feature types must be the same—for example, you use polygons to select polygons, lines to select lines, and points to select points.

## **Contain**

This method selects features in one layer that contains the features of another. This method differs from the Completely contain method in that the boundaries of the features can touch. For example, with the Contain method, a forest will contain a lake—and thus be selected—even if the border of the lake touches the border of the forest. The forest would not be selected using Completely contain because the borders touch.

## **Are contained by**

This method selects features in one layer that are contained by the features in another. For example, you can select those cities that are contained by a county. This method differs from Are completely within in that the edges of the features can touch.

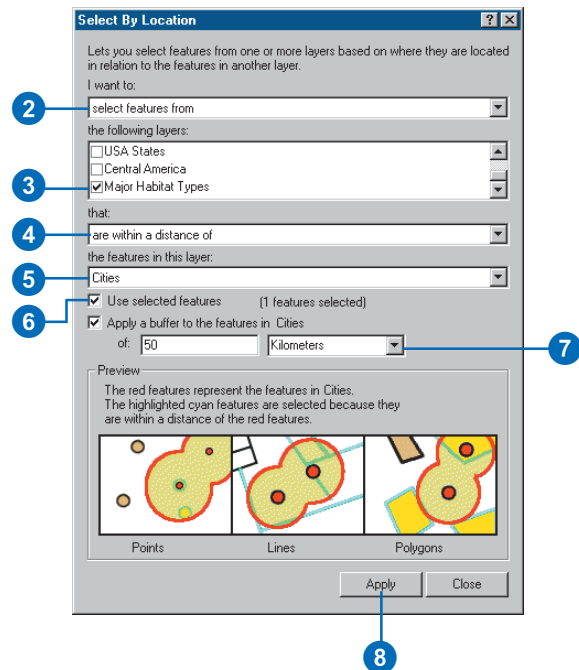
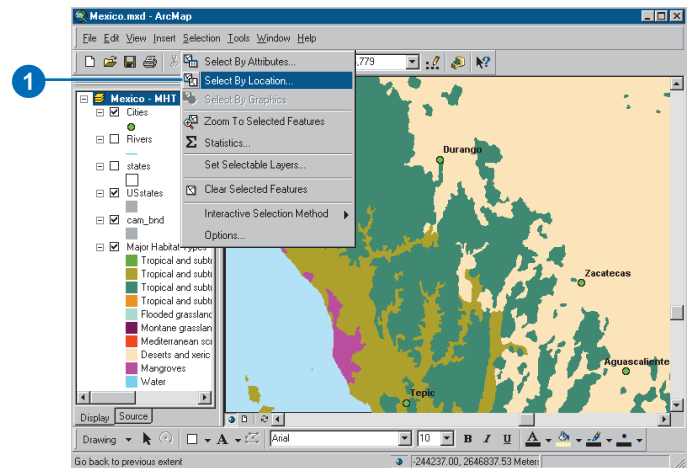
## Selecting features by their location

Suppose you want to know how many homes were affected by a recent flood. Answering this question—and others like it—involves forming a spatial query. You want to find features based on where they are in relation to other features. For instance, if you mapped the flood boundary, you could then select all the homes that are within this area.

By combining queries, you can perform more complex searches. For example, suppose you want to find all the customers who live within a 20-mile radius of your store *and* who made a recent purchase so you can send them a promotional mailing. You would first select the customers within this radius (select by location) and then refine the selection by finding those customers who have made a purchase within the last six months according to a date-of-last-purchase attribute (select by attribute).

1. Click Selection and click Select By Location.
2. Click the dropdown arrow and click a selection method.
3. Check the layers whose features you would like to select.
4. Click the dropdown arrow and click a selection method.
5. Click the dropdown arrow and click the layer you want to use to search for the features.
6. Check to use only the selected features.
7. Check Apply a buffer to the features in <layer> and set the distance within which to search for features.
8. Click Apply.

ArcMap selects the features.



## Specifying how selected features highlight

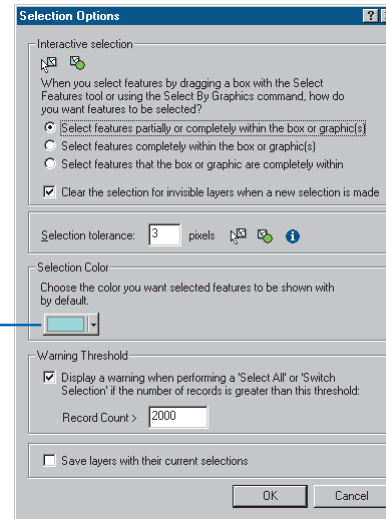
You can display selected features in any color or symbol. You can control this for all layers at once or for any specific layer.

### Specifying how all layers highlight

1. Click the Selection menu and click Options.
2. Click the color box and click the color you want to use.

For polygons, this is the color the edges highlight in. For points and lines, this is the color the entire feature highlights in.

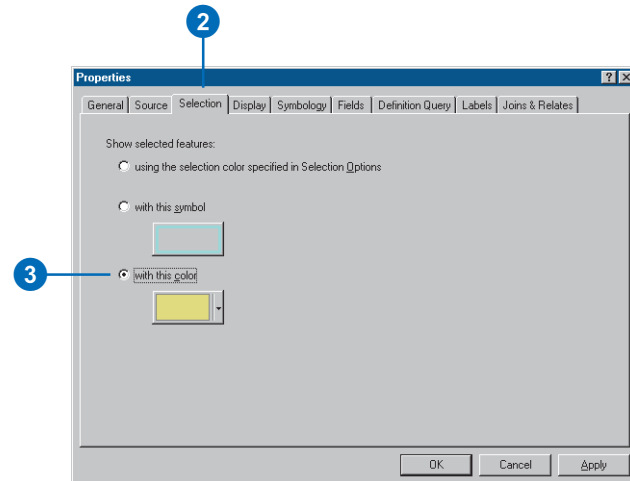
3. Click OK.



### Specifying how a specific layer highlights

1. In the table of contents, right-click a layer and click Properties.
2. Click the Selection tab.
3. Click the third option and click the color you want.
4. Click OK.

This setting overrides any setting you make with the Selection Options dialog box.



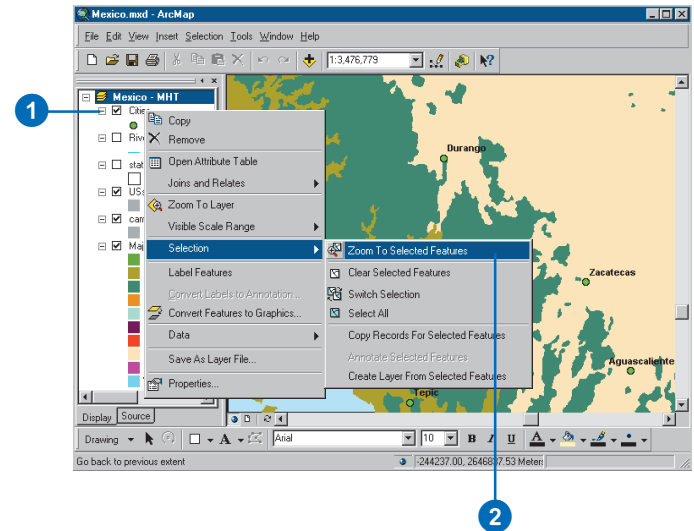
## Displaying information about selected features

Once you've selected features, you can zoom to them or display their attributes or statistics. You can also create a report or graph of them. For information on how to create reports and graphs, see Chapter 11, 'Looking at data with graphs', and Chapter 12, 'Creating reports'.

### Zooming to selected features

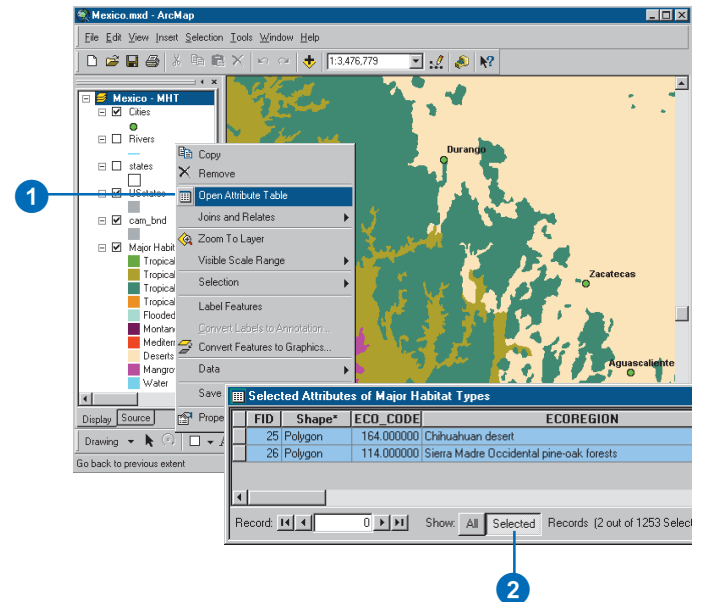
1. Right-click the layer in the table of contents that contains selected features.
2. Click Selection and click Zoom To Selected Features.

ArcMap zooms to the selected features.



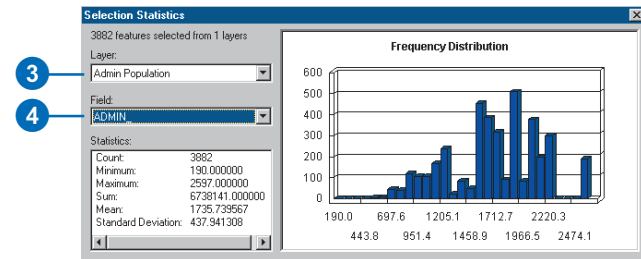
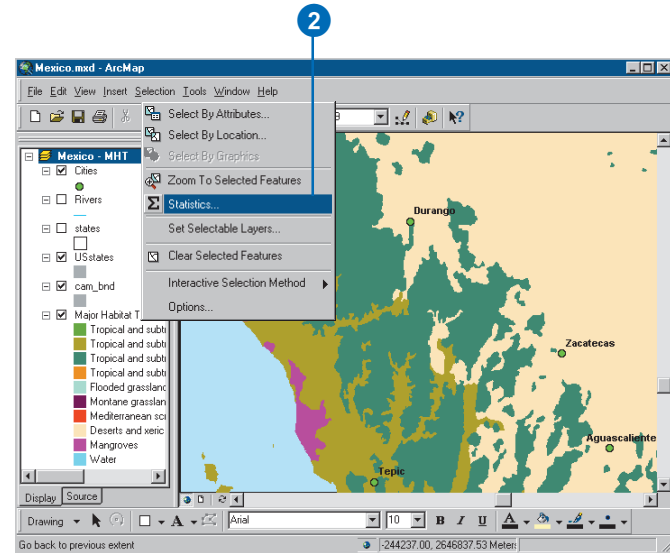
### Displaying the attribute of selected features

1. In the table of contents, right-click the layer containing selected features and click Open Attribute Table.
2. Click Show Selected records. Records of the selected features display.



## Displaying statistics

1. Select features using any selection method discussed in this chapter.
2. Click Selection and click Statistics.
3. Click the Layer dropdown arrow and click the map layer you want to see statistics about.
4. Click the Field dropdown arrow and click the field you want to see statistics about. The statistics display.

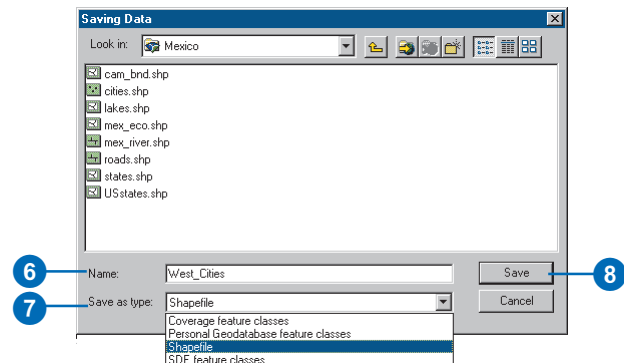
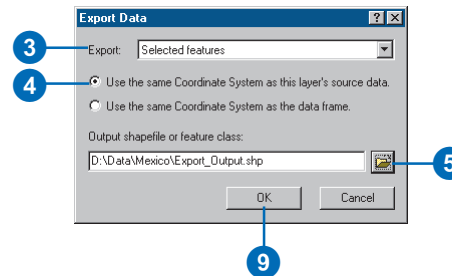
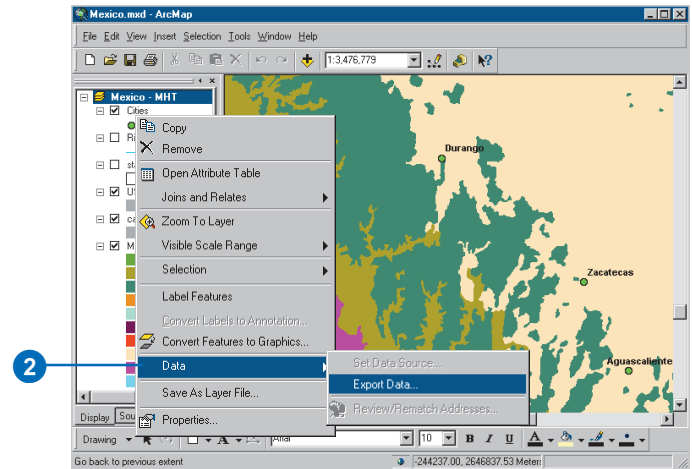


## Exporting selected features

Suppose you've selected a set of features that meet some criteria and you want to work with these features outside of the current layer. You can export the selected features to a new shapefile, coverage, or geodatabase feature class. Alternatively, instead of creating a new data source, you can simply create a new layer that only contains the selected features.

## Exporting selected features to a new data source

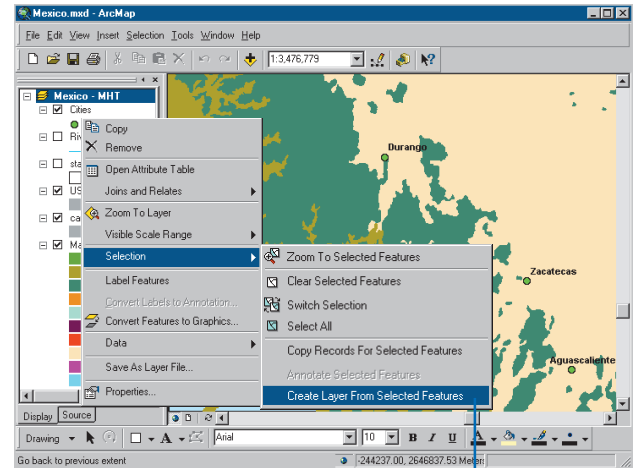
1. Select features using any selection method discussed in this chapter.
2. Right-click the layer that contains the selected features, point to Data, and click Export Data.
3. Click the Export dropdown arrow and click Selected features.
4. Click Use the same Coordinate System as this layer's source data.
5. Click the Browse button and navigate to a location to save the exported data.
6. Type the Name for the output source data.
7. Click the Save as type dropdown arrow and choose the output type.
8. Click Save.
9. Click OK.



## Creating a new layer from the selected features

1. Select features in a layer using any selection method discussed in this chapter.
2. Right-click the layer in the table of contents, point to Selection, and click Create Layer From Selected Features.

The new layer is added to the map.





## Creating buffers around features

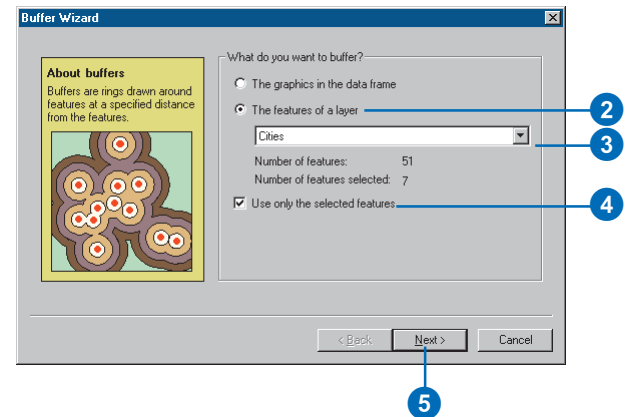
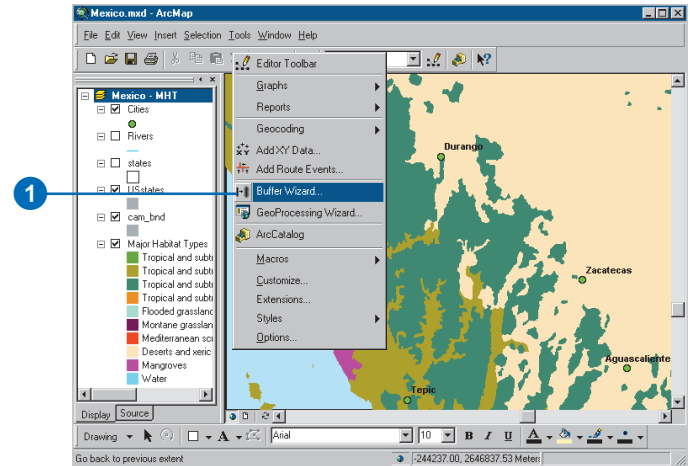
Finding what features are within a set distance identifies an area, and the features inside that area, affected by an event or activity. For example, a forester would monitor logging to make sure it doesn't occur within a 100-meter buffer along streams.

Distance is one way of defining and measuring how close something is. You can also measure what's nearby using cost. Time is one of the most common costs—it takes longer, for example, for customers to get to a store through heavy traffic. Other costs include money (such as the operating cost per mile for a delivery van) and effort expended (for instance, for a deer walking through thick underbrush versus open forest to reach a stream). These are often referred to as travel costs.

ArcMap lets you buffer features in a layer or graphics you draw on top of your map. You can buffer features at a specific distance or use an attribute value to create variable width buffers. Use multiple ring buffers to show features within distinct bands of distance—for example, 50, 100, and 150 meters.

## Buffering features at a specified distance

1. Click the Tools menu and click Buffer Wizard.
2. Click to buffer the features of a layer.
3. Click the dropdown arrow and select the layer to buffer.
4. Check Use only the selected features if needed.
5. Click Next. ▶



## Tip

### Using the buffers you create on different maps

To use the buffers you create on different maps, save the buffer as a new data source such as a shapefile. Then you can easily add the data to another map.

## Tip

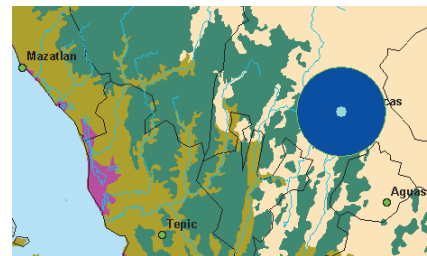
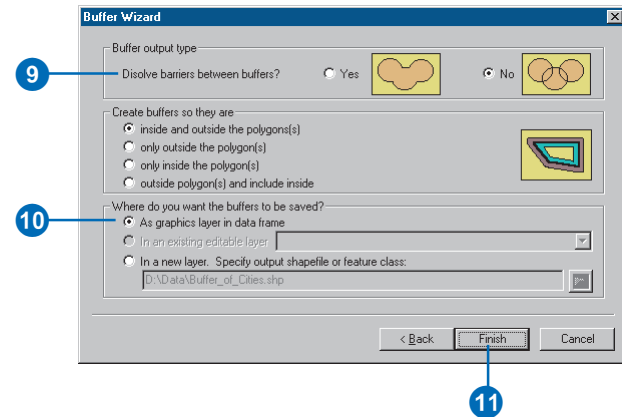
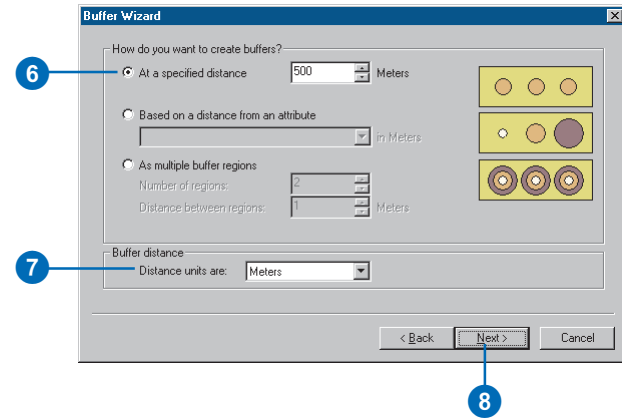
### What to do with a buffer layer

Creating a buffer provides a visual representation on your map of the area within a certain distance of one or more features. You can also use the buffer to select features in other layers that fall within the buffered area.

## See Also

For more conceptual information on buffering features, see Chapter 6, 'Finding what's nearby', in The ESRI Guide to GIS Analysis.

- Click to create buffers at a specified distance and type the distance.
- Click the Distance units dropdown arrow and click the appropriate units.
- Click Next.
- Click to Dissolve barriers between buffers.
- Click to output the buffer as a graphic on the map or as a new layer.
- Click Finish.



The newly created buffer appears on the map.

# Aggregating data with the GeoProcessing Wizard

The GeoProcessing Wizard allows you to combine layers in different ways based on the geography of the features in the layers. The GeoProcessing Wizard lets you:

- Aggregate features in a single layer that have the same attribute value (dissolve).
- Append two or more adjacent layers into a single layer (merge).
- Reduce the spatial extent of one layer based on the extent of another (clip).
- Find those features falling within the spatial extent common to two layers (intersect).
- Combine two polygon layers (union).

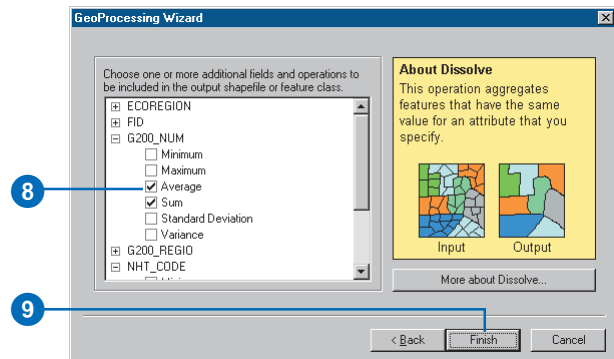
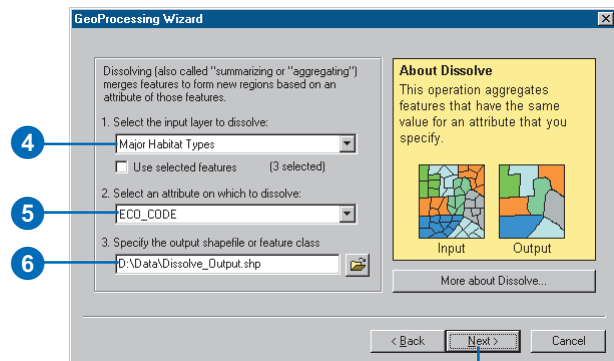
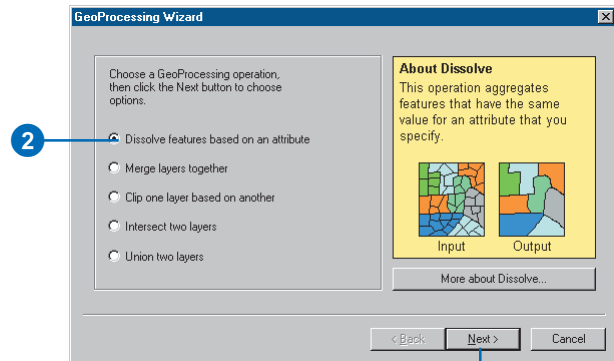
Here are some examples of when to use a particular option.

Dissolve—You might dissolve a detailed land use layer into more general categories of land use such as residential, commercial, and undeveloped. ►

## Dissolving features based on an attribute

1. Click the Tools menu and click GeoProcessing Wizard.
2. Click Dissolve features based on an attribute.
3. Click Next.
4. Click the input layer dropdown arrow and click a layer to dissolve.
5. Click the attribute field dropdown arrow and click the attribute on which to dissolve.
6. Type the name of the output shapefile or feature class.
7. Click Next.
8. Check the boxes to specify how you want to summarize the attributes.
9. Click Finish.

Because you're dissolving the boundary between adjacent features, you need to decide how you want to combine their attributes.



**Merge**—You could merge several tiled county layers containing census data to make a layer representing a metropolitan area.

**Clip**—You might use the boundary of a study area to clip a layer of roads or wildlife habitats that extends over a much larger area.

**Intersect**—You could intersect a flood zone layer with a land parcel layer to see which parcels are in the flood zones.

**Union**—You might union a layer representing soil type with another representing slope to create a new layer of erosion potential.

### Tip

#### Can I merge layers that overlap?

*You can merge layers that overlap. However, the features are not intersected (that is, two crossing lines will not be split and joined at the intersection). Instead, features and attributes are simply appended together.*

## Merging layers together

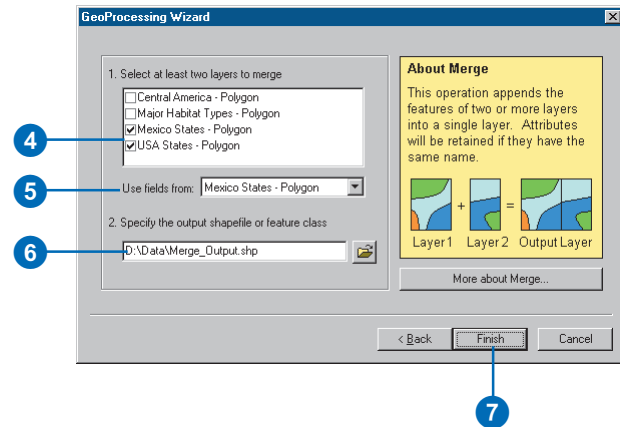
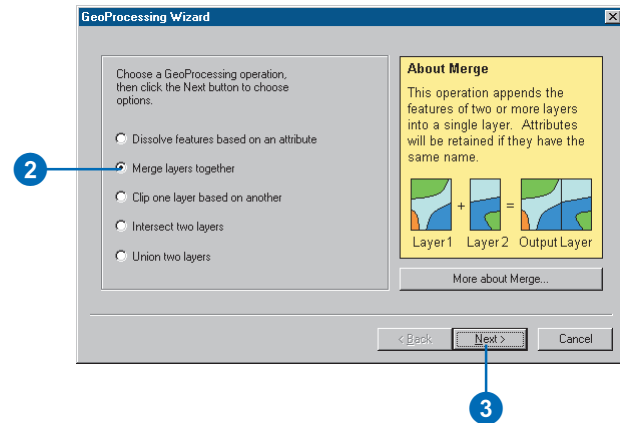
1. Click the Tools menu and click GeoProcessing Wizard.
2. Click Merge layers together.
3. Click Next.
4. Check two or more adjacent layers to merge.

The layers must be of the same type (e.g., polygons).

5. Click the Use fields from dropdown arrow and click the layer containing the fields you want to maintain.

If the layers merged to this layer have the same fields, the attributes will be copied to the new layer. If a merged layer contains an extra field, it will be dropped. Also, if a merged layer is missing a field, the field value for features in that layer will be null.

6. Type the name of the output shapefile or feature class.
7. Click Finish.



## Tip

### Clip using selected features

Suppose a layer delineates several study areas, but you only want to clip using one of them. Select the study area before starting the GeoProcessing Wizard, then use only the selected study area to clip other layers.

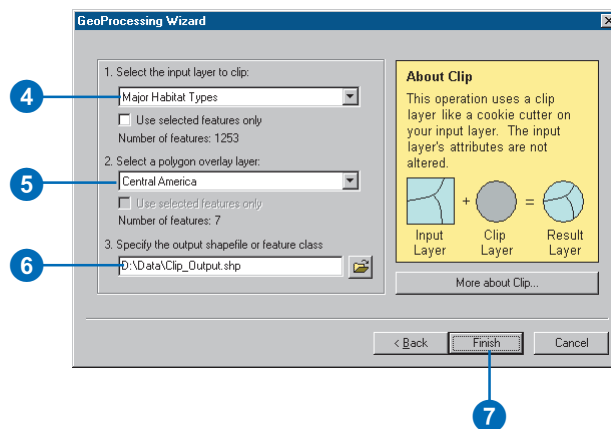
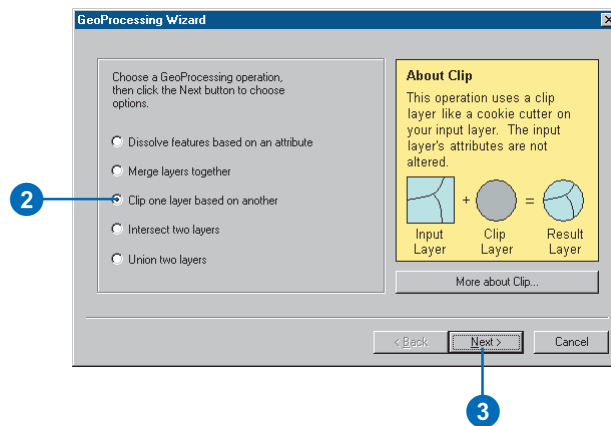
## Tip

### Why are some geoprocessing options unavailable?

Some geoprocessing options may be grayed out because the active data frame doesn't have enough layers in it. For example, the union option requires two polygon layers as input. If the active data frame doesn't have two layers in it, the option is unavailable.

## Clipping one layer based on another

1. Click the Tools menu and click GeoProcessing Wizard.
2. Click Clip one layer based on another.
3. Click Next.
4. Click the input layer dropdown arrow and click a layer to clip.
5. Click the polygon clip layer you want to clip features with.
6. Type the name of the output shapefile or feature class.
7. Click Finish.



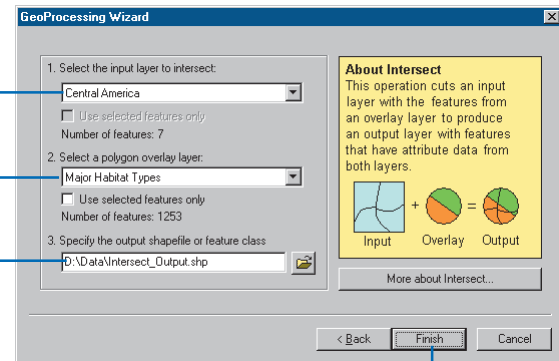
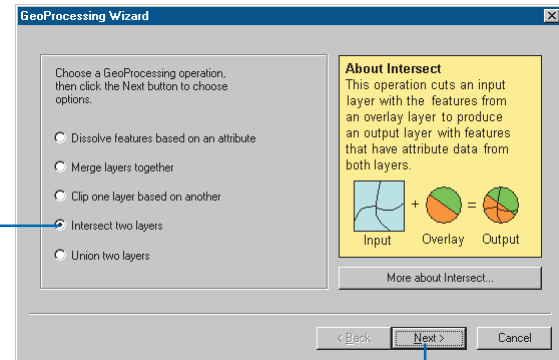
## Tip

### What do you end up with after intersecting?

Suppose you have a roads layer and a counties layer and you want to know what roads are in what counties. Intersecting the roads layer with the counties layer creates a new layer that combines the attributes of both. The features in the new layer are roads with the attributes of the county they're in. Where a road crosses a county boundary, it will be split in two, with the appropriate county attributes assigned to each piece.

## Intersecting two layers

1. Click the Tools menu and click GeoProcessing Wizard.
2. Click Intersect two layers.
3. Click Next.
4. Click the input layer dropdown arrow and click a layer to intersect.
5. Click the polygon overlay layer you want to intersect features with.
6. Type the name of the output shapefile or feature class.
7. Click Finish.



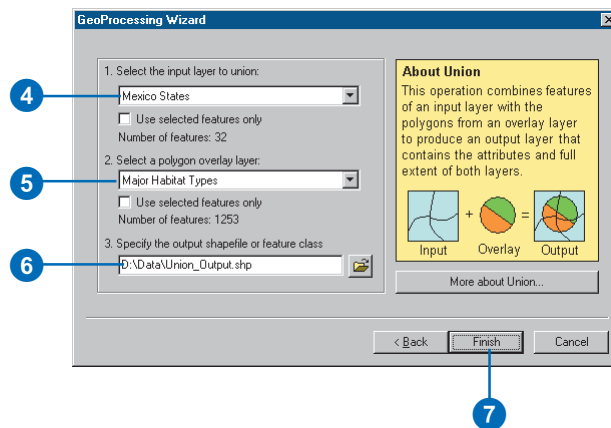
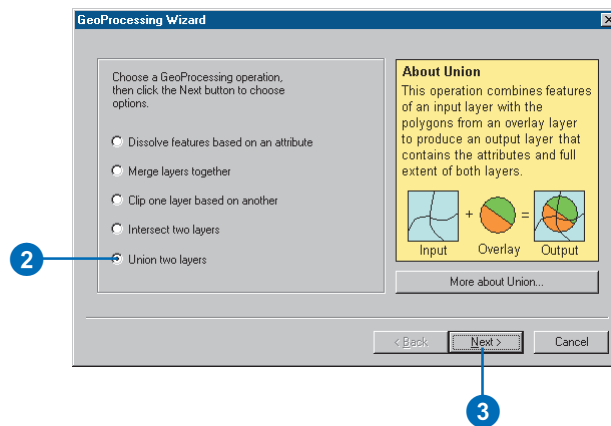
## Tip

### What types of layers can I union?

*You can only union a layer containing polygons with another layer containing polygons.*

## Unioning two layers

1. Click the Tools menu and click GeoProcessing Wizard.
2. Click Union two layers.
3. Click Next.
4. Click the input layer dropdown arrow and click a layer to union.
5. Click the polygon overlay layer you want to union features with.
6. Type the name of the output shapefile or feature class.
7. Click Finish.



## Joining the attributes of features by their location

Often, what's most interesting about a map is not the individual layers on it, but the relationships between the features in those layers. For example, suppose you wanted to tell a customer where they can find the nearest branch office of your business, or you want to compare different wildlife species with information about the habitats they live in. These types of queries can be answered with a *spatial join*.

A spatial join joins the attributes of two layers based on the location of the features in the layers. With a spatial join, you can:

- Find the closest features to another feature.
- Find what's inside a feature.
- Find what intersects a feature. ►

### Tip

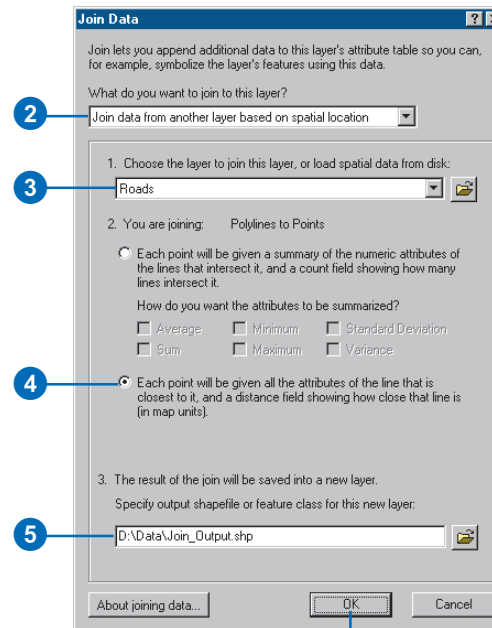
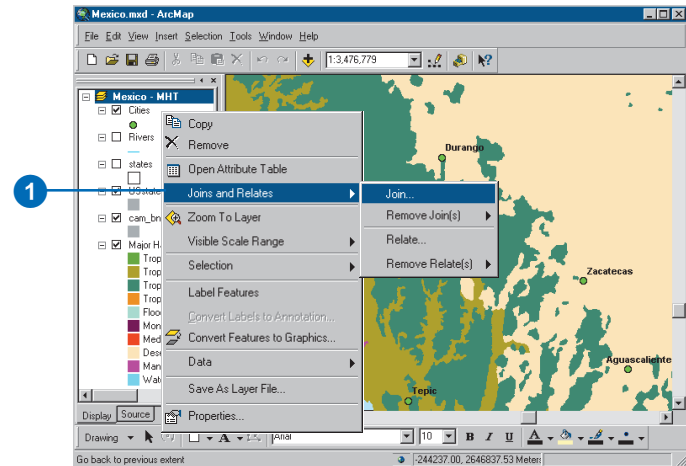
#### What is the nearest feature?

*The nearest feature is defined as the feature that is geographically closest to another one. Proximity is based on a straight line distance between features.*

## Finding the nearest feature

1. Right-click the layer you want to join attributes to, point to Joins and Relates, and click Join.
2. Click the first dropdown arrow and click Join data from another layer based on spatial location.
3. Click the layer dropdown arrow and click the name of the layer you want to join the attributes of. If the layer is not currently part of the map, click the browse button to search for it on disk.
4. Click the option to join the attributes of the feature closest to it.
5. Type the name of the output shapefile or feature class.
6. Click OK.

A new layer is added to the map.





Like joining two tables by matching attribute values in a field, a spatial join appends the attributes of one layer to another. You can then use the additional information to query your data in new ways.

While you can also select features in one layer based on their location relative to another layer, a spatial join provides a more permanent association between the two layers because it creates a new layer, containing both set of attributes.

## See Also

*For more information on joining attribute tables, see 'Joining attribute tables' in Chapter 10.*

## See Also

*For more information on selecting features by location, see 'Selecting features by their location' in this chapter.*

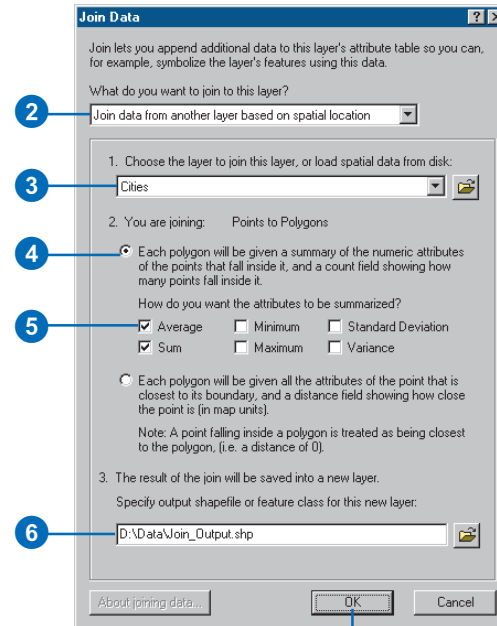
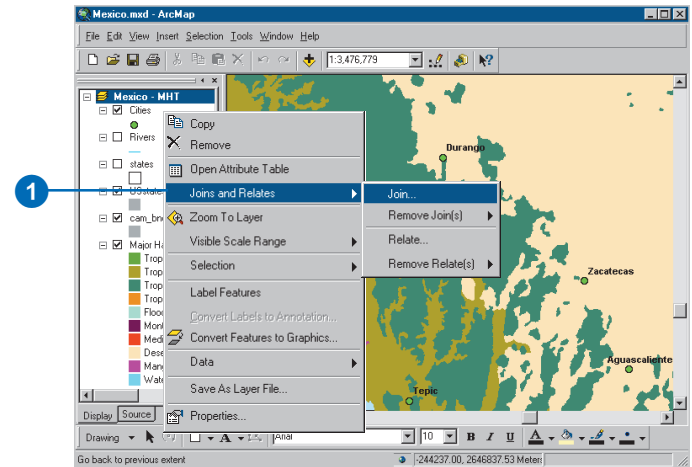
## Finding what's inside a polygon

1. Right-click the layer you want to join attributes to, point to Joins and Relates, and click Join.
2. Click the first dropdown arrow and click Join data from another layer based on spatial location.
3. Click the layer dropdown arrow and click the name of the layer you want to join the attributes of. If the layer is not currently part of the map, click the browse button to search for it on disk.
4. Click the option to join the attributes of the features that fall inside the polygon.
5. Check how you want to summarize attributes.

In this example, the attributes of a city layer are being joined to a states layer. As more than one city will fall in a state, the attributes of the cities will be summarized. For instance, the output will contain the sum and average population for all cities that fall in a given state.

6. Type the name of the output shapefile or feature class.
7. Click OK.

A new layer is added to the map.



7

## Finding what intersects a feature

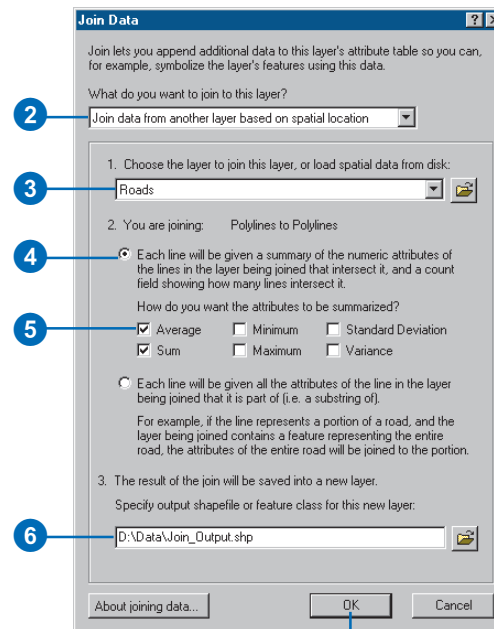
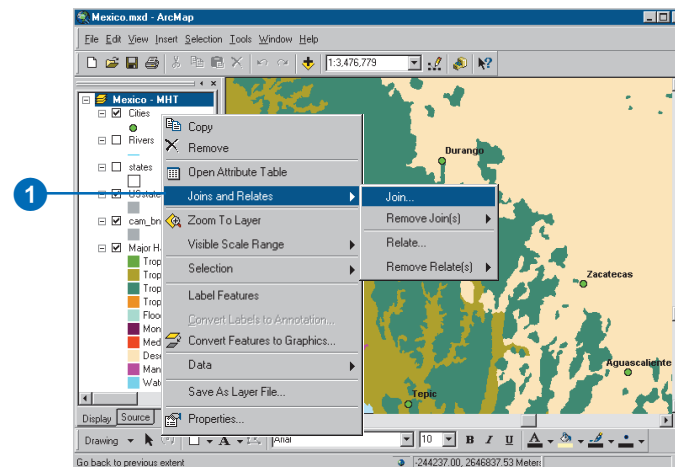
1. Right-click the layer you want to join attributes to, point to Joins and Relates, and click Join.
2. Click the first dropdown arrow and click Join data from another layer based on spatial location.
3. Click the layer dropdown arrow and click the name of the layer you want to join the attributes of. If the layer is not currently part of the map, click the browse button to search for it on disk.

4. Click the option to join the attributes of the features that intersect it.
5. Check how you want to summarize attributes.

In this example, the attributes of a roads layer are being joined to a rivers layer. For each river, you'll be able to find out how many roads cross it and the summary of the attributes of those roads.

6. Type the name of the output shapefile or feature class.
7. Click OK.

A new layer is added to the map.



# Working with rasters

## IN THIS CHAPTER

- Adding a raster to your map
- Displaying rasters
- Ways to improve raster display
- Faster drawing with pyramids
- About georeferencing
- The Georeferencing toolbar
- Georeferencing a raster

Vector data—such as coverages and shapefiles—represents geographic features with lines, points, and polygons. *Rasters*—such as images and grids—represent geographic features by dividing the world into discrete squares called *cells*. Cells are laid out in a grid, where each cell has a location relative to an origin and a value describing the feature being observed—for instance, the cell values in an aerial photograph represent the amount of light reflecting off the earth’s surface.

A raster can represent thematic data, such as land use and elevation; spectral data, such as satellite images and aerial photographs; and pictures, such as scanned maps and building photographs. You’ll generally display thematic and spectral rasters as a background to other geographic data on your map. Picture rasters, when displayed alongside geographic data, can convey additional information about map features.

Some rasters have a single *band* of data, while others have multiple bands; a satellite image commonly has multiple bands representing different wavelengths of energy from the ultraviolet through the visible and infrared portions of the electromagnetic spectrum.

## Adding a raster to your map

When you create a layer from a raster, you can choose to display a single band of data or form a color composite from three bands.

If you have raster data covering the same geographic area but in different coordinate systems, ArcMap uses the coordinate system of the first dataset added and transforms any other data on the fly into this coordinate system.

In order to transform a raster dataset, you must have georeferencing information or a world file and know its coordinate system. If your raster is in pixel space with no georeferencing information, you can georeference it in ArcMap. See ‘Georeferencing a raster’ in this chapter.

In order for ArcMap to recognize your raster’s coordinate system, it must be defined. Use ArcCatalog to attach the coordinate system information to the raster. See ‘Defining a raster’s coordinate system’ in the online Help for more information.

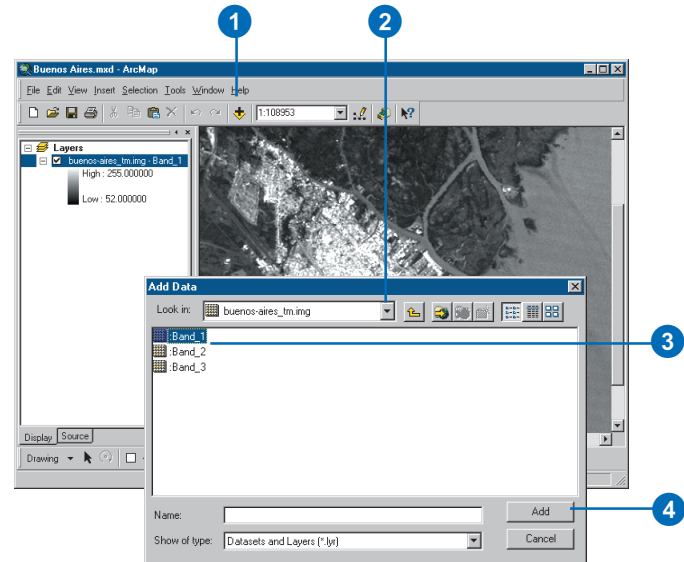
## Adding a single band raster

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the raster.

If the single band is part of a multiband raster dataset, double-click the dataset to expose the bands.

3. Click the single band raster.
4. Click Add.

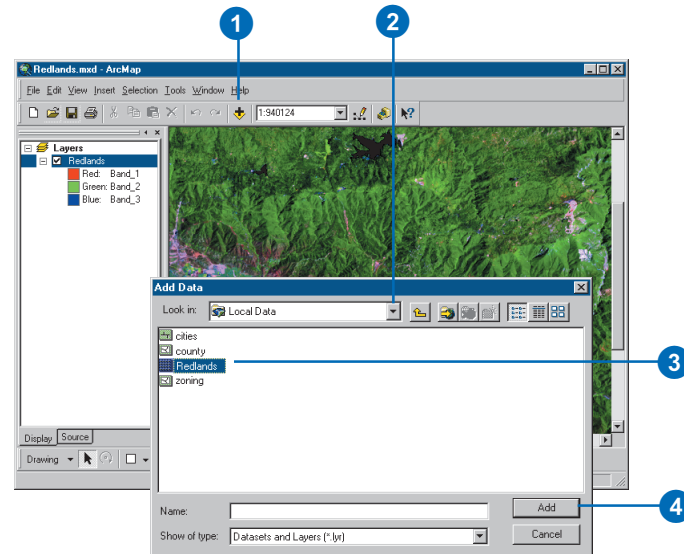
ArcMap creates a new raster layer on the map that references the raster data source.



## Adding a multiband raster

1. Click the Add Data button on the Standard toolbar.
2. Click the Look in dropdown arrow and navigate to the folder that contains the raster.
3. Click the multiband raster.
4. Click Add.

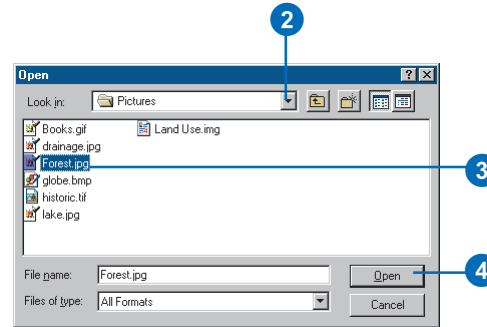
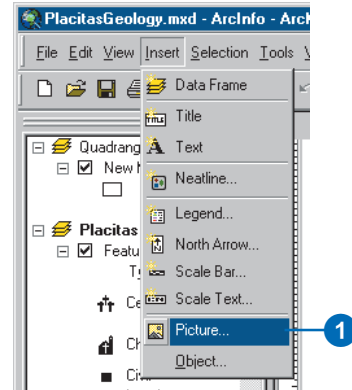
ArcMap creates a new raster layer on the map that references the raster data source.



## Adding a raster as a picture

1. Click the Insert menu on the Standard toolbar and click Picture.
2. Click the Look in dropdown arrow and navigate to the picture you want to add.
3. Click the picture.
4. Click Open.

If you're in layout view, the picture is inserted on the layout. If you're in data view, the picture is inserted within the data frame.



# Displaying rasters

How you display a raster depends on what type of data it contains and what you want to show. Some rasters have a predefined color scheme that ArcMap automatically uses to display them. For those that don't, ArcMap chooses an appropriate display method that you can adjust as needed.

If you want, you can change display colors, group data values into classes, or stretch values to increase the visual contrast. For multiband rasters, you can display three bands together as a red-green-blue (RGB) composite. This drawing method often improves your ability to distinguish features in spectral rasters.

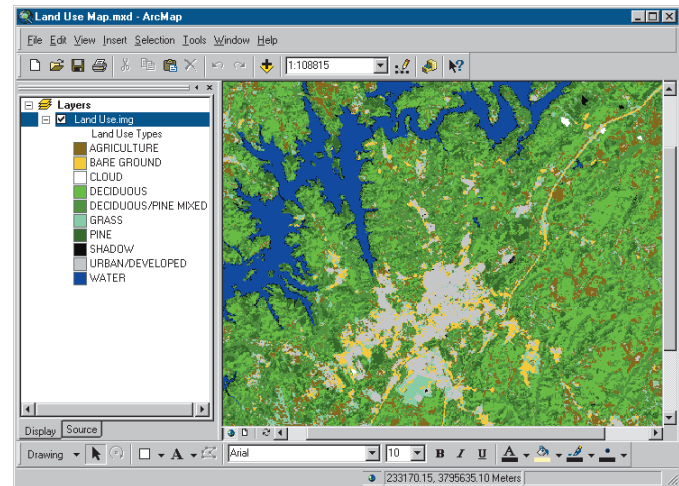
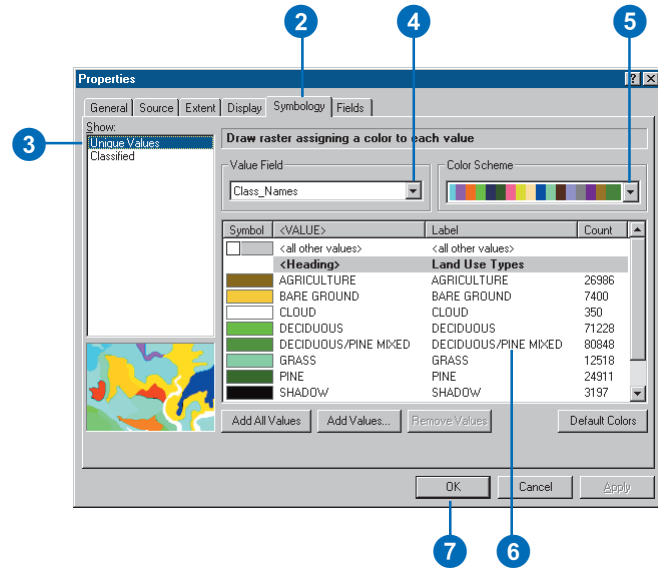
The raster resolution is the ratio of screen pixels to dataset pixels at the current map scale. Displaying the raster resolution allows you to determine if you are actually close to the maximum resolution of the raster.

A ratio of 1:1 means you have reached the best display, or the maximum resolution of the raster, where every screen pixel is displaying exactly one raster cell. A ratio of 1:20 means that every screen pixel has to display ▶

## Drawing thematic rasters that represent unique categories such as land use

1. In the table of contents, right-click the raster layer that you want to draw showing unique categories and click Properties.
2. Click the Symbology tab.
3. Click Unique Values.
4. Click the Value Field dropdown arrow and click the field you want to map.
5. Click the Color Scheme dropdown arrow and click a color scheme.
6. Optionally, click a label and type in a more descriptive one.
7. Click OK.

If your raster has a colormap, click Default Colors to revert the raster display to the colors specified in the colormap.



20 raster cells, so less detail will be seen in the raster layer. A ratio of 1:0.02 means that every screen pixel is displaying only a portion of a raster cell or that it takes many screen pixels to display a single raster cell.

### Tip

#### Displaying pictures

*If your raster is just a picture that doesn't align to any other geographic data, you can simply place it on a layout as a map element. Alternatively, create a hyperlink and associate it with a geographic feature on your map.*

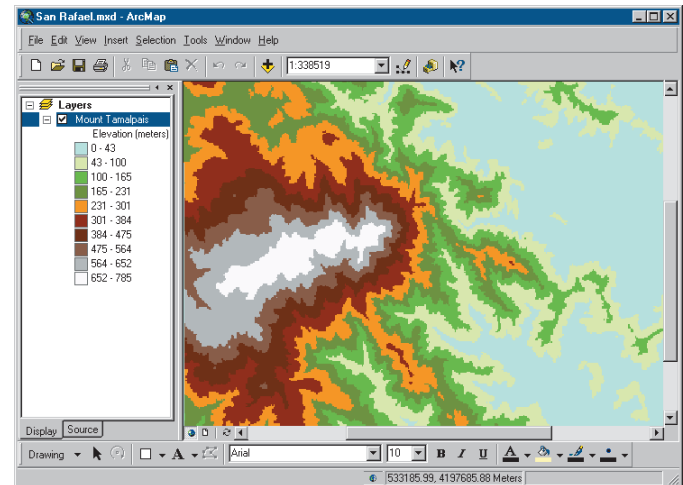
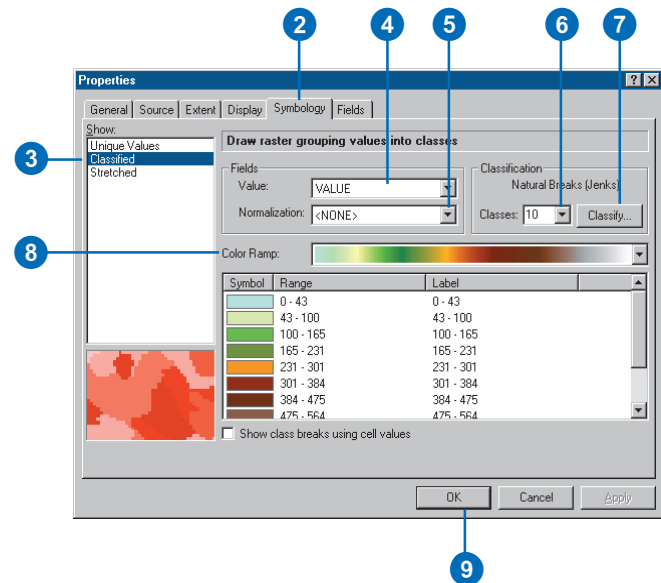
### Tip

#### Changing the color from the table of contents

*You can quickly change the colors applied to a raster by clicking on the color in the table of contents.*

## Drawing thematic rasters that represent continuous data such as elevation

1. In the table of contents, right-click the raster layer that you want to display by grouping values into classes and click Properties.
2. Click the Symbology tab.
3. Click Classified.
4. Click the Value dropdown arrow and click the field you want to map.
5. Optionally, click the Normalization dropdown arrow and click a field to normalize your data.
6. Click the Classes dropdown arrow and click the number of classes you want.
7. Click Classify and choose the classification method you want to use.
8. Click the Color Ramp dropdown arrow and click a color ramp.
9. Click OK.



## Tip

### The raster draws too dark

You can alter the overall brightness and contrast of a raster through the *Effects* toolbar. Alternatively, some raster drawing methods will allow you to stretch the data values to take advantage of the available colors.

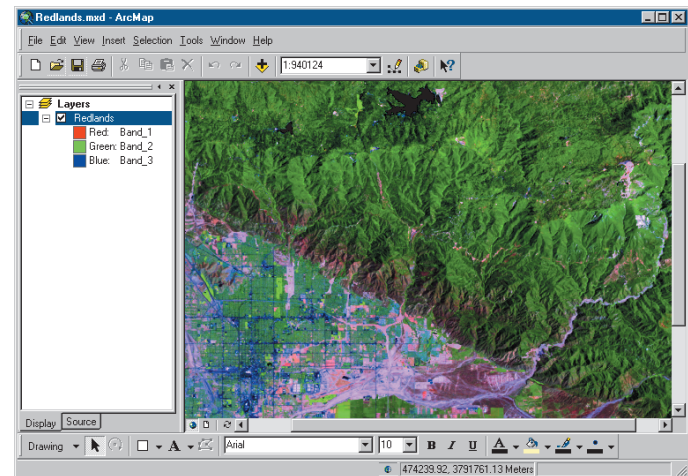
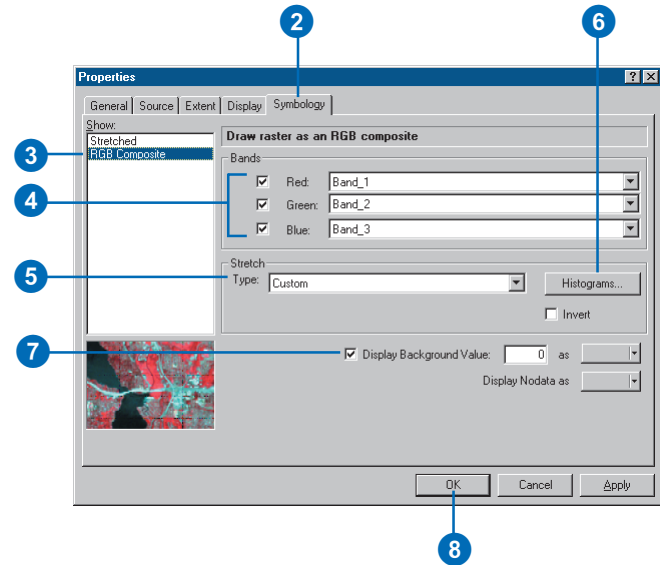
## Tip

### Displaying the RGB value for a cell

To see the RGB value for a given cell, turn on *Map Tips* for the layer. Right-click the layer in the table of contents and click *Properties*. Check the *Show Map Tips* box on the *Display* tab.

## Drawing a multiband raster as an RGB composite

1. In the table of contents, right-click the raster layer that you want to draw as an RGB composite and click *Properties*.
2. Click the *Symbology* tab.
3. Click *RGB Composite*.
4. Click the *Bands* dropdown arrow next to each color and click the band you want to display for that color.
5. Optionally, click the *Stretch Type* dropdown arrow and click the stretch you want to apply.
6. Optionally, click *Histograms* to modify the stretch settings.
7. If the raster contains a background or border around the data that you want to hide, check *Display Background Value* and set the color to *No Color*.  
The cells will display transparently.
8. Click *OK*.





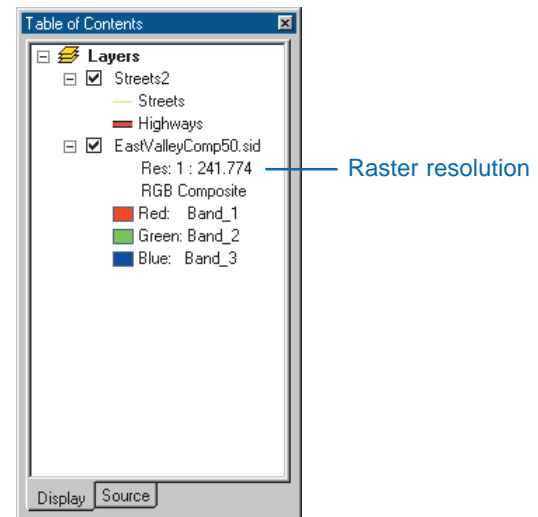
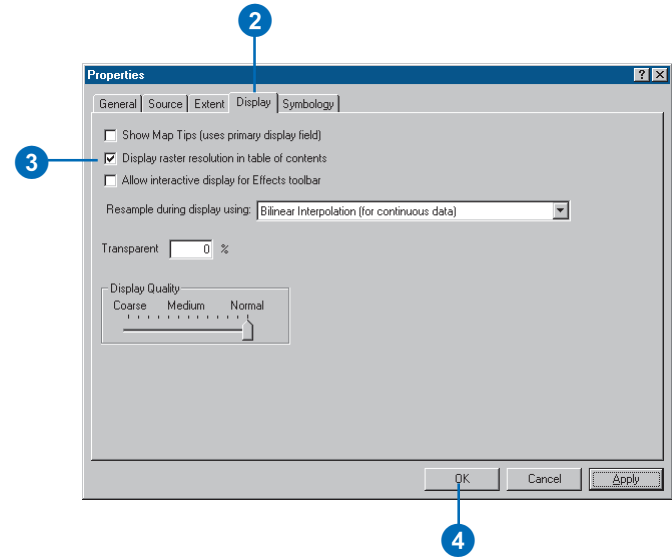
## Tip

### Drawing a raster transparently

Use the *Effects* toolbar to draw raster layers transparently over other layers on your map.

### Displaying the raster resolution in the table of contents

1. In the table of contents, right-click the layer and click Properties.
2. Click the Display tab.
3. Check Display raster resolution in table of contents.
4. Click OK.



## Ways to improve raster display

ArcMap provides additional tools to enhance the display of a raster. For instance, you can change the brightness and contrast of your raster and display the raster transparently over other layers.

If your raster represents continuous data, you can also apply a contrast stretch to it. A stretch increases the visual contrast of the raster. You might apply a stretch when your raster appears dark or has little contrast. Different stretches will produce different results in the raster display. You can experiment to find the best one for a particular raster.

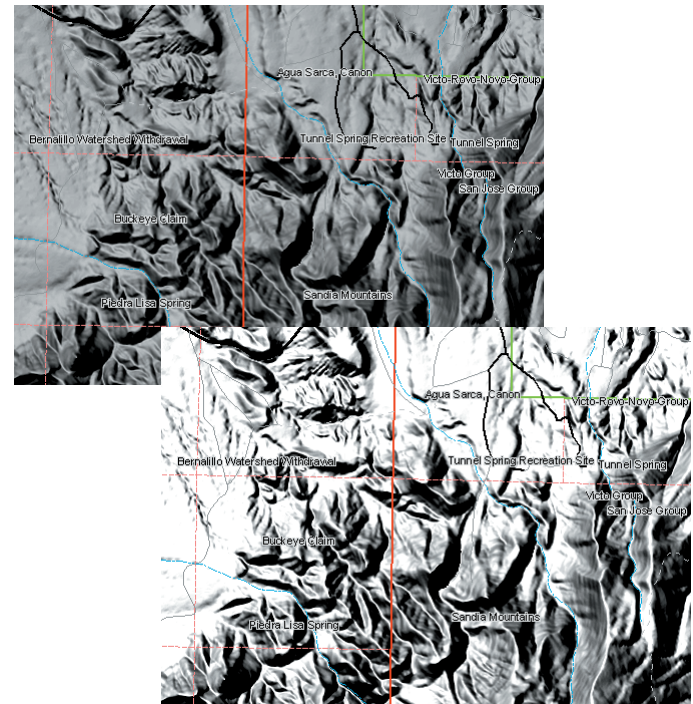
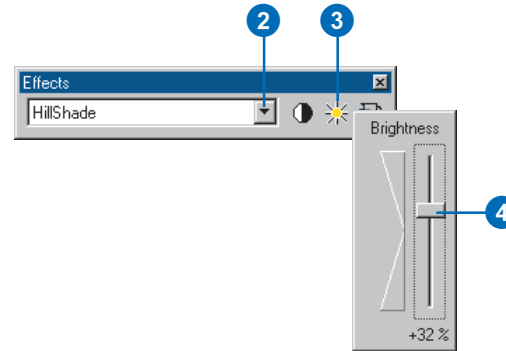
### Tip

#### See the results of the Effects toolbar immediately

When you adjust the brightness, contrast, and transparency of your raster, you can immediately see the results as you drag the slider bar. To enable this feature, right-click the raster layer in the table of contents and click Properties. Click the Display tab and check the option to Allow interactive display for Effects toolbar.

## Improving the brightness or contrast of your raster layer

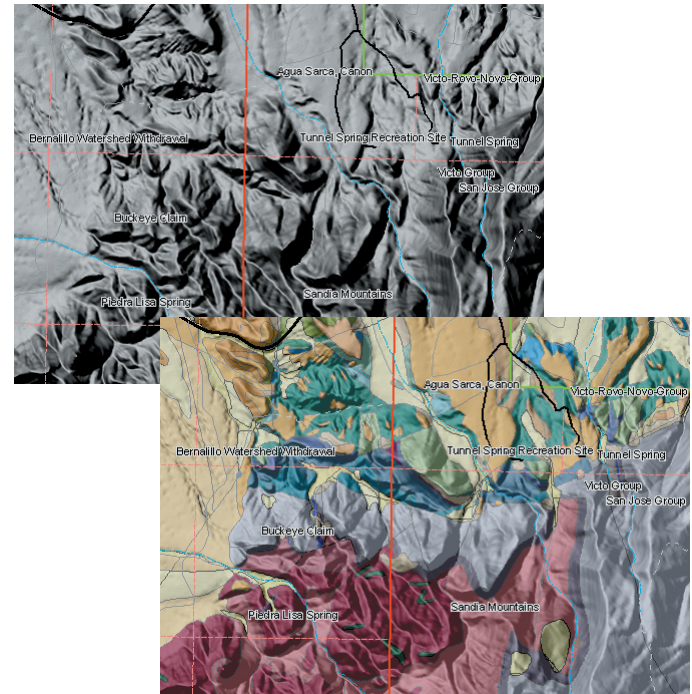
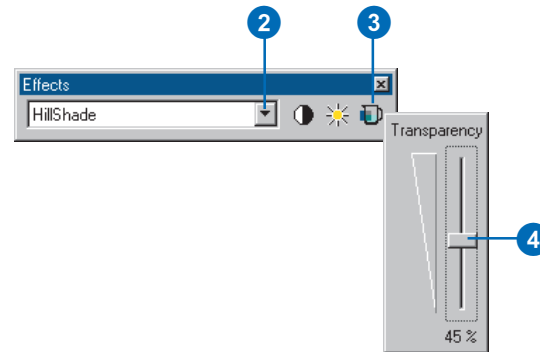
1. Click the View menu, point to Toolbars, and click Effects.
2. Click the dropdown arrow and click the raster layer you want to change the brightness or contrast of.
3. Click the brightness or contrast button.
4. Drag the slider bar to increase or decrease the brightness or contrast.



Before (top) and after (bottom) adjusting the contrast and brightness of the raster.

## Drawing a raster layer transparently

1. Click the View menu, point to Toolbars, and click Effects.
2. Click the dropdown arrow and click the raster layer you want to draw transparently.
3. Click the Adjust Transparency button.
4. Drag the slider bar to adjust the transparency.



*Without transparency (top), the hillshade obscures the underlying land use layer. With transparency (bottom), the underlying symbology appears through the hillshade, yielding a three-dimensional effect.*

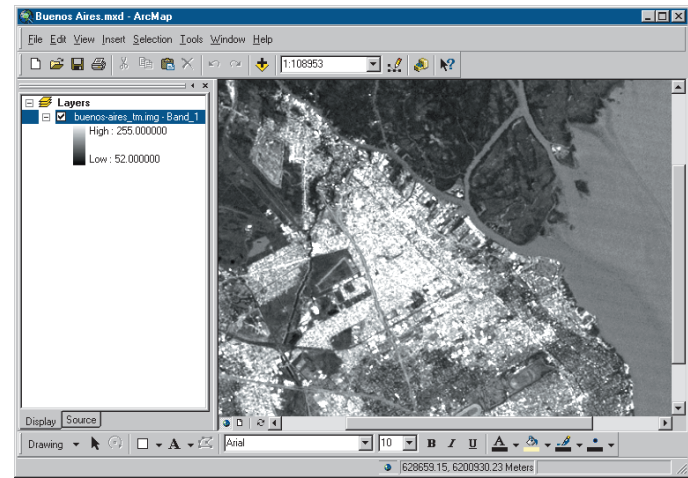
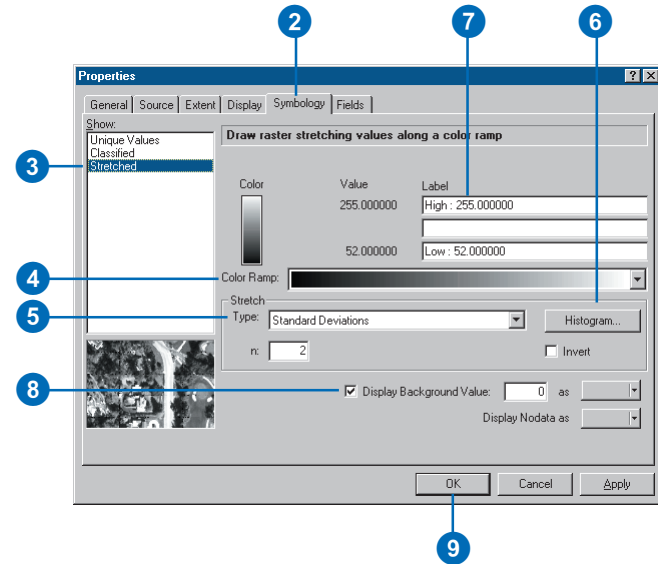
## Tip

### Displaying the attributes of a cell

Use the Identify tool on the Tools toolbar and point at the cell you're interested in. The attribute information, including the cell value, will display.

## Stretching a raster to improve the visual contrast

1. In the table of contents, right-click the raster layer that you want to increase the visual contrast of and click Properties.
2. Click the Symbology tab.
3. Click Stretched.
4. Click the Color Ramp dropdown arrow and click a color ramp.
5. Click the Stretch Type dropdown arrow and click the stretch you want to apply.
6. Optionally, click Histogram to modify the stretch settings.
7. Type in labels that describe the attributes.
8. If the raster contains a background or border around the data that you want to hide, check Display Background Value and set the color to No Color.
9. Click OK.



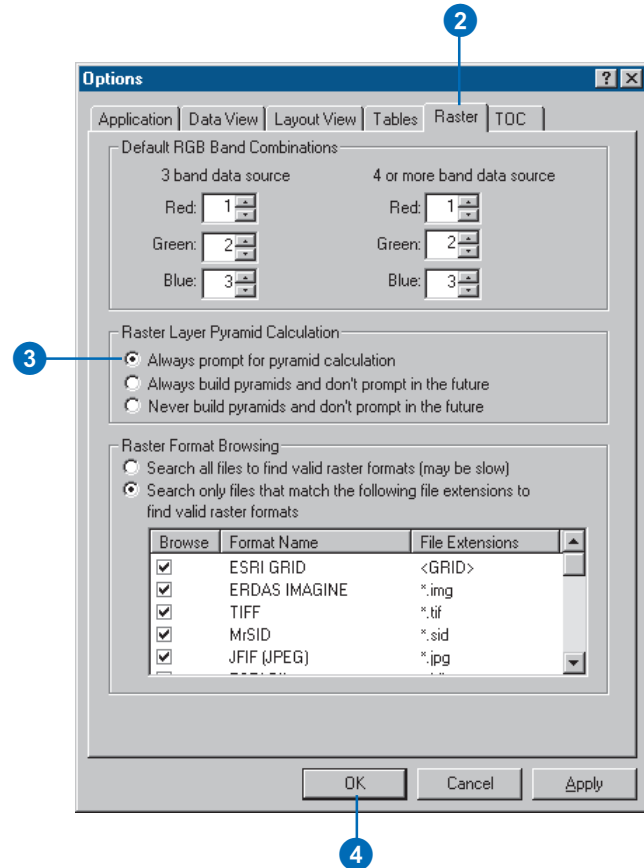
## Faster drawing with pyramids

You can reduce the time it takes to display a large raster dataset by creating pyramids. *Pyramids* are reduced resolution layers that record the original data in decreasing levels of resolution. ArcMap uses the coarsest level of resolution to quickly draw the entire dataset. As you zoom in, ArcMap displays layers with finer resolution. Performance is maintained because you're drawing successively smaller areas. Without pyramids, ArcMap queries the entire raster dataset to determine the subset of cells that need to be displayed.

When you add a raster without pyramids to a map, ArcMap prompts you to create them. The pyramid file created is a Reduced Resolution Dataset (RRD) file, with the same filename as the dataset. For uncompressed rasters, the minimum RRD file size is approximately 8 percent of the size of the original raster dataset. In certain situations, however, the RRD file can be larger than the original file, depending on the compression technique used in the original raster file.

## Changing the default setting for building pyramids

1. Click the Tools menu and click Options.
2. Click the Raster tab.
3. Click the choice that describes when you want to create pyramid layers.
4. Click OK.



## About georeferencing

Raster data is commonly obtained by scanning maps or collecting aerial photographs and satellite images. Scanned maps don't usually contain information as to where the area represented on the map fits on the surface of the earth; the locational information delivered with aerial photos and satellite imagery is often inadequate to perform analysis or display in proper alignment with other data. Thus, in order to use these types of raster data in conjunction with your other spatial data, you often need to align—or georeference—it to a map coordinate system.

When you *georeference* your raster, you define how the data is situated in map coordinates. This process includes assigning a coordinate system that associates the data with a specific location on the earth. Georeferencing raster data allows it to be viewed, queried, and analyzed with other geographic data.

### How to align the raster

Generally, you'll align your raster to existing spatial data, such as a coverage, that resides in the desired map coordinate system. This assumes that there are features in your spatial data (target data) that are also visible in the raster—for example, streets, building footprints, and streams. The basic procedure for georeferencing is to move the raster into the same space as the target data by identifying a series of *ground control points*—of known x,y coordinates—that link locations on the raster with locations in the target data in map coordinates. A combination of one control point on the raster and the corresponding control point on the target data is called a *link*.

The number of links you need to create depends on the method you plan to use to transform the raster to map coordinates. However, adding more links will not necessarily yield a better registration. If possible, you should spread the links out over the entire raster rather than concentrating them in one area. Typically,

having at least one link near each corner of the raster and a few throughout the interior produces the best results. In general, the greater the overlap between the raster and target data, the better the alignment results because you'll have more widely spaced points with which to georeference the raster. For example, if your target data only occupies one quarter of the area of your raster, the points you could use to align the raster would be confined to that area of overlap. You can only assume that areas outside the overlap area are properly aligned.

### Transforming the raster

When you've created enough links, you can transform—or *warp*—the raster to map coordinates. Warping uses a mathematical transformation to determine the correct map coordinate location for each cell in the raster.

Use a first order—or affine—transformation to shift, scale, and rotate your raster. Straight lines on the raster are mapped onto straight lines in the warped raster. Thus squares and rectangles on the raster are commonly changed into parallelograms of arbitrary scaling and angle orientation.

A first-order transformation will probably handle most of your georeferencing requirements. With the minimum of three links, the mathematical equation used with a first-order transformation can exactly map each raster point to the target location. Any more than three links introduces errors, or residuals, that are distributed throughout all the links. In practice, add more than three links. Given only three, if one link is positionally wrong, it has a much greater impact on the transformation. Thus, even though the mathematical transformation error may increase as you create more links, the overall accuracy of the transformation will increase as well.

The higher the transformation order, the more complex the distortion that can be corrected. However, in practice, transformations higher than third order are rarely needed. Higher-order transformations require more links and thus will involve progressively more processing time. In general, if your raster needs to be stretched, scaled, and rotated, use a first-order transformation. If, however, the raster must be bent or curved, use a second- or third-order transformation.

### Interpreting the root mean square error

The degree to which the transformation can accurately map all control points can be measured mathematically by comparing the actual location of the map coordinate to the transformed position in the raster. The distance between these two points is known as the residual error. The total error is computed by taking the root mean square (RMS) sum of all the residuals to compute the RMS error. This value describes how consistent the transformation is between the different control points. While the RMS error is a good assessment of the accuracy of the transformation, don't confuse a low RMS error with an accurate registration. The transformation may still contain significant errors, for example, due to a poorly entered control point.

### What is resampling?

While you might think each cell in a raster is transformed to its new map coordinate location, in reality the process works in reverse. During georeferencing, a matrix of “empty” cells is computed in map coordinates. Then each cell is given a value based on a process called *resampling*.

The three most common resampling techniques are nearest neighbor assignment, bilinear interpolation, and cubic convolution. These techniques assign a value to each empty cell by examining the cells in the untransformed raster. Nearest

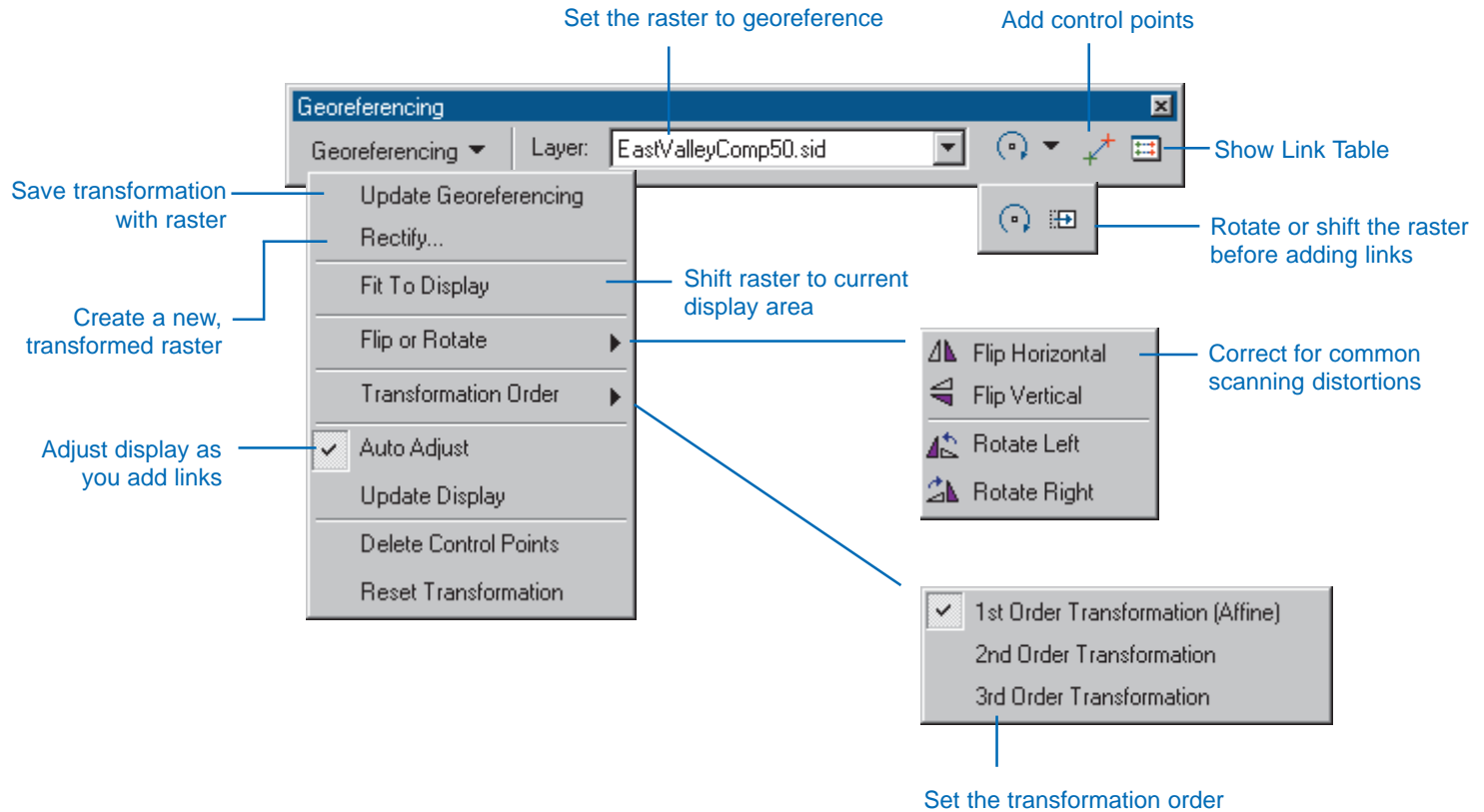
neighbor assignment takes the value from the cell closest to the transformed cell as the new value. It's the fastest resampling technique and is appropriate for categorical, or thematic, data. Bilinear interpolation and cubic convolution techniques combine a greater number of nearby cells (4 and 16, respectively) to compute the value for the transformed cell. These two techniques use a weighted averaging method to compute the output transformed cell value and thus are only appropriate for continuous data such as elevation, slope, and other continuous surfaces.

### Should you rectify your raster?

You can permanently transform your raster after georeferencing it by using the Rectify command on the Georeferencing toolbar. Rectify creates a new raster that is georeferenced to map coordinates. You can save this in ESRI GRID, TIFF, or ERDAS® IMAGINE® format.

ArcMap doesn't require you to rectify your raster to display it with other spatial data. You might choose to rectify your raster if you plan to perform analysis with it or want to use it with another software package that doesn't recognize the external georeferencing information created by ArcMap and requires the raster to be in map coordinates.

# The Georeferencing toolbar





## Georeferencing a raster

The general steps for georeferencing a raster are:

1. Add to your map the raster and the layers (target data) you want to align it to.
2. Add control points that link known raster positions to known target data positions in map coordinates.
3. When you're satisfied with the registration, save the georeferencing information with the raster.

For most rasters, the georeferencing information is stored in a separate file with the same name as the raster but with an .aux file extension. You can permanently transform the raster by using the Rectify command on the Georeferencing toolbar.

The coordinate system assigned to the raster is the same as the coordinate system defined on the data frame the raster is part of.

### Tip

#### Displaying the Georeferencing toolbar

Right-click the Tools menu, point to Toolbars, and click Georeferencing.

## Georeferencing a raster

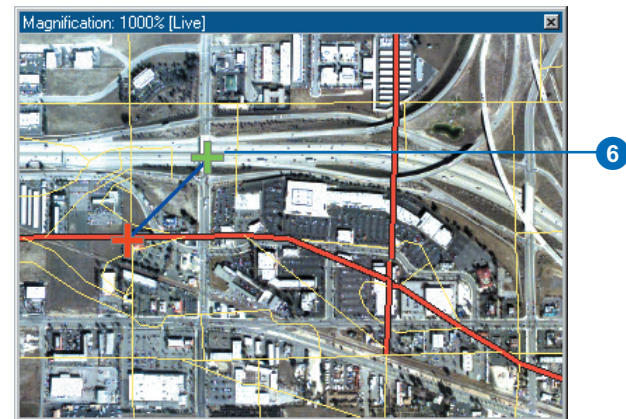
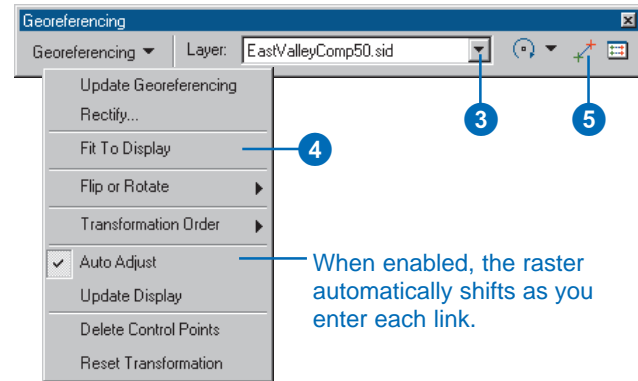
1. Add the layers residing in map coordinates (target data) and the raster you want to georeference.
2. In the table of contents, right-click a target layer and click Zoom to Layer.
3. From the Georeferencing toolbar, click the Layer dropdown arrow and click the raster layer you want to georeference.
4. Click Georeferencing and click Fit To Display.

This will display the raster in the same area as the target layers. You can also use the Shift and Rotate tools to move the raster as needed.

5. Click the Control Points tool to add control points.
6. To add a link, click the mouse pointer over a known location on the raster, then over a known location on the target data.

You may find it useful to use a Magnification window to add your links in.

7. Add enough links for the transformation order. You need a minimum of three links for a first-order transformation, six links for a second order, and 10 links for a third order. ►



To create a link, click a control point on the raster, then click the corresponding control point on the target data.

## Tip

### Deleting a link

You can delete an unwanted link from the Link Table dialog box.

## Tip

### Deleting a link while creating it

Press the *Esc* key to remove a link while you're in the middle of creating it.

## Tip

### Permanently transform the raster

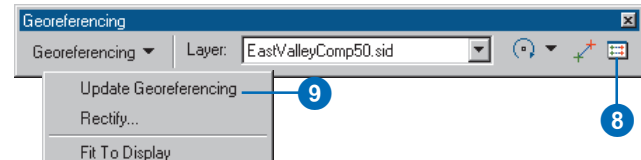
You can permanently transform your raster after georeferencing by using the *Rectify* command. Click *Georeferencing* and click *Rectify*. This creates a new raster dataset in *GRID*, *TIFF*, or *ERDAS IMAGINE* format.

- Click *View Link Table* to evaluate the transformation.

You can examine the residual error for each link and the RMS error. If you're satisfied with the registration, you can stop entering links.

- Click *Georeferencing* and click *Update Georeferencing* to save the transformation information with the raster.

This creates a new file with the same name as the raster but with an *.aux* file extension.

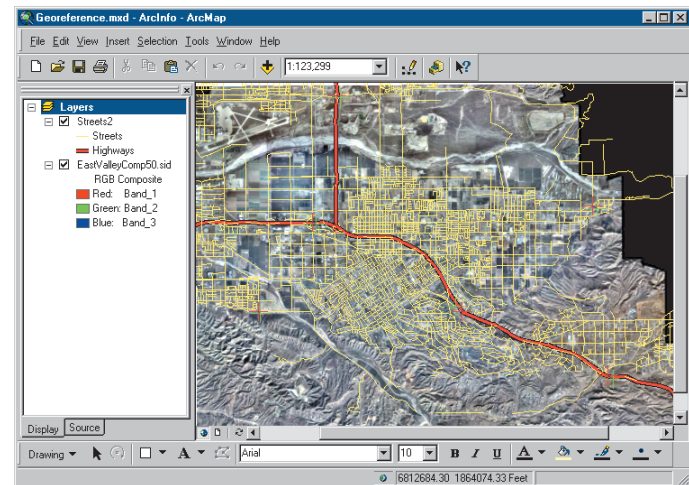


Link	X Source	Y Source	X Map	Y Map	Residual
1	480735.946309	3763953.815321	6801487.783567	1847599.451469	415.848114
2	481950.346309	3774140.441736	6804388.899237	1862577.304462	451.380286
3	485747.893479	3768549.196453	6819231.816618	1837007.005883	984.175752
4	491382.734248	3763870.770517	6836571.042831	1829383.143774	717.193074
5	478732.767706	3766331.229975	6795044.608068	1836973.271980	293.115182
6	490829.915301	3770049.799512	6834681.234068	1849507.103691	644.101369

Auto Adjust    Transformation: 1st Order    Total RMS Error: 1536.029622

Load...    Save...    OK    Cancel

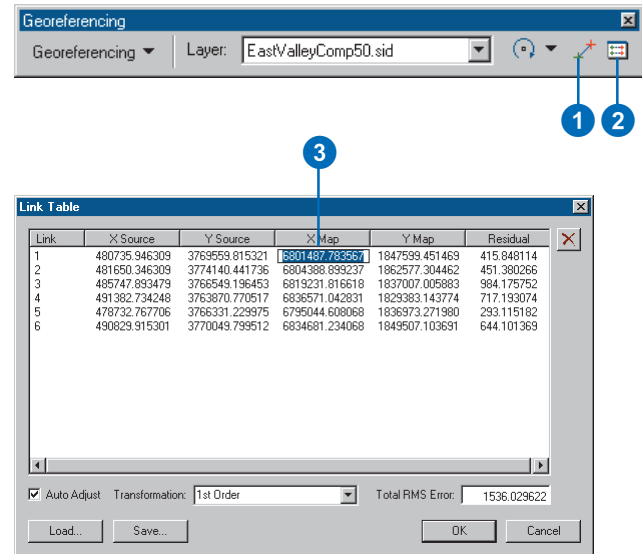
Evaluate the links.



After updating georeferencing information, the raster will align to other spatial data when added to a map.

## Entering explicit x,y map coordinates

1. Click the Control Points tool and add links.
2. Click View Link Table on the Georeferencing toolbar.
3. Click a map coordinate and type in a new value.





# Geocoding addresses

## IN THIS CHAPTER

- **Managing geocoding services in ArcMap**
- **Controlling the geocoding process**
- **Finding an address**
- **Geocoding a table of addresses**
- **Rematching a geocoded feature class**

A feature is an object that has geometry. In most cases, this geometry is captured by digitizing or scanning paper maps. In many cases, however, geographic data exists that indirectly captures geometry by describing locations such as street addresses, city names, or even telephone numbers. While humans understand what these descriptions mean and how they relate to locations on the earth's surface, computers do not. In order to display these locations on a map and perform analyses with them, a computer must be given geometric representations (such as point features) of these locations.

*Geocoding* (also commonly known as address matching) is the process of creating geometric representations for descriptions of locations. A *geocoding service* defines a process for converting alphanumeric descriptions of locations into geometric shapes.

You can use geocoding services in ArcMap to find individual addresses and to geocode tables of addresses. You can also review and rematch the feature classes and shapefiles that you create by geocoding tables of addresses.

In order to geocode in ArcMap, you must first define geocoding services. For information on creating geocoding services, see *Using ArcCatalog*.

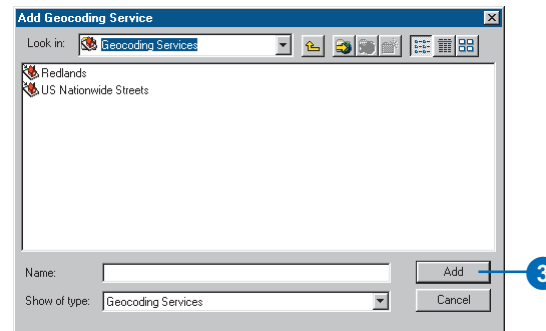
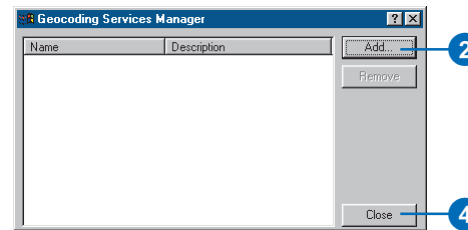
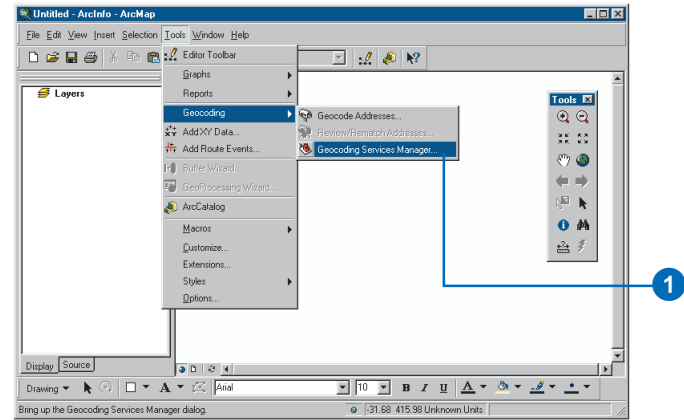
# Managing geocoding services in ArcMap

In ArcMap, you can find addresses or geocode tables of addresses using geocoding services. Your ArcMap document can contain any number of geocoding services. You can use the Geocoding Services Manager to manage the set of geocoding services contained in an ArcMap document.

For information on creating geocoding services, see *Using ArcCatalog*.

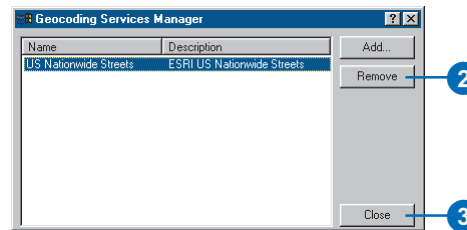
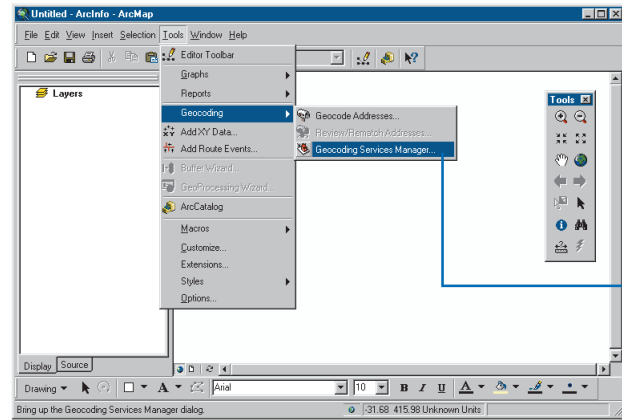
## Adding a geocoding service to an ArcMap document

1. Click the Tools menu, point to Geocoding, then click Geocoding Services Manager.
2. Click Add.
3. Browse for the geocoding service that you want to add to the ArcMap document and click Add.
4. Click Close.



## Removing a geocoding service from an ArcMap document

1. Click the Tools menu, point to Geocoding, then click Geocoding Services Manager.
2. Click the geocoding service that you want to remove from the ArcMap document, then click Remove.
3. Click Close.



# Controlling the geocoding process

## The geocoding process

Once you have added a geocoding service to an ArcMap document, you can begin geocoding addresses with it. However, understanding how a geocoding service matches addresses and how modifying a geocoding service's settings affects this process can help you improve both the performance and accuracy of your geocoding.

Geocoding services use a specific set of steps to find a match for an address. First, the geocoding service standardizes the address. Second, the geocoding service searches the *geocoding reference data* to find potential *candidates*. Next, each potential candidate is assigned a score based on how closely it matches the address. Finally, the address is matched to the candidate with the best score.

When a geocoding service standardizes an address, it dissects the address into its address components. For example, the address “4 Dundas St. E.” has four address components: the street number, “4”; the street name, “Dundas”; the street type, “St.”; and the street direction, “E.” Each style of geocoding service standardizes an address into a different set of address components.



*A geocoding service standardizes an address into a number of address components.*

If your geocoding service uses a place name alias table, it searches this table for entries that match the address you are trying to geocode to determine if the address is actually a place

name alias. If one is found, it substitutes the address in the place name alias table for the place name that you are trying to locate and standardizes this address.

Once it has standardized the address, the geocoding service searches the reference data to find features with address components that are similar to the components of the standardized address. Each style of geocoding service bases this search on a different set of address components. The geocoding service uses its spelling sensitivity setting for some address components, such as street name, to determine how closely the address components of a feature must match the address components of the address you are geocoding. If the geocoding service uses an alternate street name table, then it also searches this table to find potential candidates.

Street Name	Street Type	Street Direction
Dundas	St	E
Dundas	St	W
Centre	St	
Richmond	Blvd	E
Dundalk	Ct	
Dunrobin	St	

*The geocoding service searches the reference data for features with address components that are similar to the components of the standardized address.*

Once the geocoding service has generated a set of potential candidates, it scores each potential candidate in order to determine how closely each potential candidate matches the address that you are geocoding. Each potential candidate is assigned a score from 0 to 100. Each address component is used to generate this score. The score for each potential candidate will be lower if address components are misspelled (for example, the street name is misspelled), incorrect (for example, the street number of the address does not fall within the address range for the candidate), or missing (for example, the street direction is specified in the



address but not in the potential candidate). Once each potential candidate is scored, the geocoding service generates a set of match candidates. The geocoding service determines which potential candidates are match candidates using its minimum candidate score setting.

From Address	To Address	Street Name	Street Type	Street Direction	Match Score
1	99	Dundas	St	E	100
1	99	Dundas	St	W	75
1	49	Dundalk	Ct		10
1	99	Dunrobin	St		25

*The geocoding service scores each potential candidate using all of the address components. A set of match candidates is generated based on the geocoding service's minimum candidate score setting.*

Finally, the geocoding service finds the match candidates with the highest match score. If the score of the match candidate with the best match score exceeds the geocoding service's minimum match score setting, then the geocoding service matches the address to that match candidate.

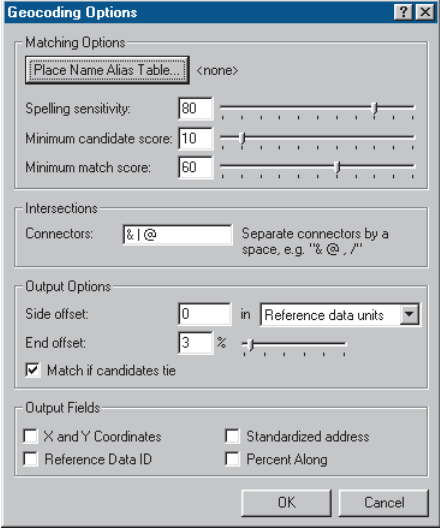
### Geocoding service settings

Geocoding services have a number of settings that allow you to control the geocoding process. These settings control how a geocoding service reads a table of addresses that you want to geocode, how it matches addresses to features in the reference data, and what it writes to the geocoded output. Modifying a geocoding service's settings will impact how well the geocoding service will be able to match addresses to the reference data, as well as what information the geocoding result will contain.

#### Matching options

##### Spelling sensitivity

The spelling sensitivity setting controls how much variation the geocoding service will allow when it searches for likely candi-



*The Geocoding Options dialog box allows you to modify the settings of a geocoding service.*

dates in the reference data. A low value for spelling sensitivity will allow “Mane”, “Maine”, and “Man” to be treated as match candidates for “Main”. A higher value will restrict candidates to exact matches. The spelling sensitivity does not affect the match score of each candidate; it only controls how many candidates the geocoding service considers. The geocoding service then computes the match score of each candidate and ranks the candidates by score.

The spelling sensitivity setting for a geocoding service is a value between 0 and 100. By default, the spelling sensitivity is 80, which does not allow for much variation in spelling. If you are sure that your addresses are spelled correctly, you could set a higher spelling sensitivity. If you think that your addresses may contain spelling errors, then you should use a lower setting. The

geocoding process takes longer when you use a lower setting because the geocoding service has to compute scores for more candidates.

### **Minimum candidate score**

When a geocoding service searches for likely candidates in the reference data, it uses this threshold to determine whether a potential candidate should be considered. Candidates that yield a match score lower than this threshold will not be considered.

The minimum candidate score for a geocoding service is a value between 0 and 100. By default, this is set to 30. If the geocoding service is unable to come up with any likely candidates for an address that you want to geocode, you could lower this setting so that candidates with very low scores are considered.

### **Minimum match score**

The minimum match score setting lets you control how well addresses have to match their most likely candidate in the reference data in order to be considered matched. A perfect match yields a score of 100. A match score between 75 and 100 can generally be considered a good match. An address below the minimum match score is considered to have no match.

The minimum match score for a geocoding service is a value between 0 and 100. By default, this setting is 60. If your application demands that addresses be located with a high level of confidence, you should set a higher minimum match score. If you want to maximize the number of addresses that can be matched and don't mind if some addresses are potentially matched incorrectly, you can use a lower setting.

### **Intersection connectors**

Geocoding services that are based on the US One Range, US Streets, and StreetMap™ geocoding service styles can geocode street intersections in addition to street addresses. In ArcGIS,

intersections are designated as two streets delimited by an intersection connector string. Some examples of intersection descriptions are “Hollywood Blvd. & Vine St.” and “Yonge and Bloor”.

The intersection connectors setting lets you specify all the strings that the geocoding service recognizes as intersection connectors. By default, “&”, “|”, and “@” are recognized as intersection connectors.

### **Output options**

#### **Side offset**

Geocoding services based on the US Streets or StreetMap geocoding service styles can determine on which side of a street an address is located. The reference data that you use for each of these styles of geocoding service contains address range information for each side of the street. For cartographic purposes, you can specify a side offset for geocoded features when using these styles of geocoding services. When you specify a side offset, the geocoding service locates geocoded features at the specified distance from the street centerline on the correct side of the street.

#### **End offset**

Geocoding services based on the US One Range, US Streets, or StreetMap geocoding service styles can interpolate a position along reference features for a geocoded address. In order to prevent features that are located at the end of a reference feature from falling on top of other features (for example, a cross street), the geocoding service can apply a “squeeze factor”, or end offset, to the location of a geocoded address. The end offset setting of a geocoding service is expressed as a percentage of the length of the reference feature, between 0 percent and 50 percent. An end offset setting of 0 percent will not offset features from the end of the reference feature. An end offset of 50 percent will locate all

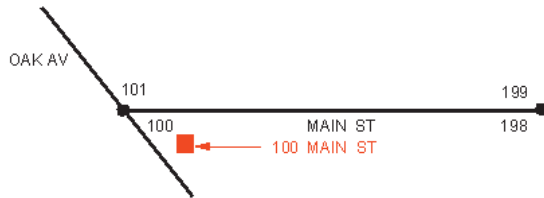
features at the middle of the reference feature. By default, the end offset setting for a geocoding service is 3 percent.



*The address, 100 MAIN ST, has been offset from the street feature by the offset distance of 25 feet. This address falls at the end of the street feature and is therefore in-line with the end of the street feature.*



*When streets intersect at odd angles, specifying an offset distance can have the undesirable effect of placing the address so it appears that the address does not belong to MAIN ST, but rather to OAK AV.*



*An end offset can be specified that adjusts the location of the address toward the center of the street feature. Using an end offset will often rectify the condition shown in the previous diagram. In this example, a squeeze factor of 10 percent was used to move the address toward the center of the street feature by a distance equal to 10 percent of the length of the street feature.*

## Match if candidates tie

If a geocoding service finds two or more reference features that have the same best match score, you can specify whether or not to match an address arbitrarily to one of these features. Use this

setting to specify whether to arbitrarily match these addresses or to leave them unmatched. In either case, you can review addresses with tied candidates during the interactive review process, whether or not they are matched.

## Output fields

### x,y coordinates

Use this setting to specify whether or not to create attributes in geocoded feature classes that contain the x,y coordinates of the geocoded features. If you use this setting, then a geocoding service will create two attributes in the output features classes that you create with it, one each for the x,y coordinates of the geocoded features.

### Standardized addresses

Use this setting to specify whether or not to create an attribute in a geocoded feature class that contains the standardized address. The contents of this field for each address are the address components used by the geocoding service, separated by the pipe (“|”) character. This attribute is useful for determining how the geocoding service standardized the addresses.

### Reference data ID

Use this setting to specify whether or not to create an attribute in a geocoded feature class that contains the ID of the reference feature to which an address was matched. If an address is not matched, then the geocoding service writes a value of -1 in this attribute for the address.

### Percent along

Geocoding services based on the US One Range, US Streets, or StreetMap geocoding services styles can interpolate a position along reference features for a geocoded address. Use this setting to specify whether or not to create an attribute in a geocoded

feature class that contains the position along the reference feature to which the address was matched. The value of this attribute is a number between 0 and 100, with 0 indicating the starting node of the reference feature and 100 indicating the ending node of the reference feature. If an address is not matched, then the geocoding service does not write a value in this attribute for the address.

## Finding an address

You can use geocoding services to find addresses in ArcMap. In order to use a geocoding service in ArcMap, it must be loaded into the ArcMap document. You don't need to load the reference data for a geocoding service into the ArcMap document, but doing so will help you choose an appropriate candidate for an address.

In ArcMap, you can modify the geocoding settings that the geocoding service uses to find addresses. Modifying the geocoding settings in ArcMap does not change the geocoding service that you are using. Only the settings that are used to find addresses in your ArcMap session are modified.

1. In ArcMap, click the Find tool.
2. Click the Addresses tab.
3. Choose the geocoding service that you want to use to find the address from the list.

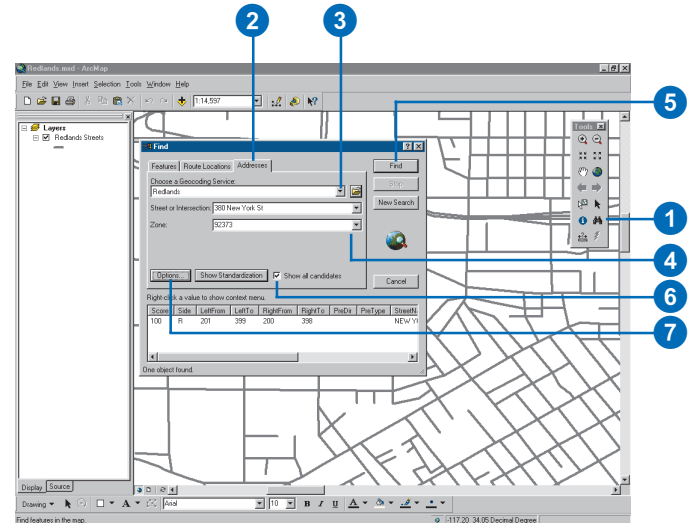
If the geocoding service that you want to use does not appear in the list, you need to add it to the ArcMap document. Click the Browse button to browse for geocoding services to add to the document.

4. Type the address components in the text boxes.
5. Click Find.
6. Click Show all candidates to see all of the candidates that the geocoding service generated.

By default, only the candidates that meet or exceed the minimum match score are shown.

7. If you want to modify the geocoding settings that the geocoding service uses to find the address, click Options.

Otherwise, skip to step 9. ►

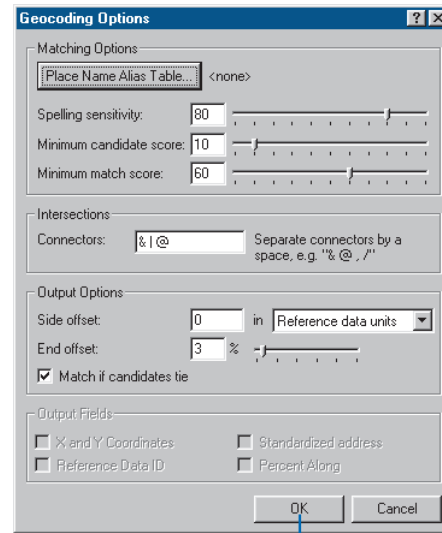


8. Modify the geocoding service's settings and click OK.
9. If you want to change how the geocoding service standardized the address, click Show Standardization.

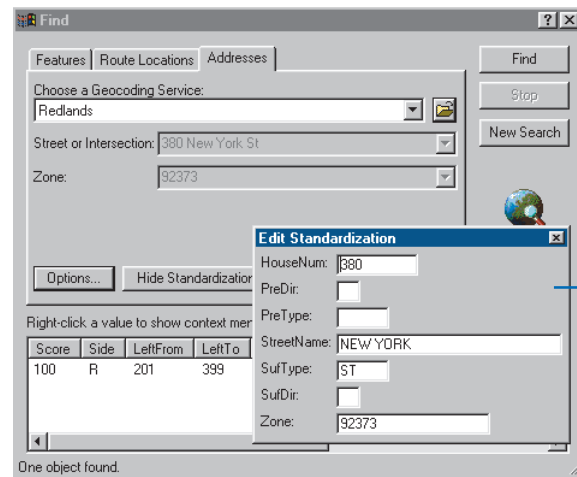
Otherwise, skip to step 11.

10. Edit the address's standardization by editing the values in the fields in the Edit Standardization dialog box.

When you make edits in the Edit Standardization dialog box, the list of candidates is automatically updated. ►

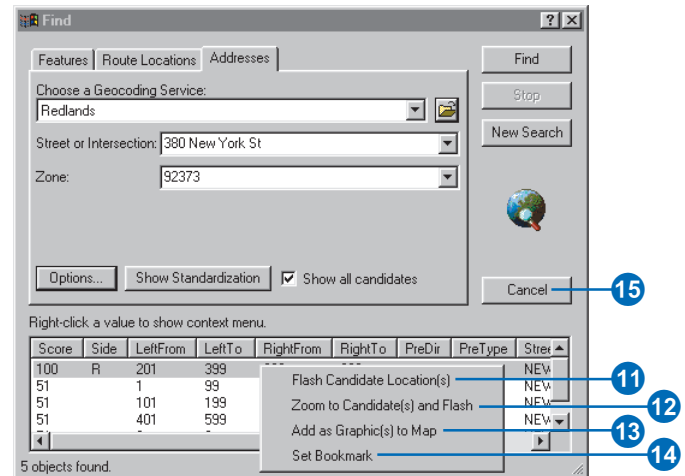


8



10

11. Right-click the candidate and click Flash Candidate Location(s) to flash the location of a candidate.
12. Right-click the candidate and click Zoom to Candidate(s) and Flash to zoom into a candidate.
13. Right-click the candidate and click Add as Graphic(s) to Map to add a graphic to the map at a candidate's location.
14. Right-click the candidate and click Set Bookmark to set a spatial bookmark for a candidate's location.
15. Click Cancel to close the Find dialog box.



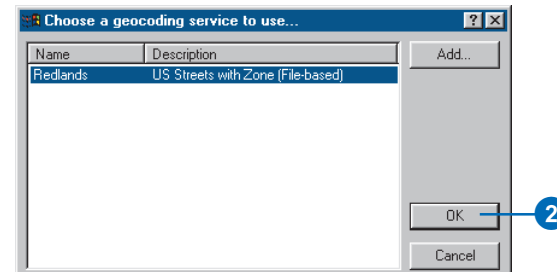
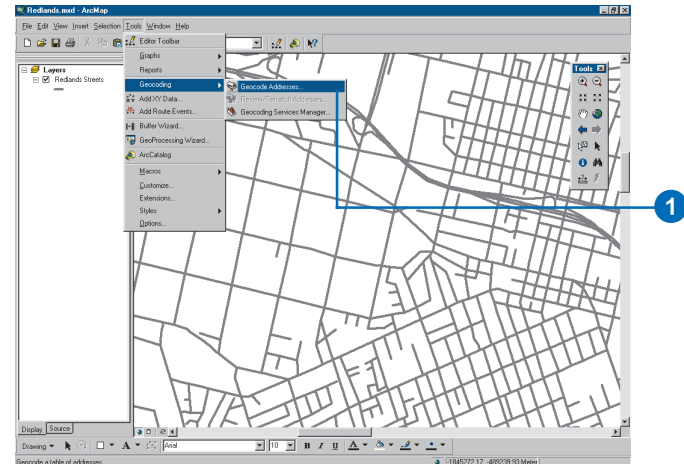
## Geocoding a table of addresses

When you geocode a table of addresses, you use a geocoding service to create point features that represent the locations of the addresses. You can geocode a table of addresses into any spatial format supported by ArcGIS including ArcSDE™ feature classes, personal geodatabase feature classes, and shapefiles. ArcView® GIS users cannot create ArcSDE feature classes.

Before you can geocode a table of addresses, you must create a geocoding service and prepare your table to be geocoded. For information on preparing your address tables for geocoding, see ‘Preparing address data for geocoding’ in the online Help system.

1. Click the Tools menu, point to Geocoding, then click Geocoding Addresses.
2. Click the geocoding service that you want to use to geocode the table of addresses and click OK.

If the geocoding service that you want to use does not appear in the list, click Add to browse for the geocoding service. ►





## Tip

### Geocoding dynamic feature classes related to the address table

*If you want to create a dynamic feature class related to the address table, the address table and geocoded feature class must be in the same geodatabase. This option is not available to ArcView GIS users.*

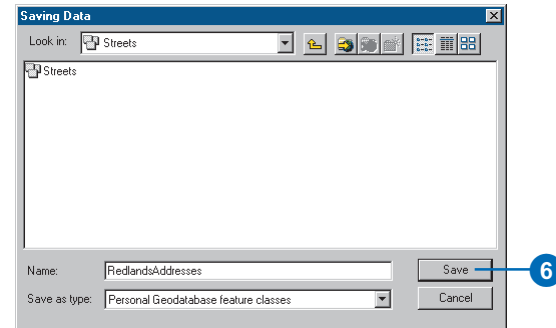
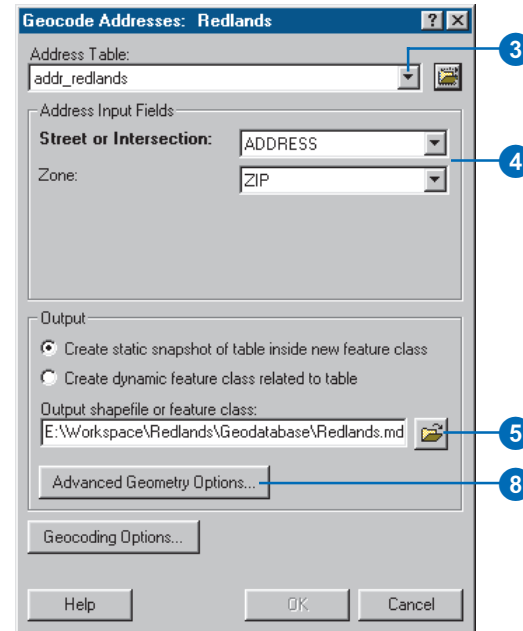
3. Click the dropdown arrow and click the table that you want to geocode.

If the table does not appear in the dropdown list, click the Browse button to browse for the table.

4. Choose the column name from each dropdown list that contains the specified address information.

The names of the required address attributes are shown in bold.

5. Click the Browse button and navigate to the location where you want to create the geocoded feature class.
6. Click Save.
7. Click the option to create a dynamic feature class related to the table to create a geocoded feature class that has a dynamic relationship with the address table.
8. Click Advanced Geometry Options to specify the geometry settings for the geocoded feature class. ▶



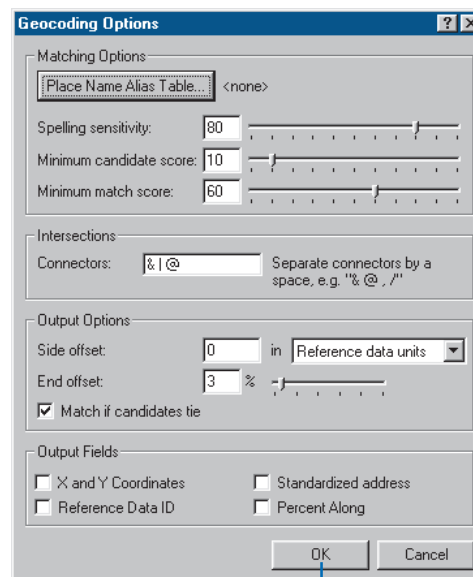
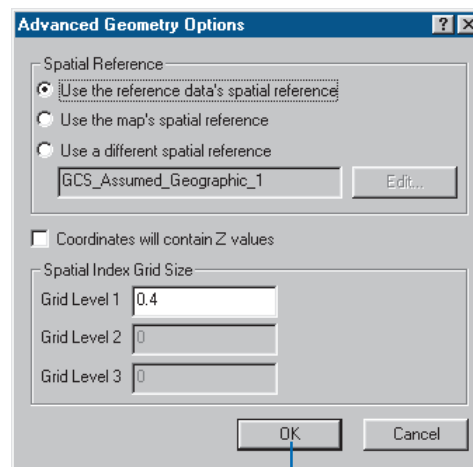
## Tip

### Specifying the geocoding settings

When you are geocoding a table of addresses, modifying the geocoding settings does not change the geocoding service that you are using. Only the settings that are used to geocode this table are modified. These settings are stored with the geocoded feature class. The original geocoding service is not modified.

For more information on modifying a geocoding service's settings, see Using ArcCatalog.

- Specify the geometry settings for the geocoded feature class and click OK.
- Click Geocoding Options to specify the geocoding options that will be used to geocode the table of addresses.
- Specify the geocoding settings that you want to use to geocode the table of addresses and click OK.
- Click OK on the Geocode Addresses dialog box to geocode the table. ►



## Tip

### Attributes in geocoded feature classes

When you geocode a table of addresses, a geocoding service creates some special attributes in the output feature class.

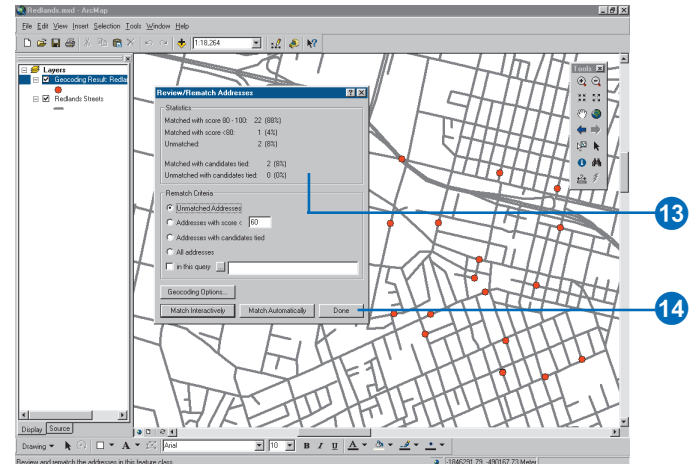
The *Status* attribute indicates whether or not the address was matched. This attribute has values of “M” for matched addresses, “U” for unmatched addresses, and “T” (tied) for addresses for which there were more than one candidate with the best match score.

The *Score* attribute contains the match score of the candidate to which the address was matched.

The *Side* attribute contains the side of the street to which an address was matched, if the geocoding service that was used to match the table contains address information for both sides of the street. This attribute has values of “L” for the left side of the street, “R” for the right side of the street, or nothing if the geocoding service could not determine the side of the street.

13. Review the results of the geocoding process.

14. Click Done.



## Rematching a geocoded feature class

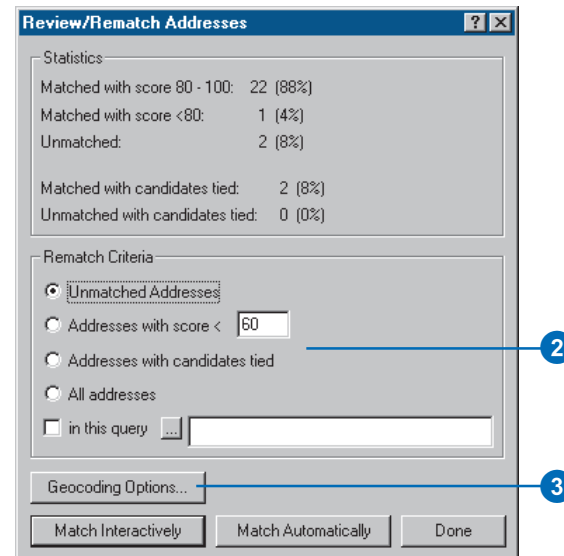
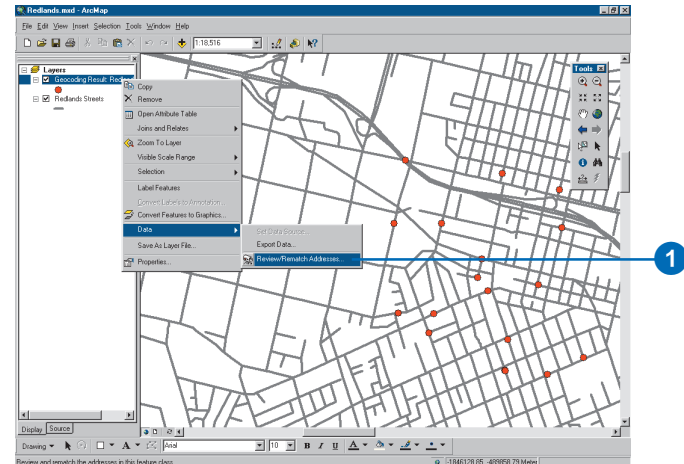
After you have geocoded a table of addresses, you may want to review the results. If you are unhappy with the results, you may want to modify the geocoding service's settings and try to geocode the table of addresses again. This process is known as *rematching*.

There are a number of options for specifying which addresses in a geocoded feature class you want to rematch. You can rematch just the addresses that are unmatched, all of the addresses with a match score less than a certain value, all of the addresses with two or more candidates with the best match score, or all of the addresses. In addition, you can specify a query to use that defines the set of addresses to rematch.

For more information on defining queries, see Chapter 13, 'Querying maps'.

## Rematching a geocoded feature class automatically

1. Right-click the feature class that you want to rematch, click Data, then click Review/Rematch Addresses.
2. Specify the criteria for the addresses that you want to rematch.
3. Click Geocoding Options to modify the geocoding settings that you want to use to rematch the addresses. ►



4. Specify the geocoding settings that you want to use to rematch the geocoded feature class and click OK.
5. Click Match Automatically.
6. Review the results of rematching the specified addresses.
7. Click Done.

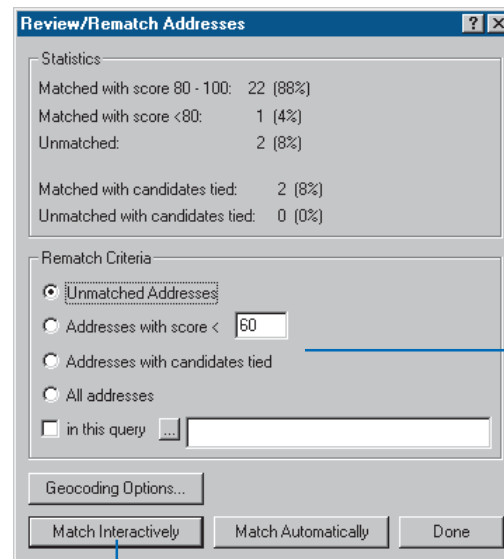
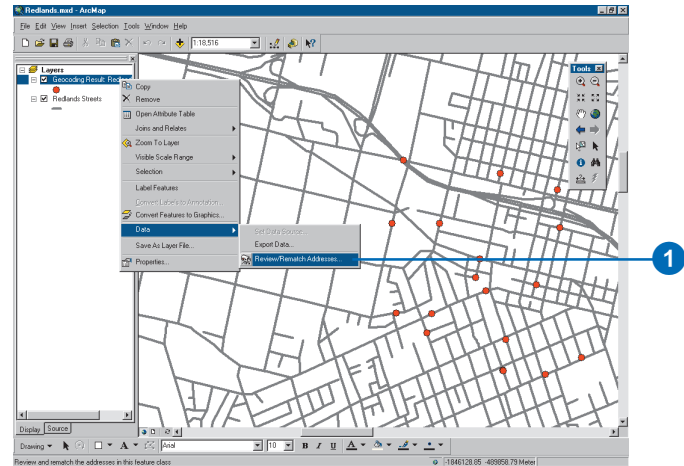
The screenshot shows the 'Geocoding Options' dialog box with the following settings:

- Matching Options:**
  - Place Name Alias Table: <none>
  - Spelling sensitivity: 80
  - Minimum candidate score: 10
  - Minimum match score: 60
- Intersections:**
  - Connectors: & | @
  - Separate connectors by a space, e.g. "% @ . /"
- Output Options:**
  - Side offset: 0 in Reference data units
  - End offset: 3 %
  - Match if candidates tie
- Output Fields:**
  - X and Y Coordinates
  - Standardized address
  - Reference Data ID
  - Percent Along

Buttons: OK, Cancel

## Rematching a geocoded feature class interactively

1. Right-click the feature class that you want to rematch, click Data, then click Review/Rematch Addresses.
2. Specify the criteria for the addresses that you want to rematch.
3. Click Match Interactively. ▶









# Analyzing utility networks

# 16

## IN THIS CHAPTER

- What is a geometric network?
- What can you do with networks in ArcMap?
- Opening a geometric network
- Symbolizing network features
- Editing geometric networks
- Loading the Utility Network Analyst toolbar
- Exploring the Utility Network Analyst toolbar
- Flow direction
- Displaying flow direction
- Setting flow direction
- Tracing on networks
- Tracing operations

The economic foundation of the modern world is its infrastructure—the collection of cables, pipelines, and wires that enables the movement of energy, commodities, and information. This infrastructure can be modeled as networks. ArcGIS provides a complete model for capturing, storing, and analyzing networks.

## What can you do with networks in ArcMap?

ArcMap provides a rich set of tools that perform many common network analysis tasks on geometric networks. Some of the common types of analyses that you can perform on your network using ArcMap are:

- Trouble call analysis: determines the likely cause of a problem based on the location of customers with service problems.
- Isolation traces: determines which switches have to be opened in order to cut power to a part of the network.
- Contaminant tracing: determines whether a particular site is a possible cause of contamination.

Before you can work with geometric networks in ArcMap, you need to build a geometric network. To learn how to build a geometric network using ArcCatalog, see *Building a Geodatabase*.

## Geometric networks

*Networks* consist of two fundamental components: edges and junctions. The edges and junctions in a network are topologically connected to each other. An *edge* is a type of network element that has a length and through which some commodity flows. Electrical transmission lines, pipes, and stream reaches are examples of edges. A *junction* occurs at the intersection of two or more edges and allows the transfer of flow between edges. Fuses, switches, service taps, and the confluence of stream reaches are examples of junctions. Edges connect to each other at junctions; the flow from edges in the network is transferred to other edges through junctions.

In ArcGIS, feature classes can participate together in a network. Feature classes representing transmission lines, switches, fuses, and transformers can all be part of the same network. Because the features have geometry and can be mapped, the network of features is called a *geometric network*. A geometric network contains the connectivity information between edges and junctions and defines rules of behavior such as which classes of edges can connect to a particular class of junction or to which class of junction two classes of edges must connect.

To create a geometric network, you use a wizard to specify which feature classes will participate in the network, or you create an empty network and add feature classes to it later. Once the network is created, it is maintained throughout the life cycle of the database. ArcGIS maintains the connectivity information whenever you edit the participating feature classes, based on the connectivity rules and relationships that you define in the geodatabase.

ArcGIS includes a variety of tools for analyzing networks and a rich set of objects for building custom networks with complex behavior. For more information on modeling networks in ArcGIS, see *Modeling Our World*. To learn how to create geometric networks and define connectivity rules, and for information on defining relationships between feature classes, see *Building a Geodatabase*.

# Opening a geometric network

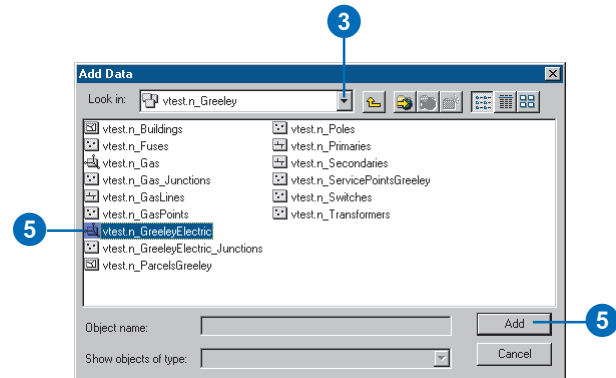
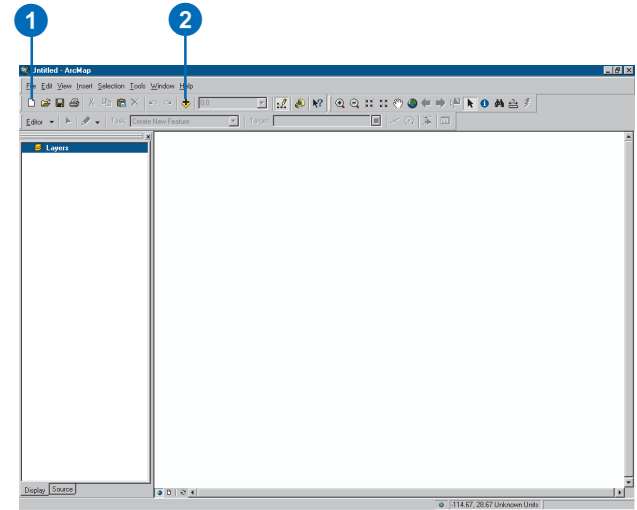
Geometric networks are objects within the geodatabase. Geometric networks are automatically maintained by ArcGIS when their feature classes are edited.

In order to work with a geometric network in ArcMap, you must load a minimum of one feature class that participates in the network. If you want to work with only the feature classes that participate in the network—for example, if you are performing some analysis on the network—then you can load only these feature classes by loading the network object.

If you want to load all of the feature classes in the feature dataset that contains the network—for example, if you want to produce a printed map of the network—you can open the network by loading the feature dataset that contains the network.

1. Open the document to which you want to add the network data or create a new document.
2. Click the Add Data button.
3. Navigate to the feature dataset in the geodatabase that contains the network you want to open.
4. Double-click the feature dataset to view the feature classes and geometric networks that it contains.
5. Click the geometric network and click Add.

Your geometric network is added to ArcMap.



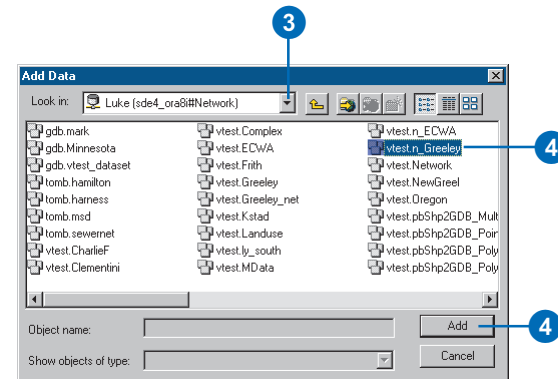
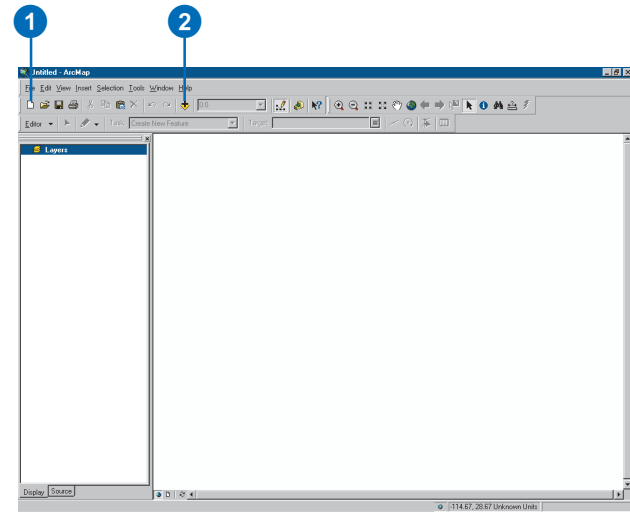
## See Also

For information on creating geometric networks, see 'Geometric networks' in Building a Geodatabase.

## Opening a feature dataset containing a geometric network

1. Open the document to which you want to add the network data or create a new document.
2. Click the Add Data button.
3. Navigate to the feature dataset in the geodatabase that contains the network you want to open.
4. Click the feature dataset and click Add.

The feature dataset containing your geometric network is added to ArcMap.



# Symbolizing network features

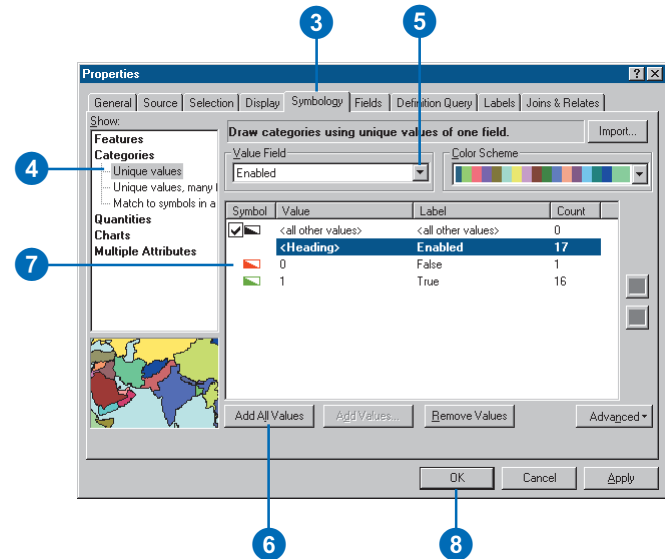
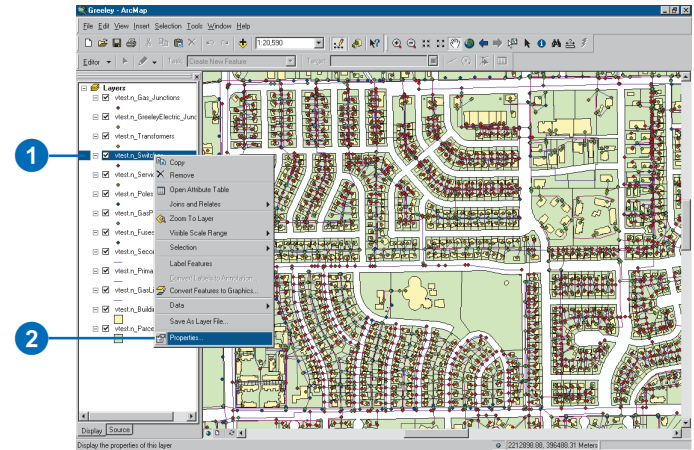
You can use symbology in ArcMap to easily identify enabled or disabled features, sources, or sinks in your network.

All network features can be either enabled or disabled. Enabled features allow flow to pass through them, while disabled features do not. The status of each feature is stored in the Enabled field of the feature class's attribute table. The values in this field are defined by a coded value attribute domain and can only be 0 or 1. Features with a value of 1 are enabled, and those with a value of 0 are disabled. By symbolizing your features using this attribute, you can quickly tell which features are enabled and which are disabled.

A junction feature can act as a source or a sink (or neither). When you build a geometric network, you specify which feature classes contain sources or sinks. Those feature classes have an attribute named AncillaryRole that contains this information. The values in this field are defined by a coded value attribute domain. A value of 1 represents a source, and a value of 2 represents a sink. ►

## Displaying enabled and disabled features in a layer

1. In the table of contents, right-click the feature layer for which you want to display enabled and disabled features.
2. Click Properties.
3. Click the Symbology tab.
4. Click the Categories item in the list and click Unique values in the expanded list of items.
5. Click the Value Field drop-down arrow and click Enabled to use this attribute for the symbolization.
6. Click Add All Values.
7. To change the symbol for a particular value, double-click the symbol.
8. Click OK when you are finished formatting the symbols.



A value of 0 means that the feature is neither a source nor a sink. By symbolizing features using this attribute, you can quickly tell which junctions are sources and sinks.

For more information on attribute domains, see *Building a Geodatabase*.

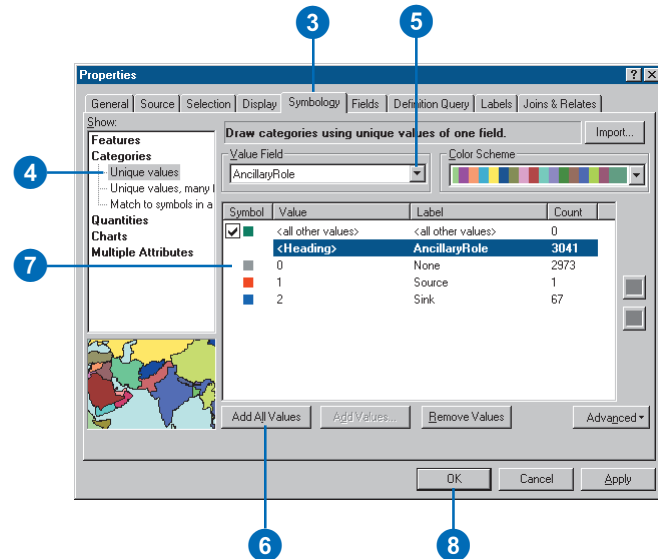
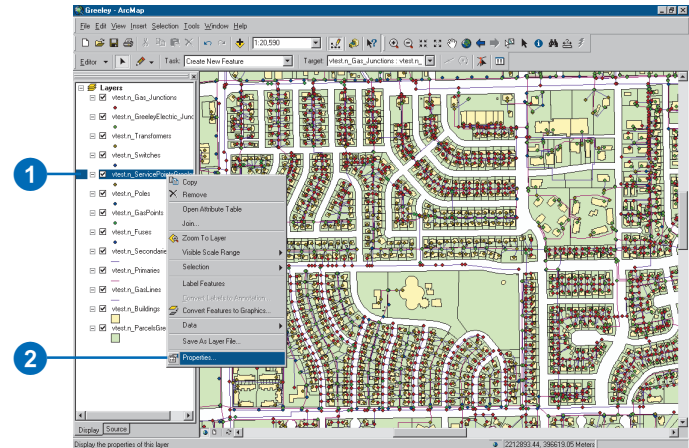
## Tip

### Stopping map redraws

Each change made to the data view or layout view that affects the display of the data (such as docking a toolbar, maximizing the window, or changing symbology) causes the map to be redrawn. When working with large datasets, redrawing the map can take a considerable amount of time. If you are making multiple changes that will affect the view, you can stop the map from being redrawn by pressing the *Esc* key.

## Displaying source and sink features in a layer

1. In the table of contents, right-click the feature layer for which you want to display source and sink features.
2. Click Properties.
3. Click the Symbology tab.
4. Click the Categories item in the list and click Unique values in the expanded list of items.
5. Click the Value Field drop-down arrow and click AncillaryRole to use this attribute for the symbolization.
6. Click Add All Values.
7. To change the symbol for a particular value, double-click the symbol.
8. Click OK when you are finished formatting the symbols.



# Adding network features

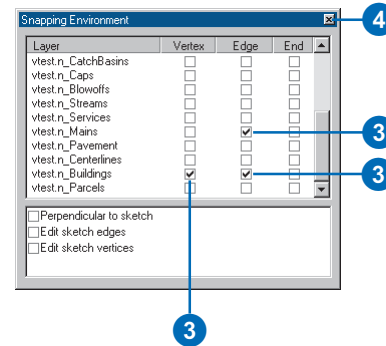
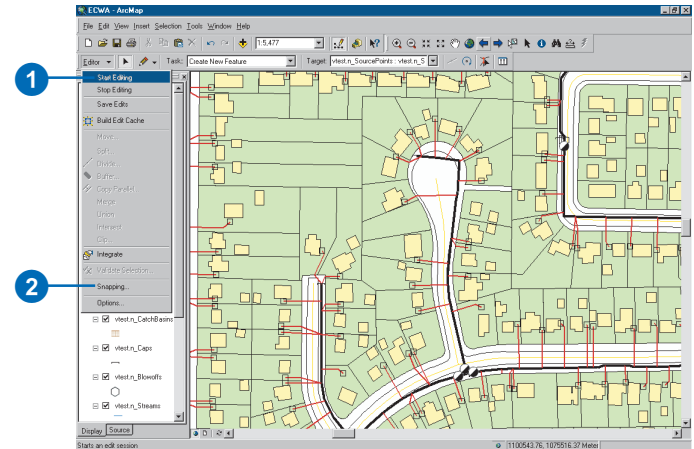
Adding features to a network is the same as adding features to any dataset. However, when features are added to a network, they connect topologically to other features in the network. These connections are automatically maintained inside the geodatabase.

In this example, a new service is added to the network to provide water to a building. The new service connects to a water main on one end and snaps to a building on the other. In order to ensure that the new feature in the services feature class connects to the water main on one end and touches the building on the other, you must use snapping.

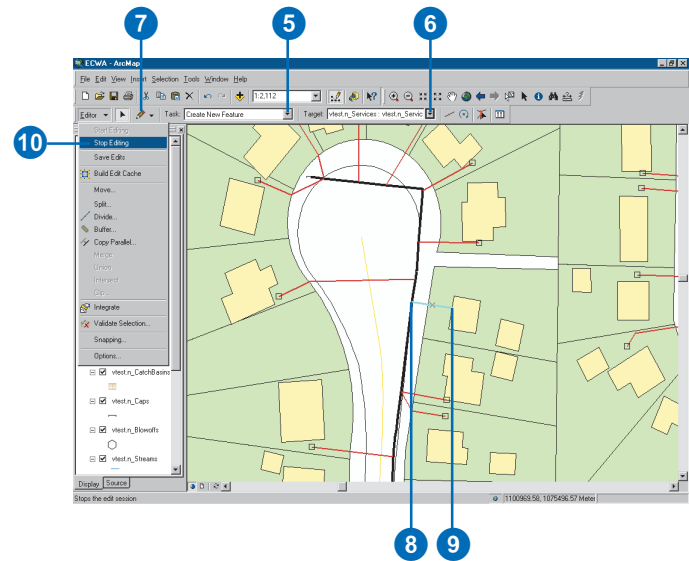
## See Also

*For information on snapping, see Editing in ArcMap.*

1. Click Editor and click Start Editing.
2. Click Editor and click Snapping.
3. In the Snapping Environment window, set the appropriate snapping properties.
4. Close the Snapping Environment window. ►



5. Click the Task dropdown arrow and click Create New Feature.
6. Click the Target dropdown arrow and click the layer to which you want to add a feature.
7. Click the Sketch tool.
8. Point to a position on the feature where the new feature is to connect. A target appears to show that snapping is on. Click to create the first vertex of the new feature.
9. Create the remaining vertices of the sketch and double-click to finish it.
10. Click Editor and click Stop Editing.
11. Click Yes to save your changes.





## Connecting and disconnecting network features

In some cases, you may wish to disconnect a feature from the network. Disconnecting a feature does not delete it from the database; it removes the topological connections the feature has to other features in the network. Similarly, connecting a feature to the network creates topological relationships between the feature and its neighboring features.

To disconnect a feature, you must first add the Disconnect button to a toolbar from the Commands tab of the Customize dialog box. The Disconnect button is available from the Editor category.

For information on adding a button to a toolbar, see Chapter 17, ‘Customizing ArcMap’.

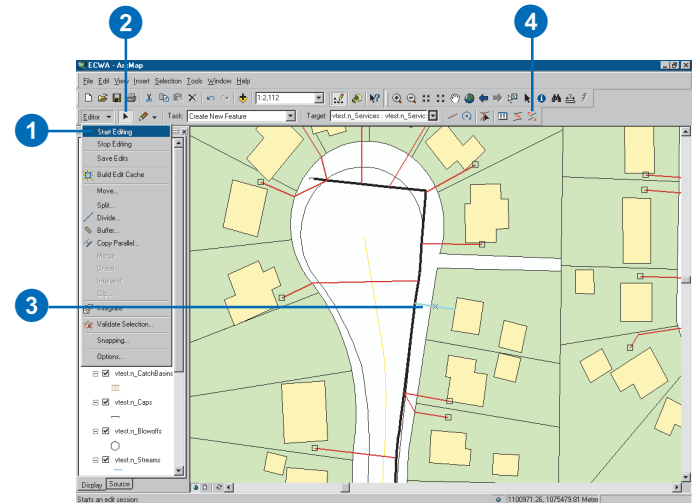
### Tip

#### Connecting network features

*You can connect a disconnected feature by following the same procedure as for disconnecting features, using the Connect button instead of the Disconnect button.*

## Disconnecting network features

1. Click Editor and click Start Editing.
2. Click the Edit tool.
3. Select the feature to be disconnected.
4. Click the Disconnect button.



# Enabling and disabling features

Any feature in a geometric network can be enabled or disabled. An *enabled feature* allows flow to pass through it, while a *disabled feature* does not. Disabling features allows you to treat features as if they were disconnected from the network, without actually removing the topological connections that they have to other features in the network. By default, all features in a geometric network are enabled when you create the network.

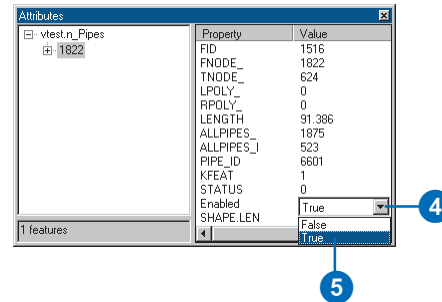
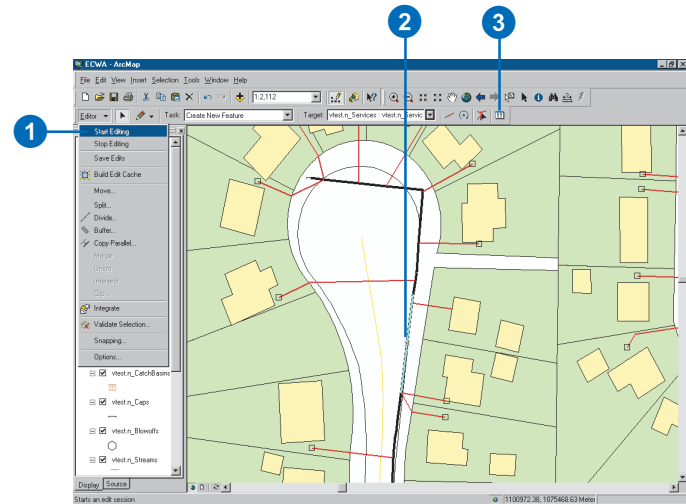
To enable or disable a feature, its Enabled attribute must be edited in the Attributes dialog box.

## Tip

### Enabling and disabling features

You can also enable or disable a feature by changing the value of its Enabled attribute in the attribute table. Open the attribute table for the feature's feature class, find the feature in the table, and edit the value for this attribute. For more information on working with attribute tables, see Chapter 10, 'Working with tables'.

1. Click Editor and click Start Editing.
2. Click the Edit tool and click the feature that you want to enable or disable.
3. Click the Attributes button.
4. Click in the Value column next to the Enabled property.
5. Click True to enable the feature. Click False to disable the feature.
6. Click Editor and click Stop Editing.
7. Click Yes to save your changes.



# Adding the Utility Network Analyst toolbar

In order to use ArcMap to analyze your networks, you must load the Utility Network Analyst toolbar. This toolbar contains most of the tools needed to perform the analysis tasks presented later in this chapter.

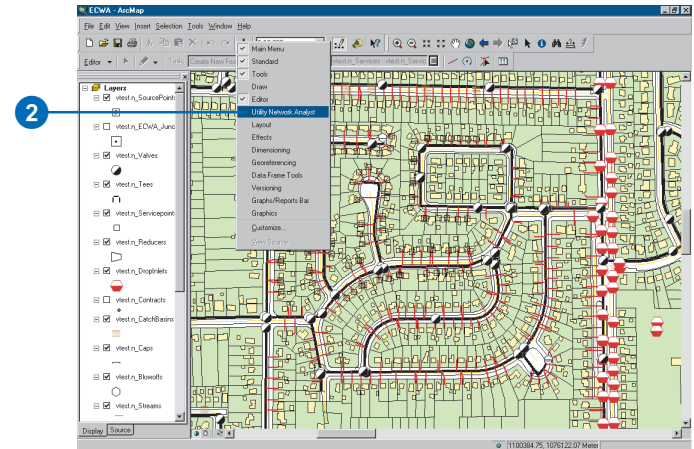
## Tip

### Adding the toolbar

*You can also add the toolbar by clicking the View menu, pointing to Toolbars, then clicking Utility Network Analyst.*

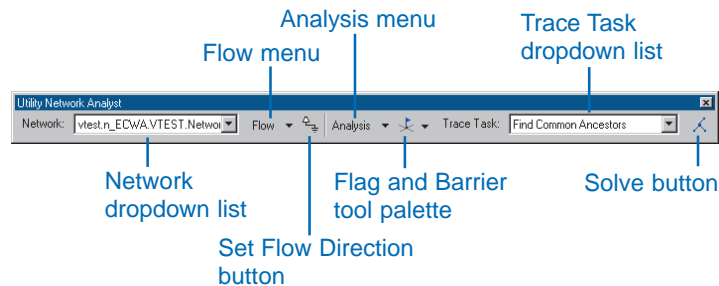
1. Right-click the Main menu.
2. Click Utility Network Analyst.
3. Dock the toolbar to the ArcMap window.

Now, each time you start ArcMap the toolbar will be displayed.



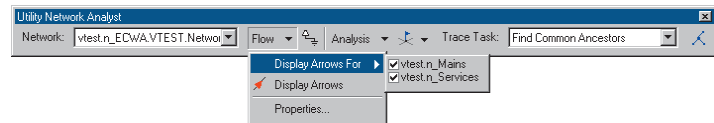
# Exploring the Utility Network Analyst toolbar

The Utility Network Analyst toolbar is divided into two sections. The left side of the toolbar lets you choose a network with which to work and to set and display its flow direction. The right side of the toolbar lets you set up and perform trace operations on the current network (see ‘Tracing on networks’ in this chapter).



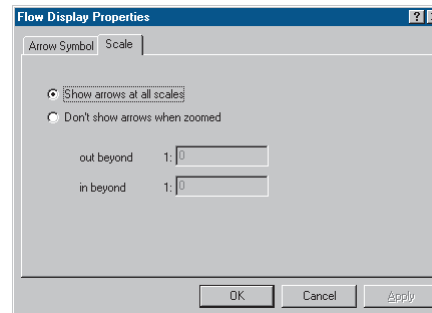
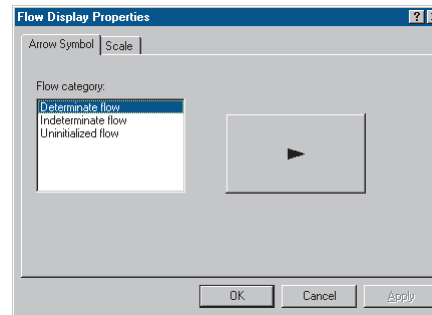
The Network dropdown list contains all of the geometric networks that are currently loaded in ArcMap. In order to work with a network in ArcMap—for example, set the flow direction or perform a trace operation—you must choose the network in this list.

The Flow menu contains items for displaying the flow direction of the features in the network. Clicking the Flow menu reveals three items: Display Arrows For, Display Arrows, and Properties.



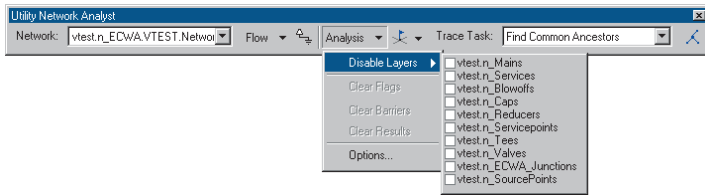
Clicking Display Arrows For produces a list of the edge feature classes in your network. By checking items in this list, you can specify for which layers to display flow direction. The Display Arrows command is a toggle button that turns on or off the

display of flow direction arrows for your network. Clicking the Properties command opens the Flow Display Properties dialog box. The Arrow Symbol tab lets you specify the symbol, size, and color of the arrows used to indicate flow direction. The Scale tab lets you specify the scale range in which the arrows are displayed.



The Set Flow Direction button establishes flow direction in the network. This button is enabled when your network contains feature classes that you have designated as containing persistent sources and sinks.

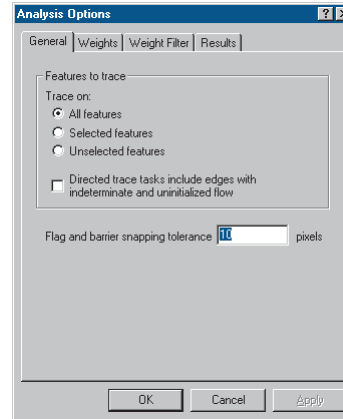
The Analysis menu contains commands for setting up your network to perform trace operations. Clicking the Analysis menu reveals five commands: Disable Layers, Clear Flags, Clear Barriers, Clear Results, and Options.



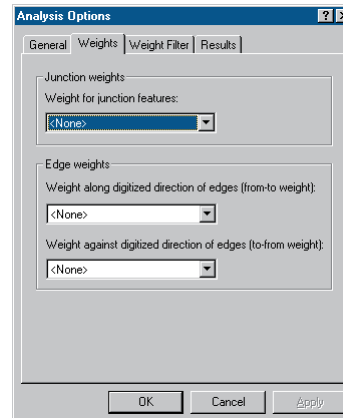
Clicking Disable Layers displays a list of feature classes contained in the geometric network. By checking feature classes in this list, you can disable feature classes in trace operations. This makes trace operations behave as if all of the features in those feature classes are disabled. The Clear Flags and Clear Barriers menu items remove flags and barriers, respectively, from the network. Clicking Clear Results clears the results of the previous trace operation.

Clicking Options opens the Analysis Options dialog box. This dialog box allows you to specify options for subsequent trace operations.

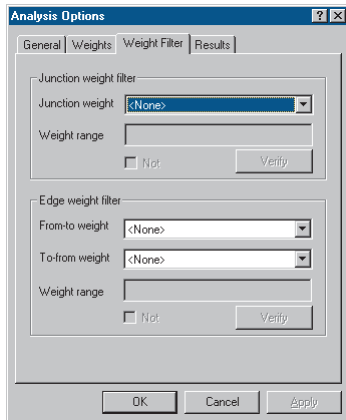
The General tab of the Analysis Options dialog box lets you specify on which features trace tasks are performed. You can perform trace tasks on all of the features in the network, only the selected features, or only the unselected features. You can specify whether or not trace tasks that consider flow direction include edges with indeterminate or unspecified flow direction. You can also use this tab to specify the snapping tolerance for placing flags and barriers on the map.



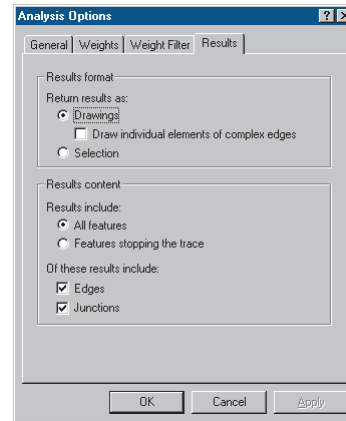
The Weights tab lets you specify which network weights are used when tracing. For example, the Find Path trace task uses weights to determine the cost of including a network feature in the result of the trace task.



The Weight Filter tab lets you specify which network features can be traced based on weights assigned to the network features. For both edges and junctions, you can specify valid ranges of weights for features that may be traced.



With the Results tab, you can determine in which format you want to receive the results of trace operations. Results can be given as drawings overlaid on the map or as a set of selected features. If you choose to draw the results, you can choose to render only the parts of complex edges that are actually traced, rather than the entire complex feature. You can also specify whether the results will include features that are traced during the operation or features stopping the trace. Finally, you can specify whether the results include both edge and junction features.



The Trace Task dropdown list contains a list of all of the trace operations that you can perform using the Utility Network Analyst toolbar. ArcGIS comes with nine built-in trace operations.

While the Trace Task dropdown list is used to select the trace task, the Solve button is used to perform the trace operation once you have finished configuring your trace operation using the toolbar. The Solve button performs the trace operation that you selected in the Trace Task dropdown list; it does this using the parameters that you specified using the Analysis Options dialog box and the placement of flags and barriers on the network.

# Flow direction

In utility network applications, knowing the flow direction along network edges is essential. Establishing the *flow direction* in a geometric network determines the direction in which commodities flow along each edge. The flow direction in a network is determined by the topology of the network, the locations of sources and sinks in the network, and the enabled or disabled state of features.

*Sources* and *sinks* drive flow through a utility network. Sources are junction features that push flow away from themselves through the edges of the network. For example, in a water distribution network, pump stations can be modeled as sources, since they drive the water through the pipes away from the pump stations. Sinks are junction features that pull flow toward themselves from the edges in the network. For example, in a river network, the mouth of the river can be modeled as a sink, since gravity drives all water towards it. Flow moves away from sources or towards sinks. Because flow direction can be established with either sources or sinks, it usually suffices to specify only sources or only sinks in a network.

It is important to remember that disabled features are accounted for when setting flow direction. Disabling a feature makes it act as if flow cannot pass through it. Thus, disabling a feature means that the flow direction cannot be set for the disabled features, or for those features that are connected to the sources or sinks exclusively through the disabled feature.

After you set the flow direction for your network, an edge has one of three categories of flow direction: determinate, indeterminate, or uninitialized.

## Determinate flow direction

If the flow direction of an edge can be uniquely determined from the topology of the network, the locations of sources and sinks, and the enabled or disabled states of features, the feature is said

to have *determinate flow*. Determinate flow for an edge is specified as either with or against the direction in which the feature was digitized.

## Indeterminate flow direction

*Indeterminate flow direction* in a network occurs when the flow direction cannot be uniquely determined from the topology of the network, the locations of sources and sinks, and the enabled or disabled states of the features. Indeterminate flow commonly occurs for edges that form part of a loop, or closed circuit. It can also occur for an edge whose flow is determined by multiple sources and sinks, where one source or sink is driving the flow in one direction through the edge, but another source or sink is driving it in the opposite direction. For example, an edge that has a source at both of its ends will have indeterminate flow.

## Uninitialized flow direction

*Uninitialized flow direction* in a network occurs in edges that are isolated from the sources and sinks in the network. This can happen if the edge is not topologically connected through the network to the sources and sinks or if the edge is only connected to sources and sinks through disabled features.

## Specifying flow direction

All utility networks that have flow have sources and sinks. In some cases, you may not know the locations of the sources and sinks, but you may know the flow direction. If this is the case, you must choose the junctions in your network to act as sources and sinks that produce the correct flow direction.

After setting the flow direction for your network, indeterminate flow may occur, even when you know the direction of flow. This is because the flow direction is determined by properties of the

network or the features making up the network in addition to the topology or locations of sources and sinks. For example, in a water network, the flow direction in a pipe is determined by the difference in water pressure between the ends of the pipe. The pressure at each end of the pipe is affected by such things as the material out of which the pipe is made, the pipe diameter, the flow rate through the pipe, the physical configuration of the pipe (including any bottlenecks, valves, or sharp bends), the temperature of the water, the elevation of the ends of the pipe, and the topology of the network. Since ArcGIS deals with general utility networks (and not with domain-specific types of networks), this information is not used to set the flow direction. Thus, the flow direction may be set to indeterminate for some edges in these networks.

A set of similar variables exists in every domain. Developers can write custom flow-direction solvers that use these variables to find determinate flow direction in domain-specific networks.



## Displaying flow direction

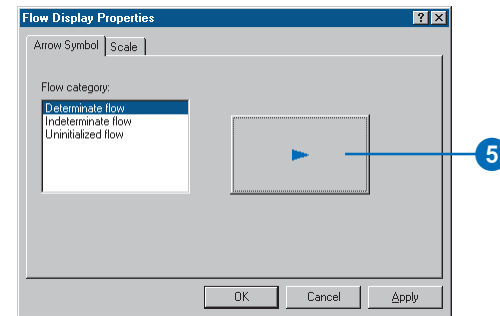
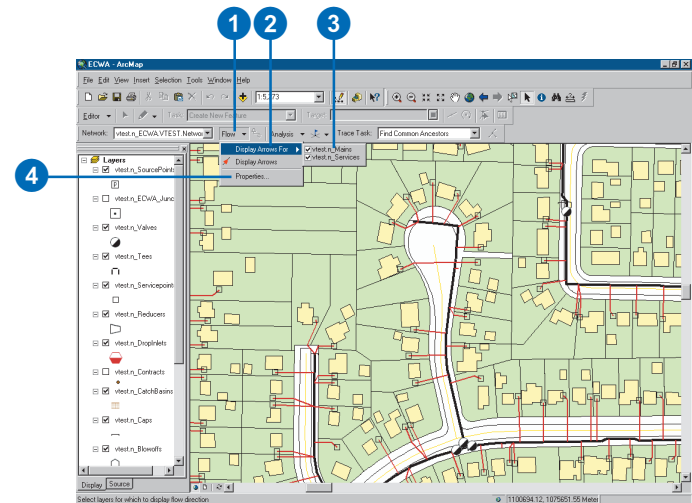
Network flow direction specifies the direction in which commodity flows through the network. ArcGIS stores this information for edge features in a network.

You can display the flow direction for edges using the Utility Network Analyst toolbar. You can display which edges have determinate flow direction, indeterminate flow direction, or uninitialized flow.

### See Also

*For more information on flow direction, see 'Flow direction' in this chapter.*

1. Click the Flow menu on the Utility Network Analyst toolbar.
2. Point to Display Arrows For.
3. Check the layers for which you want to display flow direction.
4. Click Properties.
5. Click the Arrow Symbol tab. Click a flow category in the list and click the button to specify the size and color of the flow direction arrows. ▶



## Tip

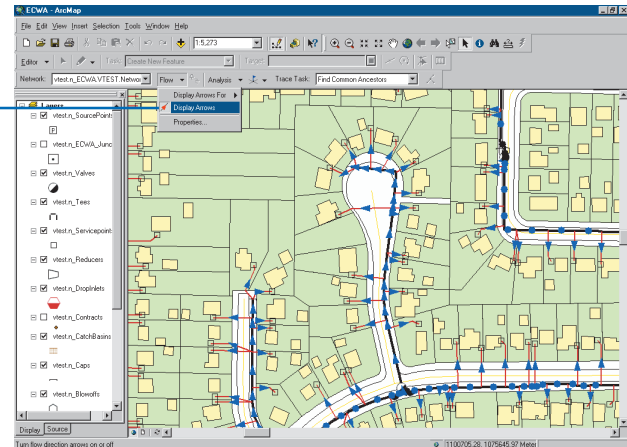
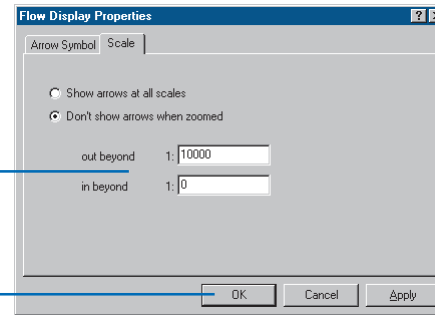
### Clearing flow direction arrows

To remove the flow direction arrows, click *Flow* and click *Display Arrows*.

- Click the *Scale* tab and specify the scales at which you want to display the flow direction arrows. To show the arrows at all scales, click *Show arrows at all scales*. To only show the arrows within a scale range, click *Don't show arrows when zoomed* and type the scale range limits in the text boxes.

- Click *OK*.
- Click *Flow* and click *Display Arrows*.

The arrows symbolizing the flow direction are displayed.



# Setting flow direction

You can use ArcMap to maintain flow direction in your geometric network. ArcMap uses the network topology, the enabled or disabled state of network features, and the locations of sources and sinks to establish flow direction.

You must set flow direction whenever you:

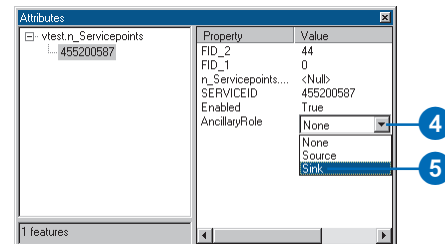
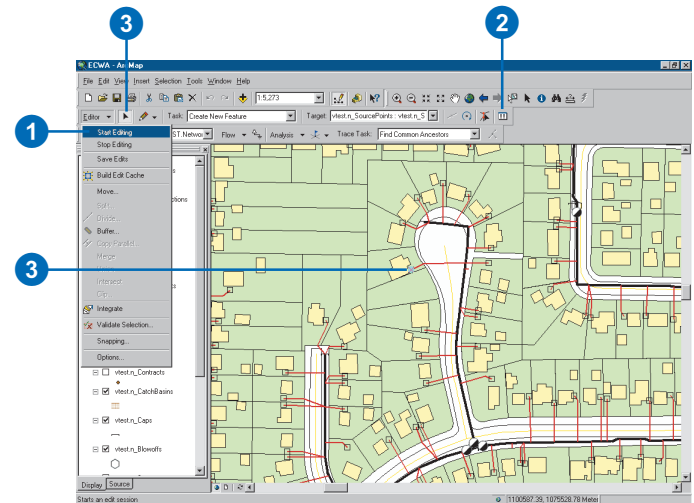
- Create a new geometric network
- Add or remove features from the network
- Reshape features so as to change the network topology
- Connect or disconnect features
- Add or remove sources or sinks
- Enable or disable features

Setting the flow direction establishes the correct flow direction for the new network topology.

In order to set flow direction, your network must contain at least one junction feature class that you specified as containing sources and/or sinks.

# Creating sources and sinks

1. Click the Editor menu and click Start Editing.
2. Click the Attributes button.
3. Click the Edit tool and click the feature that you want to set as a source or sink. This feature must belong to one of the feature classes that you specified as containing sources and sinks when you built your network.
4. In the Attributes window, click the Value column next to the AncillaryRole property.
5. Click Source or Sink to designate this feature as a source or sink (you can undo this later by clicking None in this list).
6. Click Editor and click Stop Editing.
7. Click Yes to save the edits to your network.



## Tip

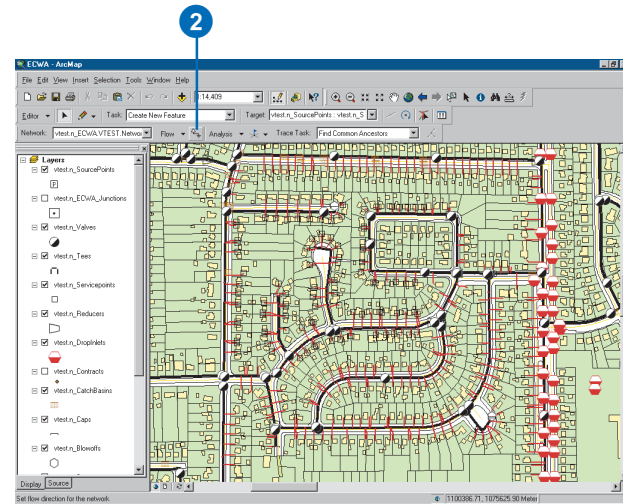
### Versioning networks

You can use the versioning features of ArcGIS to create different versions of your network. Each version of the database that you create maintains its own set of information for your geometric network including the network topology, the enabled or disabled state of features, sources and sinks, and flow direction. With versions, for example, you could maintain one version of the network for use in trouble call analysis and maintain another version for planning maintenance and upgrades to the network.

For more information on versioning, see 'Working with a versioned geodatabase' in Building a Geodatabase.

## Setting flow direction

1. Click the Editor menu and click Start Editing.
2. Click the Set Flow Direction button on the Utility Network Analyst toolbar. This sets the correct flow direction for your network.
3. Click Editor and click Stop Editing.
4. Click Yes to save the edits to your network.



# Tracing on networks

Network analysis involves tracing. The term *tracing* is used here to describe building a set of network elements according to some procedure. You can think of tracing as placing a transparency on top of a map of your network and tracing all of the network elements that you want to include in your result onto the transparency.

When working with networks, tracing involves connectivity. A network element can only be included in a trace result if it is in some way connected to other elements in the trace result. The *trace result* is the set of network features that is found by the trace operation.

For example, suppose you want to find all of the features upstream of a particular point in a river network. Using a transparency placed over the map of the river network, you could trace over all of the branches of the river that were upstream of that point. What is drawn on the transparency after this would be your desired result.

Similarly, when you perform a trace operation in ArcMap, your result is a set of the network elements included in the trace. In ArcMap, your trace results can either be drawings on top of your map or a selection.

## Flags and barriers

In ArcMap, *flags* define the starting points for traces. For example, if you are performing an upstream trace, you use a flag to specify where the upstream trace will begin. Flags can be placed anywhere along edges or on junctions. When performing the trace operation, ArcMap uses the underlying edge or junction feature as the starting point of the trace operation. Network elements connected to these edges or junctions are considered for inclusion in the trace result.

*Barriers* define places in the network past which traces cannot continue. If you are only interested in tracing on a particular part

of your network, you can use barriers to isolate that part of the network. Like flags, barriers can be placed anywhere along edges or on junctions. When performing trace operations, ArcMap treats the underlying network features as if they are disabled, thus preventing the trace from continuing beyond these features.

## Disabling features

Disabling features is a more permanent method of creating a barrier at a particular location. In a municipal water network, for example, if a water main has been opened and capped due to a road construction project, water cannot flow through that section of the water main. Disabling the network feature representing this water main would stop a trace at this feature.

## Disabling feature layers

In some cases, disabling entire layers may be necessary. For example, by disabling the switches layer in an electrical distribution network and tracing from some point in the network, you can find the switches that need to be thrown to isolate this point from the network; these will be the features at which the trace operation is stopped.

## Weights

Edges and junctions can have any number of weights associated with them. A *weight* is a property of a network feature typically used to represent a cost for traversing across an edge or through a junction. An example of an edge weight is the length of the edge. In a shortest path analysis, you would choose this weight if you wanted the resulting path to be of the shortest length. Another example is the resistance to traversing an edge in an electrical network. Using a resistance weight, the shortest path would be the path of least resistance.

When you build a network, you specify which attributes of edge and junction feature classes will become weights. You can use these weights to specify the cost of including a feature in the results of a trace operation. Of the trace tasks included with ArcGIS, only the Find Path, Find Path Upstream, and Find Upstream Accumulation trace tasks use weights to calculate the cost of the trace.

In order to find the cost using these trace tasks, you must specify which weights to use. For junction features, a single weight is used. For edge features, two weights can be used: one along the digitized direction of the edge feature (the From-to weight) and one against the digitized direction of the edge feature (the To-from weight). The digitized direction of an edge feature refers to the order in which the shape nodes of the feature are stored in the geodatabase. You can specify a different weight for each direction of an edge for cases where tracing an edge in one direction has a different cost than tracing it in the other direction.

## Weight filters

You can use a weight filter to limit the set of network features that may be traced. A *weight filter* specifies which network features can be traced based on their weight values. A weight filter serves the same purpose as creating a selection of network elements based on a simple SQL query, except that the performance of the weight filter is much faster.

Using a weight filter, you specify valid or invalid ranges of weight values for network features that may be traced. As with using weights to represent the cost of including a feature in trace results, a single weight is used for junction features, and two weights may be used for edge features.

## Traced features and features stopping the trace

When tracing using the Find Connected, Trace Downstream, or Trace Upstream trace tasks, you can return either the features that are traced or the features that stop the trace. Features that are traced are those that are actually traced over by the operation. Features that stop the trace are those features past which the trace cannot continue. Features that stop the trace include the following:

- Disabled features
- Features upon which barriers are placed
- Traced features that are only connected to one other feature (deadends)
- Features that have been filtered out with a weight filter

## Using selections to modify trace tasks

When tracing, ArcMap lets you use selections to modify trace tasks in three main ways.

First, the Analysis Options dialog box lets you specify whether the trace operation is performed on all features in the network, on the selected features only, or on the unselected features only. Tracing on just the selected features means that unselected features act as barriers, while tracing on just the unselected features means that selected features act as barriers. By using selections in this manner, you could, for example, perform a trace operation to produce a set of barriers for a subsequent operation, or you could build a selection query to produce a set of network features upon which to perform a trace operation.

ArcMap also lets you specify which layers are selected when performing a trace operation. From the Selection menu in ArcMap, you can specify which layers can and cannot be selected. When ArcMap returns the results of a trace operation as a selection set, the settings you specify in the Selection menu are used to determine which features should be included in the selection set returned by the trace.

Finally, you can also use the interactive selection method—set through the Selection menu—to specify the behavior of the resulting selection set. You can create a new selection, add the results of your trace operation to the current selection, select the results of your trace operation from the current selection, or remove the results of your trace operation from the current selection.

By using the power of selections in ArcMap, you can use the simple trace tasks included with ArcMap to perform compound and complex trace operations.

## **Putting it all together**

This section introduced some concepts you can use when constructing traces to perform on your network. You can return the trace results as a selection set, disable individual features or entire feature layers, place barriers on edges or junctions, include the traced features or the features stopping the trace, trace only on selected or unselected features, specify which layers to include in the results, and use different selection methods. All of these concepts can be used simultaneously when creating a trace result. Combining these concepts in trace operations allows you to execute very powerful traces on your network.

# Tracing operations

Using the Utility Network Analyst toolbar, you can do the following:

- Trace downstream
- Trace upstream
- Find the upstream accumulation
- Find an upstream path to the source
- Find common ancestors
- Find connected features
- Find disconnected features
- Find a path
- Find loops

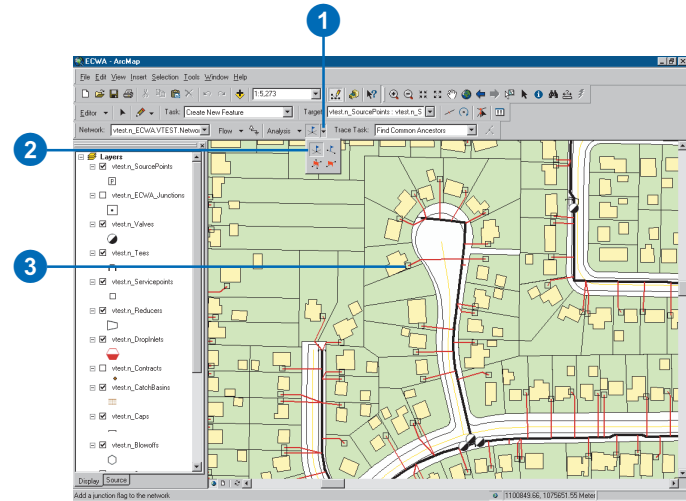
You can use these simple tasks to perform many useful network analyses. You can also combine these with other features of ArcMap to perform complex network analysis operations.

To find all network elements that lie downstream of a given point in your network, use the Trace Downstream task.

To find all network elements that lie upstream of a given point in your network, use the Trace Upstream task. ►

## Adding flags and barriers

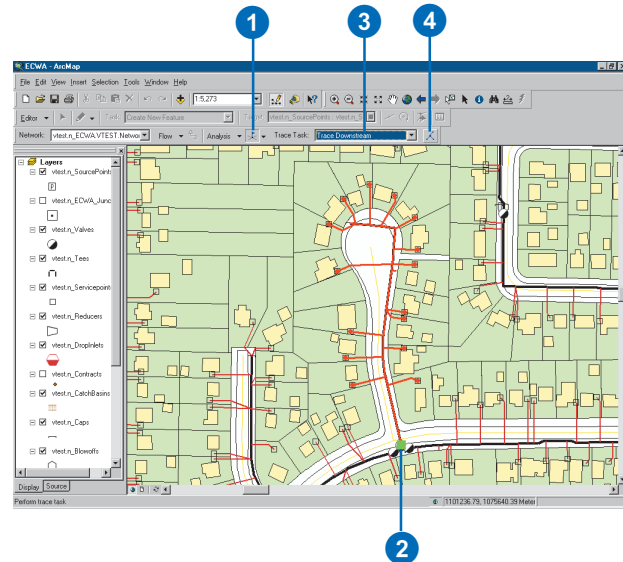
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow.
2. Click the button representing the flag or barrier element that you want to add to the network.
3. Point to the edge or junction feature to which you want to add the flag or barrier.
4. Click to add the flag or barrier.



## Tracing downstream

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point from which you want to trace downstream.
3. Click the Trace Task dropdown arrow and click Trace Downstream.
4. Click the Solve button.

All of the features downstream of your flags are displayed.





To find the total cost of all network elements that lie upstream of a given point in your network, use the Find Upstream Accumulation task.

To find an upstream path from a point in the network to the source, use the Find Path Upstream task.

To find the common features that are upstream of a set of points in your network, use the Find Common Ancestors task.

To find all of the features that are connected to a given point through your network, use the Find Connected task.

To find all of the features that are not connected to a given point through your network, use the Find Disconnected task.

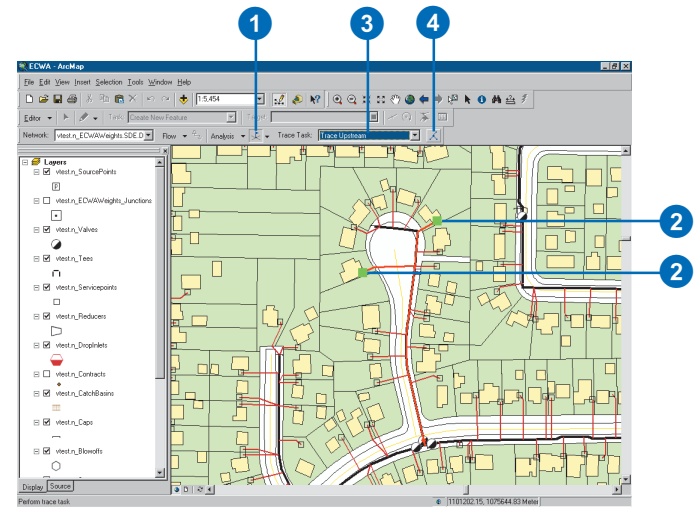
To find a path between two points in the network, use the Find Path task. The path found can be just one of a number of paths between these two points—depending on whether or not your network contains loops.

To find loops in your network, use the Find Loops task. Loops can result in multiple paths between points in a network.

## Tracing upstream

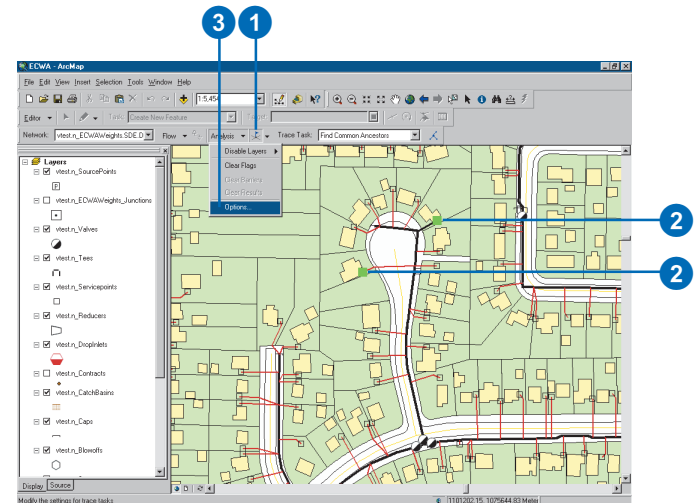
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point from which you want to trace upstream.
3. Click the Trace Task dropdown arrow and click Trace Upstream.
4. Click the Solve button.

All of the features upstream of your flags are displayed.



## Finding the upstream accumulation

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point from which you want to find the upstream accumulation.
3. Click Analysis and click Options. ▶



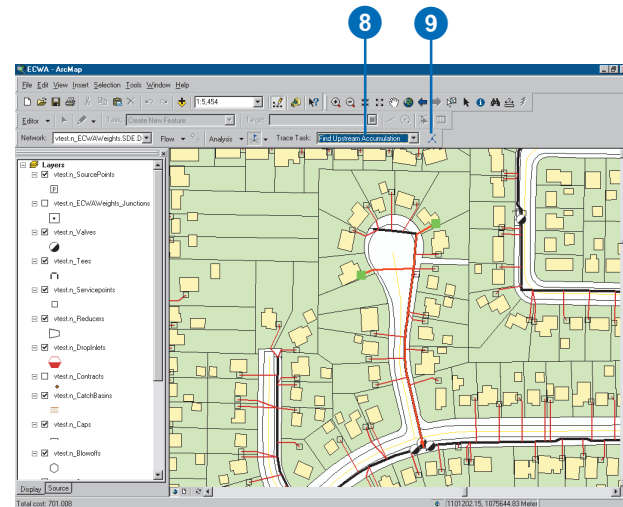
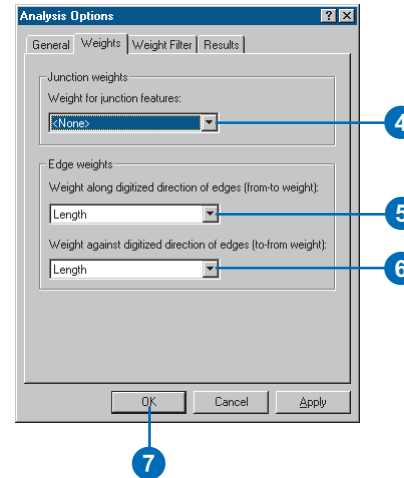
## Tip

### Finding the upstream accumulation without weights

By default, the Find Upstream Accumulation trace task does not use weights. If you do not use weights, the cost reported is the number of edge elements in the result.

- Click the Weights tab. Click the Junction weights dropdown arrow and click the name of the weight you want to use for junctions.
- Click the from-to edge weight dropdown arrow and click the name of the weight you want to use for tracing edges along the digitized direction.
- Click the to-from edge weight dropdown arrow and click the name of the weight you want to use for tracing edges against the digitized direction.
- Click OK.
- Click the Trace Task dropdown arrow and click Find Upstream Accumulation.
- Click the Solve button.

All of the features upstream of your flags are displayed and the total cost of these features is reported in the status bar.



## Tip

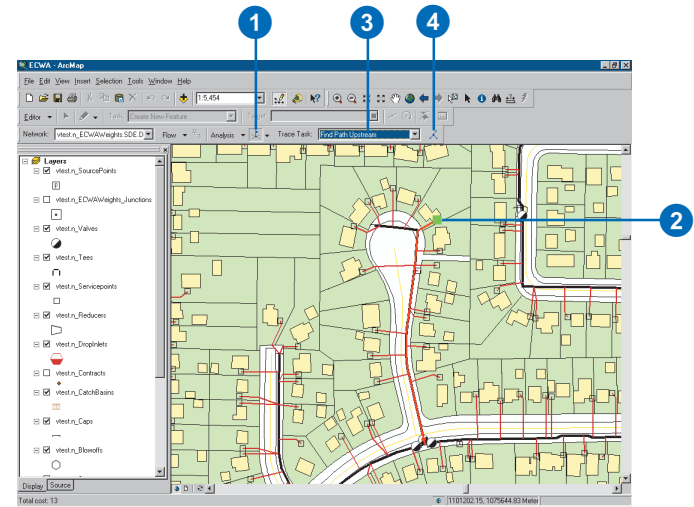
### Finding an upstream path with weights

By default, the Find Path Upstream trace task does not use weights. If you use weights, the upstream path found to the source is the shortest path based on the weights you specify. To specify weights, follow steps 3 through 7 for finding the upstream accumulation.

## Finding an upstream path to the source

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find an upstream path to the source.
3. Click the Trace Task dropdown arrow and click Find Path Upstream.
4. Click the Solve button.

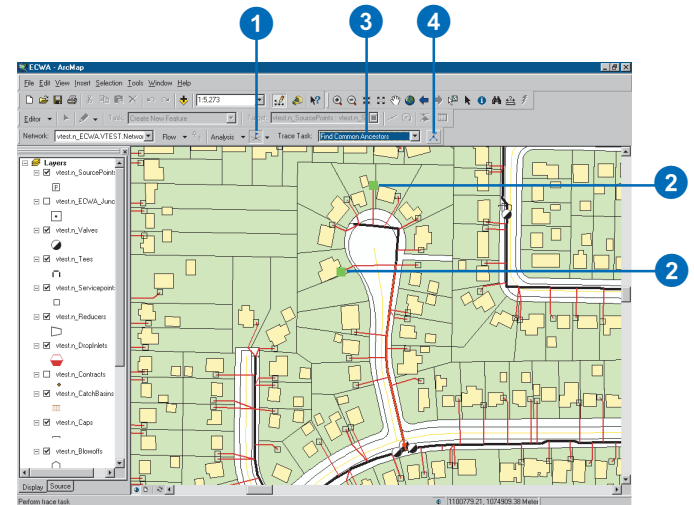
For each of your flags, an upstream path from the flag to the source is displayed.



## Finding common ancestors

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the common ancestors.
3. Click the Trace Task dropdown arrow and click Find Common Ancestors.
4. Click the Solve button.

The features that are upstream of all of your flags are displayed.



## Tip

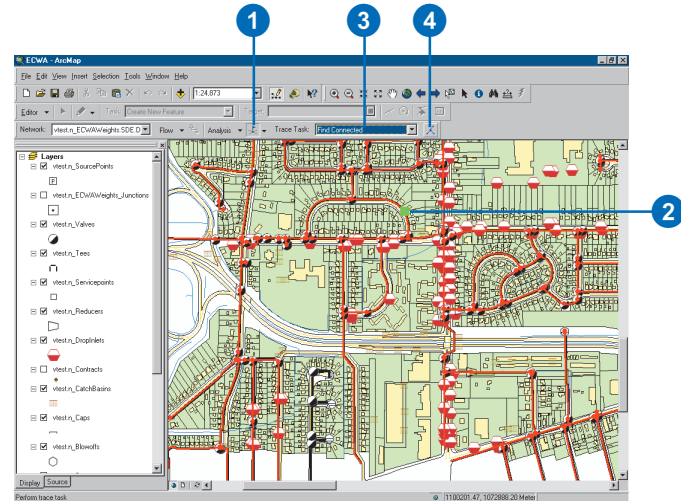
### Using Find Connected or Find Disconnected

The *Find Disconnected* trace task always returns the features that the *Find Connected* trace task does not. The results of one of these trace tasks are often easier to view and analyze than the results of the other. For example, suppose you have a mostly connected network and you would like to check to make sure all of your network features are connected to each other. Performing a *Find Disconnected* trace task and checking to see if no features are returned is easier than performing a *Find Connected* trace task and making sure all of your features are returned.

## Finding connected features

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the connected features.
3. Click the Trace Task dropdown arrow and click Find Connected.
4. Click the Solve button.

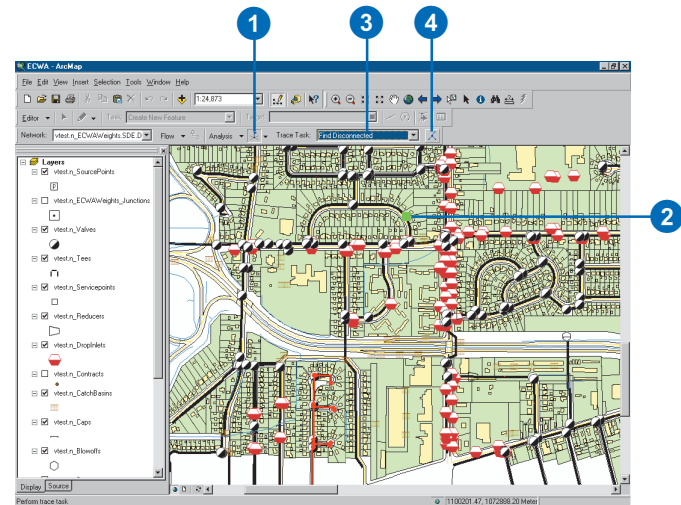
The features that are connected to the features on which you placed your flags are displayed.



## Finding disconnected features

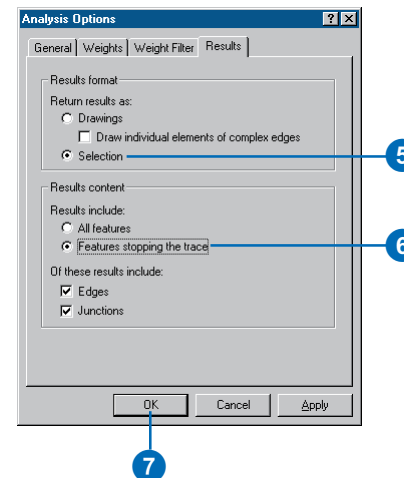
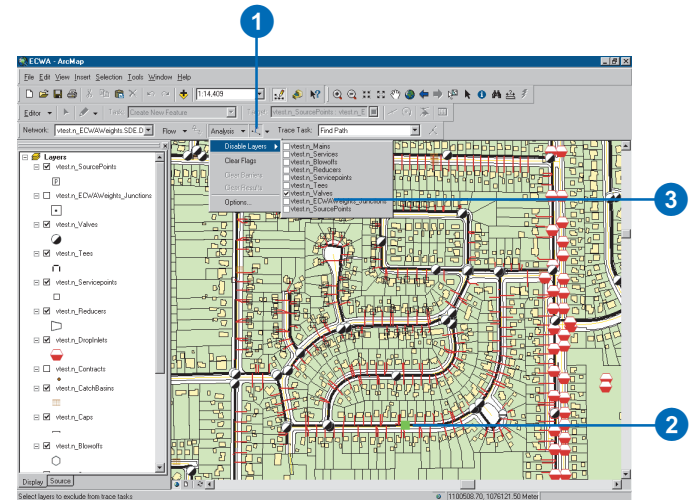
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the disconnected features.
3. Click the Trace Task dropdown arrow and click Find Disconnected.
4. Click the Solve button.

The features that are not connected to the features on which you placed your flags are displayed.



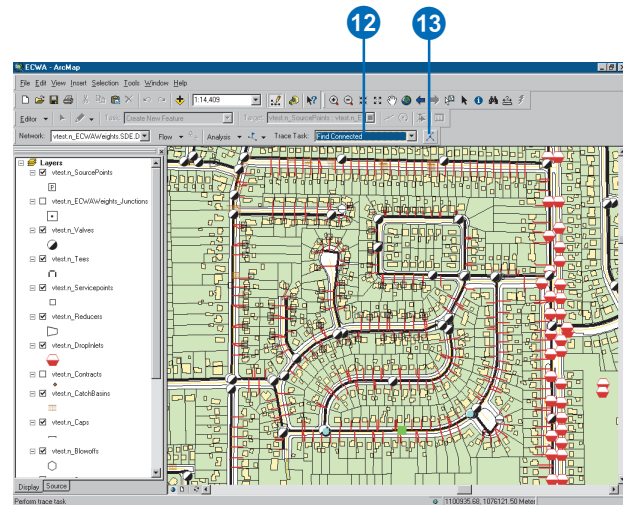
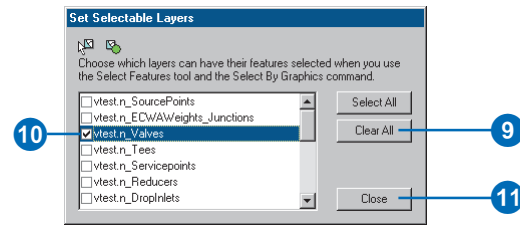
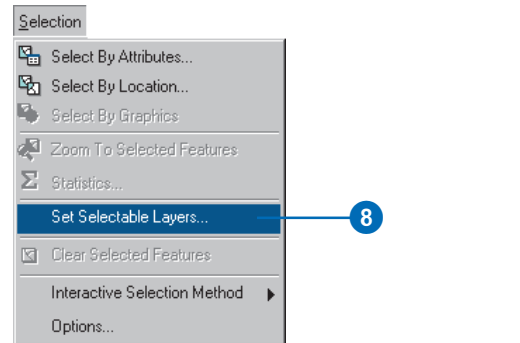
## Isolating a point on the network

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click on the map to place a flag at the point you want to isolate.
3. Click Analysis and click Disable Layers. Check the layer or layers containing the features that will be used to isolate this point.
4. Click Analysis and click Options.
5. Click the Results tab and click Selection.
6. Click Features stopping the trace.
7. Click OK. ►



8. Click the Main menu, click Selection, then click Set Selectable Layers.
9. Click Clear All to uncheck all of the layers.
10. Check the layers that contain the features that will be used to isolate your point in the network.
11. Click Close.
12. Click the Trace Task dropdown arrow and click Find Connected.
13. Click the Solve button.

The features that are selected can be used to isolate your point in the network.



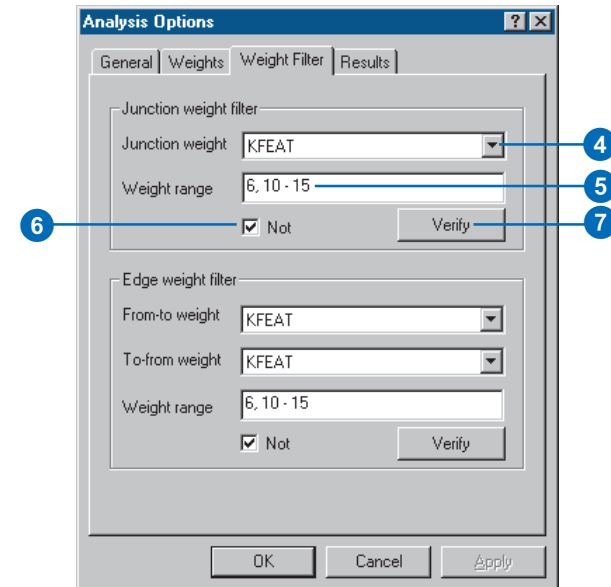
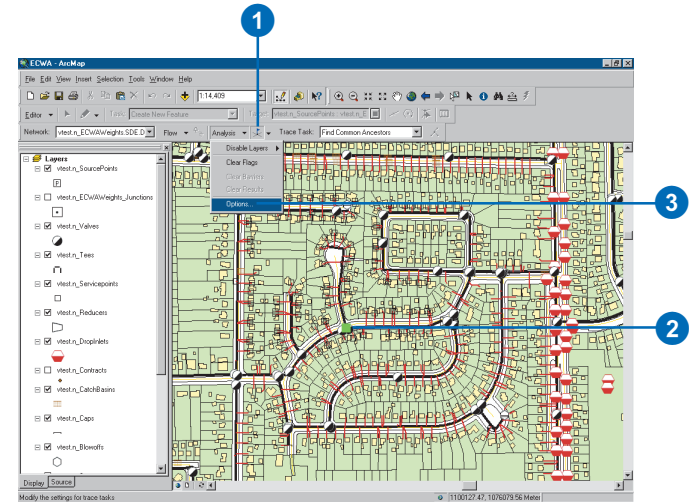
## Tip

### Weight filter syntax

When you create a range expression for a weight filter, you must use correct syntax. You can specify multiple valid or invalid ranges for each weight. You must delimit each range with commas. Each range can include a single value or a range of values. To specify a range of values, type a hyphen between the lower and upper bounds of the range (for example, "1-5, 10-22.2, 27").

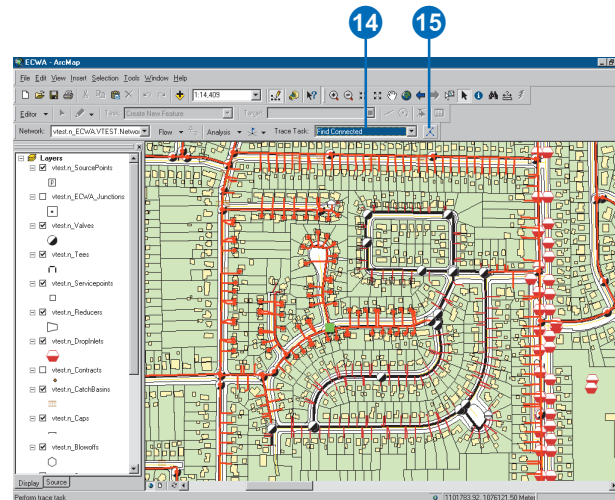
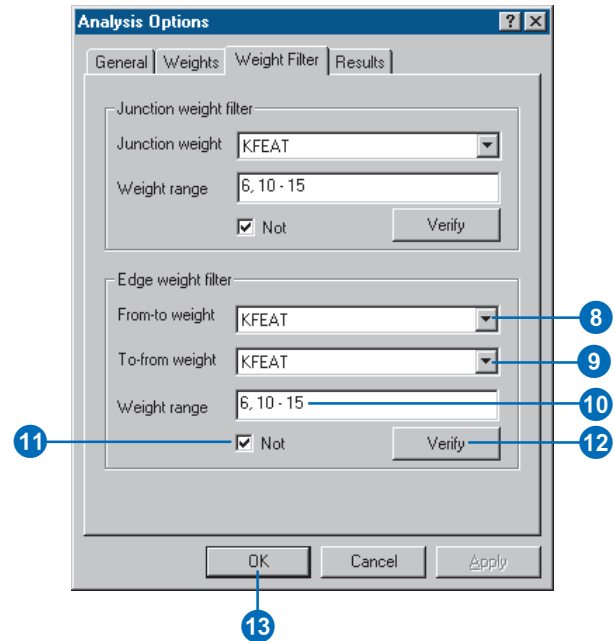
## Finding connected features using weight filters

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags at each point for which you want to find the connected features.
3. Click Analysis and click Options.
4. Click the Weight Filter tab. Click the Junction weight dropdown arrow and click the name of the weight you want to use to filter junctions.
5. In the Weight range text box for junctions, type the expression you want to use to filter junctions.
6. Check the Not check box to exclude this range.
7. Click Verify to check the syntax of the junction weight filter. ▶



8. Click the From-to weight dropdown arrow and click the name of the weight you want to use to filter edges along their digitized direction.
9. Click the To-from weight dropdown arrow and click the name of the weight you want to use to filter edges against their digitized direction.
10. In the Weight range text box for edges, type the expression you want to use to filter edges.
11. Check the Not check box to exclude this range.
12. Click Verify to check the syntax of the edge weight filter.
13. Click OK.
14. Click the Trace Task dropdown arrow and click Find Connected.
15. Click the Solve button.

The features that are connected to the features on which you placed your flags, using the weight filter you specified, are displayed.





## Tip

### The Find Path trace task

When you use the Find Path trace task, the flags you place on the network must be either all edge flags or all junction flags. You cannot find a path among a mixture of edge and junction flags.

## Tip

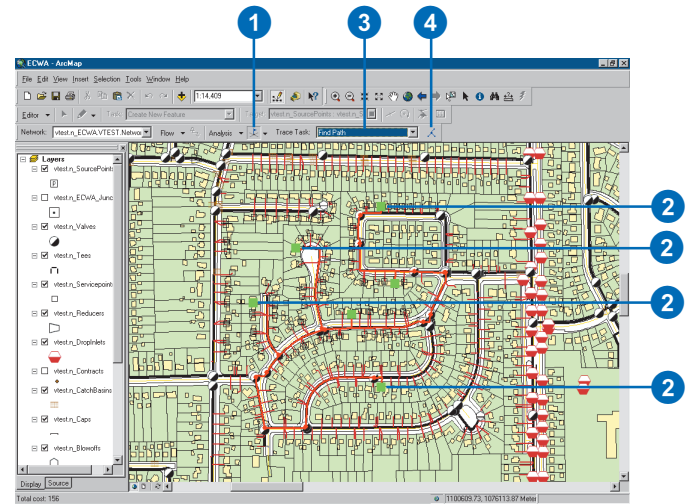
### Finding paths without weights

By default, the Find Path trace task does not use weights. If you do not use weights, the shortest path based on the number of edge elements in the path is found.

## Finding a path

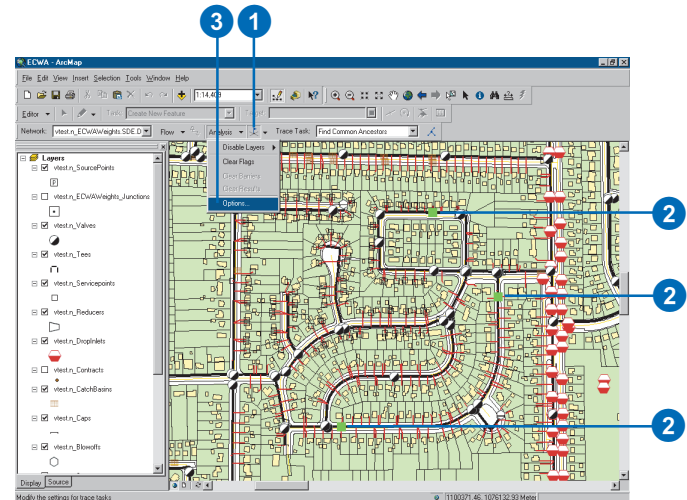
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags on the features among which you want to find a path.
3. Click the Trace Task dropdown arrow and click Find Path.
4. Click the Solve button.

A path between the features on which you placed flags is displayed.



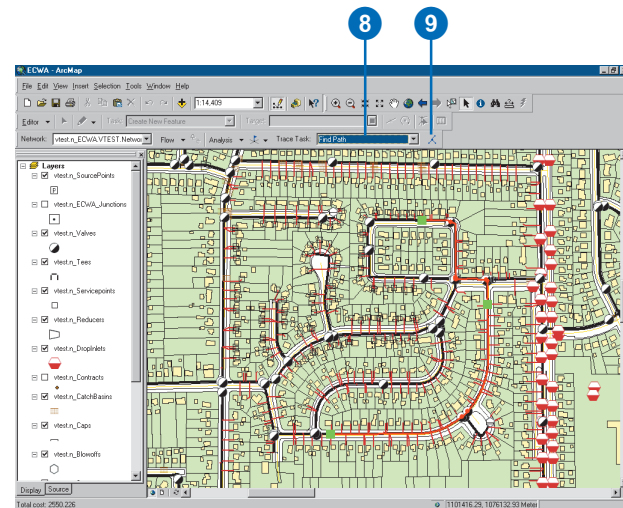
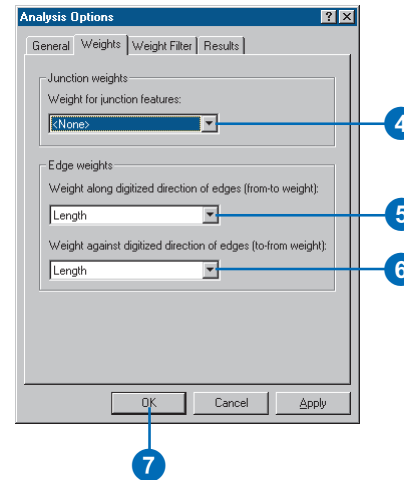
## Finding the shortest path

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.
2. Click to place flags on the features among which you want to find a path.
3. Click Analysis and click Options. ►



4. Click the Weights tab. Click the Junction weights dropdown arrow and click the name of the weight you want to use for junctions.
5. Click the from-to edge weight dropdown arrow and click the name of the weight you want to use for tracing edges along the digitized direction.
6. Click the to-from edge weight dropdown arrow and click the name of the weight you want to use for tracing edges against the digitized direction.
7. Click OK.
8. Click the Trace Task dropdown arrow and click Find Path.
9. Click the Solve button.

The shortest path based on the weights you chose is displayed. The total cost of this path is reported in the status bar.



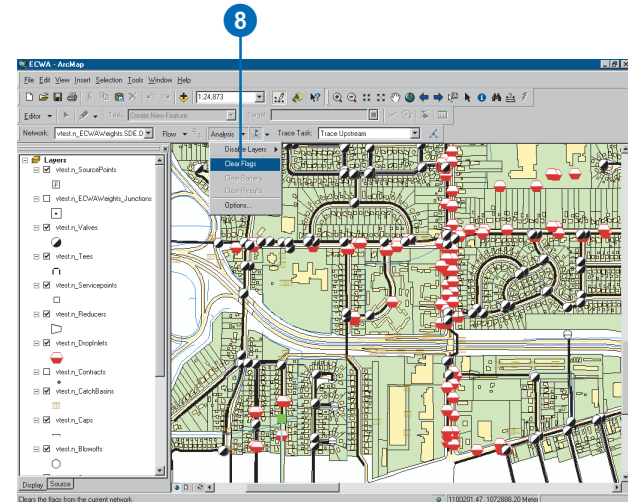
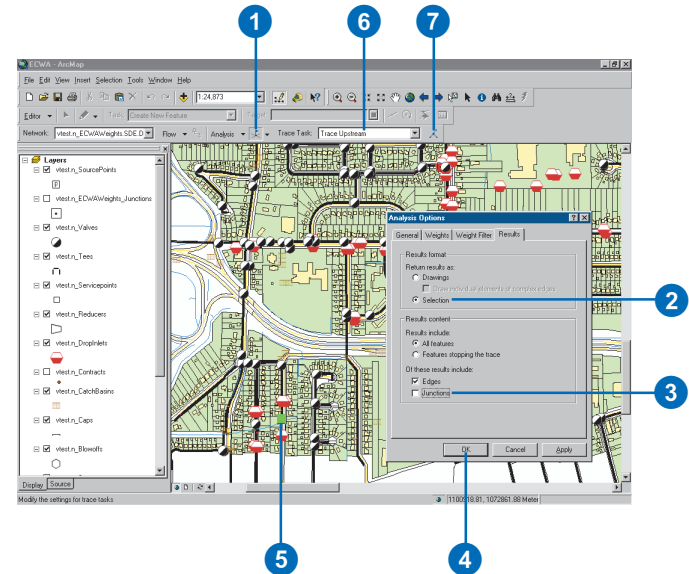
## Tip

### Finding a downstream path

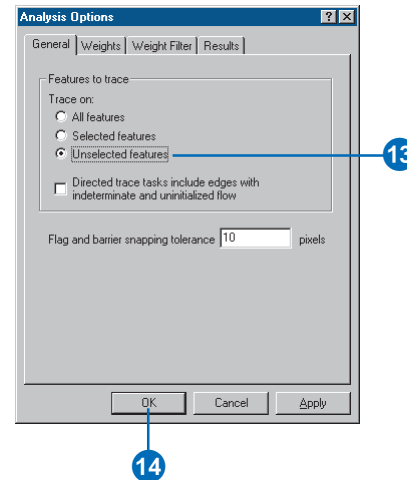
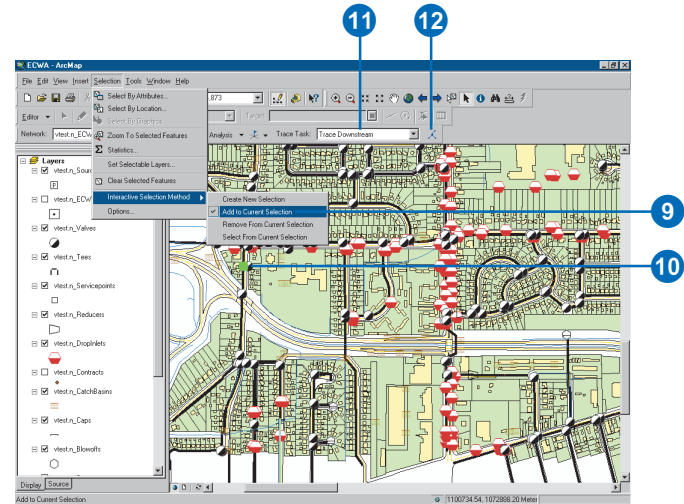
Find a downstream path using a process similar to finding an upstream path.

## Finding an upstream path

1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and select the junction flag tool.
2. Click Analysis and click Options. Click the Results tab. Click Selection to return the results of trace tasks as selections.
3. Uncheck Junctions. This returns only edges in the results.
4. Click OK.
5. Click on the map to place a flag at the destination point.
6. Click the Trace Task dropdown arrow and click Trace Upstream.
7. Click the Solve button.
8. Click Analysis and click Clear Flags. ▶



9. Click the Main menu and click Selection. Point to Interactive Selection Method and click Add to Current Selection.
10. Click on the map to place a flag at the origin point.
11. Click the Trace Task drop-down arrow and click Trace Downstream.
12. Click the Solve button.
13. Click Analysis and click Options. Click the General tab and click Unselected features to treat the current selection as barriers.
14. Click OK. ▶



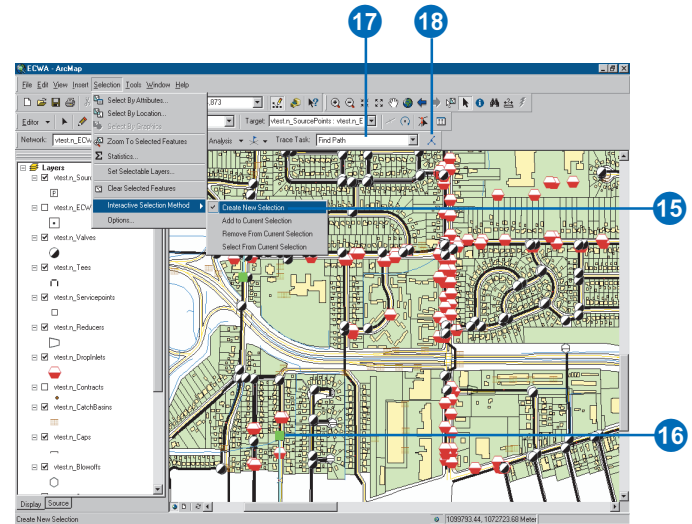
15. Click the Main menu and click Selection. Point to Interactive Selection Method and click Create New Selection.

16. Click on the map to place a flag at the destination point.

17. Click the Trace Task dropdown arrow and click Find Path.

18. Click the Solve button.

If it exists, the result will be an upstream path from the origin point to the destination point.



## Finding loops

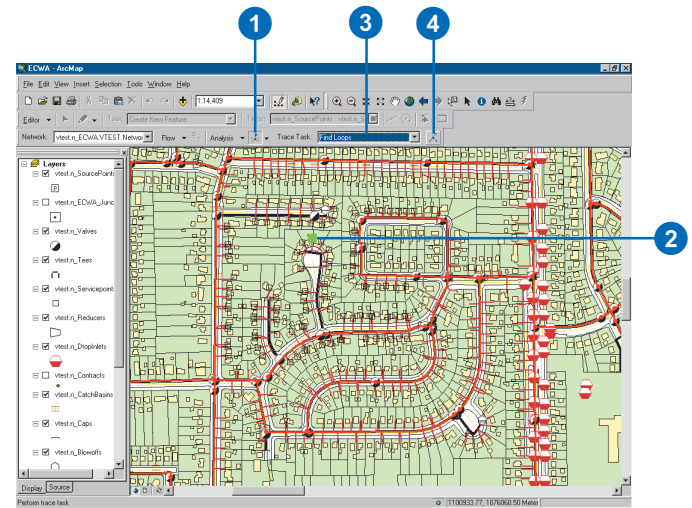
1. On the Utility Network Analyst toolbar, click the tool palette dropdown arrow and choose a flag tool.

2. Click to place at least one flag on each connected component in which you want to find the loops.

3. Click the Trace Task dropdown arrow and click Find Loops.

4. Click the Solve button.

For each connected component on which you placed a flag, the features that loop back on themselves (i.e., can be reached from more than one direction) are displayed.





# Customization

**Section 4**





# Customizing ArcMap

# 17

## IN THIS CHAPTER

- **Basic user interface elements**
- **Hiding and showing toolbars**
- **Creating custom toolbars**
- **Changing a toolbar's contents**
- **Changing a command's appearance**
- **Creating shortcut keys**
- **Saving customizations in a template**
- **Setting toolbar options**
- **Creating, editing, and running macros**
- **Creating custom commands with VBA**
- **Working with UIControls**
- **Locking documents and templates**
- **And more**

Although ESRI end user applications are designed to be flexible and easy to use, you may want the ArcMap interface to reflect your own preferences and the way you work. If you work in a larger organization, others may want you to develop a customized work environment for them. As a developer, you'll be glad to learn that many of the customization tasks you may be asked to perform can be handled without writing a single line of code; in fact, you may be able to instruct others on how to use the customization environment themselves to create the look and feel they want on their own. You can change or create toolbars, menus, keystrokes, and so on, to help you get your work done in the most efficient way. Not only can you change the way the existing work environment is organized, but you'll also be able to provide additional functionality by linking code you or others have written to menu commands or tools. This chapter shows that the customization environment for ArcMap is rich with possibilities.

## Basic user interface elements

ArcMap has a Main Menu and a Standard toolbar, which appear by default. Both are referred to as *toolbars*, although the Main Menu toolbar contains menus only. Toolbars can contain menus, buttons, tools, combo boxes, and edit boxes; these are different types of commands. Whether it's built into the application or it's something you've created yourself, code is associated with each command. All commands execute in generally the same manner, although you use each type differently when interacting with the application.

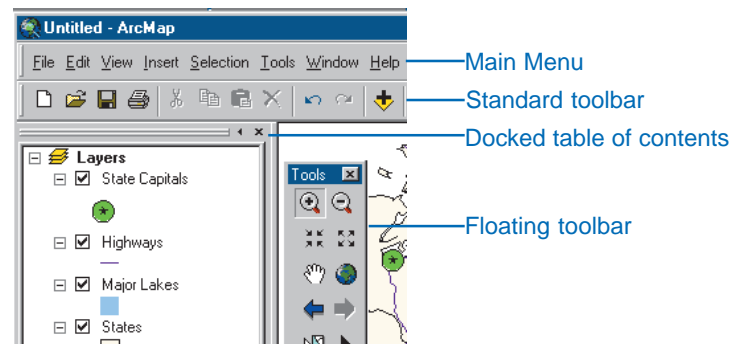
- *Menus* arrange other commands into a list. A *context menu* is a floating menu that pops up at the location of the pointer when you press the right mouse button.
- *Buttons* and *menu items* run a script when you click them.
- *Tools* require interaction with the display before an action is performed—that is, before their script is run. The Zoom In tool is a good example of a tool—you click or drag a rectangle over a map before seeing the contents of the rectangle in more detail.
- *Combo boxes* let you choose an option from a dropdown list. For example, in ArcMap you can choose the font used for the text you add to the map.
- *Text boxes* or *edit boxes* let you type in text. For example, in ArcMap you can type the scale at which you want to view the map.

The tasks in this book apply to all types of commands unless otherwise noted. Each task's description will note any exceptions that apply for specific types of commands.

## Docking toolbars

Any toolbar can be *docked* at the top or bottom or to the left or right of the ArcMap window. Alternatively, toolbars can float on the desktop while functioning as part of the application. When you dock a toolbar, it is moved and resized with the application's window. To prevent a toolbar from docking, hold down the Ctrl key while dragging it.

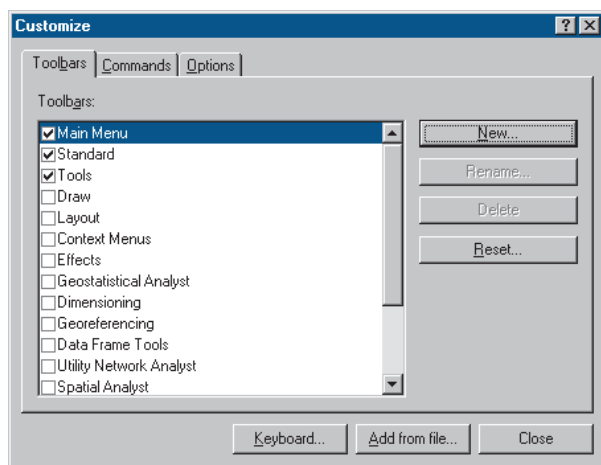
The table of contents in ArcMap is docked on the left by default, but you can dock it elsewhere in the window, or have it float on the desktop if you prefer.



## Changing the way the application looks

Whether you want to position toolbars in a specific area of the application, group commands in a way that works best for you, add new macros or load add-ins that you've gotten from another source, load styles, or always work with the same geographic data, you'll find that you can customize ArcMap in numerous

ways. One of the principle ways in which to tailor the applications to suit your needs is to use the Customize dialog box to change menus and toolbars. You can carry out many of the tasks described in the rest of this chapter by starting with this dialog box. The Customize dialog box resembles and has many of the same properties as the equivalent dialog in Microsoft Office applications. If you've used any of these applications, the environment will be familiar to you.



The Toolbars tab of the Customize dialog box

When you open the Customize dialog box, you can modify existing menus, toolbars, and context menus with simple drag-and-drop techniques. Afterwards, if you prefer, you can return the menus and toolbars built into ArcMap to their default settings. You can also create your own menus, toolbars, and context menus.

## Where to save your changes

When you make customization changes to the user interface in ArcMap, you can save your changes in one of the following three places:

- The current *map document*. There is always a map document open in ArcMap.
- A *base template*. A kind of map document that provides a quick way to create a new map. Templates can contain data, a custom interface, and a predefined layout that arranges map elements, such as North arrows, scale bars, and logos, on the virtual page. Map templates have an .mxt file extension. There may not be a base template loaded in ArcMap.
- The *Normal template*. A special template that is automatically loaded in ArcMap. This template stores any personal settings you have made to the user interface that you want loaded every time you use ArcMap.

When you first start ArcMap after installing the software, a Normal template is automatically created and put in your profiles location, which is one of the following folders depending on your operating system:

### Windows NT®

C:\WINNT\Profiles\\Application  
Data\ESRI\ArcMap\Templates\

### Windows 2000

C:\Documents and Settings\\Application  
Data\ESRI\ArcMap\Templates\

This is the default out-of-the-box Normal template that contains all the standard toolbars and commands and places the toolbars and the table of contents in their default positions. Any customizations that you save in your Normal template get saved in this file. If you want to make changes that appear every time you open ArcMap, save them in the Normal template.

You might want to make changes that only appear when working with a particular map. For example, you might want your custom query and analysis toolbar to appear only in specific maps. In this case you would choose to save your customization in the current document. By default, all of your changes are saved in the Normal template. After you save a change in the current document, however, all subsequent changes will be saved in the current document by default.

Suppose you've created more than just a custom toolbar—you've created an entire environment with custom tools and macros that are used only when you edit a dataset's features. You can save this environment as a customized template. When you create a new map document, you can choose to base it on the Normal template or your custom template. For more information on saving customized templates, see 'Saving customizations in a template' later in this chapter.

Suppose your administrator has custom toolbars or tools that she would like to make accessible to everyone in your organization. Your administrator could create a customized Normal template and allow everyone in your organization to use that Normal template instead of the default Normal template. To accomplish this, your administrator would customize her Normal template and then copy that Normal.mxt file to the \arcexe81\bin\templates folder. Everyone would then start with this Normal template instead of the default Normal template. The following is an explanation of how this works.

If there is no Normal.mxt file in your profiles location when you start ArcMap, the application will look in the \arcexe81\bin\Templates folder where ArcMap is installed. If a Normal.mxt file exists in the \arcexe81\bin\Templates folder, that file will be copied to your profiles location and is subsequently treated as your personal Normal template. Therefore, you start off with a copy of your organization's customized Normal template, but from that point on you are able to save your own customizations to it.

If a Normal.mxt file is not found in your profiles location or in the \arcexe81\bin\Templates folder, then a new default Normal.mxt file is created and placed in your profiles location.

## Hiding and showing toolbars

In addition to the Main Menu and the Standard toolbar, ArcMap has other toolbars that contain commands to help you perform a group of related tasks. ArcMap has buttons on the Standard toolbar for quickly displaying its most commonly used toolbars. You can hide or show toolbars using the Toolbars list on the View menu or the Customize dialog box. A check mark next to a toolbar name indicates that it's visible. Note that the Main Menu appears in the toolbars list but cannot be hidden. After checking a toolbar, the application displays it as a floating toolbar on the desktop. If the toolbar was previously turned on, it returns to its last position. Toolbar position and visibility are always saved in the Normal template.

### Tip

#### Shortcut to the Toolbars list

You can access the Toolbars list without using the View menu. Simply right-click any toolbar or the status bar.

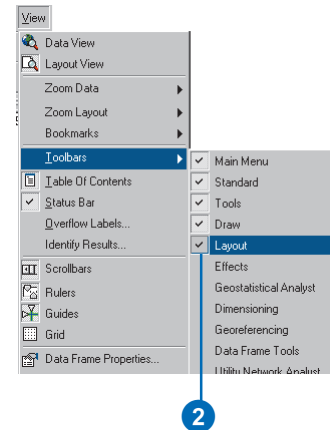
### Tip

#### Hiding floating toolbars

To quickly hide a floating toolbar, click its Close button.

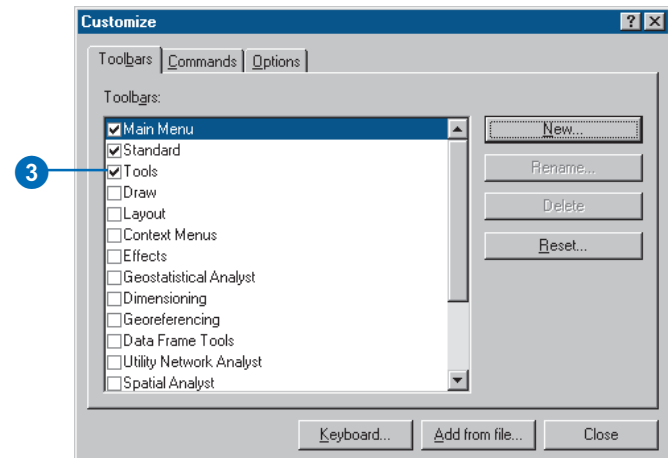
## Hiding and showing toolbars from the View menu

1. Click View and point to Toolbars.
2. Check a toolbar to show it. Uncheck a toolbar to hide it.



## Toggling toolbars from the Customize dialog box

1. Click the Tools menu and click Customize.
2. Click the Toolbars tab.
3. Check a toolbar to show it. Uncheck a toolbar to hide it.
4. Click Close.



## Creating custom toolbars

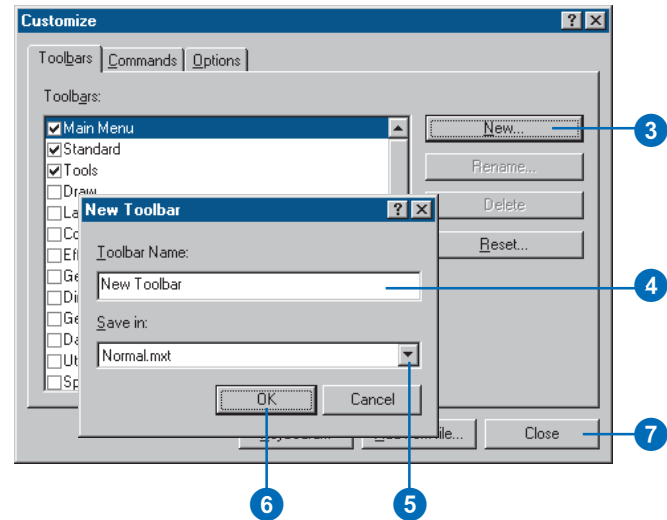
Several toolbars are provided with ArcMap, but you may want to create a new toolbar with buttons to run your custom scripts. You can rename or delete a toolbar created in ArcMap with the New button of the Customize dialog box; on the other hand, if the toolbar is built into the application or is part of an ActiveX® DLL that you added with the Add from file button, it cannot be renamed or deleted.

### Creating a new toolbar

1. Click the Tools menu and click Customize.
2. Click the Toolbars tab.
3. Click New.
4. Type in the name of your new toolbar.
5. Click the dropdown arrow of the Save in combo box and choose the template in which this toolbar will be saved.
6. Click OK.

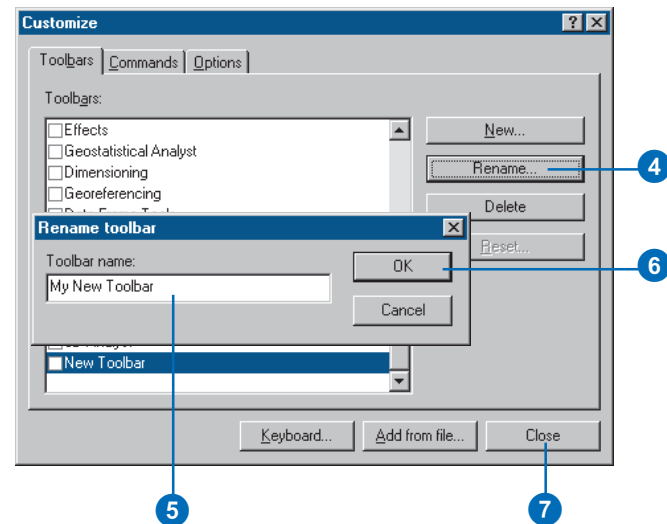
The new, empty toolbar appears in the Toolbars list and is displayed in the application as a floating toolbar.

7. Click Close.



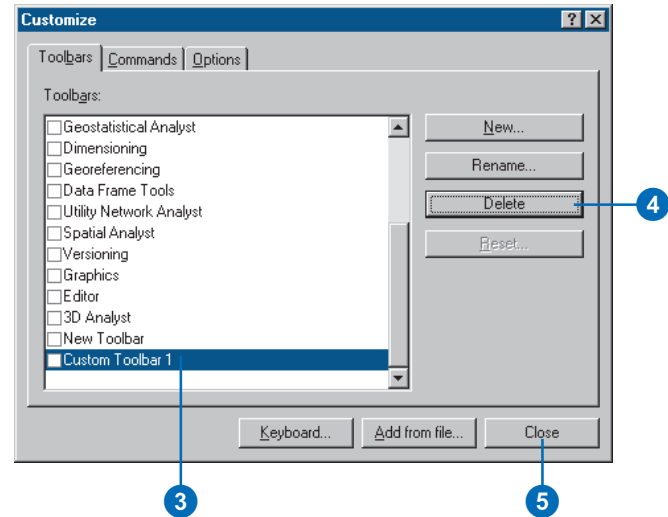
### Renaming a toolbar

1. Click the Tools menu and click Customize.
2. Click the Toolbars tab.
3. Click the toolbar you want to rename.
4. Click Rename.
5. Type the name of your toolbar.
6. Click OK.
7. Click Close.



## Deleting a toolbar

1. Click the Tools menu and click Customize.
2. Click the Toolbars tab.
3. Click the custom toolbar that you want to delete.
4. Click Delete.  
The toolbar is removed from the Toolbars list.
5. Click Close.



## Changing a toolbar's contents

You can modify the contents of any toolbar by adding, moving, and removing commands. Grouping commands together on a toolbar can help to visually separate commands used for different tasks such as browsing and querying. After modifying a built-in toolbar, you can return it to its original contents; you might want to do this if you accidentally remove a command from the toolbar.

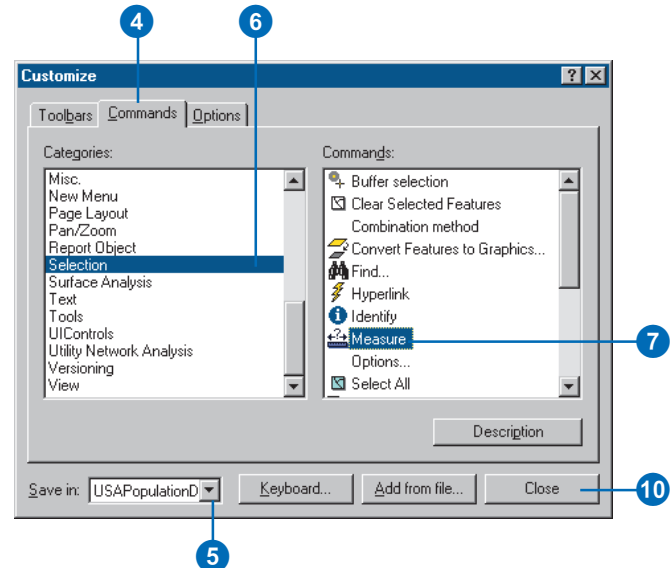
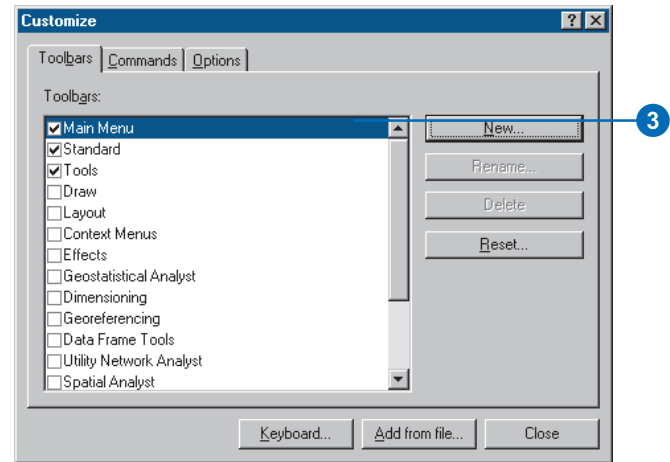
### Tip

#### About the Save in combo box

The Save in combo box appears on the Commands tab, in the New toolbar dialog, in the Reset toolbar dialog, and in the Customize Keyboard dialog. Use this setting to specify whether the change you are about to make will be saved in the Normal template, another template, or the current document.

## Adding a command to a toolbar or menu

1. Click the Tools menu and click Customize.
2. Click the Toolbars tab.
3. Make sure the toolbar you want to change is checked.
4. Click the Commands tab.
5. In the Save in combo box, click the dropdown arrow and choose the template in which the changes to the toolbar will be saved.
6. Click the category that contains the command you want to add.
7. Click the command you want to add.
8. Drag the command you want to add to any location on the target toolbar.
9. Repeat steps 6 through 8 until all the commands you want are added.
10. Click Close.





## Tip

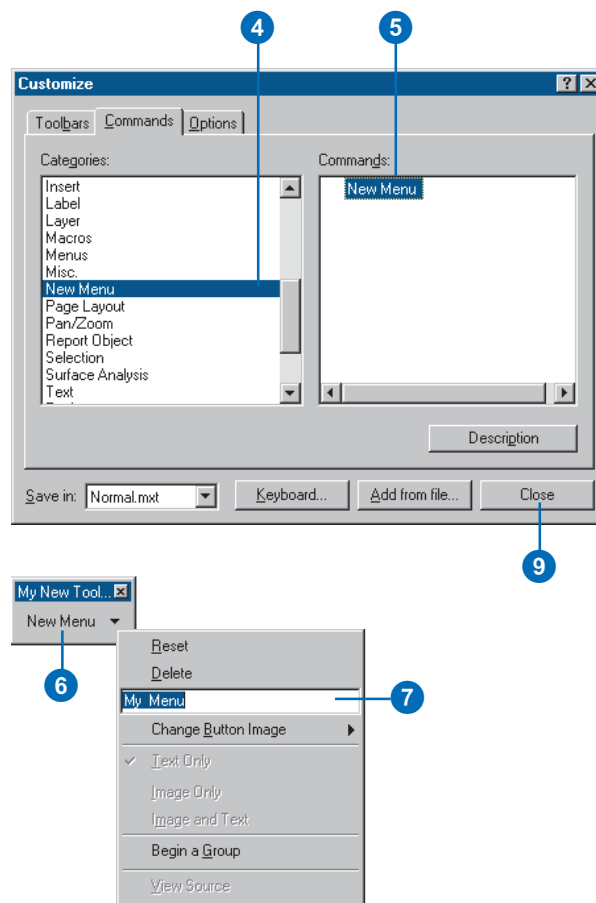
### Creating access keys

All menus on the Main Menu and their commands have an underlined character in their caption called an access key. It lets you access the menu from the keyboard by holding down *Alt* and then pressing the underlined letter. To create an access key, place an ampersand (&) in front of a letter in the menu's (or the command's) caption.

## Adding a new, empty menu to a toolbar

1. Show the toolbar to which you want to add a new, empty menu.
2. Click the Tools menu and click Customize.
3. Click the Commands tab.
4. Click New Menu in the Categories list.
5. Click and drag the New Menu command from the Commands list and drop it on the toolbar.
6. Right-click New Menu in the toolbar.
7. Type an appropriate caption for the menu in the text box.
8. Press Enter.
9. Click Close.

An empty menu called “New Menu” appears in the toolbar.



## Modifying context menus

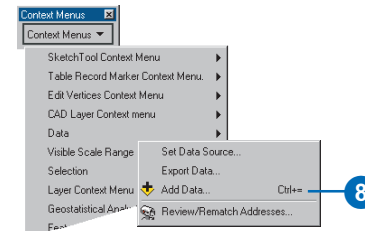
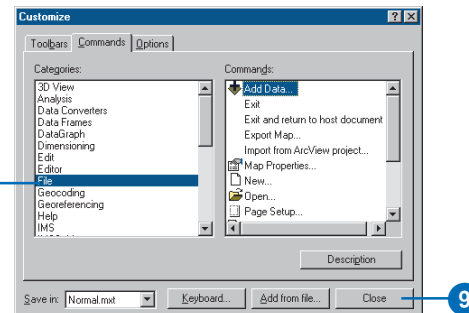
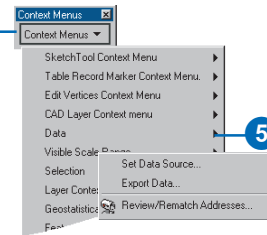
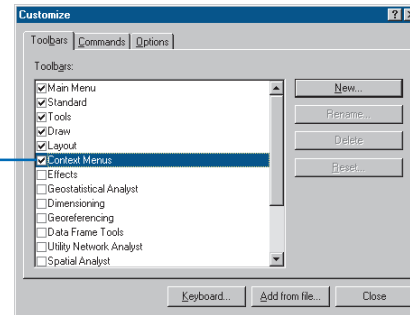
ArcMap contains several context menus to provide easy access to commands appropriate to the task at hand. By clicking the right-mouse you'll see the built-in context menus. You can add a command to any of the listed context menus should your work require it.

### Adding a command to a context menu

1. Click Tools and then click Customize.
2. Click the Toolbars tab.
3. Check the Context Menus toolbar.
4. Click Context Menus on the Context Menus toolbar.  
A list of all the context menus in the application appears.
5. Click the arrow for the context menu to which you want to add a command.

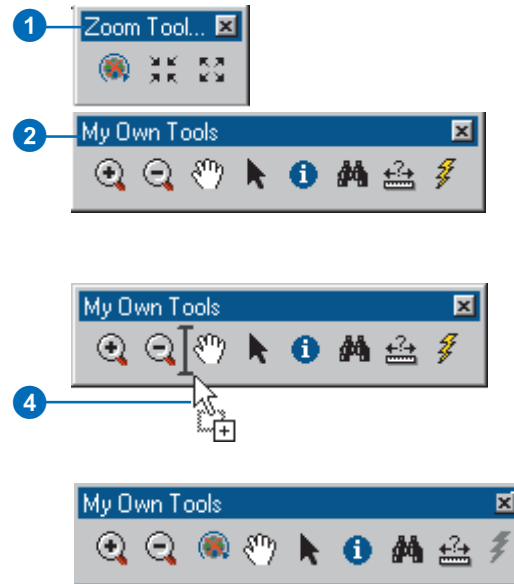
The context menu's commands are listed.

6. Click the Commands tab in the Customize dialog box.
7. Click the category that contains the command you want to add to the menu.
8. Click and drag the command from the Commands list and drop it on the context menu.
9. Click Close in the Customize dialog box.



## Moving a command

1. Show the toolbar with the command you want to move.
2. If you're moving the command to another toolbar, show the destination toolbar.
3. Click the Tools menu and click Customize.
4. Drag the command to its new position and then drop it.  
The command appears in the new position.
5. Click Close in the Customize dialog box.



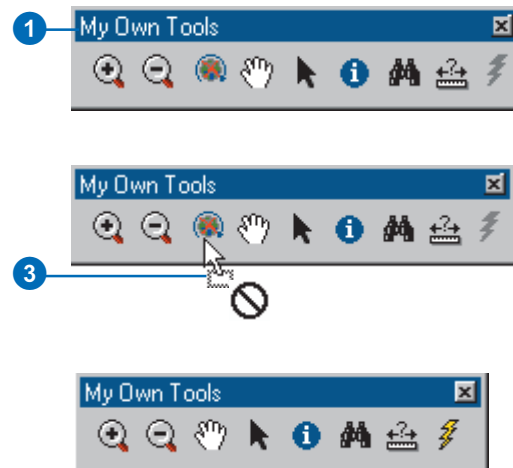
### Tip

#### Removing commands

*When you remove a command from a toolbar, you're not permanently deleting it—you're just making it unavailable on the toolbar. The command still appears in the commands list in the Customize dialog box. Later, you can always add the command to the same toolbar or to a different one.*

## Removing a command

1. Show the toolbar containing the command that you want to remove.
2. Click the Tools menu and click Customize.
3. Click and Drag the tool you want to remove from the toolbar.  
The mouse pointer changes to a line through a circle.
4. Drop the command.
5. Click Close in the Customize dialog box.



## Tip

### Why open the Customize dialog box?

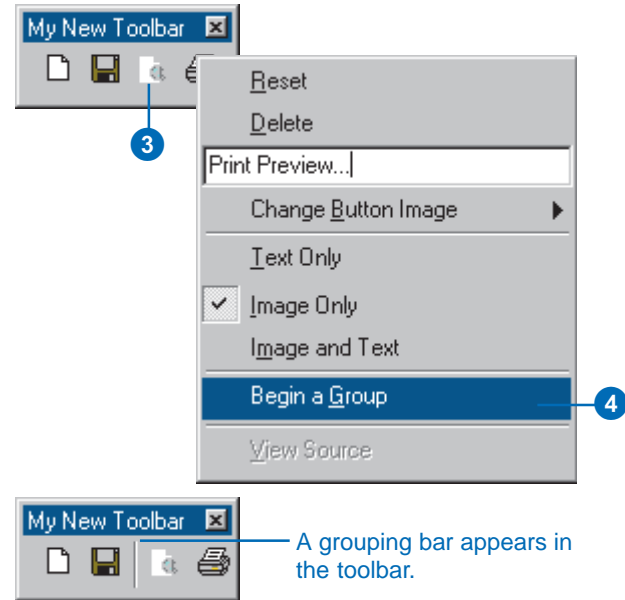
*Even though you don't make use of it in an operation such as grouping commands, you must display the Customize dialog box to place the application in a state in which you can make changes to its user interface.*

## Grouping commands

1. Show the toolbar containing the commands that you want to group together.
2. Click the Tools menu and click Customize.
3. On the toolbar, right-click the command located to the right of where the grouping bar should be placed.
4. Click Begin a Group.

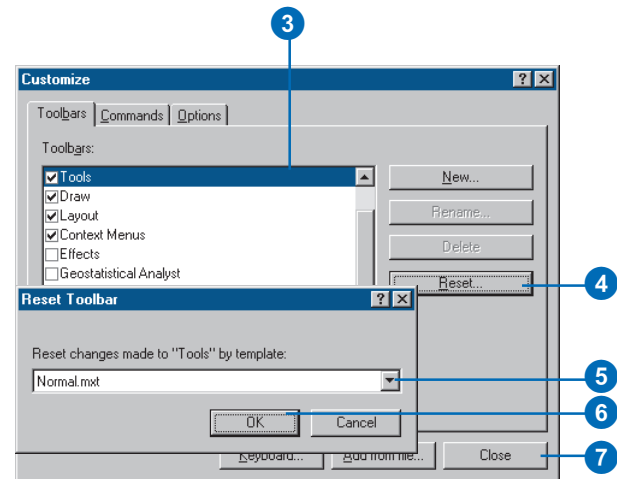
A grouping bar appears in the toolbar.

5. Click Close in the Customize dialog box.



## Resetting a built-in toolbar

1. Click the Tools menu and click Customize.
2. Click the Toolbars tab.
3. Click the built-in toolbar that you want to reset.
4. Click Reset.
5. Click the dropdown arrow and choose the template in which the changes to the toolbar settings were made.
6. Click OK.
7. Click Close.



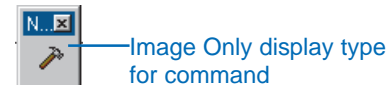
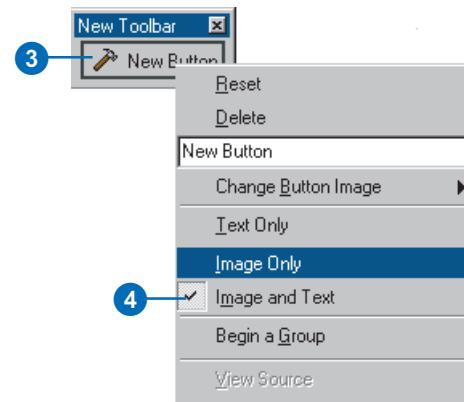
## Changing a command's appearance

You can modify the display type, caption, and image of a menu, button, or tool without programming. By default, a button or tool dropped directly onto a toolbar has the display type Image Only, while it has the display type Image and Text when dropped onto a menu. Menus can only have the display type Text Only. The caption is the text that appears with the appropriate display types. Menus and their contents can be accessed from the keyboard by holding down Alt and then pressing the underlined letter. Create one of these access keys by typing an ampersand (&) in front of a letter in the caption.

Other properties, such as ToolTip and Message, can only be modified with programming. When you hold the mouse pointer over a command, its ToolTip displays as a short message in a floating yellow box. A command's Message displays in the status bar.

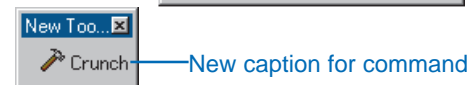
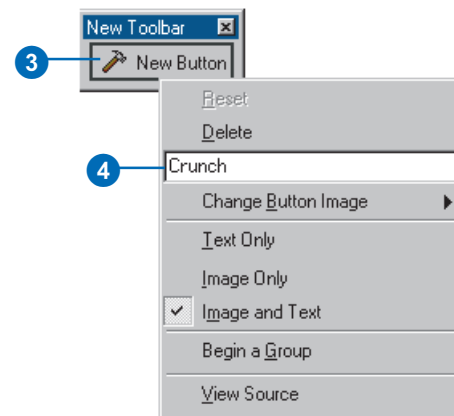
## Changing the display type

1. Show the toolbar containing the command whose display type you want to change.
2. Click the Tools menu and click Customize.
3. On the toolbar, right-click the command you want to change.
4. Check Image Only to display only the command's image. Check Text Only to display only the command's caption. Check Image and Text to display both.
5. Click Close in the Customize dialog box.



## Changing the caption

1. Show the toolbar containing the command whose caption you want to change.
2. Click the Tools menu and click Customize.
3. In the toolbar, right-click the command you want to change.
4. Type a new caption in the text box on the context menu.
5. Press Enter. The new caption is applied.
6. Click Close in the Customize dialog box.



## See Also

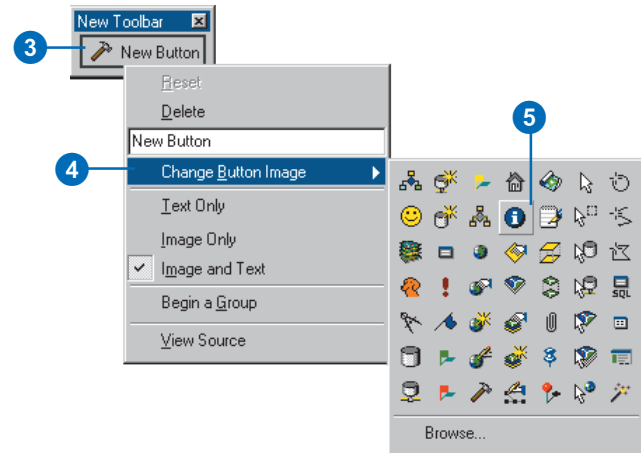
To learn how to set the properties of commands in code, see the *ArcObjects™ Developer Help*.

## Changing the icon

1. Show the toolbar containing the command whose image you want to change.
2. Click the Tools menu and click Customize.
3. In the toolbar, right-click the command you want to change.
4. Point to Change Button Image.
5. Click one of the images displayed. Or click Browse, navigate to a custom image, and then click Open.

The new image is applied. It appears in the toolbar if the display type is Image Only or Image and Text.

6. Click Close in the Customize dialog box.

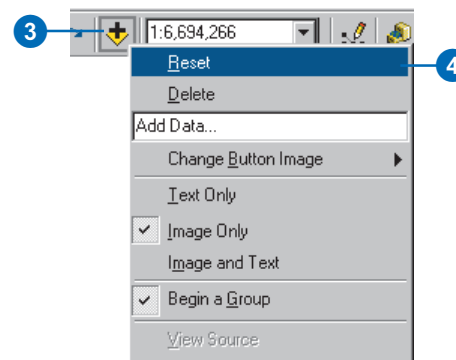


## Resetting a built-in command

1. Show the toolbar with the command you want to reset.
2. Click the Tools menu and click Customize.
3. In the toolbar, right-click the command you want to change.
4. Click Reset.

The command returns to its default settings.

5. Click Close in the Customize dialog box.



## Creating shortcut keys

When you access a menu from the keyboard using its access key, the menu opens and you can see its contents. In contrast, a command's shortcut key executes the command directly without having to open and navigate the menu first. For example, Ctrl+C is a well-known shortcut for copying something in Windows. One command can have many shortcuts assigned to it, but each shortcut can only be assigned to one command. A command's first shortcut is displayed to its right when the command appears in a menu.

## Assigning a shortcut key

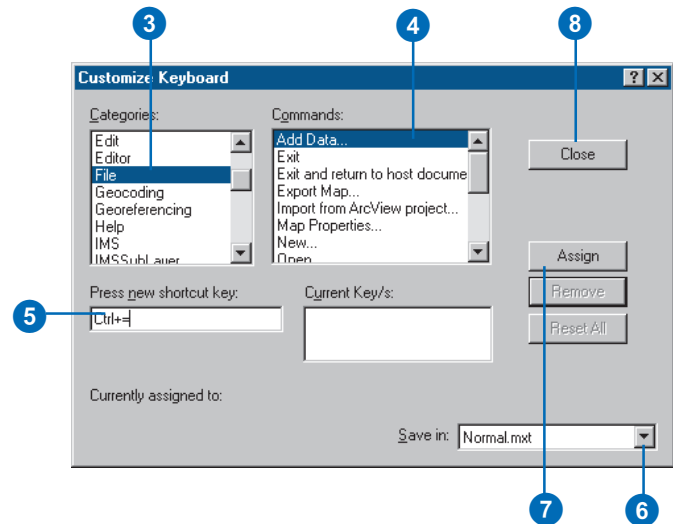
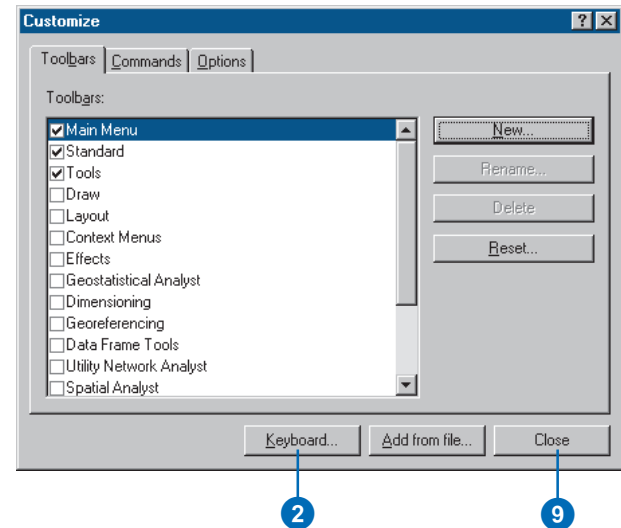
1. Click the Tools menu and click Customize.
2. Click Keyboard.
3. Click the category containing the command you want to modify.
4. Click the command to which you want to add a keyboard shortcut.
5. Click in the Press new shortcut key text box and then press the keys on the keyboard that you want to use for a shortcut.

If those keys have been assigned to another command, that command's name will appear below.

6. Click the dropdown arrow and choose the template in which the shortcut key will be saved.
7. Click Assign if the keys aren't currently assigned to another command.

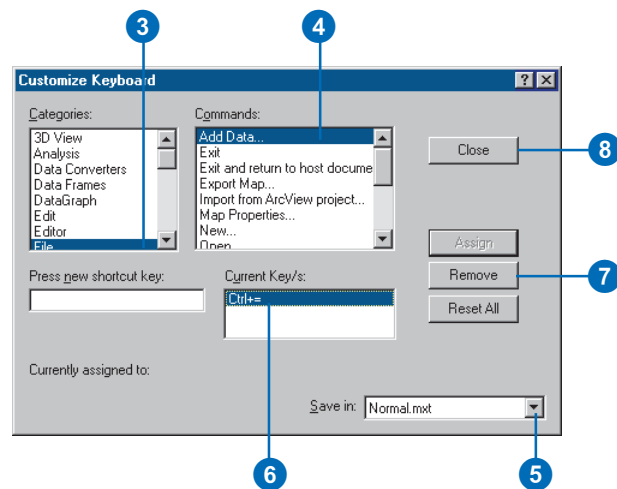
The new shortcut appears in the Current Key/s list.

8. Click Close in the Customize Keyboard dialog box.
9. Click Close in the Customize dialog box.



## Removing a keyboard shortcut key

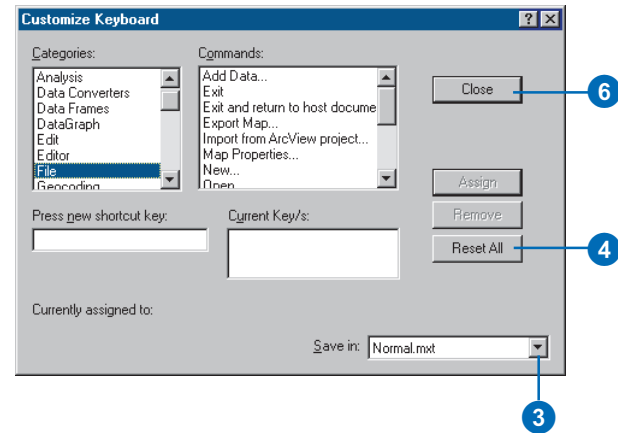
1. Click the Tools menu and click Customize.
2. Click Keyboard.
3. Click the category that contains the command you want to modify.
4. Click the command from which you want to remove a keyboard shortcut.
5. Click the dropdown arrow in the Save in combo box and choose the template from which to delete the shortcut key setting.
6. Click the shortcut in the Current Key/s list that you want to delete.
7. Click Remove.
8. Click Close in the Customize Keyboard dialog box.
9. Click Close in the Customize dialog box.





## Resetting built-in shortcut keys

1. Click the Tools menu and click Customize.
2. Click Keyboard.
3. Click the dropdown arrow in the Save in combo box and choose the template whose shortcut keys will be reset.
4. Click Reset All.
5. Click Yes when asked if you want to reset your shortcuts.
6. Click Close in the Customize Keyboard dialog box.
7. Click Close in the Customize dialog box.



## Saving customizations in a template

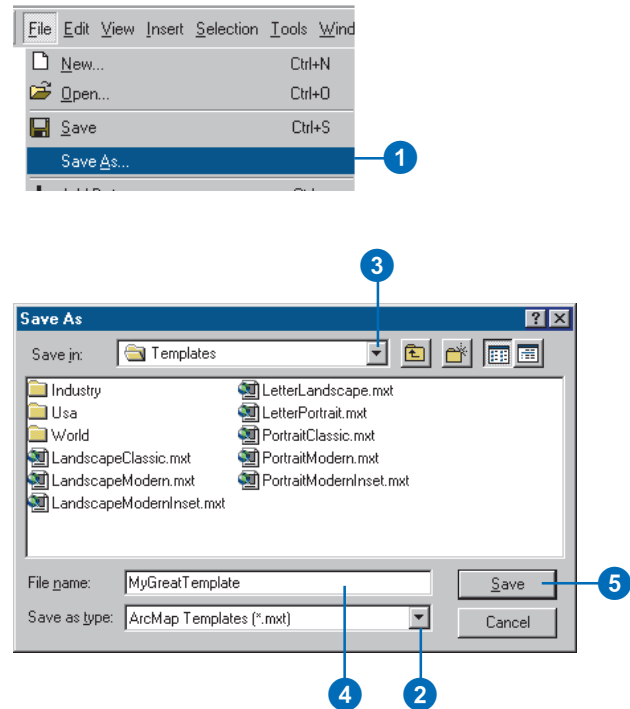
If you create a map that contains customizations or code you'd like to use as the basis for other maps, or if you modify an existing template and want to use it again, you can save it as a template. The template will contain all customizations that were made graphically as well as any modules created in the Visual Basic Editor.

You can save a map template anywhere on your network. When you want to use the template, you can open it from ArcMap.

If you save a template in the ArcMap Templates folder, the `\arcexe81\bin\templates` folder where you have installed ArcMap, it will show up in the list of templates on the New map document dialog box. You can also create subfolders in this folder, and they'll show up as separate tabs on this dialog box—when you click each tab you'll see the templates in that folder.

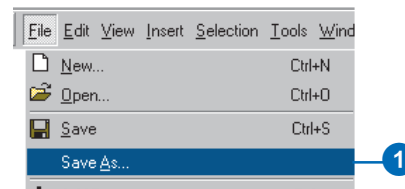
## Saving a template

1. Click File and click Save As.
2. Click the dropdown arrow and click ArcMap Templates.
3. Navigate to the folder where you want the template saved (for example, the default templates folder `arcexe81\bin\templates`).
4. Type a name for the new template.
5. Click Save.



## Saving a template so it will appear in a new tab

1. Click File and click Save As. ►



## Tip

### Regenerating Normal.mxt

If you save customizations to ArcMap's Normal.mxt template, and later decide that you'd like to reset the entire template to its original settings, delete the file. ArcMap will regenerate Normal on startup if it is missing.

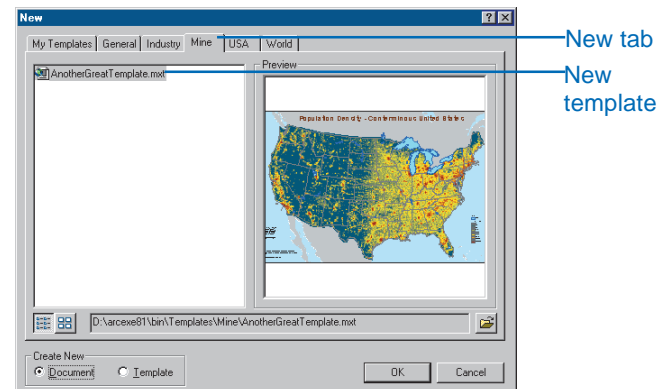
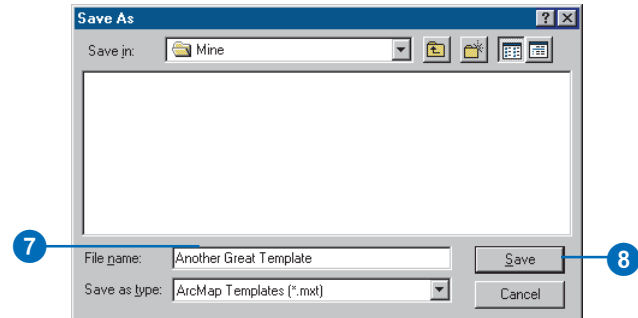
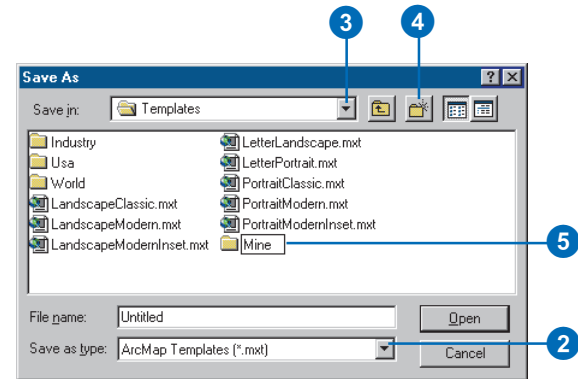
## Tip

### Making changes to an existing template

If you want to open a template as a document in order to make changes to it, use *Open* in the *File* menu. If you open the template using the "Open an existing map" option on the *Startup* dialog box or by double-clicking on the template filename, you'll create a new document based on your template instead of just opening your template as a document. This new document has a reference to your template. If you were to try to save this document as your template again, you'll get a save error because essentially you are trying to create a template that references itself.

2. Click the dropdown arrow and click ArcMap Templates.
3. Navigate to the Templates folder.
4. Click the New Folder button.
5. Type the name of the new folder—this name will appear on the New map document dialog box as a tab.
6. Double-click the new folder.
7. Type the name of the new template.
8. Click Save.

The next time you start a map from a template, you'll see a new tab with your template on the New map dialog box.



## Changing where customization changes are saved by default

By default, all customization changes you make to the user interface get saved to the Normal template, unless you select either another template or the current document in the Save in combo box before making the change. You may prefer to save all of your customizations to the current document by default. This means that unless you specify differently in the Save in combo box, all of your changes will get saved in the current document.

### Tip

#### Default document or template

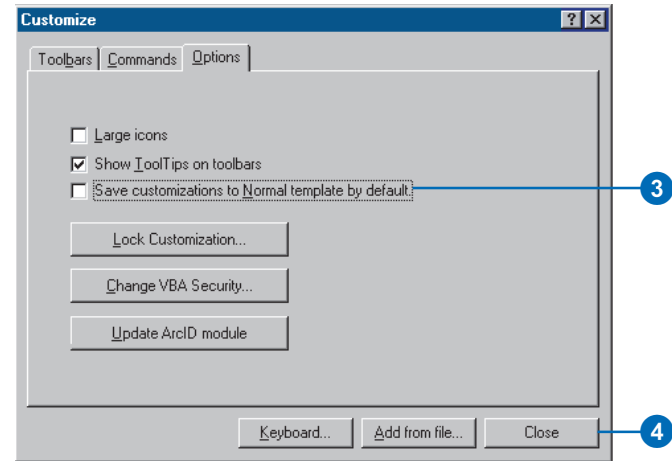
*Once you choose the document as the default for customization changes, this default setting will be in effect every time you start ArcMap—that is, until you check Save customizations to Normal template, making the Normal template the default template again.*

## Saving customizations to the document by default

1. Click the Tools menu and click Customize.
2. Click the Options tab.
3. Uncheck Save customizations to Normal template by default.

Changes are now saved to the current document by default.

4. Click Close.



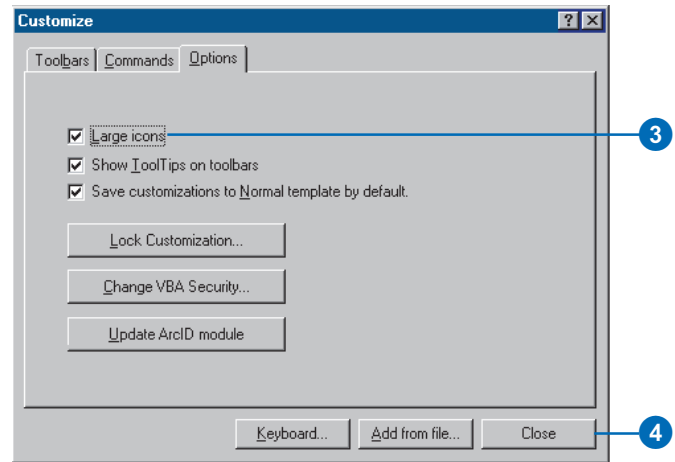
## Setting toolbar options

The Options tab in the Customize dialog box lets you specify the size of icons on commands and whether ToolTips will appear on all the toolbars in ArcMap when you hold the mouse pointer over a command.

Later, this chapter shows how the Options tab also provides a means to lock or unlock the Customize dialog box, the Macros dialog box, and the Visual Basic Editor. In addition, you can use the Options tab to change VBA security and update the status of the Normal template's ArcID module.

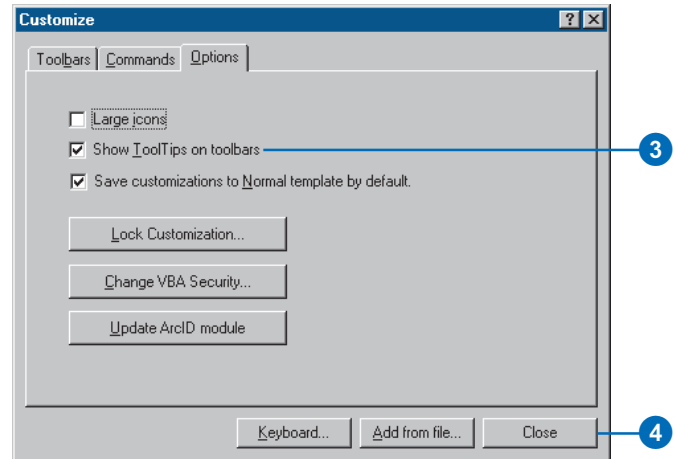
## Displaying toolbars with large icons

1. Click the Tools menu and click Customize.
2. Click the Options tab.
3. Check Large icons to display large icons for a toolbar's commands.
4. Click Close.



## Showing ToolTips on toolbars

1. Click the Tools menu and click Customize.
2. Click the Options tab.
3. Check Show ToolTips on toolbars to display ToolTips for the commands on a toolbar.
4. Click Close.



## Creating, editing, and running macros

ArcMap comes with Visual Basic for Applications. VBA is not a standalone program. It provides an integrated programming environment, the Visual Basic Editor (VBE), that lets you write a Visual Basic (VB) macro and then debug it right away in ArcMap. A macro can integrate some or all of VB's functionality with the extensive object library available through ArcMap. The ESRI Object Library is always available to you in the VBA environment.

In the VBE in ArcMap, there can be up to three VBA projects. The document, the base template, and the Normal template all have a VBA project. The VBA project for the Normal template is called Normal (Normal.mxt). The VBA project for the current document is called Project (<NameofDoc>.mxd). The VBA project for the base template is called TemplateProject (<NameofTemplate>.mxt). Macros can be stored in any of these VBA projects depending on where you want the code to be available. ►

### Creating a macro in the Visual Basic Editor

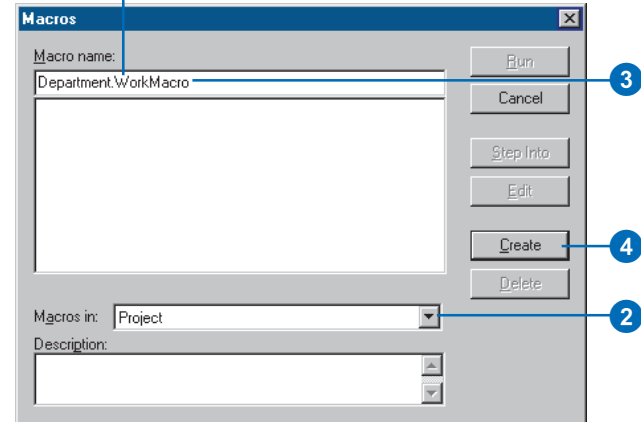
1. Click the Tools menu, point to Macros, then click Macros.
2. Click the dropdown arrow in the Macros in combo box, then click the document or template in which you want to create this macro.
3. Type the name of the macro you want to create in the Macro name text box.
4. Press the Enter key or click Create.

The stub for a Sub procedure for the macro appears in the Code window.

If you don't specify a module name, the application stores the macro in a module named NewMacros.

5. Type the code for the macro.
6. Click the VBE File menu and click Save Project.

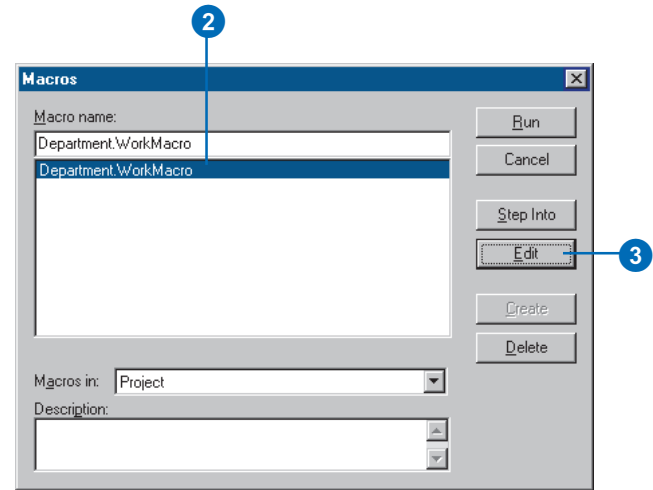
Preceding the name of a macro with a module's name and a dot stores it in the specified module.



When you create a macro, you're creating a VB Sub Procedure. The procedure's name is the name you assign to the macro. You add code to the procedure in a Code window just as you would in VB. You can organize your macros in different modules; each module has its own Code window. To add your macro to a specific module, type the module name before the macro's name, for example, "Department.WorkMacro". If the module doesn't exist, a new module with that name is created for you and added to the VBA project. Similarly, if you provide a name for a new macro, but don't specify which module to store it in, a new module "NewMacros" is created. Using modules makes it easier to share your VB code with others. You can export a module to a .bas file from, and import a .bas file to, your VBA project.

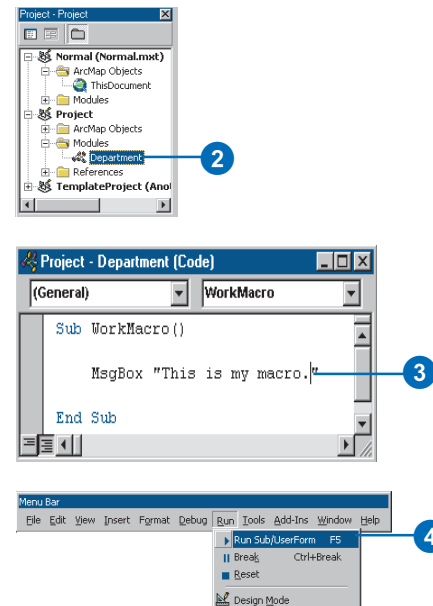
## Editing a macro in the Visual Basic Editor

1. Click the Tools menu, point to Macros, then click Macros.
  2. In the list below the Macro name text box, click the name of the macro you want to edit.
  3. Click Edit.
- The code that's been written for the macro appears in the Code window.
4. Edit the code.
  5. Click the VBE File menu and click Save Project.
  6. Click Close to close the VBE.



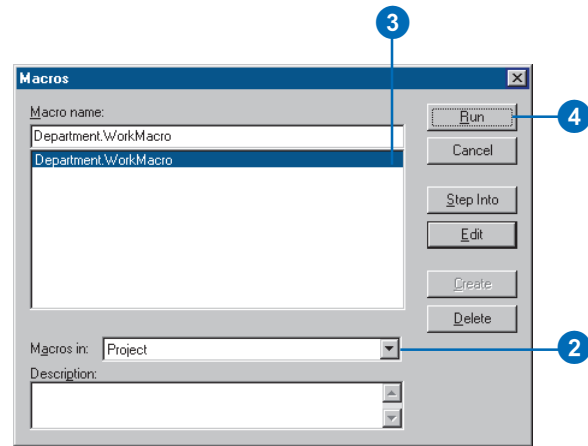
## Running a macro in the Visual Basic Editor

1. Click the Tools menu, point to Macros, and click Visual Basic Editor.
  2. In the VBE Project window, double-click ThisDocument or the module containing the macro that you want to run.
- The Code window for that module appears.
3. Position the cursor inside the appropriate Sub procedure.
  4. Click the VBE Run menu and click Run Sub/UserForm.



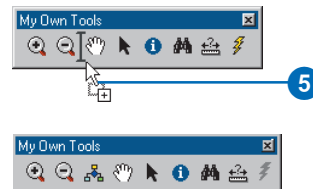
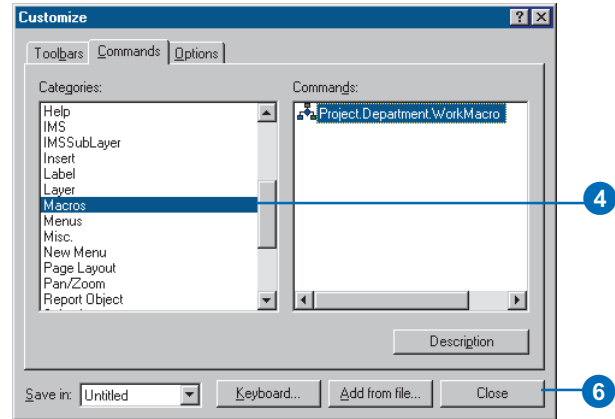
## Running a macro in the Macros dialog box

1. Click the Tools menu, point to Macros, then click Macros.
2. Click the Macros in dropdown arrow and select the document or template containing the Macro you want to run.
3. Type the name of the macro you want to run or select it from the list that appears.
4. Click Run.



## Adding a macro to a toolbar or menu

1. Show the toolbar to which you want to add a macro.
2. Click the Tools menu and click Customize.
3. Click the Commands tab.
4. Click Macros in the Categories list.
5. Click and drag the macro from the Commands list and drop it on the toolbar.
6. Click Close.





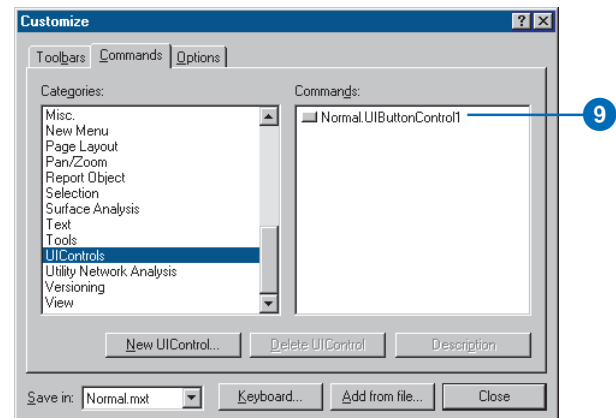
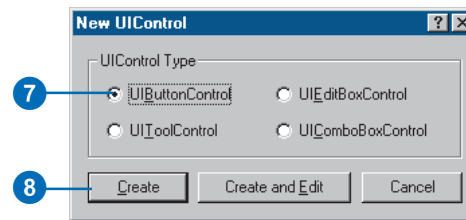
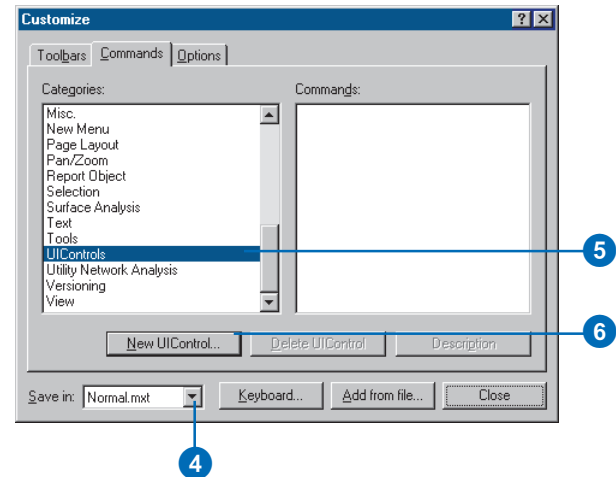
## Creating custom commands with VBA

An extensive object library is available in VBA in ArcMap. For example, ArcMap exposes a Map, a PageLayout, a LineFillSymbol, and so on. The ArcObjects Developer Help describes the classes, interfaces, properties, methods, and enumerations that are available in the development environment that is built into ArcMap.

Toolbars and commands are COM objects, too. To be a command, the object must meet a basic set of requirements for all commands. To be a tool, the object must also satisfy tool requirements. The customization environment makes it easy for you to create custom commands with VBA. You create a new button, tool, combo box, or edit box (collectively called UIControls) in the Customize dialog box, then attach code to that object's control events. After you have created it, you can drag this new control onto a toolbar.

## Creating a new command

1. Show the toolbar to which you want to add a new command.
2. Click the Tools menu and click Customize.
3. Click the Commands tab.
4. Click the dropdown arrow on the Save in combo box and click the document or template in which the new command will be saved.
5. Click UIControls in the Categories list.
6. Click New UIControl.
7. Click the type of UIControl you want to create.
8. Click Create to create the control without attaching code to it.
9. Click the newly created UIControl, click it again to activate in-place editing, and type a new name for the UIControl. ▶



- Click and drag the newly created UIControl and drop it on a toolbar or menu.
- On the toolbar or menu, right-click the control to set its image, caption, and other properties.

- Right-click the new control and then click View Source.

The Visual Basic Editor appears, displaying the control's code in the code window.

- Click the Procedures\Events dropdown arrow and click one of the control's event procedures.

- Type code for the event procedure.

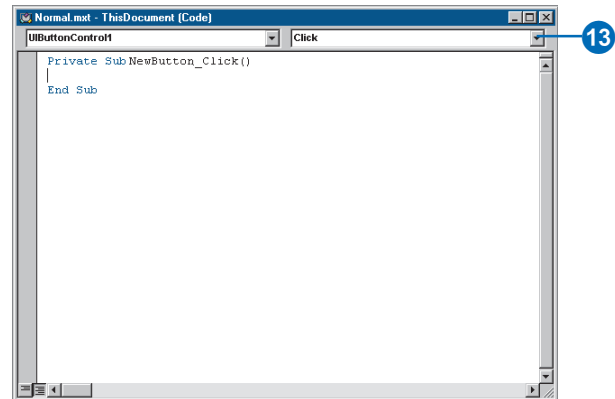
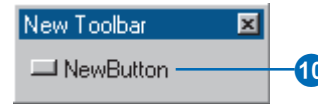
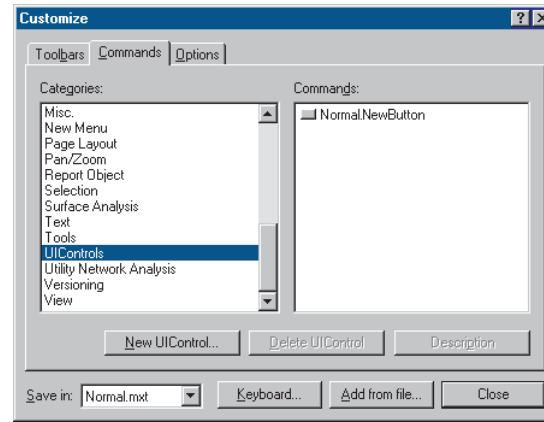
- Repeat steps 13 and 14 until all the appropriate event procedures have been coded.

- Click Save in the Visual Basic Editor.

- Click the Close button in the Visual Basic Editor.

- If you clicked Create and Edit in step 8, open the Customize dialog box, click the Commands tab, and drag the newly created UIControl from the commands list to a toolbar or menu.

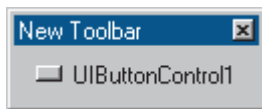
- Click Close in the Customize dialog box.



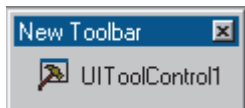
## Working with UIControls

If you create a macro and add it to a toolbar, you've essentially customized what happens when you click the button. UIControls, however, provide a way to enrich an application in addition to button clicks and menu selections. The event procedures associated with these controls allow you to respond to user interaction and update controls based on the state of the application. If you create a combo box or an edit box, you might be able to avoid using a dialog box to get information.

The *UIButtonControl* works similarly to the built-in buttons that come with the application. Typically, you use a *UIButtonControl* to start, end, or interrupt an action or series of actions. You can write code to set whether it appears enabled or appears as if it is pressed in. You can also set its *ToolTip*, provide a message that will appear in the status bar, and respond to its *Click* event.

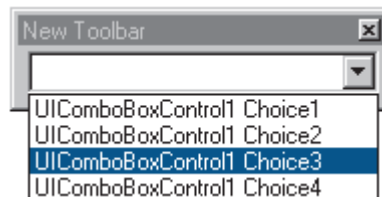


The *UIToolControl* works similarly to the built-in tools that come with the application. Typically, you use a *UIToolControl* to perform some type of interaction with the display. You can write code to toggle whether the tool appears as enabled or set its *ToolTip*. You can respond to mouse and key events. In addition, you can have it respond when the user selects the tool, double-clicks it, or right-clicks it. The *UIToolControl* can respond when the map refreshes or when the tool is deactivated.

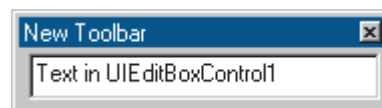


The *UIComboBoxControl* works similarly to the combo boxes that appear as part of the interface. It combines the features of a text box and a list box. Typically, you use a *UIComboBoxControl*

to provide a set of choices from which a selection can be made. You can also type into the edit box portion of the control. The combo box has methods that allow you to populate its list or remove individual or all items. Several properties associated with the combo box let you work with items, return the index of the selected item, return the text at a specific index, return the text in the control's edit box, and determine how many items are in the control. In addition, you can respond to several events including when the user makes a change in the edit portion of the control or when a change to the selection occurs. As with the *UIButtonControl*, you can set the control's *ToolTip* and provide a status bar message.



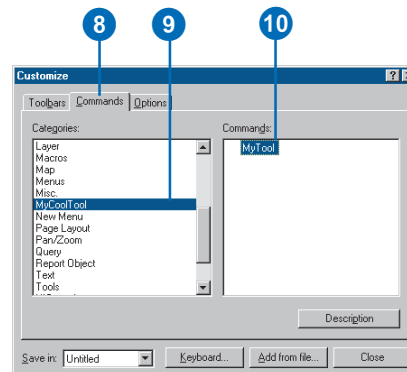
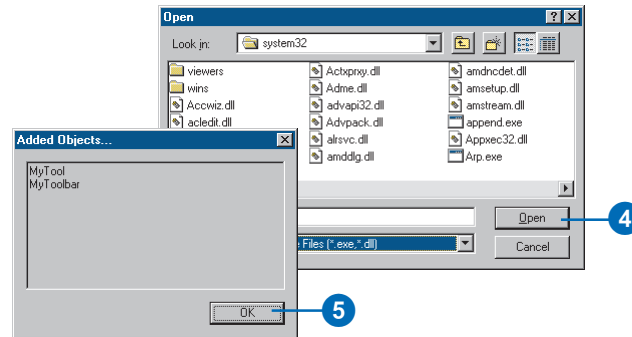
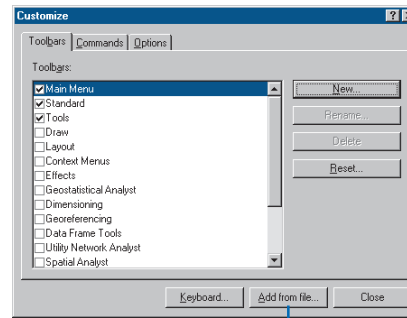
The *UIEditBoxControl* works similarly to the edit boxes that appear as part of the interface. Typically, you use a *UIEditBoxControl* to display information entered by the user. The control can also display data derived from an external source. You can use its *Clear* method to remove its contents, and its *Text* property contains the text that's displayed. You can specify whether the control appears as enabled. In addition, you can respond to when the user makes a change or presses a key. As with the *UIButtonControl*, you can set this control's *ToolTip* and provide a status bar message.



# Adding custom commands

You don't have to use VBA to create custom commands. In fact, in some cases your custom commands may require you to use another development environment. You can create custom objects in any programming language that supports the Component Object Model (COM). Custom commands or toolbars created outside VBA are often distributed as ActiveX dynamic-link libraries (DLLs). After adding a custom object into ArcMap, you can use it as you would any built-in command.

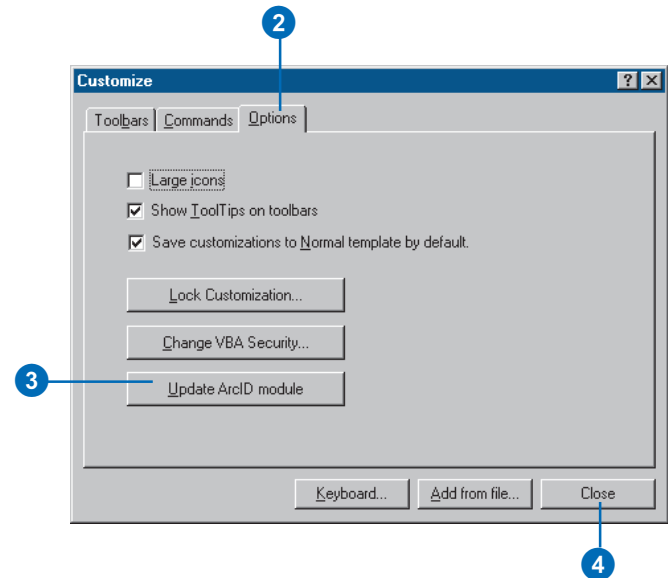
1. Click the Tools menu and click Customize.
2. Click Add from file.
3. Navigate to the file containing the custom command.
4. Click the file and click Open.  
The Added Objects dialog box appears, reporting which new objects have been registered with ArcMap.
5. Click OK.
6. Click the Toolbars tab.
7. Check the toolbar to which you want to add the custom command.
8. Click the Commands tab.
9. Click the custom command's category in the Categories list.
10. Click and drag the command from the Commands list and drop it on the toolbar.
11. Click Close.



## Updating the ArcID module

If you are developing applications or writing macros that make use of COM objects that you've added in, you can update the Normal.ArcID module to include newly added commands. In this way, you'll be able to refer to the COM objects you've added in by name when using a method such as `CommandBars.Find`. Updating also allows you to keep Normal.ArcID up to date should you remove a command.

1. Click the Tools menu and click Customize.
2. Click the Options tab.
3. Click Update ArcID module.
4. Click Close.



```
CommandBars.Find(ArcId.
```



*Using VB's code completion feature, you can list the commands that have been added to the ArcID module.*

# Locking customization, documents, and templates

In order to protect proprietary or sensitive information or work in progress or to prevent others from changing the way you've customized a document or template, you can use the Lock Customization facilities provided in the Options tab of the Customize dialog box. In addition, Lock Customization prevents access to the Macros dialog box and the Visual Basic Editor. For locking individual documents or templates while still allowing access to the Visual Basic Editor, you can use the Protection tab of the VBA Project Properties dialog box. This dialog lets you password protect the ArcMap document or template you've saved.

## See Also

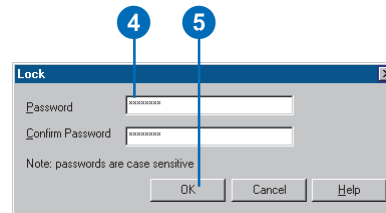
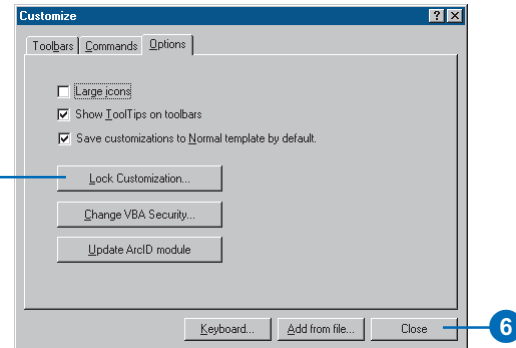
*You can create your own customization filter to control what aspects of the customization environment other users will have access to. For an example written in VB, see the ArcObjects Developer Help.*

## Locking customization

1. Click the Tools menu and click Customize.
2. Click the Options tab.
3. Click Lock Customization.
4. In the dialog box that appears, enter a password that has at least five alphanumeric characters and then confirm it.

To use the Customize dialog box, the Macros dialog box, or the Visual Basic Editor with the document or template subsequently, the correct password must be supplied.

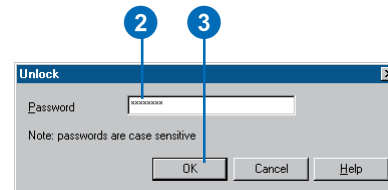
5. Click OK in the Lock dialog box.
6. Click Close.



## Unlocking customization

1. Click Tools, then click Customize.
2. Enter the password to unlock your selection.
3. Click OK.

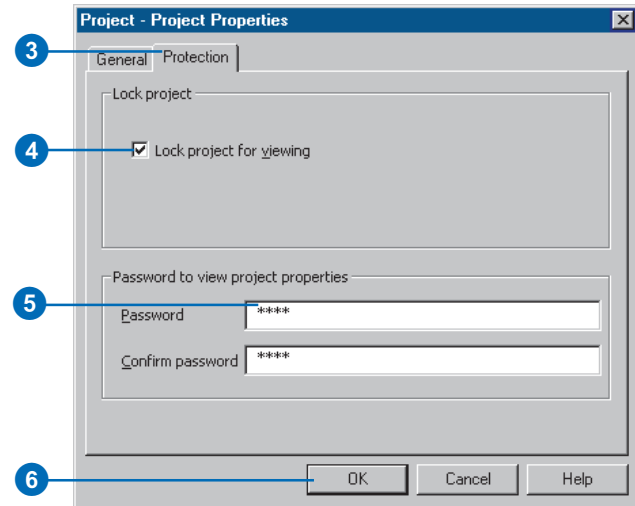
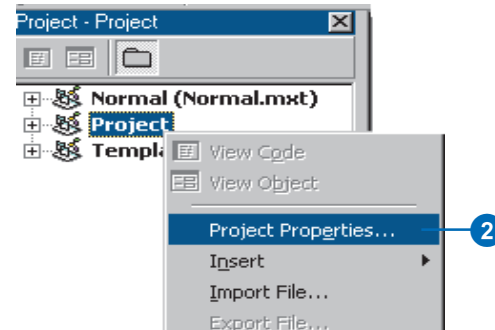
The Unlock dialog box appears. If you specify an incorrect password, a message appears.



## Locking documents and templates

1. Click the Tools menu, point to Macros, and then click Visual Basic Editor.
2. In the Project Explorer, right-click the project or template you want to lock and then click Project Properties.
3. Click the Protection tab.
4. Check Lock project for viewing to lock the project so that it cannot be viewed or edited.
5. Type a password and confirm it.
6. Click OK in the Project Properties dialog box.
7. Click Save Project.

The next time someone opens the Project and attempts to view the Project Properties, they'll be prompted for a password.



## Changing VBA security

A macro virus is a type of computer virus that's stored in a macro within a document, template, or add-in. When you open such a document or perform an action that triggers a macro virus, the macro virus might be activated, transmitted to your computer, and stored in your Normal template. From that point on, every document you open could be automatically "infected" with the macro virus; if others open these infected documents, the macro virus is transmitted to their computers.

ESRI applications offer the levels of security described in the Security dialog box to reduce the chances of macro viruses infecting your documents, templates, or add-ins.

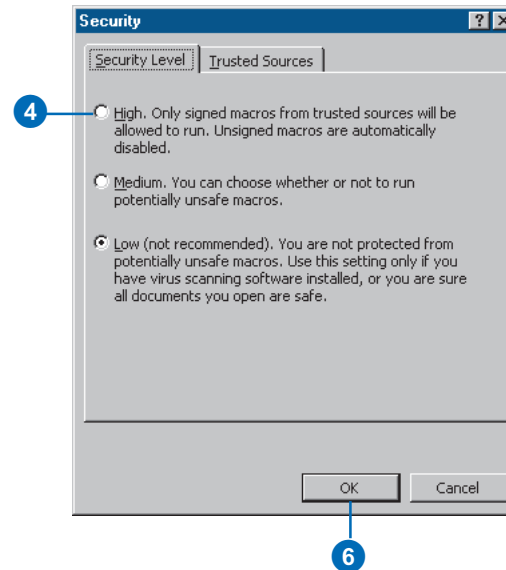
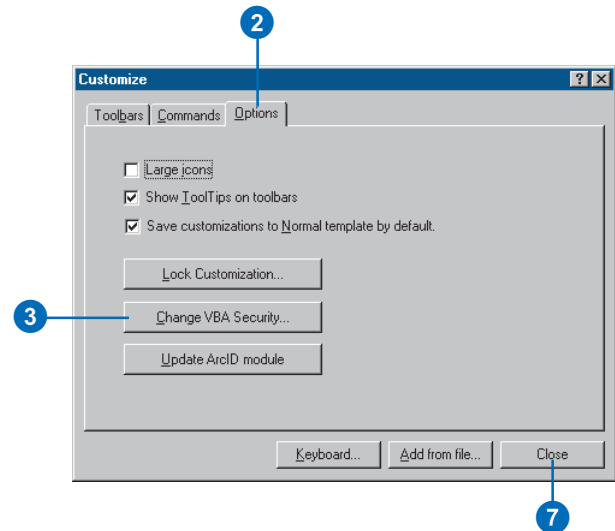
### See Also

*To learn more about using digital signatures and about how security levels and digital signatures work together, see the Microsoft Visual Basic Help in the VBE.*

1. Click the Tools menu and click Customize.
2. Click the Options tab.
3. Click Change VBA Security.
4. Click the level of security you want.
5. Click the Trusted Sources tab to see a list of the names of organizations or individuals whose signed macros will be allowed to run.

When you check the Always trust macros from this source check box in the Security Warning dialog box, which appears when you open a document or template with macros, this digital certificate is added to the Visual Basic for Applications Trusted Sources list.

6. Click OK.
7. Click Close.





# Glossary

## **active data frame**

The data frame you're currently working with, for example, adding layers to. The active data frame is shown in bold text in the table of contents.

## **address matching**

The process of assigning x,y coordinates to addresses so they can be displayed as points on a map.

## **alias**

Another name for a field in a table.

## **ArcInfo workspace**

See coverage.

## **attribute**

A characteristic of a map feature. Attributes of a river might include its name, length, average depth, and so on.

## **attribute table**

Information about features on a map, stored in rows and columns. Each row relates to a single feature; each column contains the values for a single characteristic.

## **Attributes dialog box**

A dialog box that lets you view and edit attributes of features you've selected.

## **band**

A measure of some characteristic or quality of the features being observed in a raster. Some rasters have a single band; others have more than one. For example, satellite imagery commonly has multiple bands representing different wavelengths of energy from along the electromagnetic spectrum.

## **barrier**

An object that is placed on a map to specify a place in a network past which a trace cannot continue.

## **CAD**

Computer-aided design. An automated system for the design, drafting, and display of graphically oriented information.

## **candidates**

A record from a geocoding reference data source that is a potential match for an address.

## **cell**

A discretely uniform unit—such as a square meter or square mile—that represents a portion of the earth in a raster. A cell has a value that corresponds to the feature or characteristic at that site such as a soil type, census tract, or elevation.

## **chart**

A graphic representation of tabular data. Also referred to as a graph.

## **class**

A group or category of attribute values.

## **classifying**

The process of sorting or arranging attribute values into groups or categories; all members of a group are represented on the map by the same symbol.

## **cluster tolerance**

The distance range in which all vertices and boundaries in a shapefile or feature dataset are considered identical, or coincident, when you run the Integrate command from the Editor menu.

For example, if the cluster tolerance is set to 10 map units, after running Integrate there will be no more than one vertex within 10 map units of another.

## **coincident**

See cluster tolerance.

## **color ramp**

A range of colors used in a map to show ranking or order of feature attributes.

## **control points**

Points you establish on a paper map to represent known ground points or specific locations. Control points are used to register a paper map before you begin digitizing features on it with a digitizer.

## **coordinate system**

A method for specifying the location of real-world features on the surface of the earth.

## **coverage**

A vector data storage format for storing the location, shape, and attributes of geographic features. One of the primary vector data storage formats for ArcInfo. Coverages are stored in an ArcInfo workspace.

## **current task**

The setting of the Current Task dropdown list that determines with which task the sketch construction tools (Sketch, Arc, Distance–Distance, and Intersection) will work.

The current task is set by clicking a task in the Current Task dropdown list. All tasks in the Current Task dropdown list work with a sketch that you create. For example, the Create New Feature task uses a sketch you create to make a new feature. The Extend/Trim Feature task uses a sketch you create to determine where the selected feature will be extended or trimmed. The Cut Polygon Feature task uses a sketch you create to determine where the polygon will be cut.

**data**

A collection of related facts usually arranged in a particular format and gathered for a particular purpose.

**data frame**

A frame on the map that displays layers occupying the same geographic area. You may have one or more data frames on your map depending on how you want to organize your data. For instance, one data frame might highlight a study area, and another might provide an overview of where the study area is.

**data source**

Any geographic data such as a coverage, shapefile, raster, or geodatabase.

**data view**

An all-purpose view for exploring, displaying, and querying geographic data. This view hides all map elements such as titles, North arrows, and scale bars. See also layout view.

**database**

A collection of related files organized for efficient retrieval of information.

**dataset**

Same as data source.

**decimal degrees**

Degrees of latitude and longitude expressed as a decimal rather than in degrees, minutes, and seconds.

**determinate flow direction**

For an edge feature, occurs when the flow direction can be determined from the topology of the network, the locations of sources and sinks, and the enabled or disabled states of features.

**digitizer**

See digitizing.

**digitizer puck**

See digitizing.

**digitizing**

The process of converting the features on a paper map into digital format. When you digitize a map, you use a digitizing tablet, or digitizer, connected to your computer and trace over features with a digitizer puck, which is similar to a mouse. The x,y coordinates of these features are automatically recorded and stored as spatial data.

**digitizing mode**

Also called absolute mode, digitizing mode is one of the ways in which a digitizing tablet operates. In digitizing mode, the location of the tablet is mapped to a specific location on the screen. Moving the digitizer puck on the tablet surface causes the screen pointer to move to precisely the same position. See also mouse mode.

**digitizing tablet**

See digitizing.

**disabled feature**

A network feature that does not allow flow to pass through it.

**display units**

The units—for example, feet, miles, meters, or kilometers—ArcMap uses to report measurements, dimensions of shapes, and distance tolerances and offsets.

**edge**

A network feature that has a length and through which commodity flows.

**edit cache**

A command in ArcMap Editor that causes the features visible in the current map extent to be held in memory on your local machine. Designed to be used when working with large amounts of data, an edit cache results in faster editing because the Editor doesn't have to retrieve the data from the server.

**edit session**

All editing takes place within an edit session. An edit session begins when you choose Start Editing from the Editor menu and ends when you choose Stop Editing.

**Editor toolbar**

A toolbar that lets you create and modify features and their attributes in ArcMap.

**enabled feature**

A network feature that allows flow to pass through it.

**feature**

A representation of a real-world object in a layer on a map.

**feature class**

1. A classification describing the format of geographic features and supporting data in a coverage. Coverage feature classes for representing geographic features include point, arc, node, route-system, route, section, polygon, and region. One or more coverage features are used to model geographic features; for example, arcs and nodes can be used to model linear features such as street centerlines. The tic, annotation, link, and boundary feature classes provide supporting data for coverage data management and viewing.

2. The conceptual representation of a geographic feature. When referring to geographic features, feature classes include point, line, area, and surface. In a geodatabase, an object class that stores features and has a field of type geometry in a geodatabase.

**feature dataset**

A collection of feature classes in a geodatabase that share the same spatial reference. Because the feature classes share the same spatial reference, they can participate in topological relationships with each other such as in a geometric network. Object classes and relationship classes can also be stored in a feature dataset.

**field**

A column in a table. Each field contains the values for a single attribute.

**flag**

An object that is placed on a map to specify the starting point for a trace task.

**flow direction**

The direction in which commodities flow through edge elements in a network.

**geocoding**

The process of creating geometric representations for locations (such as point features) from descriptions of locations (such as addresses).

**geocoding reference data**

Data that a geocoding service uses to determine the geometric representations for locations.

**geocoding service**

An object that defines a process for creating geometric representations for locations (such as point features) from descriptions of locations (such as addresses).

**geodatabase**

A geographic database that provides services for managing geographic data. A geodatabase is hosted inside a relational database management system. A geodatabase contains feature datasets.

**geographic coordinates**

A measurement of a location on the earth's surface expressed in degrees of latitude and longitude. See projected coordinates.

**geometric network**

A set of feature classes that participate together in a network.

**georeference**

The process of defining how raster data is situated in map coordinates. Georeferencing raster data allows it to be viewed, queried, and analyzed with other geographic data.

**graticule**

A graphic representation on a map of the network of parallels and meridians (latitude and longitude) that subdivide the earth's surface.

**grid**

A geographic representation of the world as an array of equally sized square cells arranged in rows and columns. Each grid cell is referenced by its geographic x,y location. See raster.

**ground control point**

A location of known x,y coordinates used to georeference a raster. A ground control point links a location on a raster to a location in map coordinates.

**group layer**

Several layers that appear and act like an individual layer in the table of contents in ArcMap.

**hyperlink**

Displays data, such as an image or Web page, when you click it.

**image**

Represents geographic features by dividing the world into discrete squares called cells. Examples include satellite and aerial photographs, scanned documents, and building photographs. See also raster.

**indeterminate flow direction**

For an edge feature, this occurs when the flow direction cannot be determined from the topology of the network, the locations of sources and sinks, and the enabled or disabled states of features.

**join**

The process of attaching tabular data to a layer. The fields in the table are appended to the layer using a common field. Join establishes a one-to-one, one-to-many, or a many-to-many relationship between map features and table attributes.

**junction**

A network feature that occurs at the intersection of two or more edges or at the endpoint of an edge that allows the transfer of flow between edges.

## **layer**

A collection of similar geographic features—such as rivers, lakes, counties, or cities—of a particular area or place for display on a map. A layer references geographic data stored in a data source, such as a coverage, and defines how to display it. You can create and manage layers as you would any other type of data in your database.

## **layout**

The design or arrangement of elements—such as geographic data, North arrows, and scale bars—in a digital map display or printed map.

## **layout view**

The view for laying out your map. Layout view shows the virtual page upon which you place and arrange geographic data and map elements—such as titles, legends, and scale bars—for printing. See also data view.

## **legend**

A list of symbols appearing on the map; includes a sample of each symbol and text describing what feature each symbol represents.

## **map**

A graphical presentation of geographic information. It contains geographic data and other elements such as a title, North arrow, legend, and scale bar. You can interactively display and query the geographic data on the map and also prepare a printable map by arranging the map elements around the data in a visually pleasing manner.

## **map display**

A graphic representation of the map on the computer screen.

## **map document**

The disk-based representation of a map. Map documents can be printed or embedded into other documents. Map documents have an .mxd file extension.

## **map element**

A graphic component, such as a scale bar, North arrow, and title, that helps describe the geographic data on the map.

## **map feature**

See feature.

## **map projection**

See projection.

## **map scale**

See scale.

## **map surround**

See map element.

## **map template**

A kind of map document that provides a quick way to create a new map. Templates can contain data, a custom interface, and a predefined layout that arranges map elements, such as North arrows, scale bars, and logos, on the virtual page. Map templates have an .mxt file extension.

## **map tips**

Displays onscreen descriptions of map features when you pause the mouse pointer over the feature.

## **map units**

The units—for example, feet, miles, meters, or kilometers—in which the coordinates of spatial data are stored.

## **mouse mode**

Also known as relative mode, mouse mode is one of the ways in which a digitizing tablet operates. In mouse mode, the digitizer puck behaves just like a mouse; there is no correlation between the position of the screen pointer and the surface of the digitizing tablet, but you can choose interface elements with the pointer. See also digitizing mode.

## **multipart feature**

A feature that is composed of more than one physical part but only references one set of attributes in the database.

For example, in a layer of states, the State of Hawaii could be considered a multipart feature. Although composed of many islands, it would be recorded in the database as one feature.

## **multipoint feature**

A feature that consists of more than one point but only references one set of attributes in the database. For example, a system of oil wells might be considered a multipoint feature, as there is a single set of attributes for the main well and multiple well holes.

## **neatline**

A border commonly drawn around geographic features, often to separate them from other map elements.

## **network**

A set of edges and junctions that are topologically connected to each other.

## **network feature**

A feature that participates in a geometric network.

## **nodata**

Same as null value but specific to rasters.

## **normalize**

Creating a ratio by dividing two data values. Normalizing data minimizes differences in values based on the size of areas or numbers of features in each area. For example, dividing a value by the area of a feature yields a value per unit area, or density.

## **North arrow**

A map element that shows how the map is oriented.

## **null value**

The absence of a value. A geographic feature for which there is no associated attribute information.

## **parametric curve**

A curved segment that has only two vertices as endpoints, instead of being made of numerous vertices. You can create a parametric curve using the Arc tool or the Tangent Curve command in the ArcMap Editor. Also known as a true curve.

## **point mode digitizing**

One of two methods of digitizing features digitally using ArcMap Editor's Sketch tool or from a paper map using a digitizer. With point mode digitizing, you can create or edit features by digitizing a series of precise points, or vertices. Point mode digitizing is effective when precise digitizing is required—for example, when digitizing a perfectly straight line. See also stream mode digitizing.

## **projected coordinates**

A measurement of locations on the earth's surface expressed in a two-dimensional system that locates features based on their distance from an origin (0,0) along two axes, a horizontal x-axis representing east–west and a vertical y-axis representing north–south. A map projection transforms latitude and longitude to x,y coordinates in a projected coordinate system. See also geographic coordinates.

## **projection**

A mathematical formula that transforms feature locations from the earth's curved surface to a map's flat surface. A projected coordinate system employs a projection to transform locations expressed as latitude and longitude values to x,y coordinates. Projections cause distortions in one or more of these spatial properties: distance, area, shape, and direction.

## **pyramids**

Reduced resolution raster layers that record the original raster data in decreasing levels of resolution. Pyramids help to reduce the time it takes to display raster data.

## **query**

A question or request used for selecting features. A query often appears in the form of a statement or logical expression. In ArcMap, a query contains a field, an operator, and a value.

## **raster**

Represents any data source that uses a grid structure to store geographic information. See grid and image.

## **rematching**

The process of re-geocoding a subset of features in a geocoded feature class.

## **resampling**

The process of assigning a value to a cell when transforming a raster. The three most common resampling techniques are nearest neighbor assignment, bilinear interpolation, and cubic convolution.

## **resolution**

1. The accuracy at which a given map scale can depict the location and shape of geographic features. The larger the map scale, the higher the possible resolution. As map scale decreases, resolution diminishes and feature boundaries must be smoothed, simplified, or not shown at all. For example, small areas may have to be represented as points.
2. The size of the smallest feature that can be represented in a surface.
3. The number of points in x and y in a raster.

## **scale**

The relationship between the dimensions of features on a map and the geographic objects they represent on the earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 means that one unit of measure on the map equals 100,000 of the same unit on the earth.

## **scale bar**

A map element that graphically shows a map's scale.

## **segment**

A line that connects vertices in a sketch. For example, in a sketch of a building, a segment would represent one wall.

## **select**

To choose from a number or group of features or records; to create a separate set, or subset.

## **selected set**

A subset of the features in a layer or records in a table. ArcMap provides several ways to select features and records graphically or according to their attribute values.



## **selection anchor**

A small “x” located in the center of selected features. The selection anchor is used when you move features using snapping. It is the point on the feature or group of features that will be snapped to the snapping location. This is also the point around which your selection will rotate when you use the Rotate tool and around which your feature will scale when you use the Scale tool.

## **shapefile**

A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a folder and contains one feature class.

## **shared boundary**

A segment or boundary common to two features. For example, in a parcel database, adjacent parcels will share a boundary. Another example might be a parcel that shares a boundary on one side with a river. The segment of the river that coincides with the parcel boundary would share the same coordinates as the parcel boundary.

## **shared vertex**

A vertex common to multiple features. For example, in a parcel database, adjacent parcels will share a vertex at the common corner.

## **sink**

A junction feature at which flow terminates.

## **sketch**

A shape that represents a feature’s geometry. Every existing feature on a map has an alternate form, a sketch. A sketch lets you see exactly how a feature is composed with all vertices and segments of the feature visible. To modify a feature’s geometry, you must modify its sketch. To create a feature, you must first create a sketch. You can only create line and polygon sketches, as points have neither vertices nor segments.

Sketches help complete the current task. For example, the Create New Feature task uses a sketch you create to make a new feature. The Extend/Trim Feature task uses a sketch you create to determine where the selected feature will be extended or trimmed. The Cut Polygon Feature task uses a sketch you create to determine where the polygon will be cut into two features.

## **sketch constraints**

The angle or length limitations you can place on segments you’re creating.

These commands are available on the Sketch tool context menu. For example, you can set a length constraint that specifies that the length of the segment you’re creating will be 50 map units. At whatever angle you create that segment, its length will be constrained to 50 map units.

Angle constraints work in the same way. For example, you can set an angle constraint that specifies that the angle of the segment you’re creating will be 45 degrees measured from another feature that already exists. At whatever length you create that segment, its angle will be constrained to 45 degrees.

## **sketch operations**

Editing operations that are performed on an existing sketch.

Examples are Insert Vertex, Delete Vertex, Flip, Trim, Delete Sketch, Finish Sketch, and Finish Part. All of these operations are available from the Sketch context menu, which is available when you right-click on any part of a sketch using any editing tools.

## **snapping environment**

Settings in the ArcMap Editor's Snapping Environment window and Editing Options dialog box that help you establish exact locations in relation to other features. You determine the snapping environment by setting a snapping tolerance, snapping properties, and a snapping priority.

## **snapping priority**

The order in which snapping will occur by layer. You can set the snapping priority by dragging the layer names in the Snapping Environment window to new locations.

## **snapping properties**

A combination of a shape to snap to and a method for what part of the shape you will snap to. You can set your snapping properties to have a feature snap to a vertex, edge, or endpoint of features in a specific layer.

For example, a layer snapping property might let you snap to the vertices of buildings. A more generic, sketch-specific snapping property might let you snap to the vertices of a sketch you're creating.

## **snapping tolerance**

The distance within which the pointer or a feature will snap to another location.

If the location being snapped to (vertex, boundary, midpoint, or connection) is within the distance you set, the pointer will automatically snap. For example, if you want to snap a power line to a utility pole and the snapping tolerance is set to 25 pixels, whenever the power line comes within a 25-pixel range of the pole, it will automatically snap to it. Snapping tolerance can be measured using either map units or pixels.

## **source**

A junction feature at which flow originates.

## **spatial analysis**

The study of the locations and shapes of geographic features and the relationships between them.

## **spatial bookmark**

Identifies a particular geographic location that you want to save and refer to later—for example, a study area.

## **spatial data**

The locations and shapes of geographic features with descriptions of each.

## **spatial join**

A type of spatial analysis in which the attributes of features in two different layers are joined together based on the relative locations of the features.

## **spatial overlay**

The process of superimposing layers of geographic data that occupy the same space in order to study the relationship between them.

## **stream mode digitizing**

One of the two methods of digitizing features from a paper map. Also known as streaming, stream mode digitizing provides an easy way to capture features when you don't require much precision—for example, to digitize rivers, streams, and contour lines. With stream mode, you create the first vertex of the feature and trace over the rest of the feature with the digitizer puck. You can also use digitize in stream mode with the Editor's Sketch tool when editing "freehand". See also point mode digitizing.

## **stream tolerance**

The interval at which vertices are added along the feature you're digitizing in stream mode. When streaming, vertices are automatically created at a defined interval as you move the mouse. For example, if the stream tolerance is set to 10 map units, you must move the pointer at least 10 map units before the next vertex will be created. If you move the pointer more than 10 map units, there may be more space between vertices, but there will always be a minimum interval of 10 map units. Stream tolerance is measured in map units. See also stream mode digitizing.

## **stretch**

Applied to a raster to increase the visual contrast between its cells.

## **style**

An organized collection of elements that you use to make your maps or put on your maps. Styles include elements such as symbols, scale bars, North arrows, and colors. You might create different styles that contain the specific elements for the specific types of maps you make.

## **Style Manager**

The tool that you use to create new styles and edit existing ones.

## **surface**

A geographic phenomenon represented as a set of continuous data such as elevation or air temperature over an area. A clear or sharp break in values of the phenomenon (breaklines) indicates a significant change in the structure of the phenomenon (for example, a cliff), not a change in geographic feature.

## **symbol**

A graphic representation of an individual feature or class of features that helps identify it and distinguish it from other features.

## **symbolology**

The criteria used to determine symbols for the features in a layer. A characteristic of a feature may influence the size, color, and shape of the symbol used.

## **table**

Information formatted in rows and columns. See attribute table.

## **table of contents**

Lists all the layers on the map and shows what the features in each layer represent.

## **tabular data**

Descriptive information that is stored in rows and columns and can be linked to map features.

## **target layer**

The setting of the Target Layer dropdown list that determines to which layer new features will be added. The target layer is set by clicking a layer in the Target Layer dropdown list. For instance, if you set the target layer to Buildings, any features you create will be part of the Buildings layer. You must set the target layer whenever you're creating new features—whether you're creating them with the Sketch tool, by copying and pasting, or by buffering another feature.

## **template**

See map template.

**text label**

Text added to a map to help identify features.

**TIN**

Triangulated irregular network. A data structure that represents a continuous surface through a series of irregularly spaced points with values that describe the surface at that point (for example, an elevation). From these points, a network of linked triangles forms the surface.

**topological association**

The spatial relationship between features that share geometry such as boundaries and vertices. When you edit a boundary or vertex shared by two or more features using the topology tools in ArcMap Editor, the shape of each of those features is updated.

**tracing**

The process of building a set of network features based on some procedure.

**uninitialized flow direction**

For an edge feature, this occurs when the edge feature is not topologically connected through the network to sources and sinks or if the edge feature is only connected to sources and sinks through disabled features.

**vertex**

A point that joins two segments of a feature. For instance, a square building would have four vertices, one at each corner.

**warp**

Transforming a raster to map coordinates.

**weight**

A property of a network feature typically used to represent a cost for traversing across an edge or through a junction.

**weight filter**

A specification of which network features can be traced based on their weight values.

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