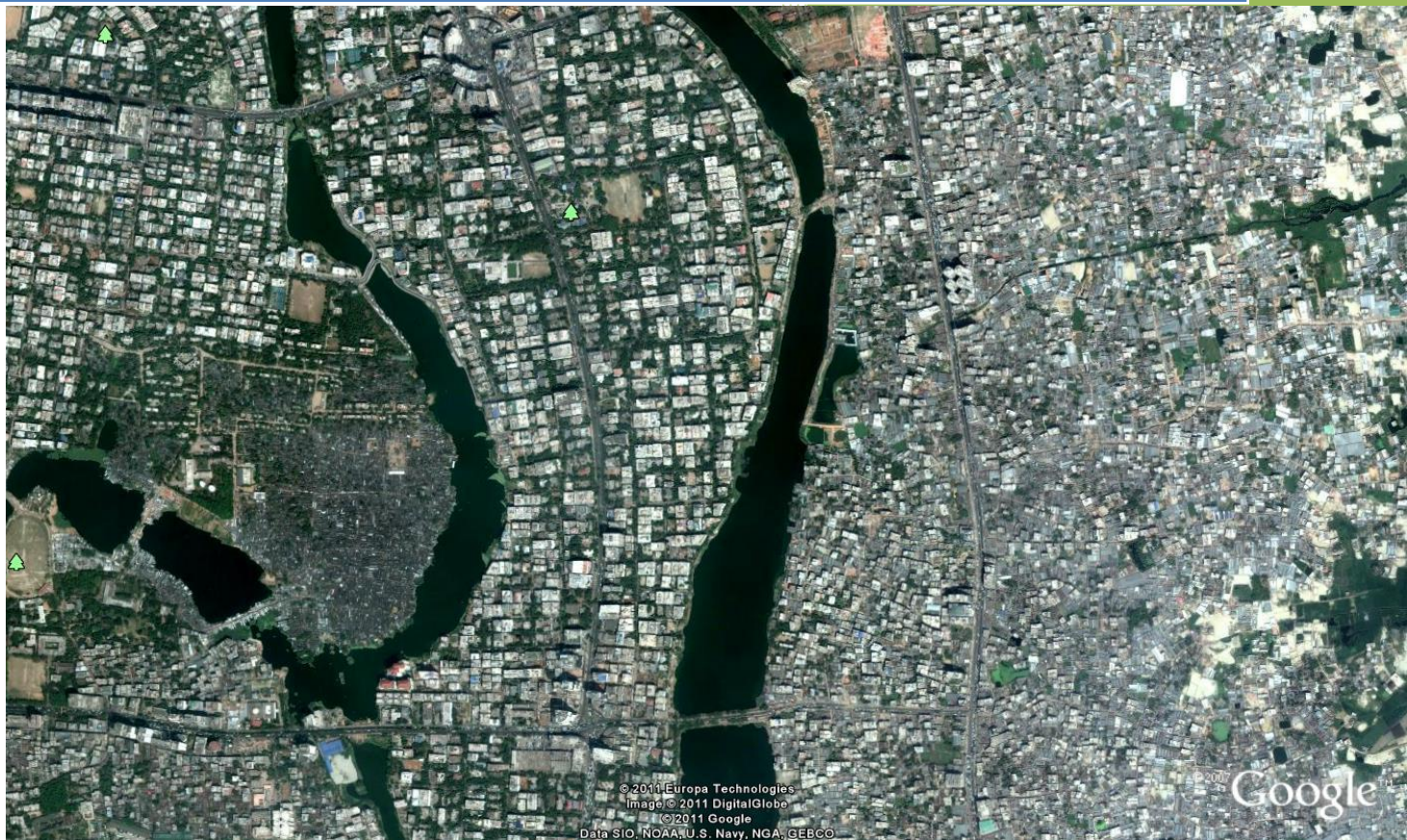**Ministry of Food and Disaster Management**
Disaster Management and Relief Division
Comprehensive Disaster Management Programme

Think Spatially

ArcGIS Advance‡

Cover Image:

A segment of Dhaka City showing planned (Gulshan) and unplanned (Badda) area captured from Google Earth.

Cover Design:

Md. Shahidul Islam with the help of MS Office Cover Page Template

Layout Design:

Md. Shahidul Islam

Contribution:

Md. Khyer Ali

Manual Development:

Md. Shahidul Islam

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Module I

ArcGIS Basic - Revisit
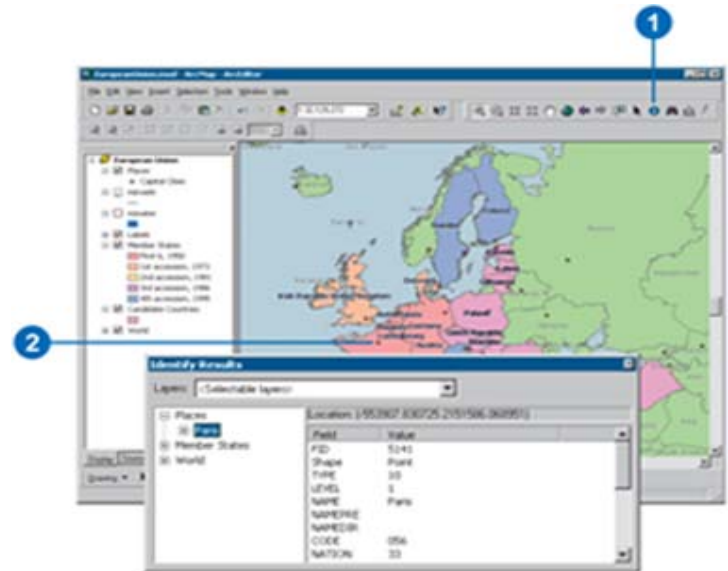
In this module:

Symbology
• Labeling
• Table
• Layout
• Georeferencing
• Primary data capturing from RS datasets

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.

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.
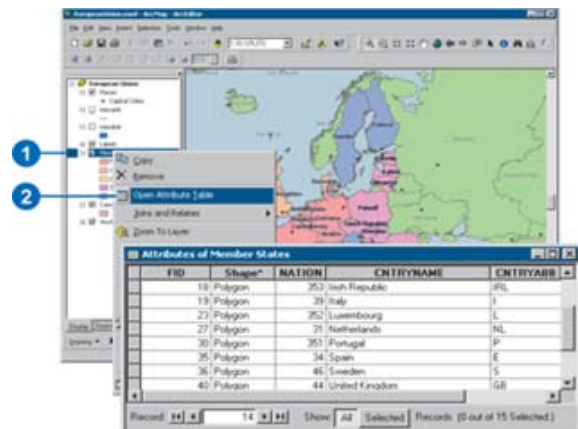
Displaying a Subset of the Features

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.
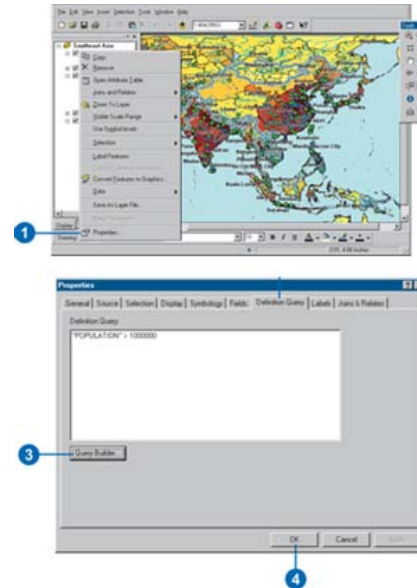
## Displaying data with a predefined coordinate system

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.
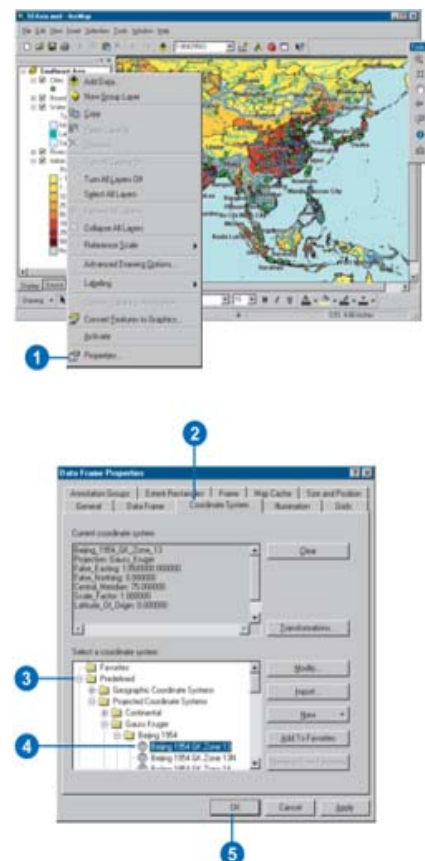
Repairing broken data source links

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 Repair 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.
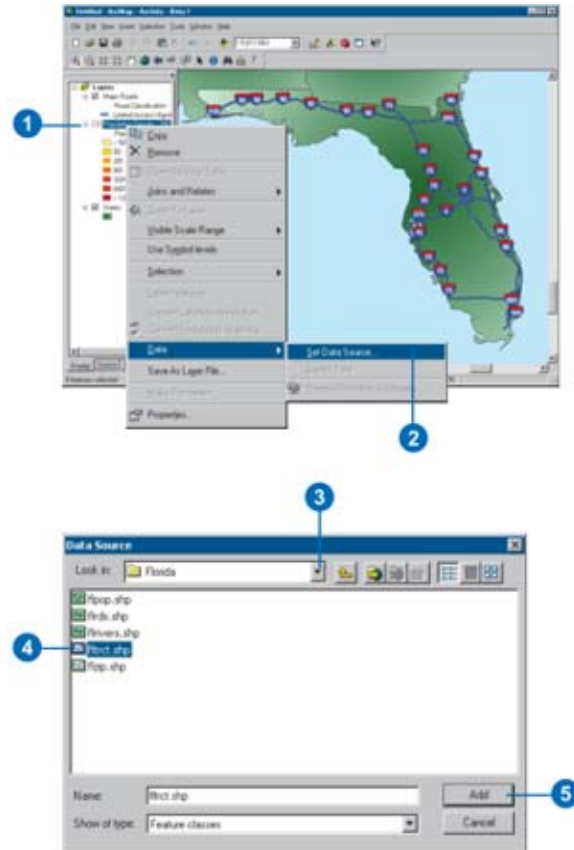
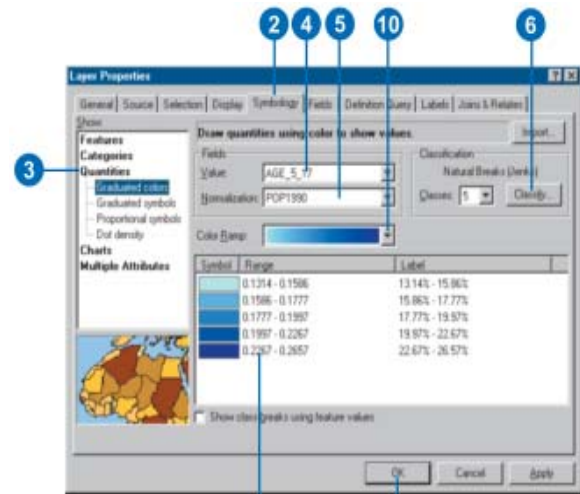## Drawing a layer showing unique values

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
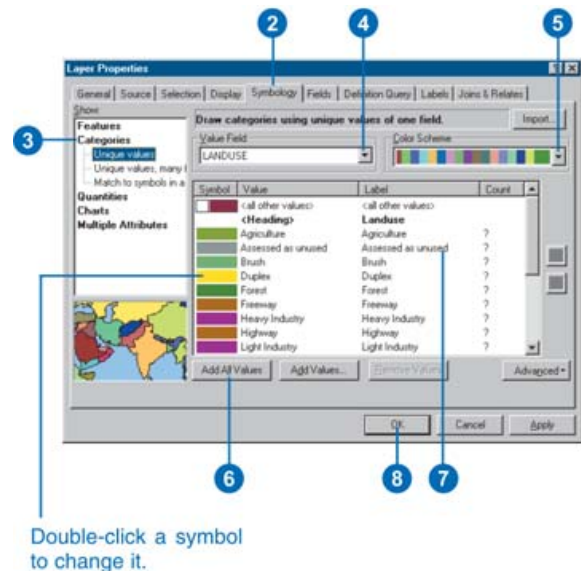
choose which unique values to display.
7. If you want to edit the default label so more descriptive labels appear in your legend and the table of contents, click a label in the Label column and type the label you want.
8. Click OK.

Symbolizing data with graduated colors

1. In the table of contents, rightclick 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 Classify.
7. Click the Method dropdown arrow and click the classification method you want.
8. Click the Classes dropdown arrow and click the number of classes you want to display.
9. Click OK on the Classification dialog box.
10. Click the Color Ramp dropdown arrow and click a ramp to display the data with.
11. Click OK on the Layer Properties dialog box.

Right-click a class to see additional options, such as sorting and number formatting.
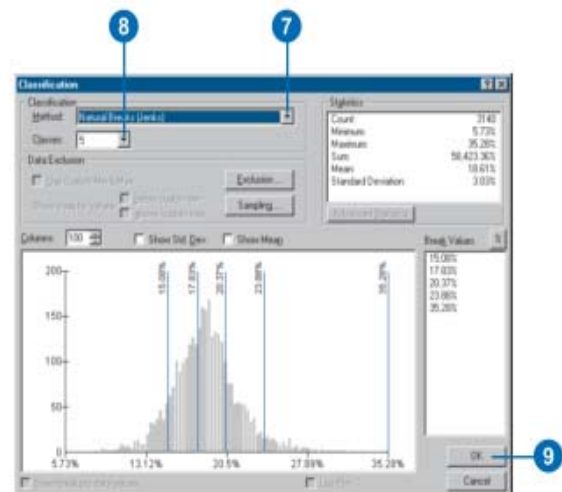
Representing quantity with graduated symbols

1. In the table of contents, rightclick 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 Classify.
8. Click the Method dropdown arrow and click
   the classification method you want.
9. Click the Classes dropdown arrow and click
   the number of classes you want.
10. Optionally, click Exclusion to remove
    unwanted values from the classification (for
    example, null values or extreme outliers).
11. Click OK on the Classification dialog box.
12. Click OK on the Layer Properties dialog box.
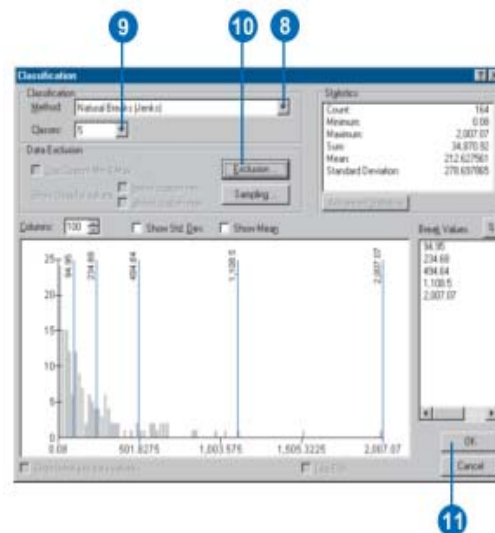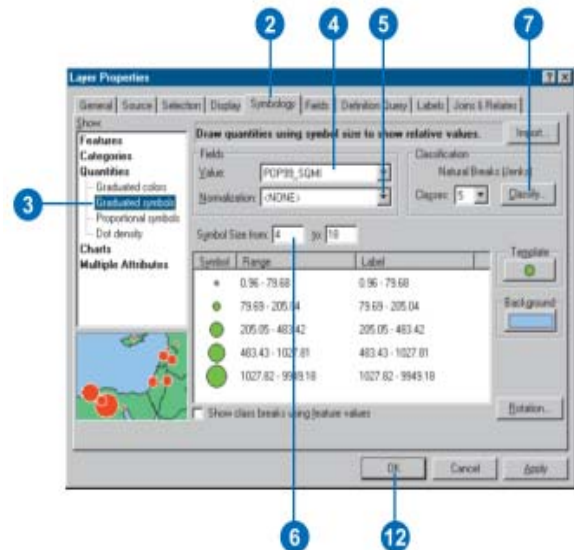
Labeling based on a single attribute field

1. Open the Label Manager.
2. Click a label class in the Label Classes list.
3. Click the Label Field dropdown arrow and click the field you want to use as a label.
4. Click OK.

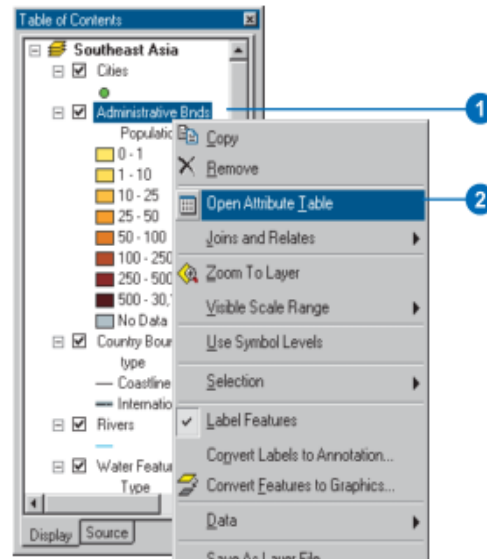## Labeling based on multiple attribute fields

1. Open the Label Manager.
2. Click a label class in Label Classes list.
3. Click Expression.
4. Click a label field and click Append to use the text of that field in your labels.
5. Optionally, use the Expression box to add additional characters you want to appear in your labels or add VBScript or JScript functions to format your labels.
6. Click Verify to make sure that there are no syntax errors and to preview your label string. Close the Label Expression Verification dialog box.
7. Click OK.
8. Click OK.
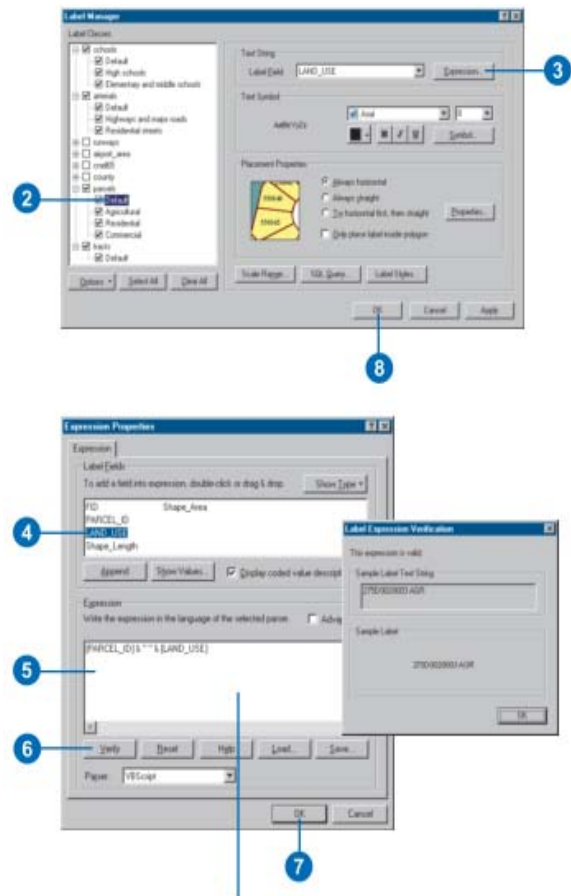
To create stacked text, use the VBScript constant, vbNewLine, between the field names—[PARCEL_ID] & vbNewLine & [LAND_USE]. You can also click the Help button for more information on syntax and building label expressions.

Opening a layer's attribute table

1. In the table of contents, rightclick the layer for which you want to display a table.
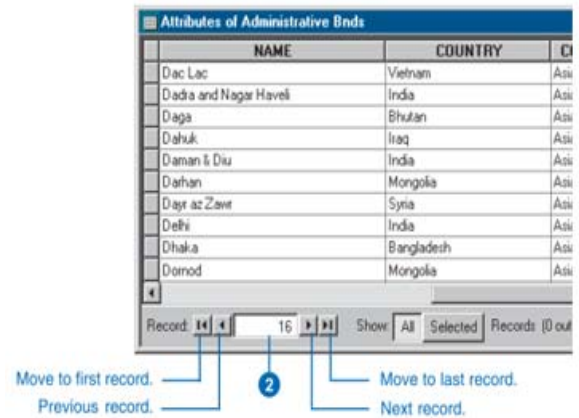2. Click Open Attribute Table. The layer's attribute table opens.
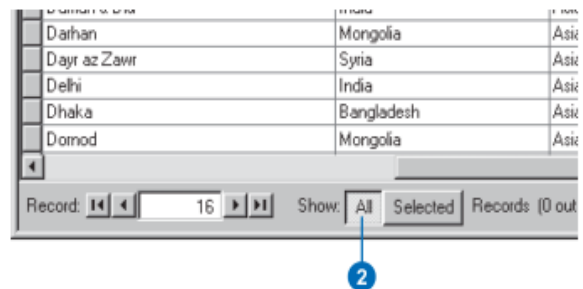
Moving to a specific record number

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

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.

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 want to use.
5. Click the Get Unique Values button, then scroll to and double-click the value in the Unique Values list you want to select. Alternatively, you can type a value directly into the text box.
6. Click Verify to verify your selection.
7. Click Close.
   Your selection is highlighted in the table. Use Apply if you intend to run more than one query or if you want to check your results before closing the Select By Attributes dialog box.
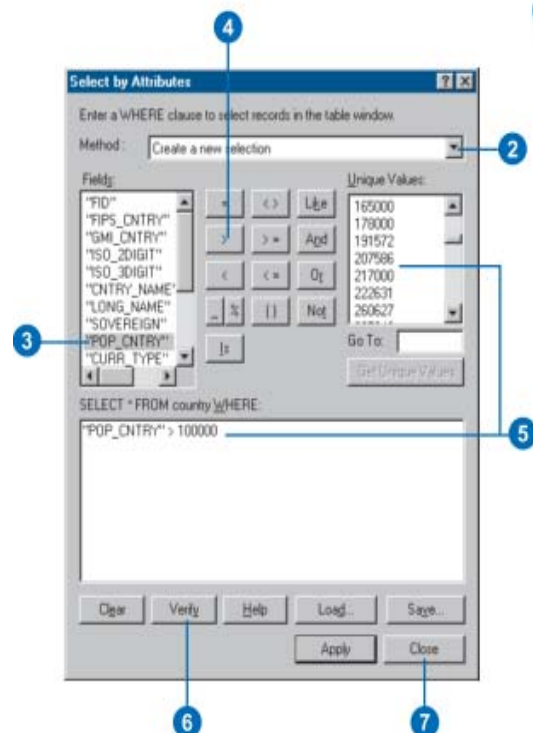
Selecting all records

1. Click Options in the table and click Select All.

Clearing the selected set

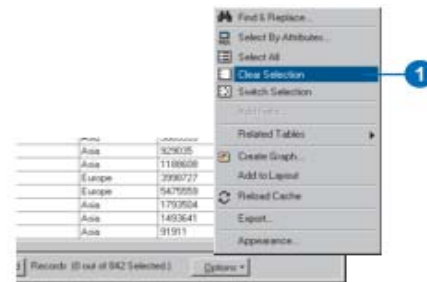1. Click Options in the table and click Clear
   Selection.

Switching the selected set

1. Click Options in the table and click Switch
   Selection.
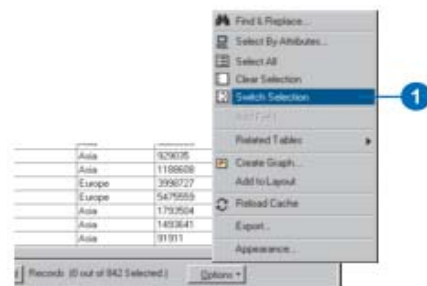
Adding a table with x,y coordinates

1. Click Tools on the Main menu 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.
   The x,y coordinates will be automatically
   transformed to match the coordinate
   system of the data frame.
6. Click OK.
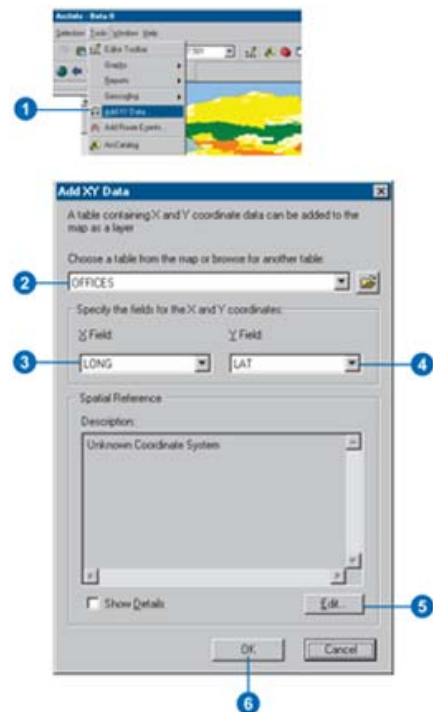
Adding a field to a table

1. Click Options in the table you want to add a field to.
2. Click Add Field.
3. Type a name for 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.
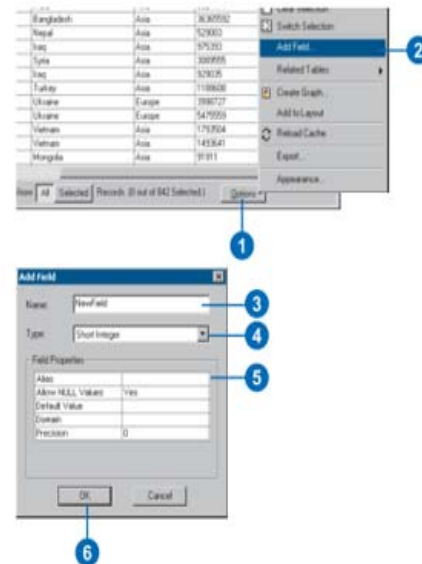
Deleting a field from a table

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.

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.

   You can make calculations without being in an edit session; however, in that case, there is no way to undo the results.

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.
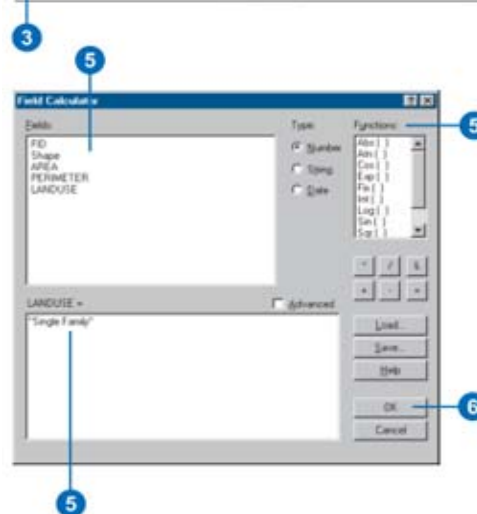
   NOTE: Use double quotes when calculating strings.

6. Click OK.
7. Don't forget to end your edit session. Click the Editor menu and click Stop Editing.
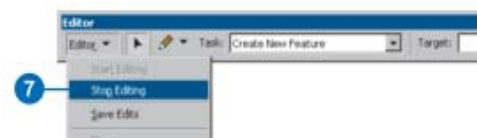
Joining the attributes in one table to another

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 second dropdown arrow and click the field name in the layer that the join will be based on.
4. Click the third dropdown arrow 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 fourth 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
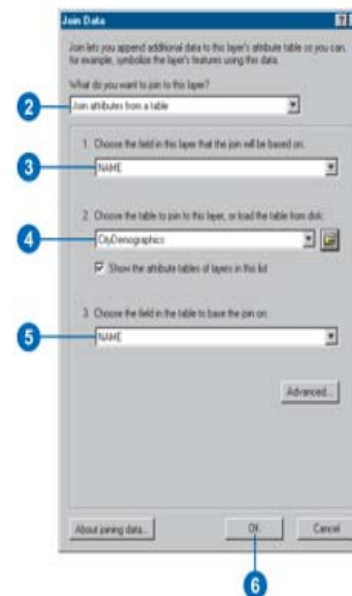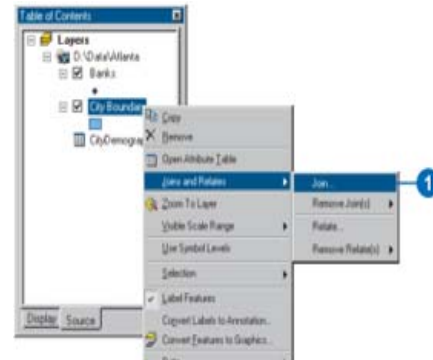
Removing a joined table

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
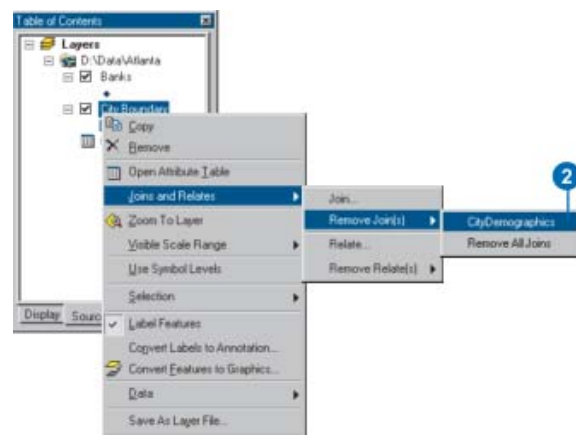
Switching to layout view

1. Click View and click Layout View.
   OR
   Click the Layout View button on the bottom
   left corner of the map display area.
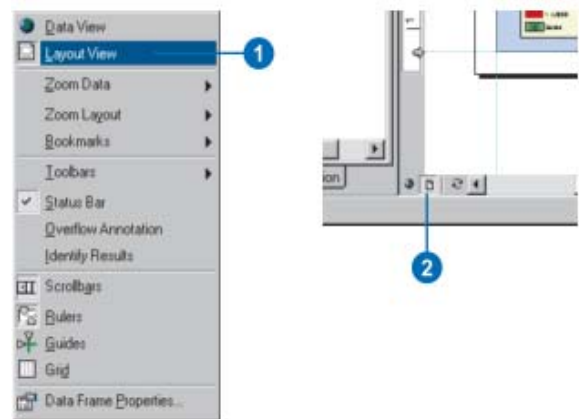
Setting the page orientation

1. On the Page and Print Setup dialog box, click
   a Paper or Page Orientation (Landscape or
   Portrait) to set the page orientation.
2. Click OK.
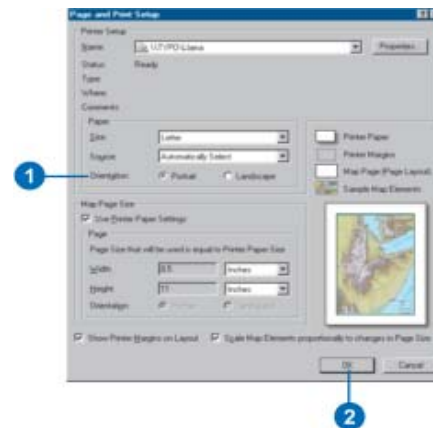
Adding a North arrow

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.
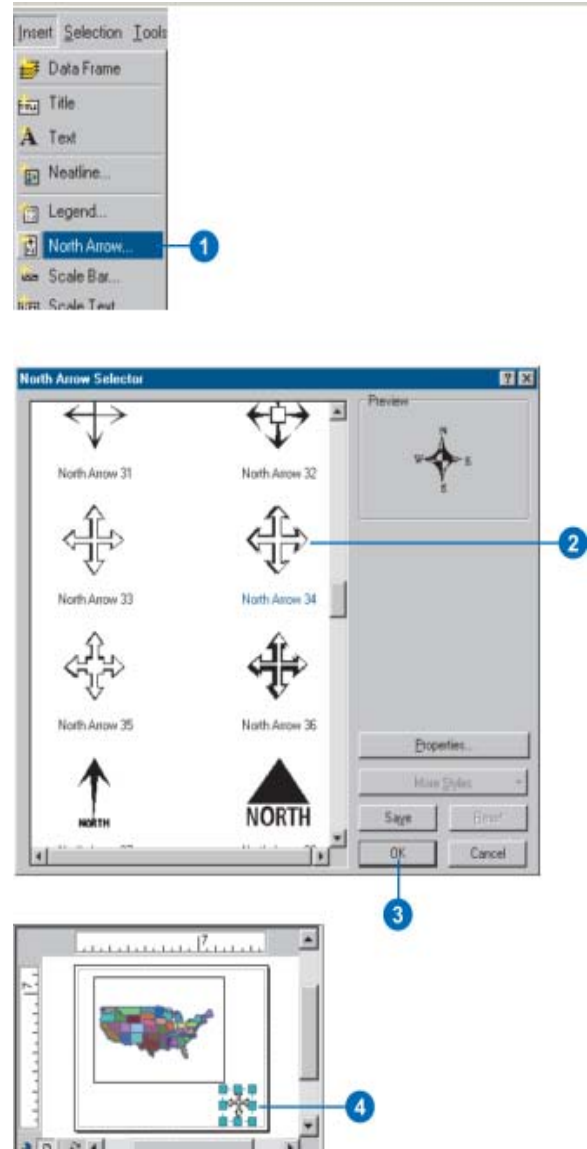
Adding a scale bar

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.

If you resize the width, the distance measures along the scale bar are recalculated. If you resize the height, the height of the bar is altered and the text size is altered accordingly.
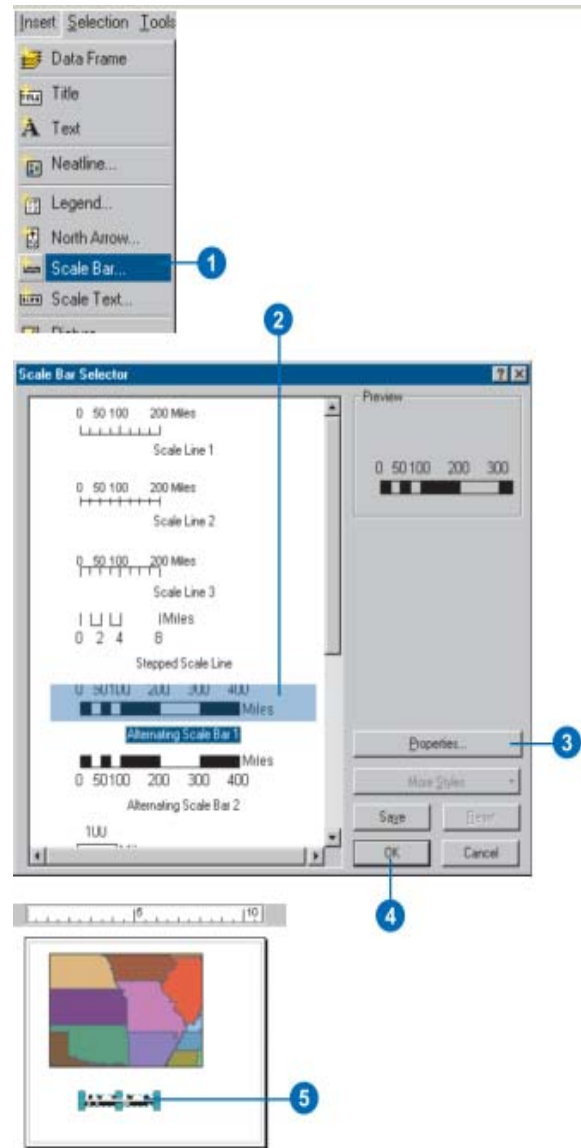
Adding a legend

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.
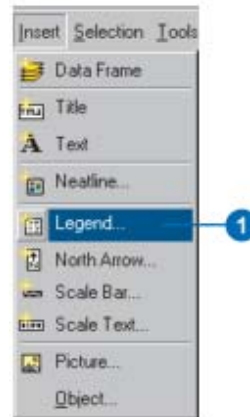
2. By default, all the layers on the map will appear as legend items in the legend.

   To remove a legend item, click it, and then click the left arrow button.

3. Use the up and down arrow buttons to order the legend items.
4. Click Next.
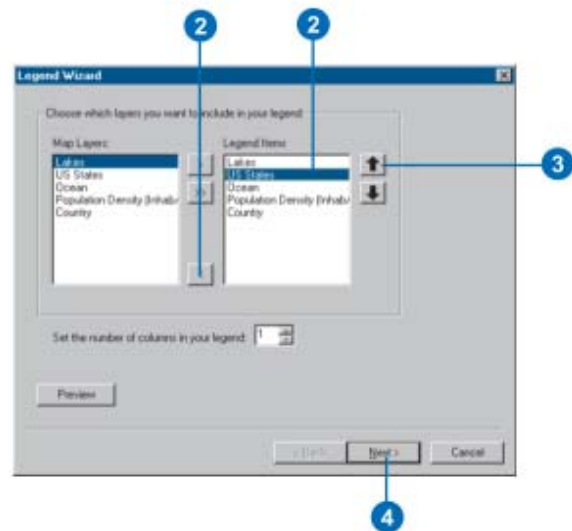
5. Type a title for the legend.
6. Set the text color, size, and font as desired.
7. Click Next.
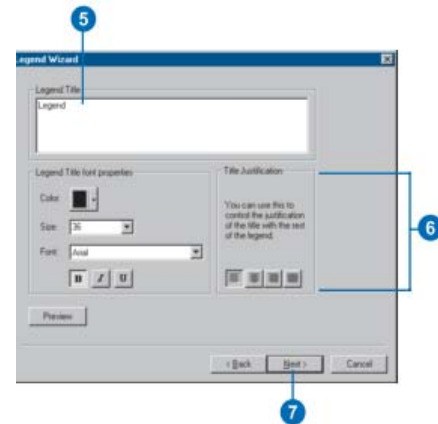
8. Click the Border dropdown arrow and click a border.

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
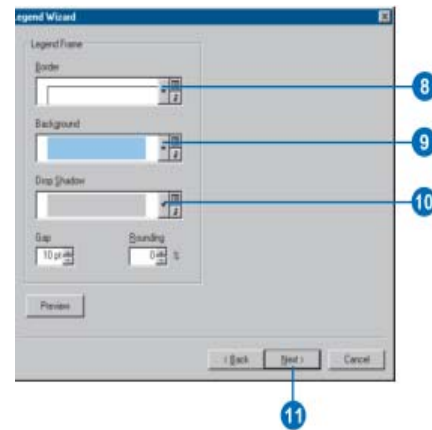
12. Click a Legend Item in the list to modify the symbol patch.
13. Set the Patch properties as desired.
14. Click Next.
15. Set the Spacing between legend elements by typing a value into the appropriate box.
16. Click Finish.
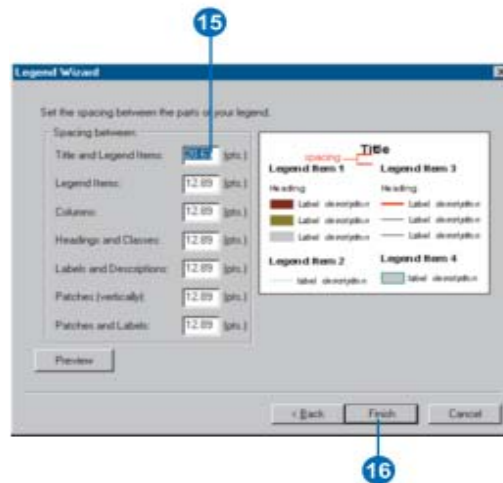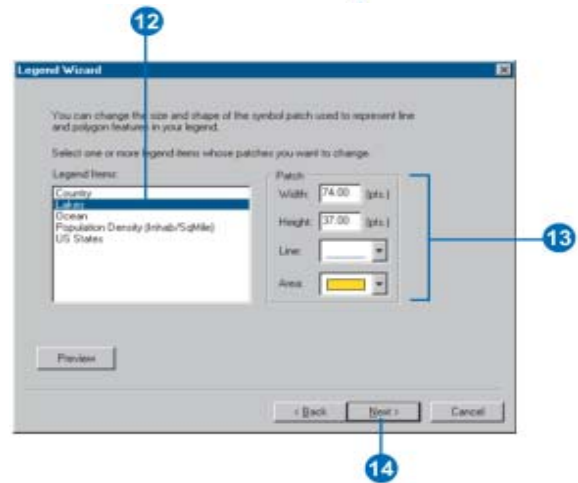
About Georeferencing

Raster data is commonly obtained by scanning maps or collecting aerial photographs and satellite images. Scanned map datasets don't normally contain spatial reference information (either embedded in the file or as a separate file). With aerial photography and satellite imagery, sometimes the locational information delivered with them is inadequate and the data does not align properly with other data you may have. Thus, to use some raster datasets in conjunction with your other spatial data, you may need to align, or georeference, to a map coordinate system. A map coordinate system is defined using a map projection (a method by which the curved surface of the earth is portrayed on a flat surface).

When you georeference your raster dataset, you define its location using map coordinates and assign a coordinate system. Georeferencing raster data allows it to be viewed, queried, and analyzed with other geographic data

The general steps for georeferencing a raster dataset are:

1. Add the raster dataset that you want to align with your projected data in ArcMap.
2. Add control points that link known raster dataset positions to known positions in map coordinates.
3. Save the georeferencing information when you're satisfied with the alignment (also referred to as registration).
4. Optionally, permanently transform the raster dataset.

Method A: Using Specific X,Y Map Coordinates

1. Click View Link Table [icon] on the Georeferencing toolbar.
2. Click the Add Control Points tool [icon] .
3. Click the mouse over the known location in the unreferenced image to add the first coordinate in the link.
4. Right-click the image and click Input X and Y.
5. Enter the reference coordinates on the Enter Coordinates dialog box.
6. Click OK.

Hands-on exercise using method A

Collection of Satellite Image

Google Earth (GE) is a very good source for high resolution image. It is free so far. For this georeferncing exercise, a portion of Dhaka City is saved from GE and then four distinct locations are identified for control points. These control points (CP) can also be managed from GPS field survey. For Example, the following image is showing four control points like GCP1...GCP4. But you are advised to select by your own choice. Now open an excel file and put the for CP to convert Degree-Minute-Second to Degree Decimal

GCP	X			Y			X	Y
	D	M	S	D	M	S		
1	90	21	40.69	23	48	41.2	**90.3613**	**23.81144**
2	90	22	14.19	23	48	50.92	**90.37061**	**23.81414**
3	90	22	24.81	23	48	24.68	**90.37356**	**23.80686**
4	90	21	47.66	23	48	16.63	**90.36324**	**23.80462**
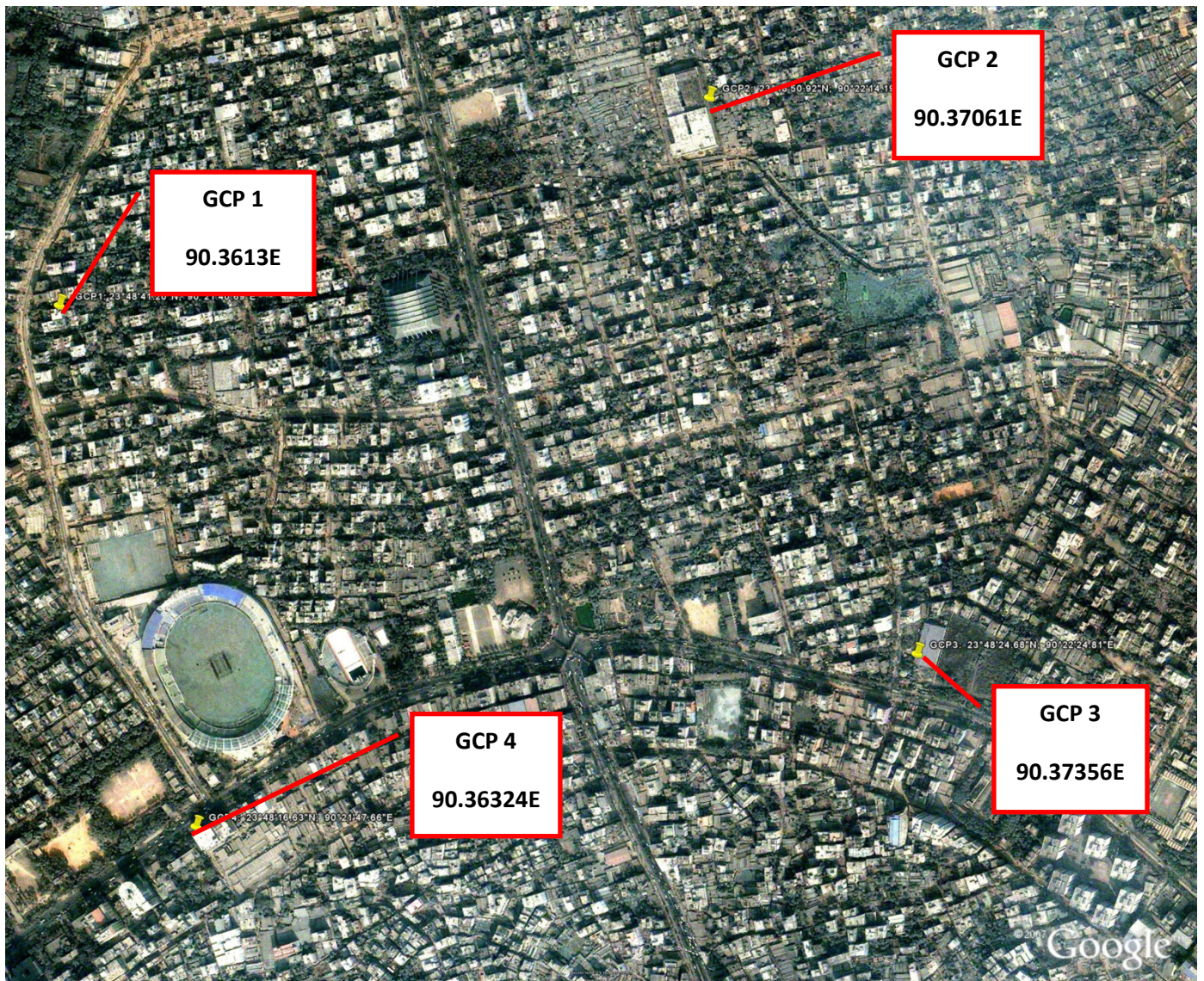
If you want to do georeferencing for images other than Google Earth, which you have purchased or collected from RS datasets providers, you could also get CP from GE. Other sources of CP are GPS survey or already georeferenced vector or raster datasets.

1. Now open the image to be georeferenced in ArcGIS using Add Data button.
2. Identify at least four control points on the image
3. Find corresponding locations on GE and get Lat/Lon for those locations; if Lat/Lon is in DMS, convert it to degree decimal with excel spreadsheet [follow the example given in previous page. The Lat/Lon of those CPs can also be taken from GPS field Survey or from already georeferenced Vector/Raster data of the same area.
4. Open georeferencing tool bar if it is not already there by clicking view – toolbars – georeferencing
5. Click Add Control Points button from Georeferencing Tool Bar
6. Click the Cross Hair at the first CP and then right click first and then left click on the option Input X and Y… to enter the value of X (lon) and Y (lat), which you have got from GE or GPS field survey.
7. Follow step 5-6 for the rest of the CPs.
8. After entering the values of all CPs, click View Link Table button to open table of entered CPs and check Residual and RRMS error to ensure the quality of CPs and adjust accordingly, if needed by deleting and entering new CPs.
9. Click Georeferencing combo box and select Update Georeferencing to associate lat/lon information with the image.
10. Georeferencing is done.
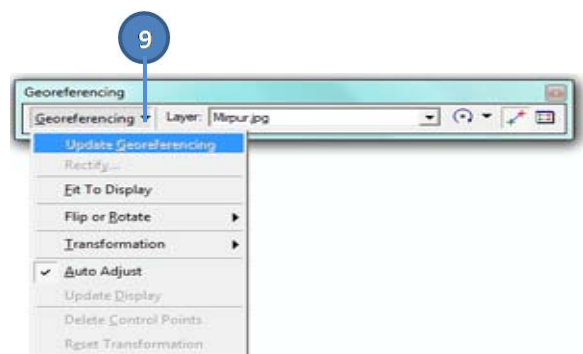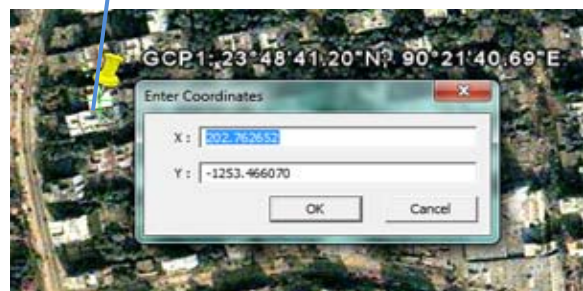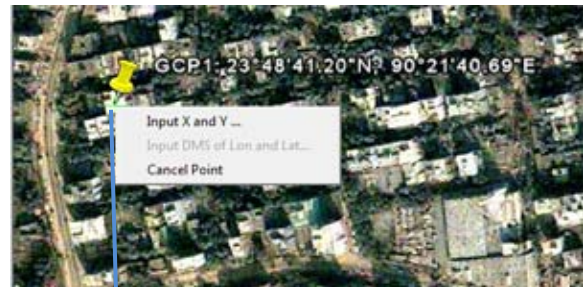
New Data Capturing

Creating a new Shapefile

1. Select a folder or folder connection in the Catalog tree.
2. Click the File menu, point to New, and click Shapefile.
3. Click in the Name text box and type a name for the new shapefile.
4. Click the Feature Type dropdown arrow and click the type of feature the shapefile will contain.
5. Click Edit to define the shapefile's coordinate system.
6. In the Spatial Reference Properties dialog box, click Select and choose a predefined coordinate system. Or click Import and choose the data source whose coordinate system you want to copy. Or click New and define a new, custom coordinate system.
7. Click OK.
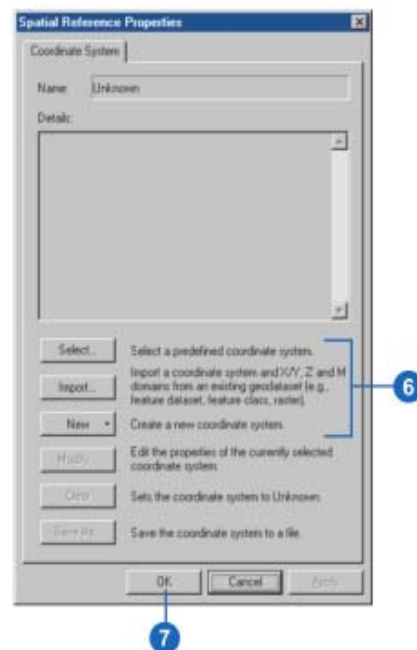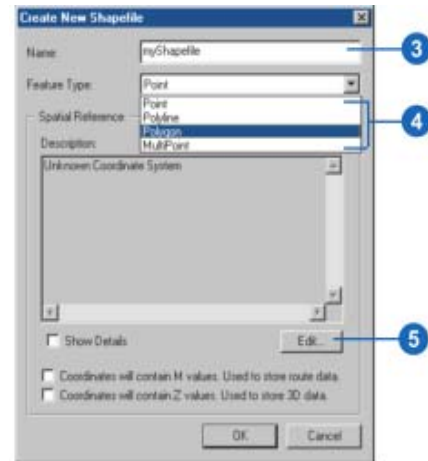
Module II

Creating New Features

In this module:

• How to create new features

• Midpoint tool

• Arc tool

• Trimming

Creating New Features

How to create a new feature

To create a new feature using ArcMap, you create an edit sketch. A sketch is a shape that you draw by digitizing vertices. A sketch is composed of vertices – the points at which the sketch changes direction, such as corners – and segments- the lines that connect the vertices. You create a sketch using the Sketch tool located on the tool palette. The type of feature you create is determined by the setting of the Target layer dropdown list. The list contains the names of all the layers in the datasets with which you're working. Choose the layer to which you want to add new features before you start to create them.

To crate point features, click once on the map. To create line or polygon features, use the Sketch tool to click on the map to digitize the vertices that make up that feature. To create the last vertex and finish the sketch, double-click with the mouse. After you finish the sketch, ArcMap adds the final segment of the sketch and the sketch turns into a feature.

1. Click the Current Task dropdown arrow and click Create New Feature.
2. Click the Target Layer dropdown list and click a point layer.
   3. Click the tool palette dropdown arrow and click the Sketch tool.
4. Click on the map to create the point.

   The point is created on your map and marked as selected.
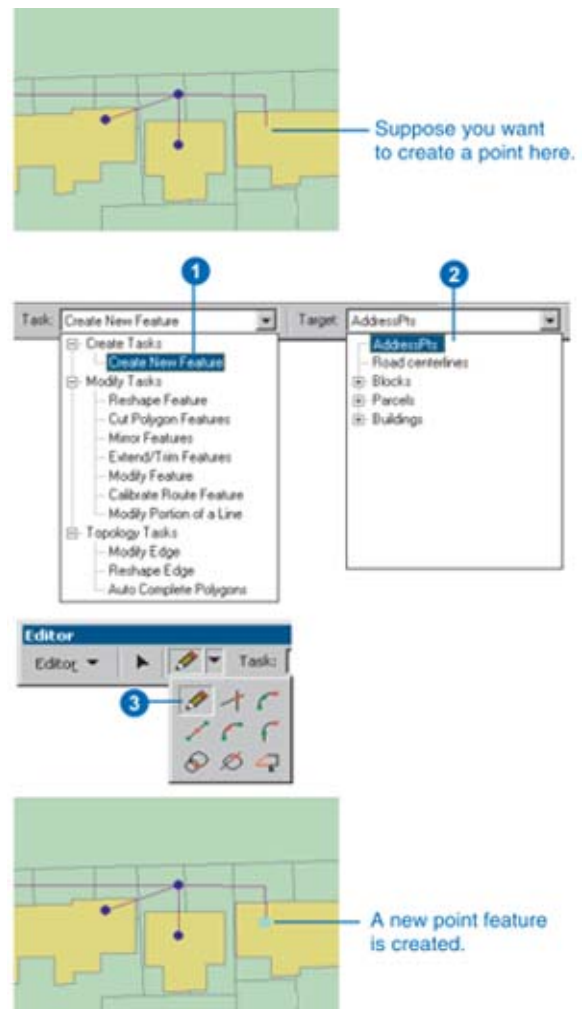
Creating a point or vertex using the Midpoint tool

1. Click the tool palette dropdown arrow and click the Midpoint tool.
2. Click once to establish the first of two points. The new vertex will be created between this point and the next point you click.
3. Click the second point.

   A vertex or point is placed at the midpoint of the line between the two points you clicked.
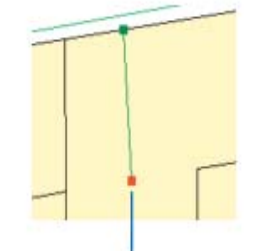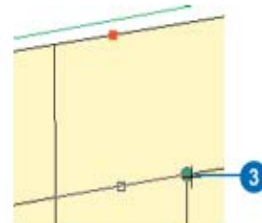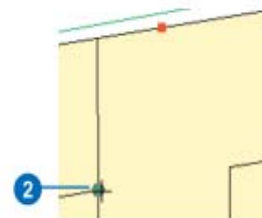
A point is created at the midpoint along the line defined by the two points you clicked.

Creating a point or vertex using the Intersection tool

1. Click the tool palette dropdown arrow and
   click the Intersection tool.
   The pointer turns into crosshairs.
2. Position the crosshairs over the first segment
   and click.
3. Position the crosshairs over the second
   segment and click.

   A vertex or point is added at the implied
   intersection of the two segments.

A vertex is added at the place where
the two segments would intersect if extended.
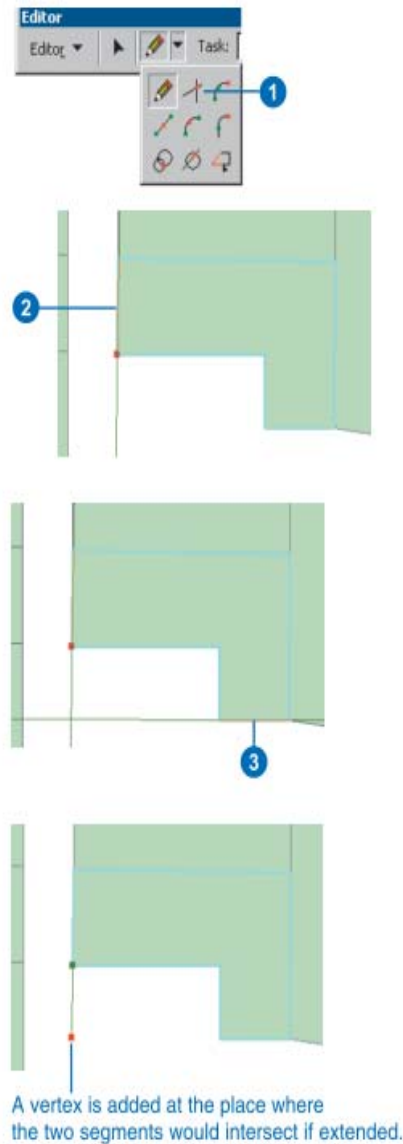
Creating a line or polygon feature by digitizing

1. Click the Task dropdown arrow and click Create New Feature.
2. Click the Target layer dropdown arrow and click a line or polygon layer.
3. Click the tool palette dropdown arrow and click the Sketch tool.
4. Click the map to digitize the feature's vertices.
5. Right-click anywhere on the map when finished and click Finish Sketch.

   The line or polygon is created on your map.
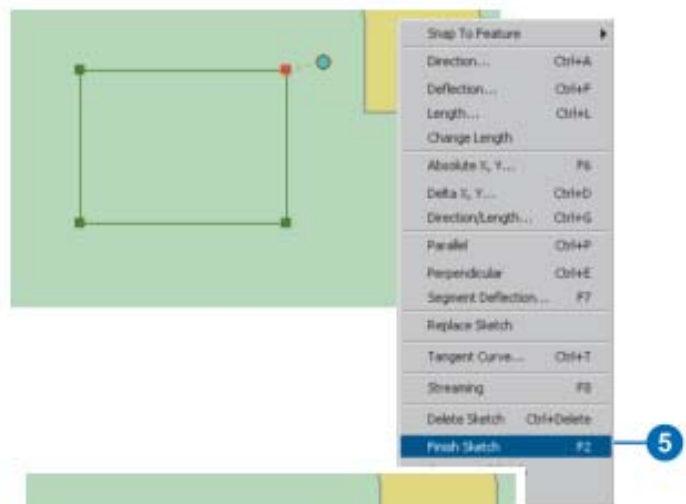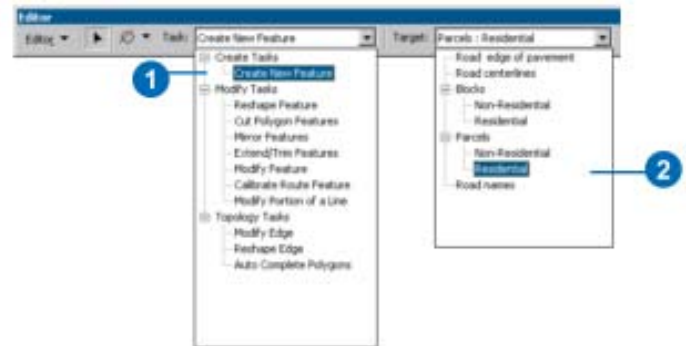
A new feature is created on your map.

Creating a multipart line or polygon

1. Create a line or polygon feature.
2. Right-click anywhere on the map when you have finished creating the first part of the feature and click Finish Part.
3. Create the next part of the feature.
4. Right-click anywhere on the map when you have finished the last part of the feature and click Finish Sketch

   Now when you click one part of the feature to select it, all parts are automatically selected because they all belong to one multipart feature.

Both parts of the feature are selected.
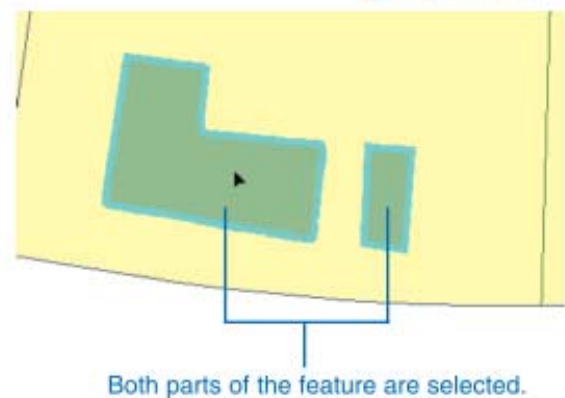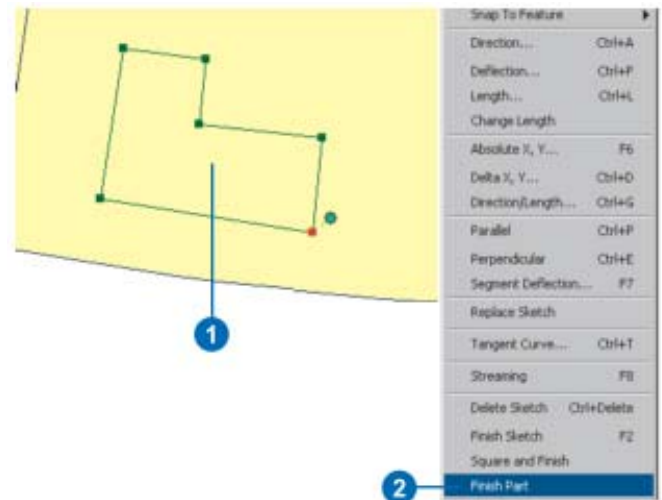
Creating a segment that is a circular arc using the Arc tool

1. Click the tool palette dropdown arrow and click the Arc tool.
2. Click once to establish the starting point of the arc. A vertex is created.
3. Click once to establish the axis of the arc. This is the invisible point through which the curve passes.
4. Click once again to establish the endpoint of the arc.
   A segment that is a true curve is created.
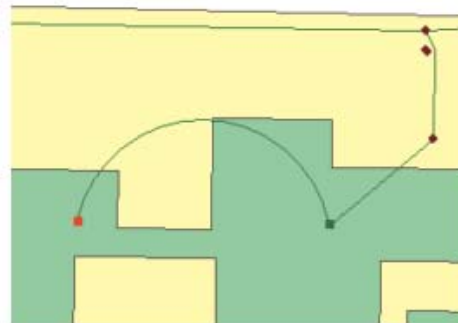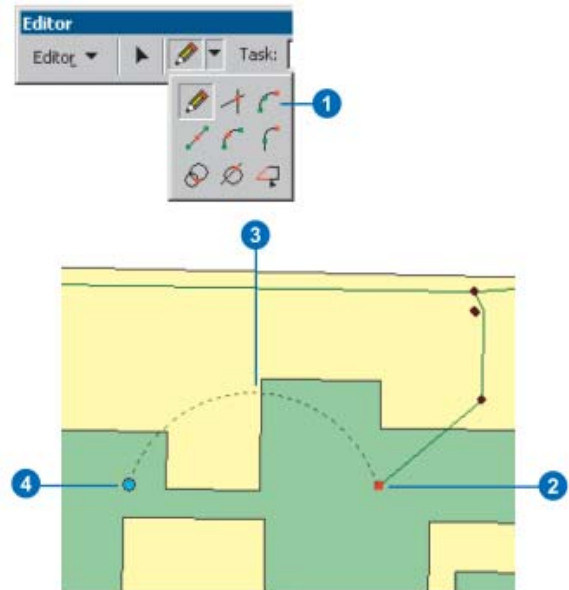
A segment that is a true curve is created.

Creating a segment that is a circular arc using the Endpoint Arc sketch tool

1. Click the tool palette dropdown arrow and click the Endpoint Arc tool.
2. Click the starting point of the arc.
3. Click the endpoint of the arc.
4. Move the pointer to get the approximate radius for the curve.

   Press the R key and type the radius for the curve. You can also click again on the map to set the radius.

A circular arc with the radius you specified is created between the two points you clicked.
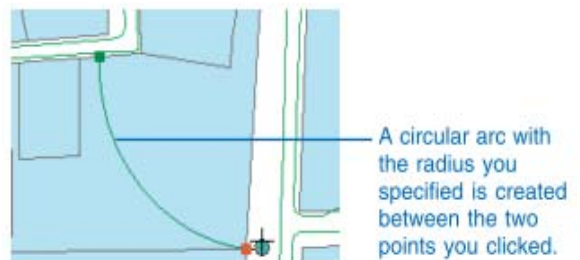
Creating a segment that is a circular arc using theTangent Curve tool

1. Click the tool palette dropdown arrow and
   click the Tangent Curve tool once a segment
   has been created using one of the other
   sketch tools.
   As the cursor is moved, the arc will bend and
   change length to remain tangent to the
   previous segment.
2. Click again to place the endpoint of the arc.
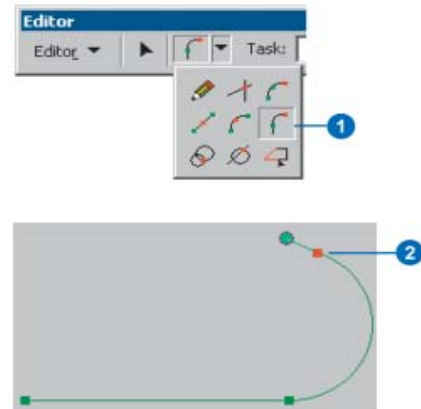
Creating a segment parallel to another segment

1. Click the tool palette dropdown arrow and
   click the Sketch tool after creating at least
   one vertex.
2. Position the pointer over the segment to
   which the new segment will be parallel and
   right-click.
3. Click Parallel.
   The segment is constrained to be parallel to
   the specified segment.
4. Click once to digitize the endpoint of the
   segment or choose Length from the Sketch
   tool context menu.

Duplicating features with the Copy Feature tool

1. Click the Edit tool.
2. Select the features that you want to copy.
3. Click the Copy Feature Tool.
4. Click the place where you want a copy of the feature to be placed.

A copy of the geometry of the selected feature is created at the location you clicked. The feature is created in the Editor's current Target layer.

The duplicate feature has whatever default values and behavior are defined for the Target feature class in the geodatabase
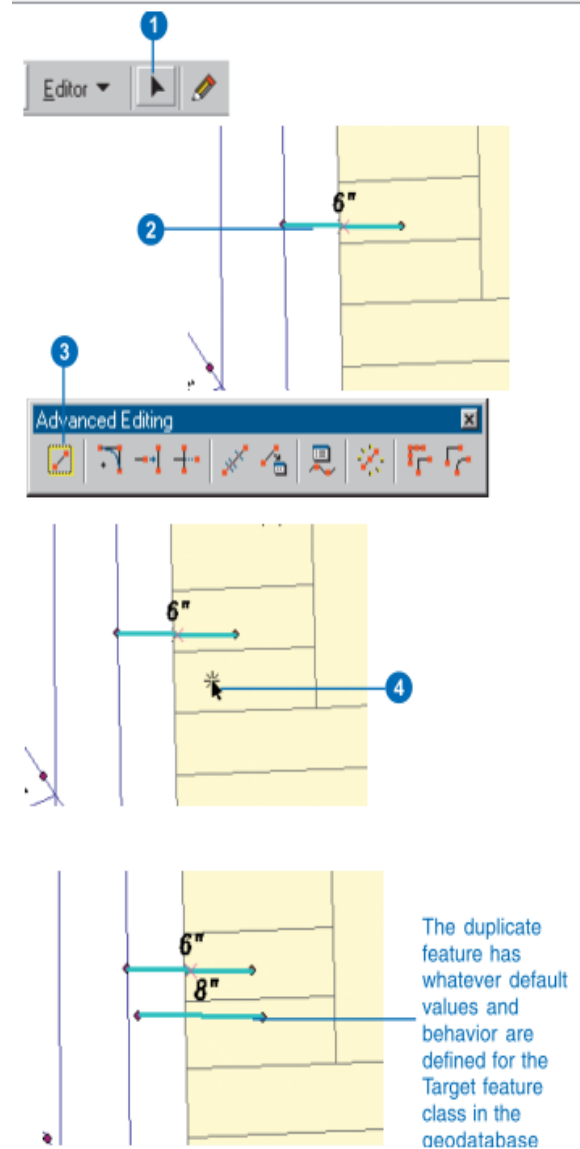
Creating a fillet curve between two lines

1. Click the Fillet tool.
2. Click first one line then the other to specify which lines you want to construct the fillet between.
   The radius of the fillet curve will change as you drag the pointer away from the first line you clicked.
   When the curve looks like it has the right radius, you can click to finish the curve. If you want the curve to have a specific radius, you can set the radius from the Fillet Options window.
3. Press the R key to set the Fillet Options.
4. Optionally, check Trim existing segments if you want to remove the segments outside of the curve's radius.
5. Optionally, check Fixed radius if you want to specify a radius for the curve.
6. Type a radius for the curve and press Enter, or click OK.
7. Click the map to indicate the quadrant of the intersection of the lines where the fillet will be created.

A new fillet curve joins the two selected lines.
   The extra line segments outside the curve are trimmed off, if you checked Trim existing segments.
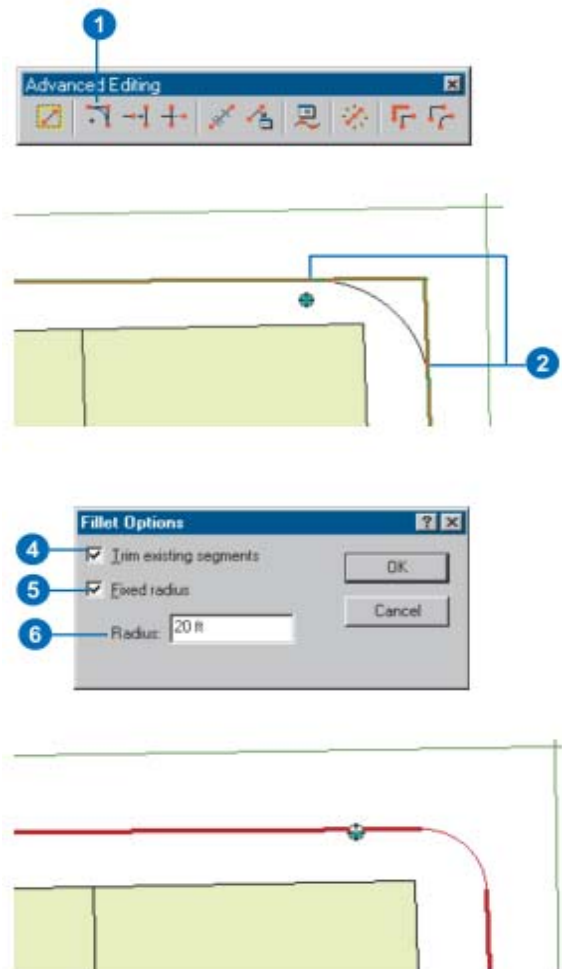
Extending a line

1. Click the Edit tool.
2. Select the line segment to which you want to extend a line.
3. Click the Extend tool.
4. Click the end of the feature that you want to extend.
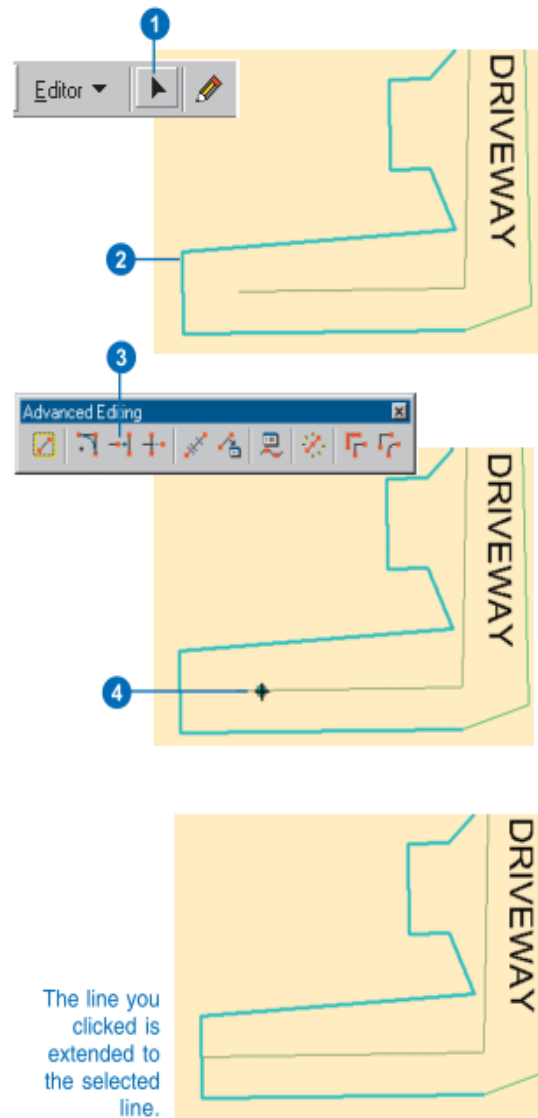
Trimming a line

1. Click the Edit tool.
2. Select the line segment at which you want to trim a line.
3. Click the Trim tool.
4. Click the end of the feature that you want to trim.

The line you clicked is trimmed at the selected line.
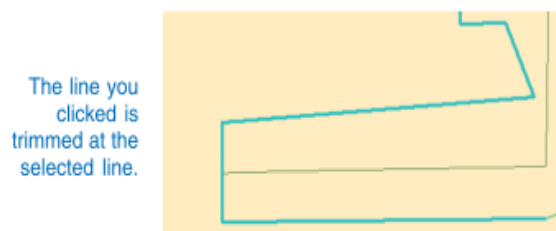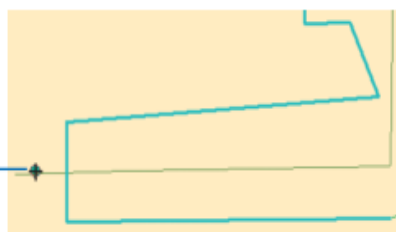
Exploding multipart feature

1. Click the Edit tool.
2. Select the multipart feature that you want to Explode.
3. Click the Explode tool.

The parts of the multipart feature become independent features.
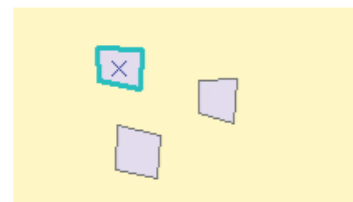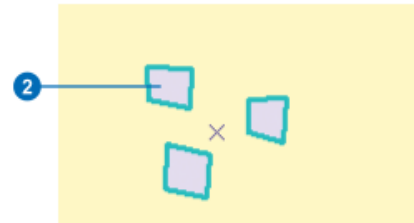
Generalizing a feature

1. Click the Edit tool.
2. Select the feature that you want to Generalize.
3. Click the Generalize tool.
4. Type the Maximum allowable offset.

   The Maximum allowable offset is the maximum distance any part of the output geometry can be from the input geometry, in map units.
5. Click OK.
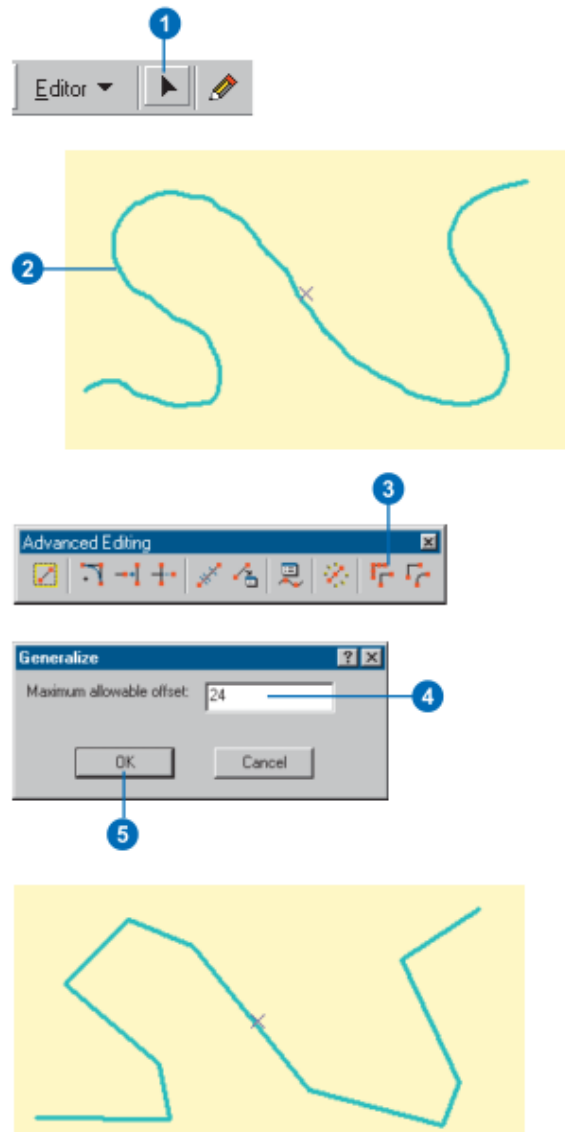
Smoothing a feature

1. Click the Edit tool.
2. Select the feature that you want to Smooth.
3. Click the Smooth tool.
4. Type the Maximum allowable offset.

   The Maximum allowable offset is the
   maximum distance any part of the output
   geometry can be from the input geometry,
   in map units.
5. Click OK

Snapping Environment window

You can keep the window open as you work—any changes in settings are effective immediately. Click the Close button when you are finished.

The layers in your map document are listed here. Set the snapping priority—the order in which snapping will occur by layer—by dragging the layer names to new locations.

Check the type of snapping properties you want for each layer.

The bottom portion of the window shows snapping properties that work with a sketch or with elements of a Topology.

Snapping Environment

Layer	Vertex	Edge	End
Water distribution r	☐	☐	☐
System valves	☐	☐	☐
Distribution mains	☐	☐	☐
Blocks	☐	☐	☐
Parcels	☑	☑	☐
Water laterals	☐	☐	☐
DistDiam Layer	☐	☐	☐
WaterLateralDiame	☐	☐	☐
Hydrants	☐	☐	☐
Road edge of pav	☑	☐	☐
Road names	☐	☐	☐
Road centerlines	☐	☐	☐

- ☐ Edit Sketch
  - ☐ Edit sketch vertices
  - ☑ Edit sketch edges
  - ☐ Perpendicular to sketch
- ☐ Topology Elements
  - ☑ Topology nodes

Types of snapping properties

When you use the snapping environment to create or place a new feature in an exact location relative to other features, you must choose to which part of existing features—vertex, edge, or endpoint—you want your feature to snap. These choices are called layer *snapping properties*. You can also specify snapping properties for the edit sketch and for topology elements; these are called sketch and topology snapping properties. You can set all three types of snapping properties using the Snapping Environment window. The following table briefly explains each of the layer snapping and sketch snapping properties.

Layer snapping properties	Sketch snapping properties	Topology snapping properties
Vertex Snaps to each vertex of the features in that layer.	**Perpendicular to sketch** Lets you create a segment that will be perpendicular to the previous.	**Topology nodes** Snaps to the nodes in the topology.
Edge Snaps to the entire outline—both segments and vertices—of each feature in that layer.	**Edit sketch edges** Snaps to the entire outline—both segments and vertices—of the sketch.	
Midpoint Snaps to the midpoint between the two end vertices of the segment.	**Edit sketch vertices** Snaps to the vertices of the sketch.	
Endpoint Snaps to the first vertex and the last vertex in a line feature.		

Module III

Editing

In this module:
• Editing tool bar
• Slitting line and polygon
• Extending
• Flipping
• Reshaping
• Inserting Vertex

Editing Tool Bar

If editing tool bar below is not already docked in your ArcMap tool bar, then click Editor Toolbar icon
from ArcMap Standard Tool Bar or from View menu, select Toolbars >> Standard.
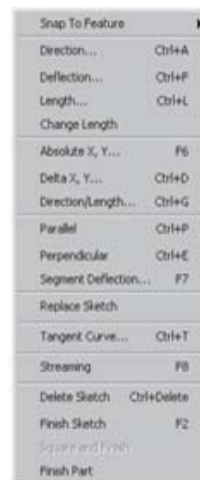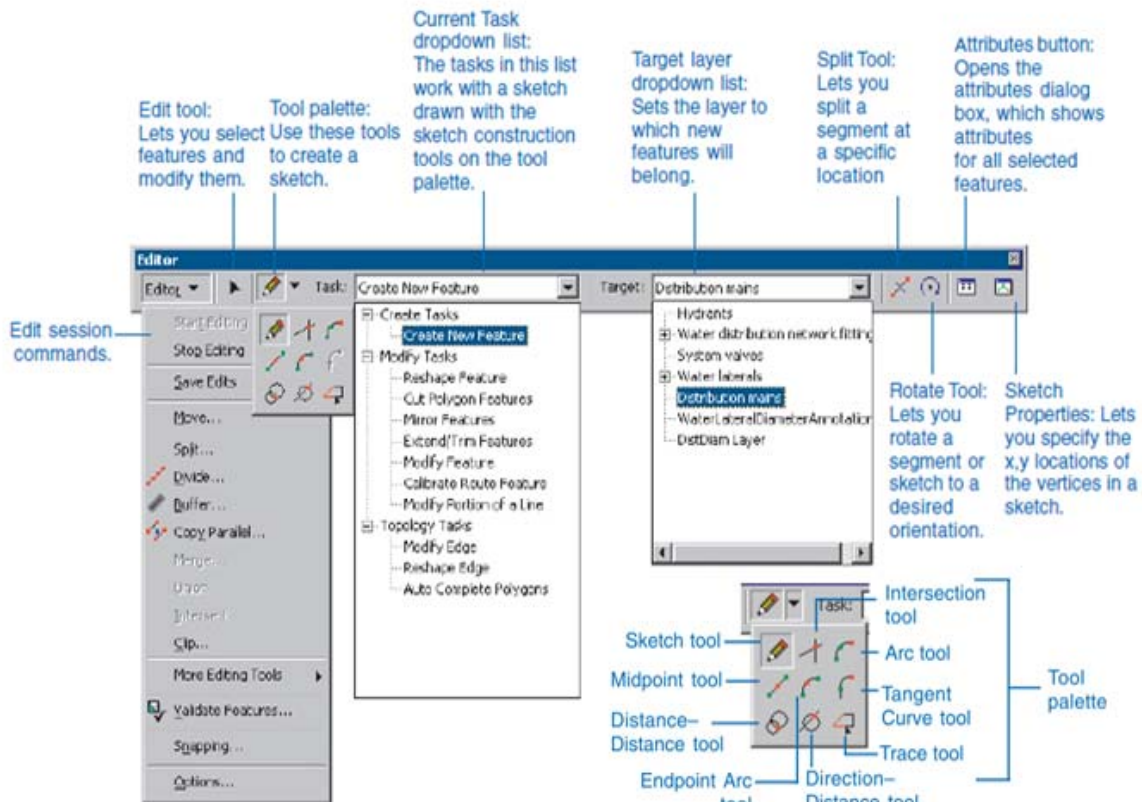
Sketch tool context menu
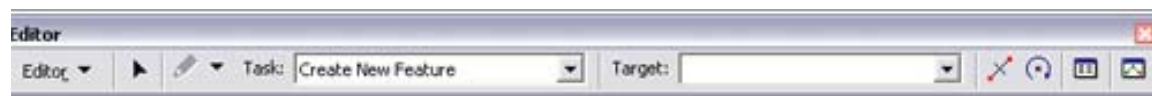
Editor toolbar buttons and their functions

Button	Name	Function
	Edit	Selects and edits features and their geometries
	Sketch	Adds points to the edit sketch
	Intersection	Intersects two line segments to create a new point
	Arc	Creates a circular arc segment
	Midpoint	Creates a new point at the midpoint of a line
	Endpoint Arc	Creates a circular arc segment
	Tangent	Constructs a tangent curve
	Distance-Distance	Creates a point at the intersection of two distances from two other points
	Direction-Distance	Creates a point at the intersection of a direction from one point and a distance from another point
	Trace	Adds points to the edit sketch by tracing existing features
	Split Tool	Splits a linear feature
	Rotate Tool	Rotates the selected feature
	Attributes	Shows the feature property editor
	Sketch Properties	Shows a dialog box for editing properties of the edit sketch geometry

Editing Attributes

Attributes can be created or edited in the attributes dialog box. After selecting the features whose attributes you want to edit, click the attributes button to see the dialog box.
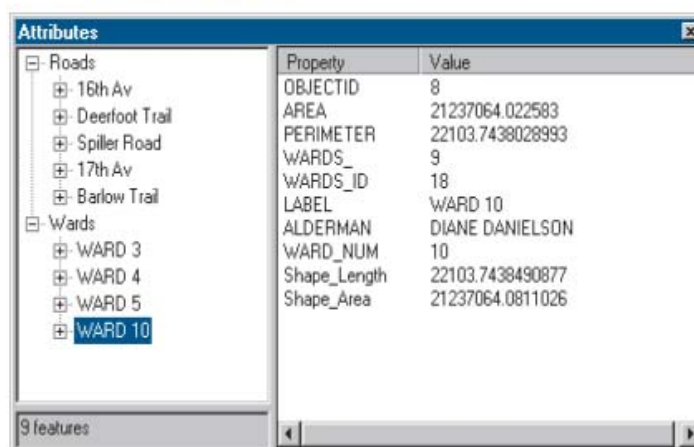
Attributes button

Attributes dialog box

Advance Editing Tool Bar

Advanced Editing toolbar buttons and their functions

Button	Name	Function
	Copy Features	Copies features
	Fillet	Allows you to place an arc tangent to two segments
	Extend	Extends a line feature to meet the selected feature
	Trim	Trims a line feature that is cut by a selected feature
	Line Intersection	Intersect features at either explicit or implied intersections
	Explode	Separates a multipart feature into individual features
	Generalize	Generalizes the selected line and polygon features
	Smooth	Smoothes the selected line and polygon features
	Rectangle	Creates a rectangle
	Circle	Creates a circle

Adding the Editor toolbar

1. Start ArcMap
2. Click the Editor Toolbar button to display the Editor toolbar..
3. Click the toolbar's title bar and drag it to the top of the ArcMap application window

Adding other editing toolbars

1. Click Editor, point to More Editing Tools, and click the toolbar that you want to add
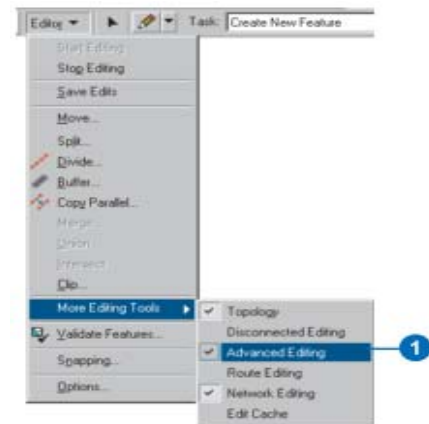
Selecting features using the Edit tool

1. Click the Edit tool.
2. Move the pointer over a feature and click.

   The selected feature is highlighted.

The selected building is highlighted.
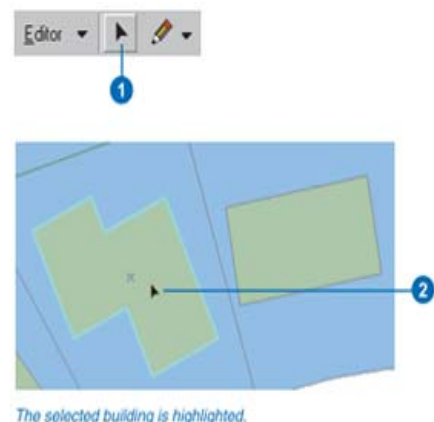
Dragging a feature

1. Click the Edit tool.
2. Click the feature or features you want to move.
3. Click and drag the feature or features to the desired Location.

The selected building is dragged to a new location.
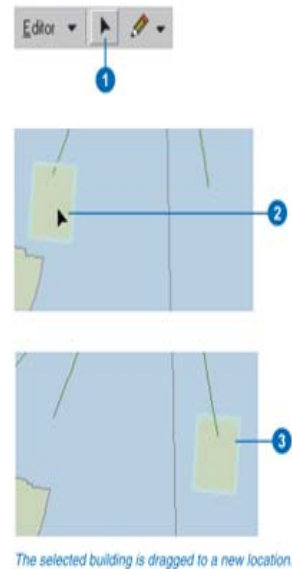
Rotating a feature

1. Click the Edit tool.
2. Click the feature or features you want to rotate.
3. Click the Rotate tool.
4. Click anywhere on the map and drag the pointer to rotate the feature to the desired position.

   The feature or features rotate around the selection anchor. You can drag the selection anchor to a new location to change the center of rotation.

The selected features are rotated.
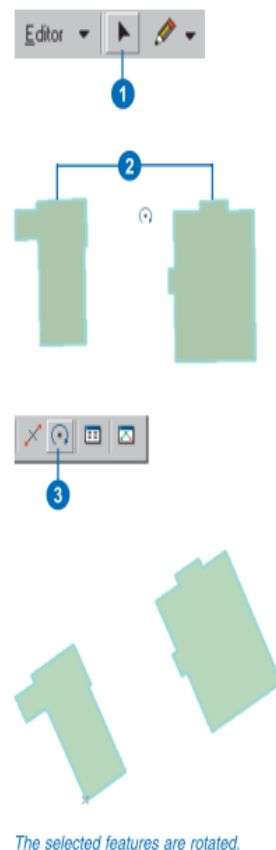
Copying and pasting features

1. Click the Target layer dropdown arrow and click the layer containing the type of features you want the new features to be.
2. Click the Edit tool.
3. Click the feature or features you want to copy.
4. Click the Copy button.
5. Click the Paste button.

The feature is pasted on top of the original feature.
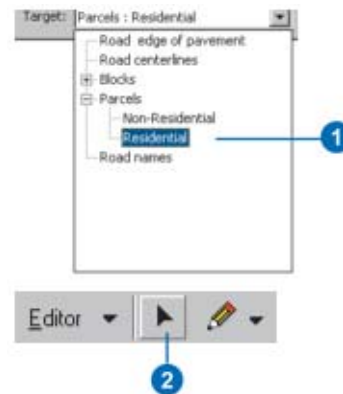
The selected feature is pasted on top of the original feature.

Deleting features

1. Click the Edit tool.
2. Click the feature or features you want to delete.
3. Click the Delete button.

   The selected features are deleted.

The selected building is deleted.

Editing Existing Features

Splitting a Line or Polygon Features

1. Click the Edit tool.
2. Click the line you want to split.
3. Click the Split tool.
4. Click the spot on the line where you want it to split.

The line is split into two features.
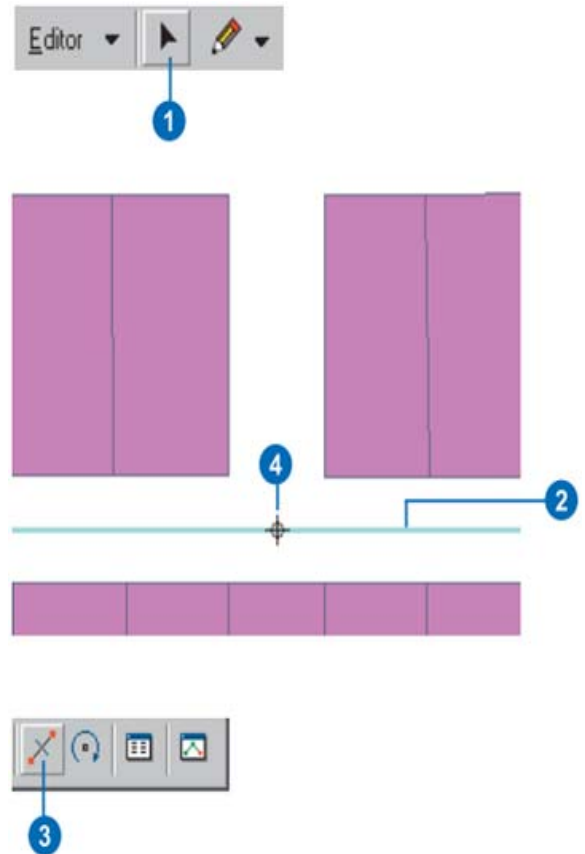
Splitting a Polygon

1. Click the Edit tool.
2. Click the polygon you want to split.
3. Click the Task dropdown arrow and click Cut Polygon Features.
4. Click the tool palette dropdown arrow and click the Sketch tool.
5. Construct a line or polygon sketch that cuts the original polygon as desired.
6. Right-click anywhere on the map and click Finish Sketch.

   The polygon is split into two features.

The sketch divides the polygon into two features.
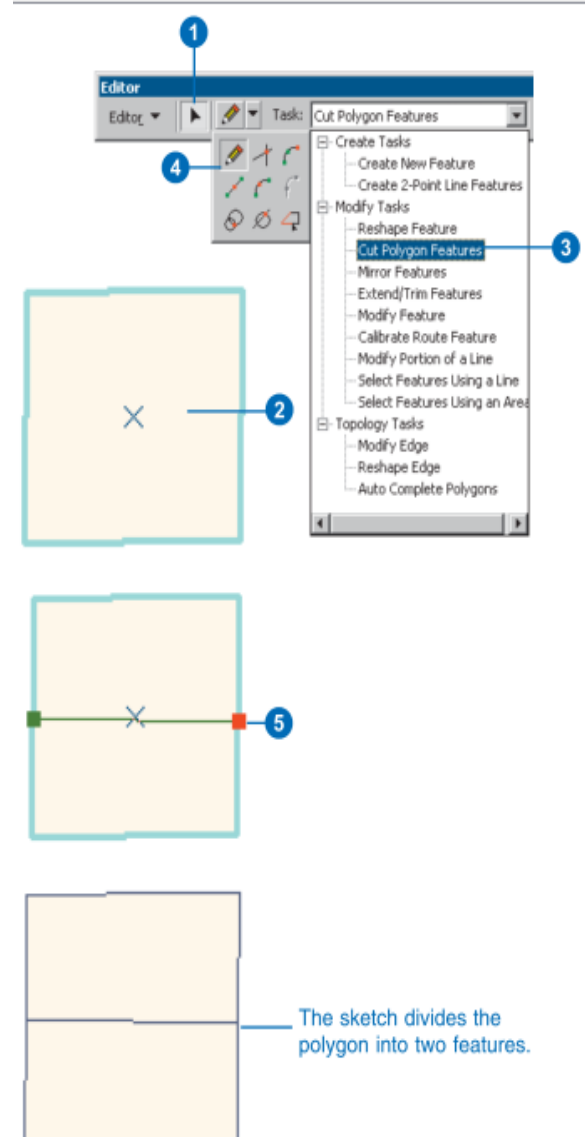
Trimming a specific length from the last point

1. Click the Task dropdown arrow and click Modify Feature.
2. Click the Edit tool.
3. Click the line that you want to trim.
   The line appears as a sketch with vertices.
4. Right-click over any part of the line and click Trim.
5. Type the length to trim the line to and press Enter.
   If you type a positive value it trims the line to the specified length. If you type a negative value it removes that much from the length of the line, starting from the last vertex. The line is trimmed.
6. When finished modifying the line, right-click over any part of the sketch and click Finis Sketch.

20 map units are trimmed from the original line.
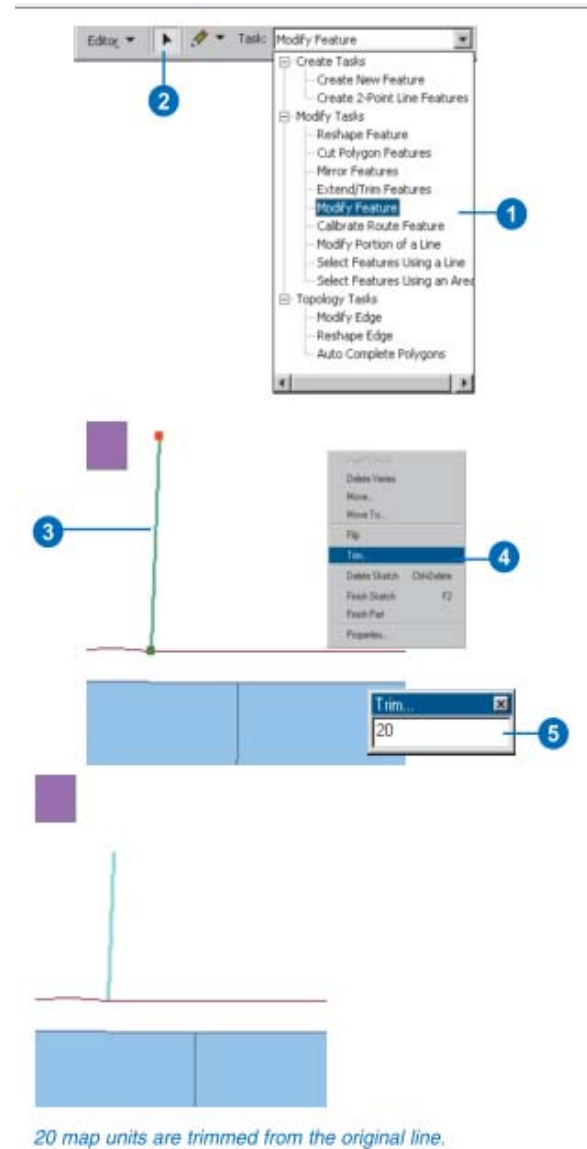
Trimming based on a line you draw

1. Click the Task dropdown arrow and click Extend/Trim Features.
2. Click the Edit tool.
3. Click the line or lines you want to trim.
4. Click the tool palette dropdown arrow and click the Sketch tool.
5. Construct a line that trims the selected line or lines as desired. The direction of the sketch line determines the part of the features to be removed. The portion of the selected features to the right of the sketch is trimmed.
6. Right-click anywhere on the map and click Finish Sketch.

   The lines are trimmed on the right side of the line you constructed.
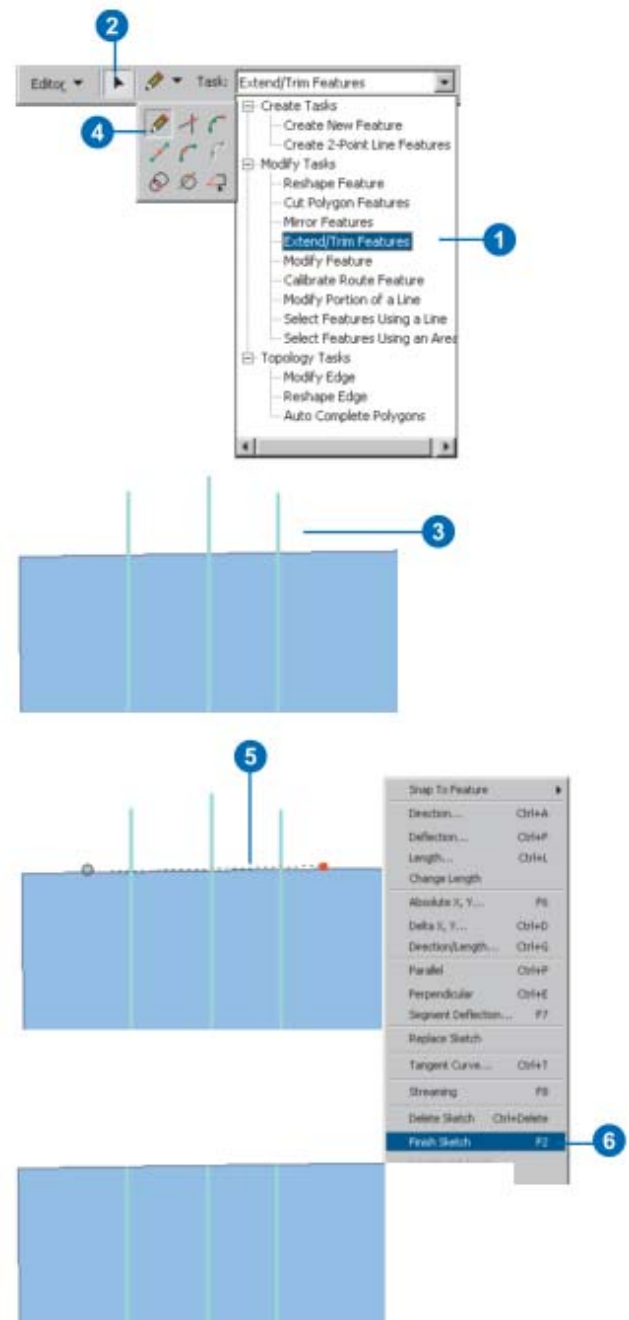
The lines are trimmed where the sketch was drawn.

Extending a Line

1. Click the Task dropdown arrow and click Extend/Trim Features.
2. Click the Edit tool.
3. Click the line or lines you want to extend.
4. Click the tool palette dropdown arrow and click the Sketch tool.
5. Construct a line to which you want to extend the selected line or lines.
6. Right-click anywhere on the map and click Finish Sketch.
   The lines are extended to the line you constructed.
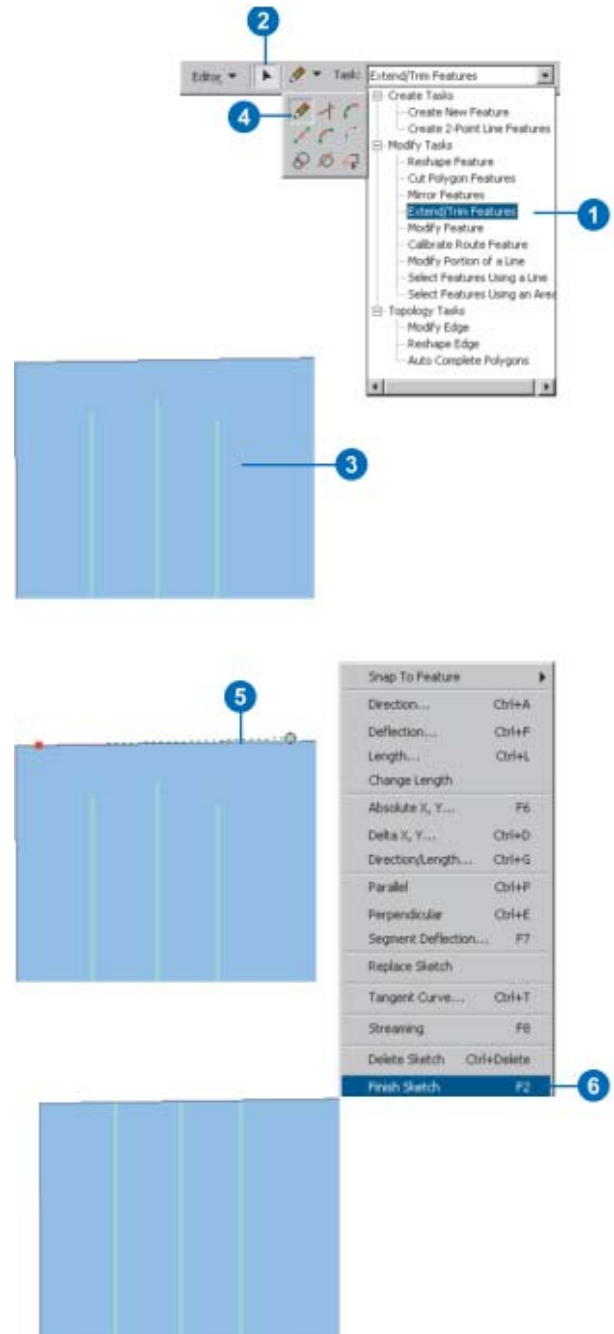
The lines are extended to where the sketch was drawn.

Flipping a Line

1. Click the Task dropdown arrow and click Modify Feature.
2. Click the Edit tool.
3. Click the line whose direction you want to change.
4. Right-click over any part o the sketch and click Flip. The sketch becomes inverted (the first vertex becomes the last, marked in red).
5. When finished modifying the line, right-click over any part of the sketch and click Finish Sketch.
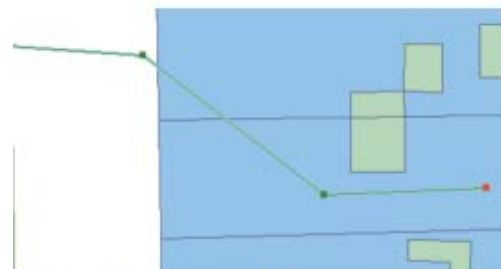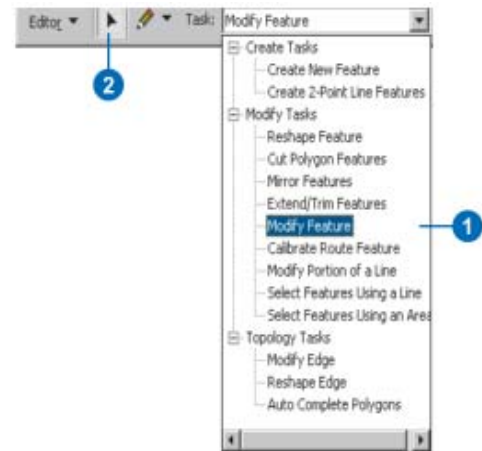
The first and last vertices of the line are reversed.

Placing a Point along a line

1. Click the Edit tool.
2. Click the line you want to divide.
3. Click the Target layer dropdown arrow and click the point layer containing the type of points you want to place along the line.
4. Click Editor and click Divide.
5. Click the first option and type a number to place a specific number of points evenly along the line.
   Or click the second option and type a number to place the points at a specific interval in map units.
   If the data has M values, you can click the third option and type a number to place the points at a specific interval of measure units
6. Click OK.

   The line is divided by points placed along the line as specified.

The line is divided by points.
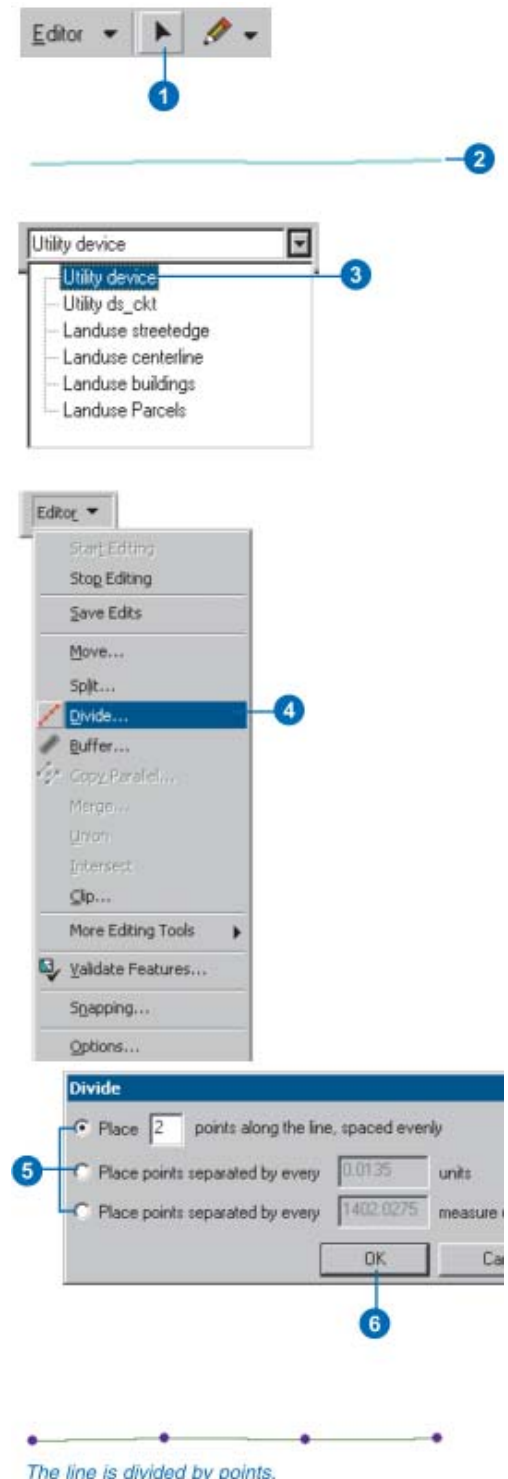
Reshaping a line or Polygon

1. Click the Task dropdown arrow and click Reshape Feature.
2. Click the Edit tool.
3. Click the feature you want to reshape.
4. Click the tool palette dropdown arrow and click the Sketch tool.
5. Create a line according to the way you want the feature reshaped.
6. Right-click anywhere on the map and click Finish Sketch.

The feature is reshaped.
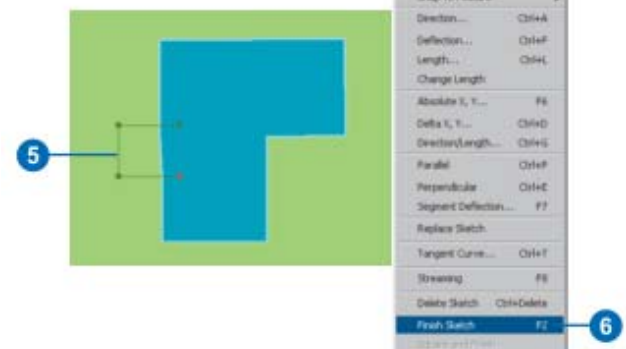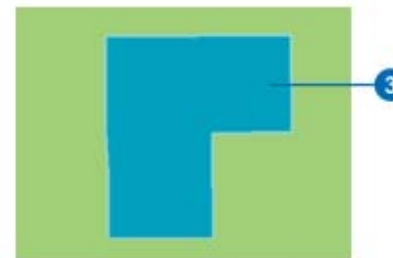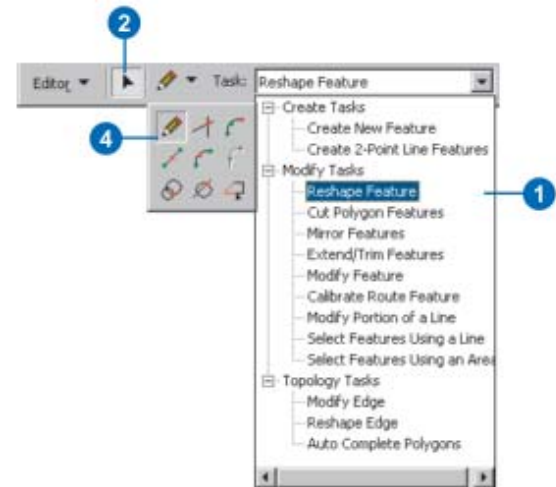
The feature is reshaped according to the sketch you constructed.

Adding a vertex to a sketch

1. Click the Task dropdown arrow and click Modify Feature.
2. Click the Edit tool and click the line or polygon to which you want to add a vertex.
3. Move the pointer to where you want the vertex inserted and right-click.
4. Click Insert Vertex.
   A vertex is added to the sketch.
5. When finished modifying the line, right-click over any part of the sketch and click Finish Sketch.

A new vertex is added to the sketch.
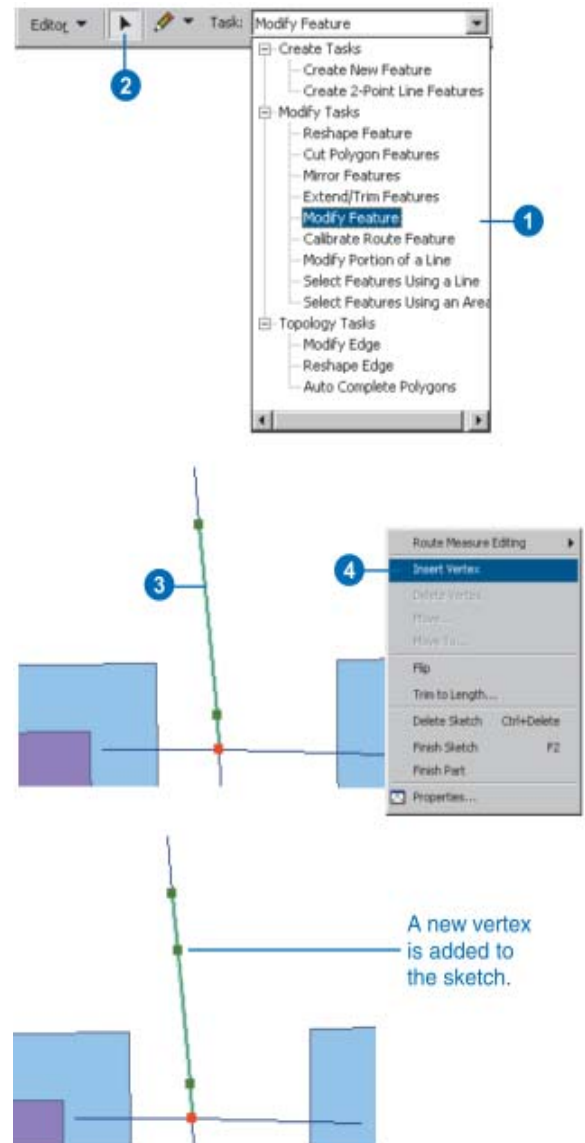
Deleting a vertex from a sketch

1. Click the Task dropdown arrow and click Modify Feature.
2. Click the Edit tool.
3. Click the line or polygon from which you want to delete a vertex.
4. Position the pointer over the vertex you want to delete.
   The pointer will change appearance to have four small arrows surrounding a circle.
5. Right-click and click Delete Vertex.
   The vertex is deleted from the sketch.
6. Right-click over any part of the sketch and click Finish Sketch.

   The feature is reshaped
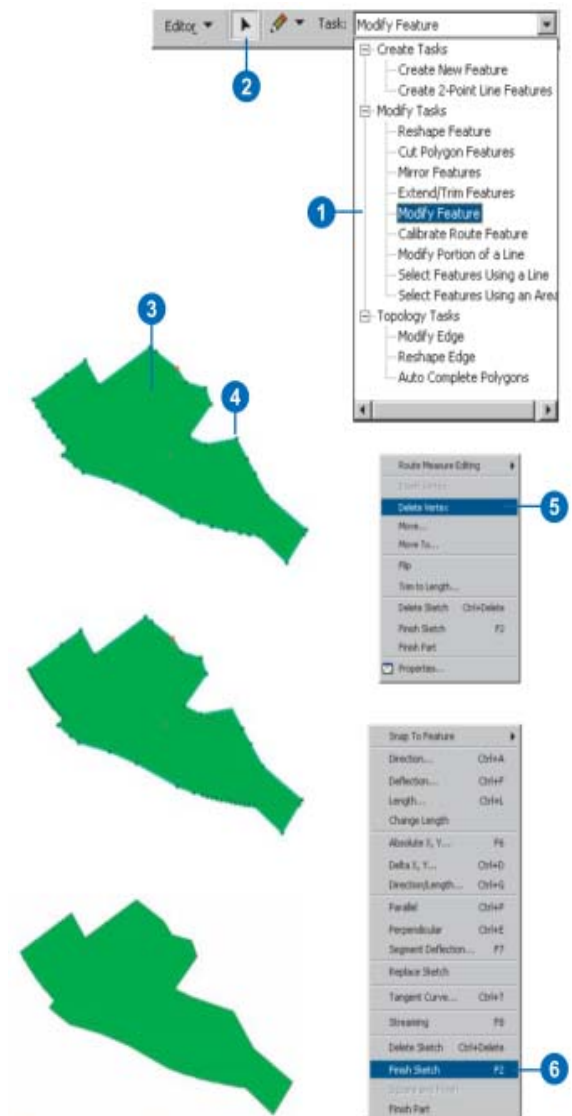
The vertex is deleted, and the feature is reshaped.

Dragging a vertex

1. Click the Task dropdown arrow and click Modify Feature.
2. Click the Edit tool and click the line or polygon whose vertex you want to move.
3. Position the pointer over the vertex you want to move.
   The pointer will change appearance to have four small arrows surrounding a circle.
4. Click and drag the vertex to the desired location.
5. Right-click over any part of the sketch and click Finish Sketch.

   The feature is reshaped
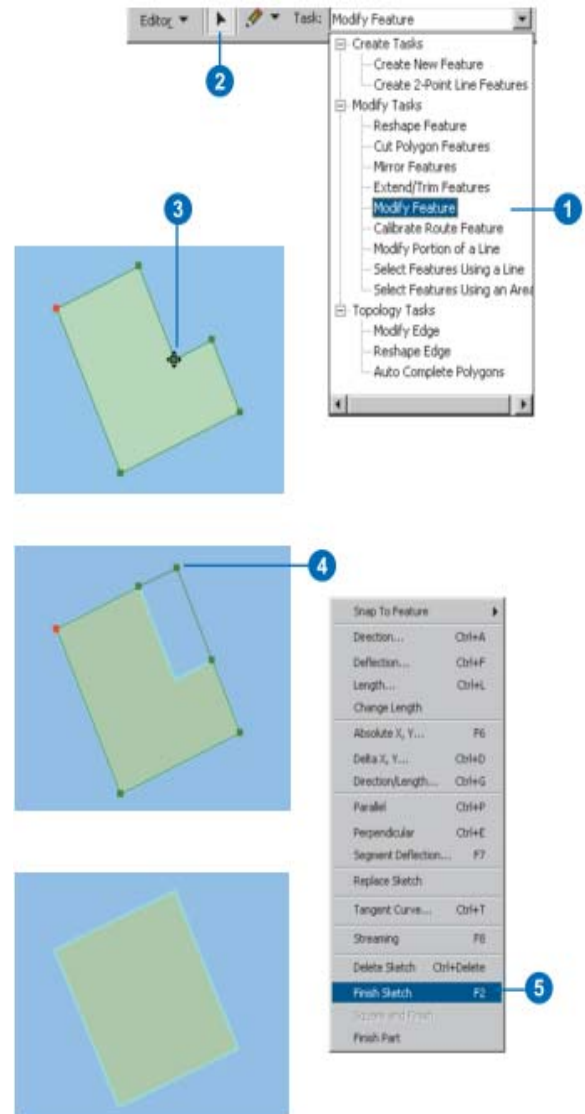
The vertex is moved, and the feature is reshaped

Inserting a vertex at the midpoint of a segment

1. Right-click over a segment of the edit sketch and click Properties.
2. Select the vertex before which you wish to insert a new vertex.
3. Right-click the selected vertex and click Insert Before.
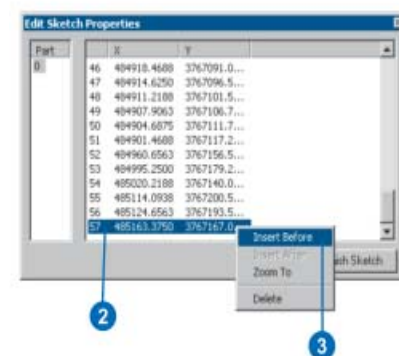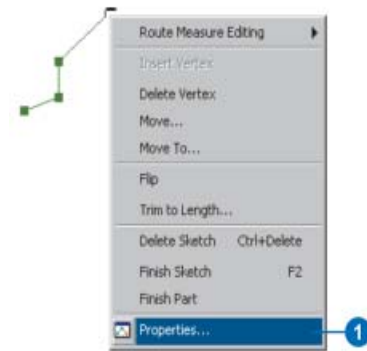
Vertex inserted at midpoint

Module IV

Geoprocessing

In this module:
• About Geoprocessing
• Map Projections
Geoprocessing Tools:
• Clip
• Append
• Merge
• Eliminate
• Dissolve
• Identity
• Intersect
• Split
• Buffer
• Selection by Location

What is Geoprocessing?

The fundamental purpose of geoprocessing is to allow you to automate your GIS tasks. Almost all uses of GIS involve the repetition of work, and this creates the need for methods to automate, document, and share multiple-step procedures known as workflows. Geoprocessing supports the automation of workflows by providing a rich set of tools and a mechanism to combine a series of tools in a sequence of operations using models and scripts.

The kinds of tasks to be automated can be ordinary—for example, to convert data from one format to another. Or the tasks can be quite creative, using a sequence of operations to model and analyze complex spatial relationships—for example, calculating optimum paths through a transportation network, predicting the path of wildfire, analyzing and finding patterns in crime locations, predicting which areas are prone to landslides, or predicting flooding effects of a storm event.

Geoprocessing is based on a framework of data transformation. A typical geoprocessing tool performs an operation on an ArcGIS dataset (such as a feature class, raster, or table) and produces a new dataset as the result of the tool. Each geoprocessing tool performs a small yet essential operation on geographic data, such as projecting a dataset from one map projection to another, adding a field to a table, or creating a buffer zone around features. ArcGIS includes hundreds of such geoprocessing tools.

```
┌─────────────────┐        ┌──────────────────────┐        ┌─────────────────┐
│  Input Dataset  │ ─────▶ │  Geopeocessing Tool  │ ─────▶ │   New Dataset   │
└─────────────────┘        └──────────────────────┘        └─────────────────┘
```

Geoprocessing allows you to chain together sequences of tools, feeding the output of one tool into another. You can use this ability to compose an infinite of geoprocessing models (tool sequences) that help you automate your work and solve complex problems.

Project and Clip

The example workflow below uses two geoprocessing tools, **Project** and **Clip**. This is but one example of an infinite number of workflows you could automate with geoprocessing.

Suppose you've received 20 shapefiles from a colleague, and they're in different map projections and contain lots of features that are outside your study area. Your task is to change the map projection of each of the 20 datasets, remove the extraneous features ("clip" the datasets).

By far the easiest way to accomplish this task is to use geoprocessing. First, you would use the geoprocessing Project tool, which applies a new projection to an input feature class to create a new output feature class. The illustration below shows the Project tool dialog box with its input features shown in the upper left and the projected features in the upper right.
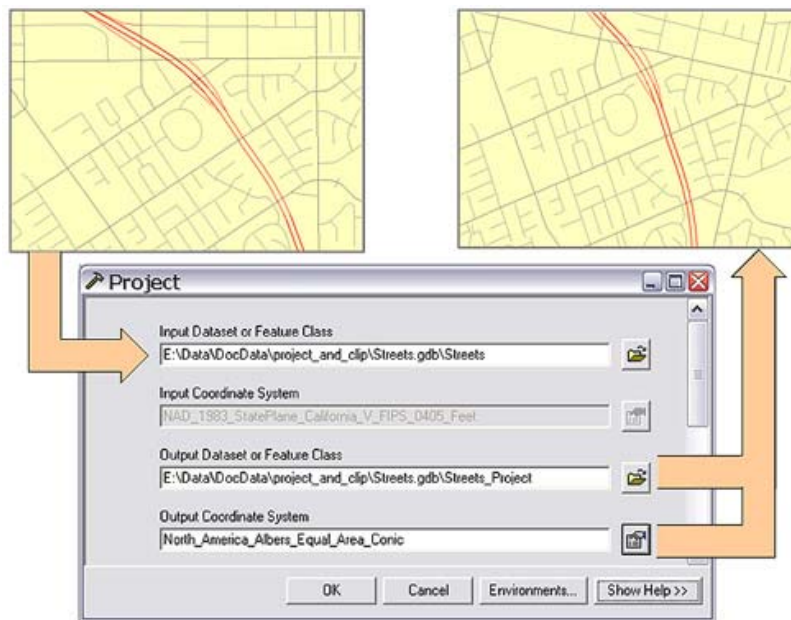
The second step is to use the geoprocessing Clip tool to clip the data that falls outside your study area. The Clip tool takes two inputs, a feature class of any type (point, polyline, polygon) and a polygon feature class (the clip feature class), and creates a new feature class of just those features that fall inside the clip polygons.
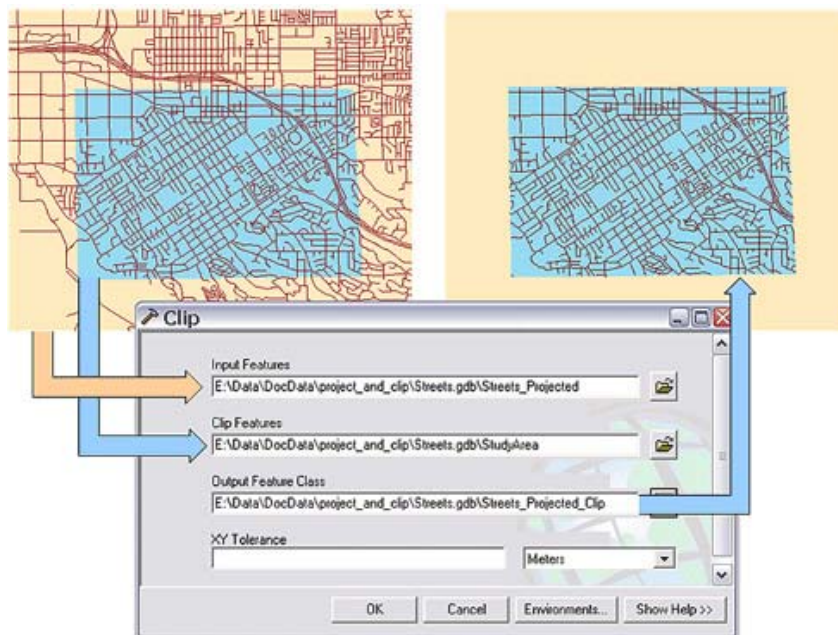
Both the Project and Clip tool can be used in Batch mode, which lets you, input the list of your 20 feature classes, and the tools automatically execute once for each of the feature classes. You can create the list by dragging and dropping the feature classes from ArcCatalog onto the tool dialog box.

Or better yet, you can quickly create a geoprocessing model that chains together the Project and Clip tools, feeding the output of Project into the input of Clip, and use the model in Batch mode. The model you create becomes a new tool in your geoprocessing environment.
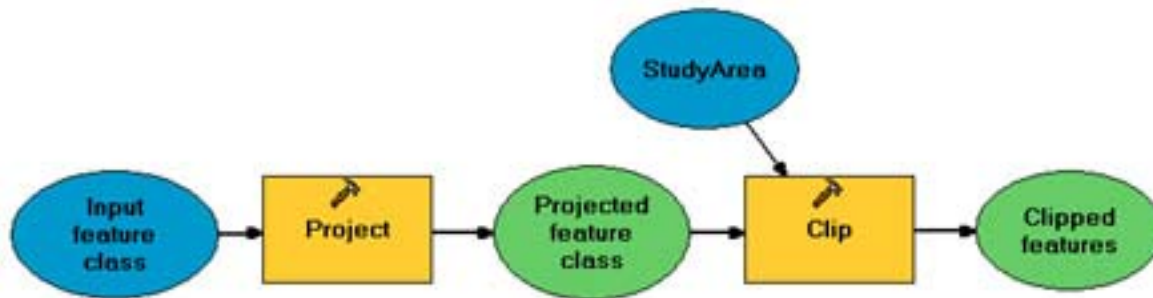
Map Projections

Within ArcGIS, every dataset has a coordinate system, which is used to integrate it with other geographic data layers within a common coordinate framework such as a map. Coordinate systems enable you to integrate datasets within maps as well as to perform various integrated analytical operations such as overlaying data layers from disparate sources and coordinate systems.
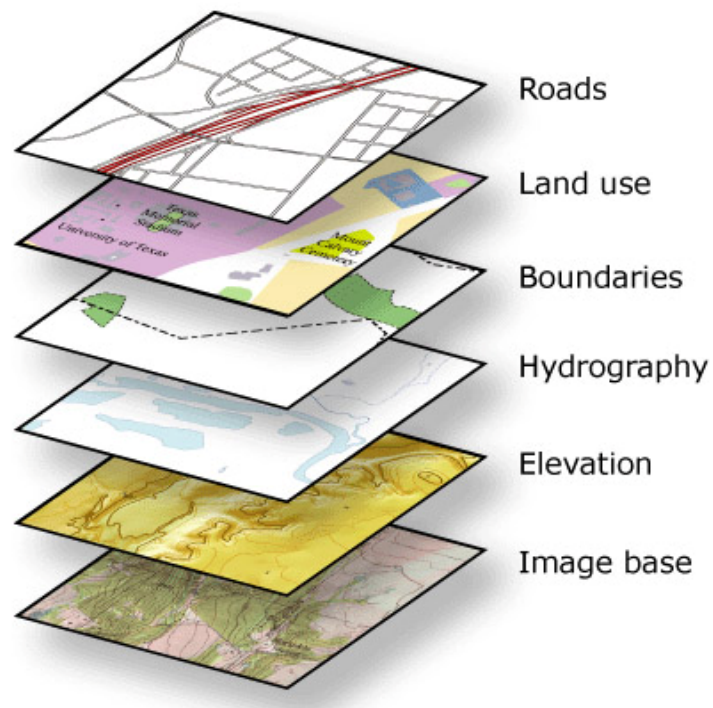
What is a coordinate system?
Coordinate systems enable geographic datasets to use common locations for integration. A coordinate system is a reference system used to represent the locations of geographic features, imagery, and observations such as GPS locations within a common geographic framework. Each coordinate system is defined by:

- Its measurement framework which is either geographic (in which spherical coordinates are measured from the earth's center) or planimetric (in which the earth's coordinates are projected onto a two-

dimensional planar surface).

• Unit of measurement (typically feet or meters for projected coordinate systems or decimal degrees for latitude-longitude).

• The definition of the map projection for projected coordinate systems.

• Other measurement system properties such as a spheroid of reference, a datum, and projection parameters like one or more standard parallels, a central meridian, and possible shifts in the x- and y-directions.

Types of coordinate systems
There are two common types of coordinate systems used in GIS:

• A global or spherical coordinate system such as latitude-longitude. These are often referred to as *geographic coordinate systems.*

• A projected coordinate system based on a map projection such as transverse Mercator, Albers equal area, or Robinson, all of which (along with numerous other map projection models) provide various mechanisms to project maps of the earth's spherical surface onto a two-dimensional Cartesian coordinate plane. Projected coordinate systems are sometimes referred to as *map projections*.

Coordinate systems (either geographic or projected) provide a framework for defining real-world locations. In ArcGIS, the coordinate system is used as the method to automatically integrate the geographic locations from different datasets into a common coordinate framework for display and analysis.

ArcGIS automatically integrates datasets whose coordinate systems are known
All geographic datasets used in ArcGIS are assumed to have a well-defined coordinate system that enables them to be located in relation to the earth's surface.
If your datasets have a well-defined coordinate system, then ArcGIS can automatically integrate your datasets with others by projecting your data on the fly into the appropriate framework—for mapping, 3D visualization, analysis, and so forth.
If your datasets do not have a spatial reference, they cannot be easily integrated. You need to define one before you can use your data effectively in ArcGIS.

What is a spatial reference in ArcGIS?
A *spatial reference* in ArcGIS is a series of parameters that define the coordinate system and other spatial properties for each dataset in the geodatabase. It is typical that all datasets for the same area (and in the same geodatabase) use a common spatial reference definition.
An ArcGIS spatial reference includes settings for:

• The coordinate system

• The coordinate precision with which coordinates are stored (often referred to as the "coordinate resolution")

- Processing tolerances (such as the cluster tolerance)

- The spatial or map extent covered by the dataset (often referred to as the "spatial domain")

Clip (Analysis Tool)

Use Clip when you want to cut out a piece of one feature class using one or more of the features in another feature class as a "cookie cutter". This is particularly useful for creating a new feature class that contains a geographic subset of the features in another, larger feature class.

For example, suppose you are studying the transportation needs of a particular county. You would like to work with a feature class that contains only the roads or segments of roads that fall inside this county boundary, but all you have is a feature class containing roads for the whole state. You can clip the roads in the state roads feature class using the county polygon as the cookie cutter to create a new feature containing just the roads in the county.

Feature classes
The feature class that is having its features clipped can contain points, lines, or polygons. The clip feature class, however, must be a polygon feature class.

- Polygon features clipped by polygon features
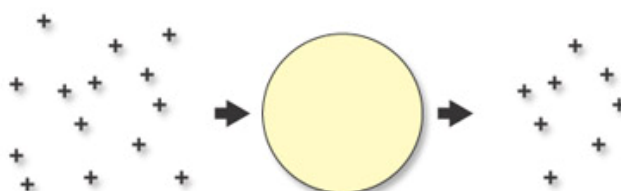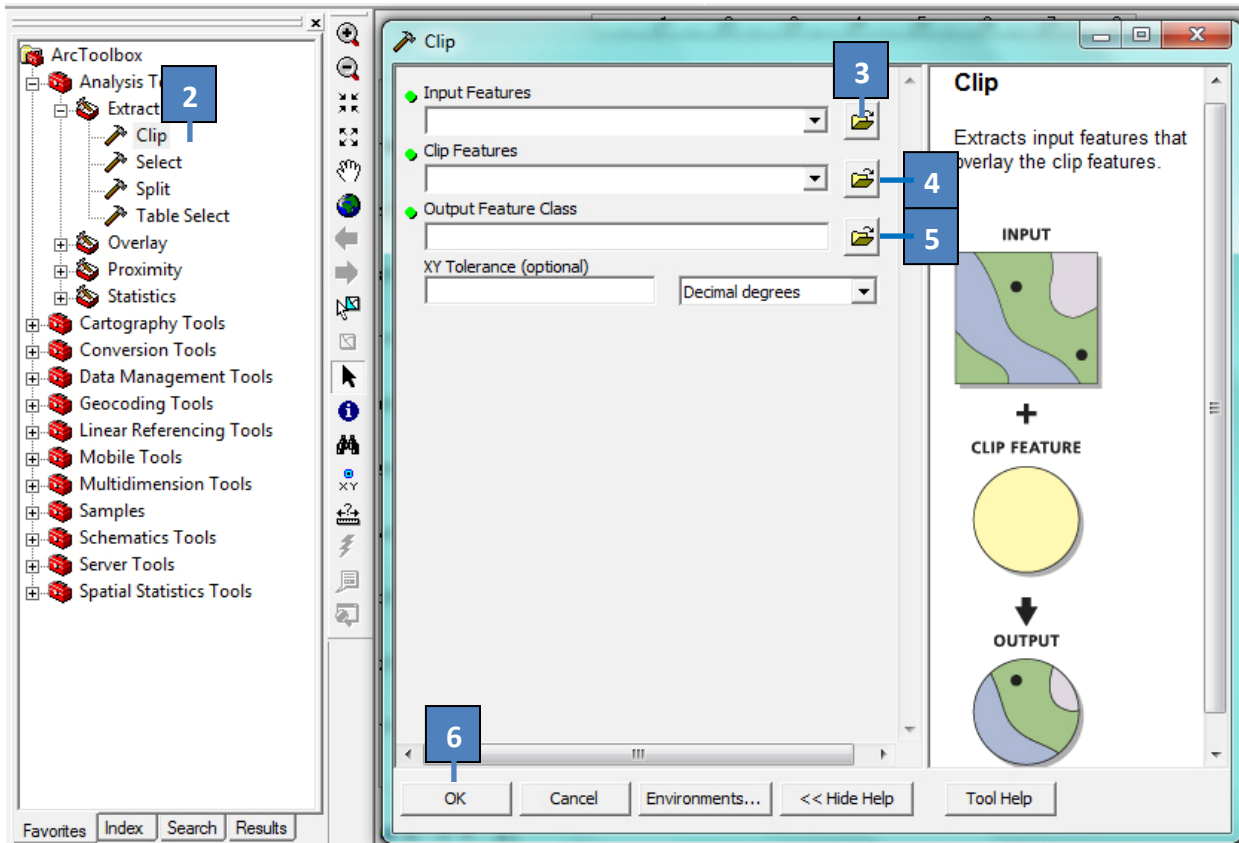
1. Open Arc Toolbox, and Go to Analysis Tools >> Extract
2. Press Clip tool and get the above dialog box
3. Press open button to select Input features
4. Press open button to select Clip feature
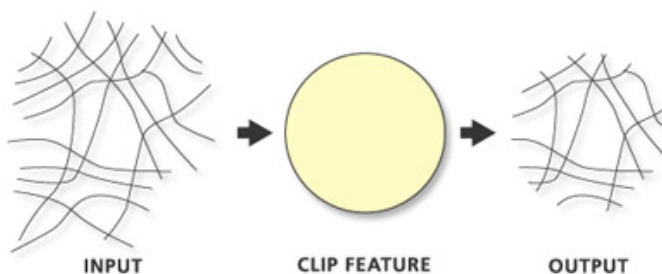5. Press open button to name Output feature
6. Press **OK** button to carry out clipping

Append (Data Management)

- Use Append when you have an existing dataset into which you want to append new data. Input datasets can be point, line or polygon feature classes, tables, rasters.
- When the inputs are features, all input features must be of the same feature type as the features of the target dataset. For example, if the target feature class contains polygon features, the input features types must be polygon as well.
- Input datasets may overlap one another and/or the target dataset.
- Input datasets in a different coordinate system from the target featureclass will be projected into the coordinate system of the target featureclass.
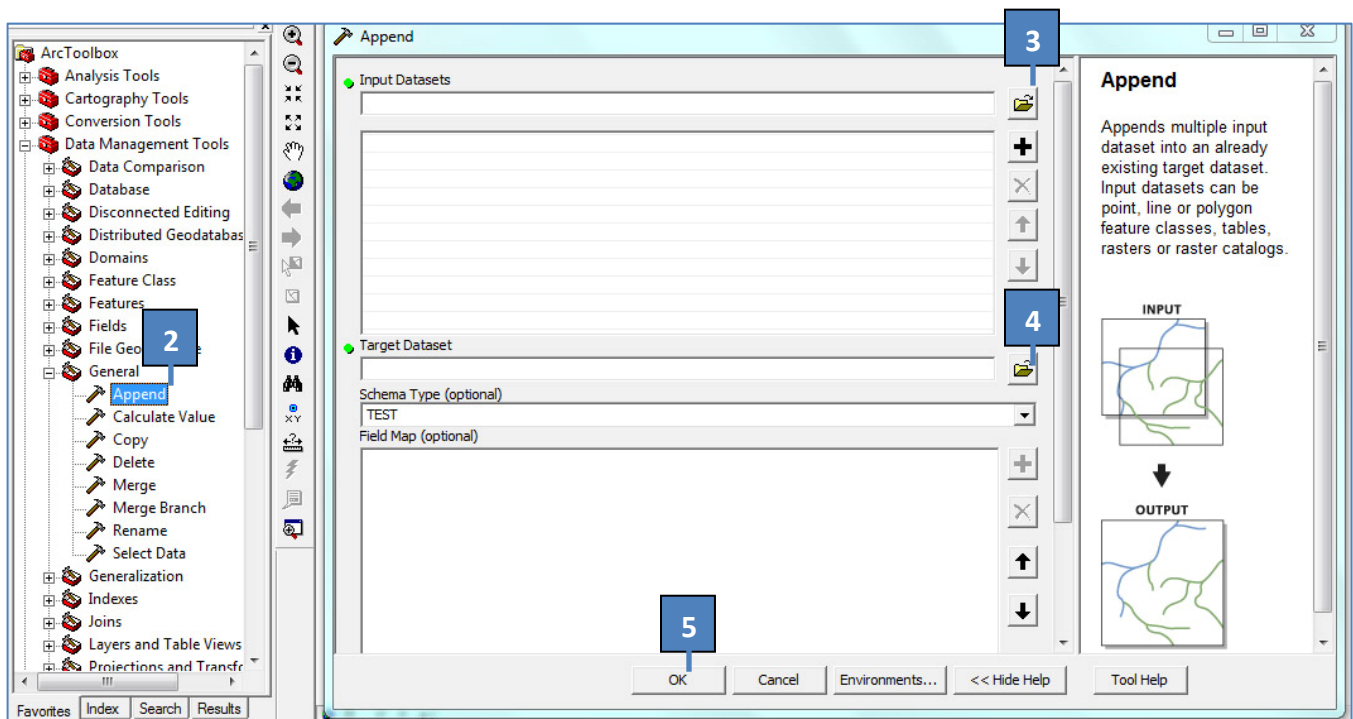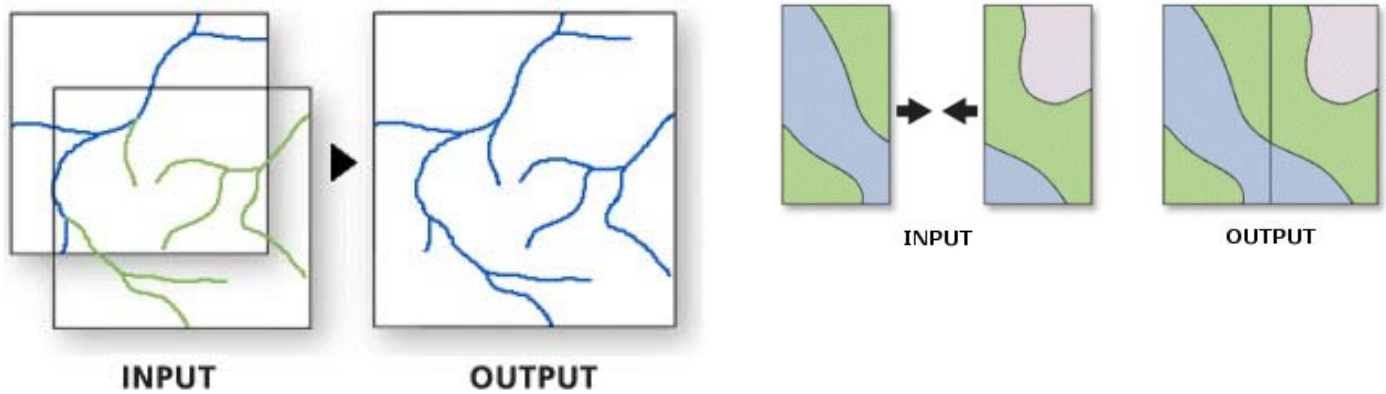
1. Open Arc Toolbox, and Go to Data Management Tools >> General tab
2. Press Append tool and get the above dialog box
3. Press open button to select input datasets
4. Press open button to select target datasets
5. Press **OK** button to carry out append function

Merge (Data Management)

Combines input features from multiple input sources (of the same data type) into a single, new, output feature class. The input data sources may be point, line, or polygon.

- Use Merge when there are features from multiple input sources that need to be combined into

one feature class.
- Input data sources need not be adjacent; overlap is allowed.
- The type of input data, such as polygons or tables, must be the same for all inputs.
- If no coordinate system is specified in the Environment Settings, the output feature class will be in the coordinate system of the first feature class in the input features list.
- Merge cannot use multiple input layers of the same name.
- The data type of an output field will default to the same as the data type of the first input field (of that name) it encounters. The data type may be changed manually at any time to any valid data type. All valid data types will be listed if the tools dialog box is used.

1. Open Arc Toolbox
2. Open Data Management Tools
3. Open General tab
4. Press Merge tool and get the above dialog box
5. Press open button to select input datasets
6. Press open button to name output datasets
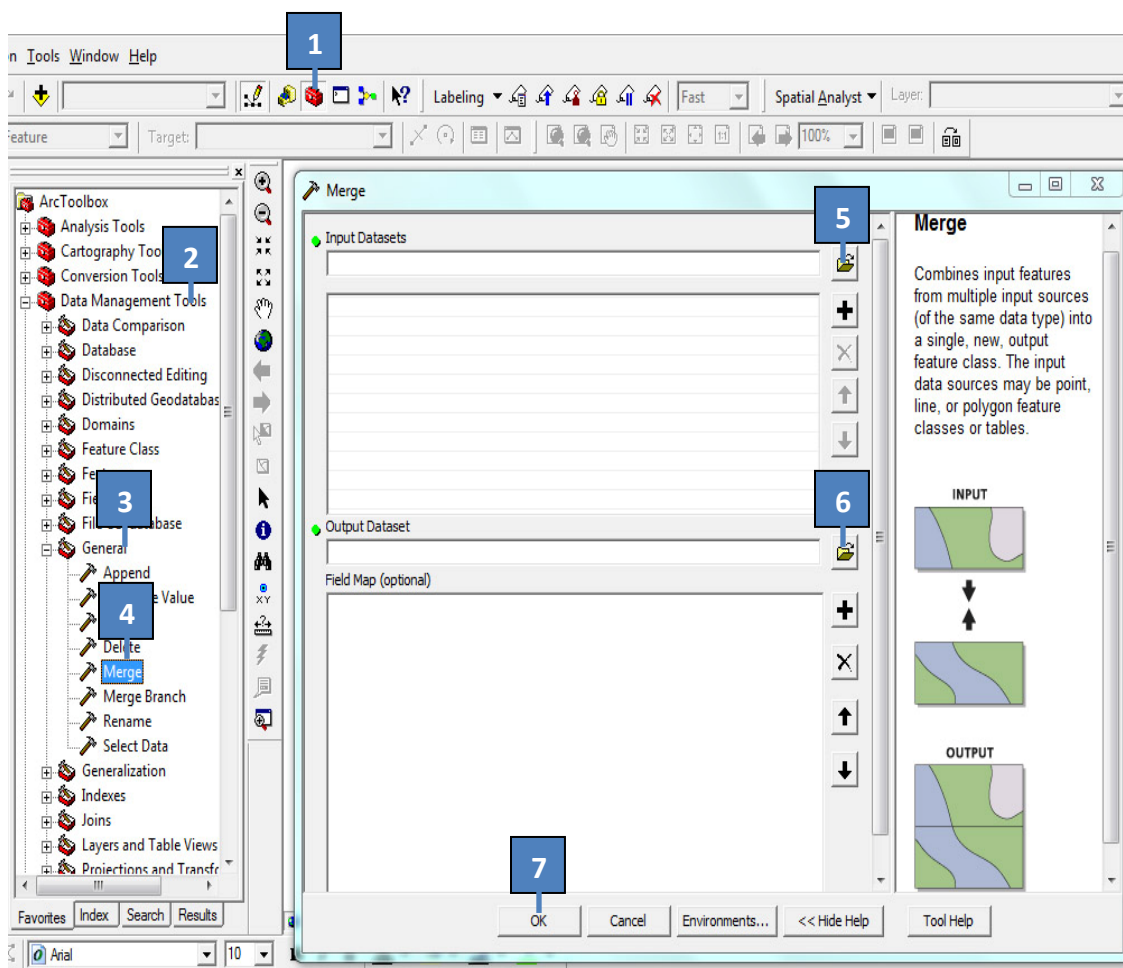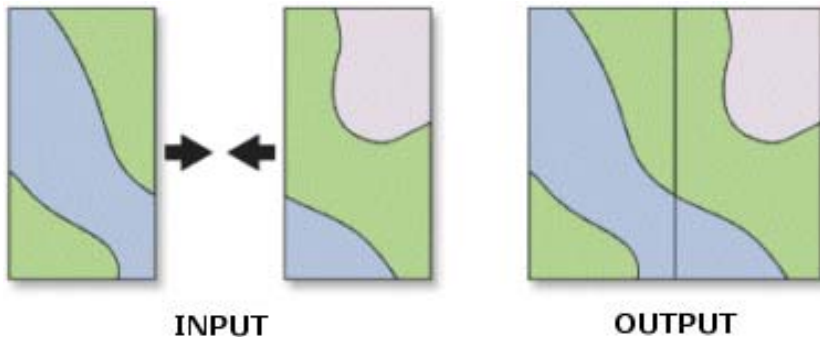7. Press **OK** button to carry out Merge function

Eliminate (Data Management)

Merges the selected polygons with neighboring polygons with the largest shared border or the largest area
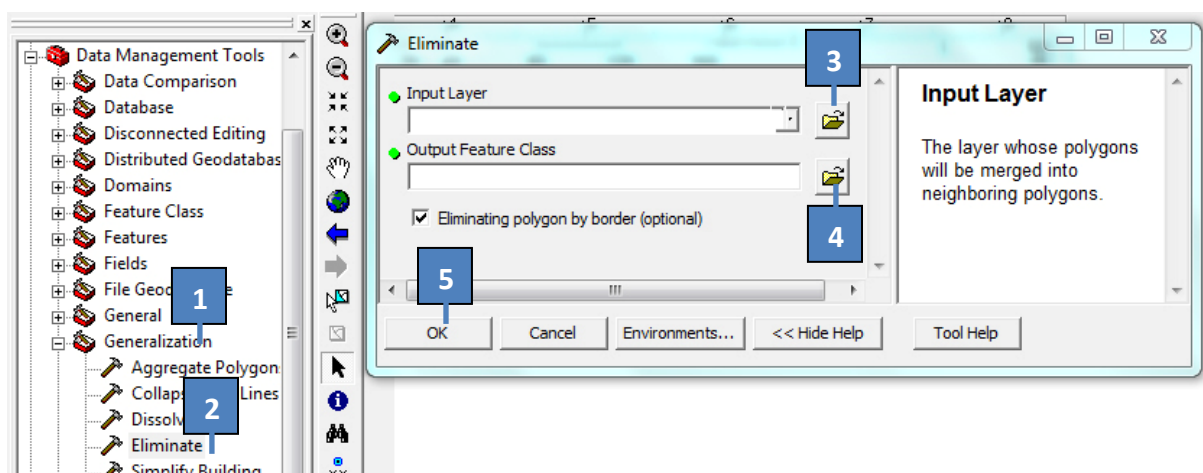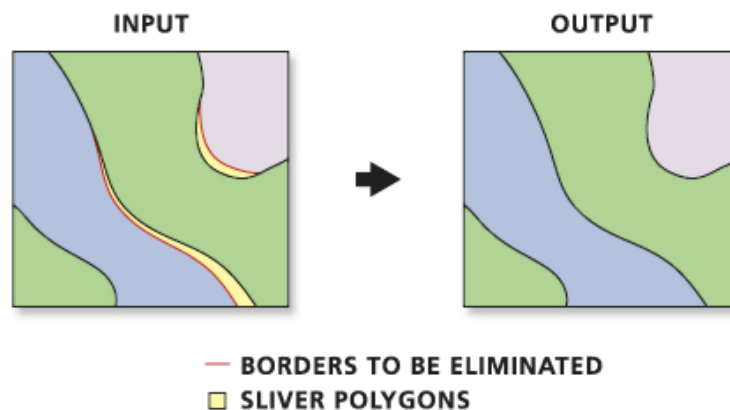
1. Open Arc Toolbox, and Go to Data Management Tools >> Generalization tab
2. Press Eliminate tool and get the above dialog box
3. Press open button to select input layer
4. Press open button to name output feature
5. Press Ok button to carry out Eliminate function

Dissolve (Data Management)

- Aggregates features based on specified attributes
- The attributes of the features which become aggregated by dissolve can be summarized or described using a variety of statistic type
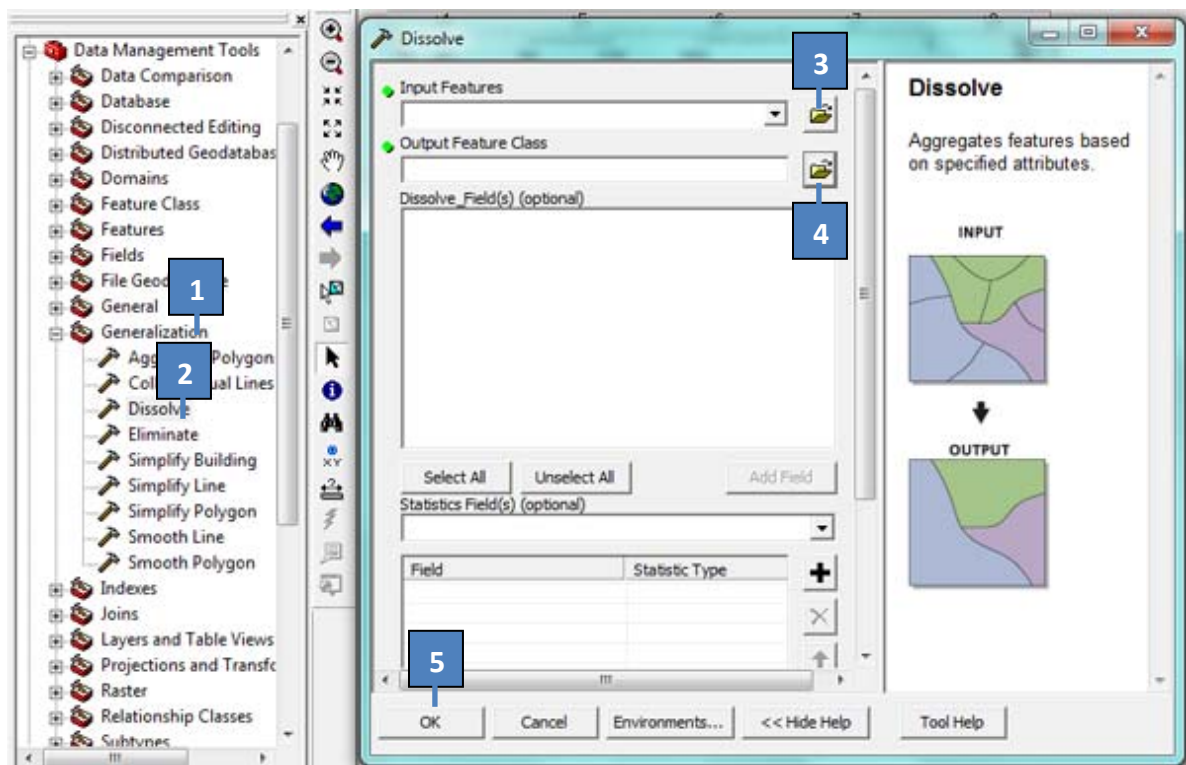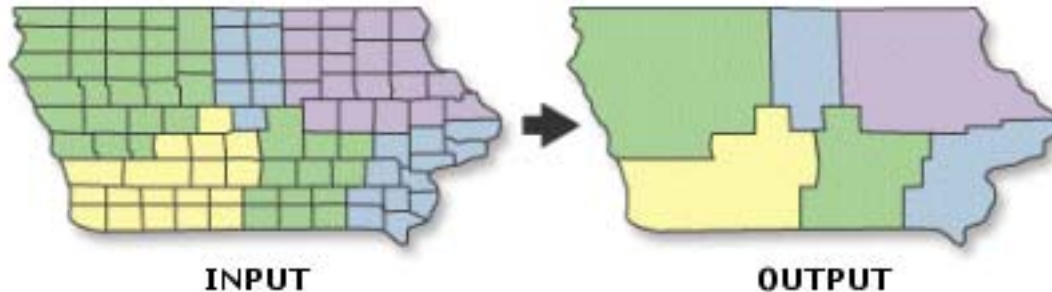
1. Open Arc Toolbox, and Go to Data Management Tools >> Generalization tab
2. Press Dissolve tool and get the above dialog box
3. Press open button to select input feature
4. Press open button to name output feature
5. Press **OK** button to carry out Dissolve function

Identity (Analysis Tool)

INPUT → OUTPUT
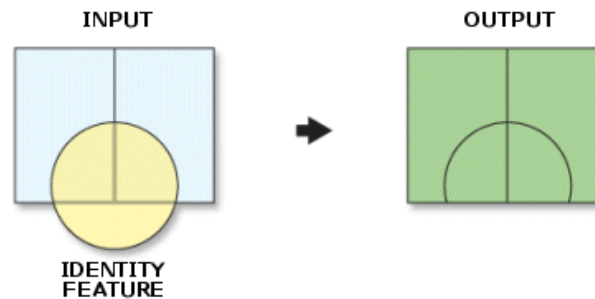
IDENTITY FEATURE

- Computes a geometric intersection of the Input Features and Identity Features. The Input Features or portions thereof that overlap Identity Features will get the attributes of those Identity Features
- The Input Features must be point, multipoint, line, or polygon. The inputs cannot be annotation features, dimension features, or network features.
- The Identity Features must be polygons.
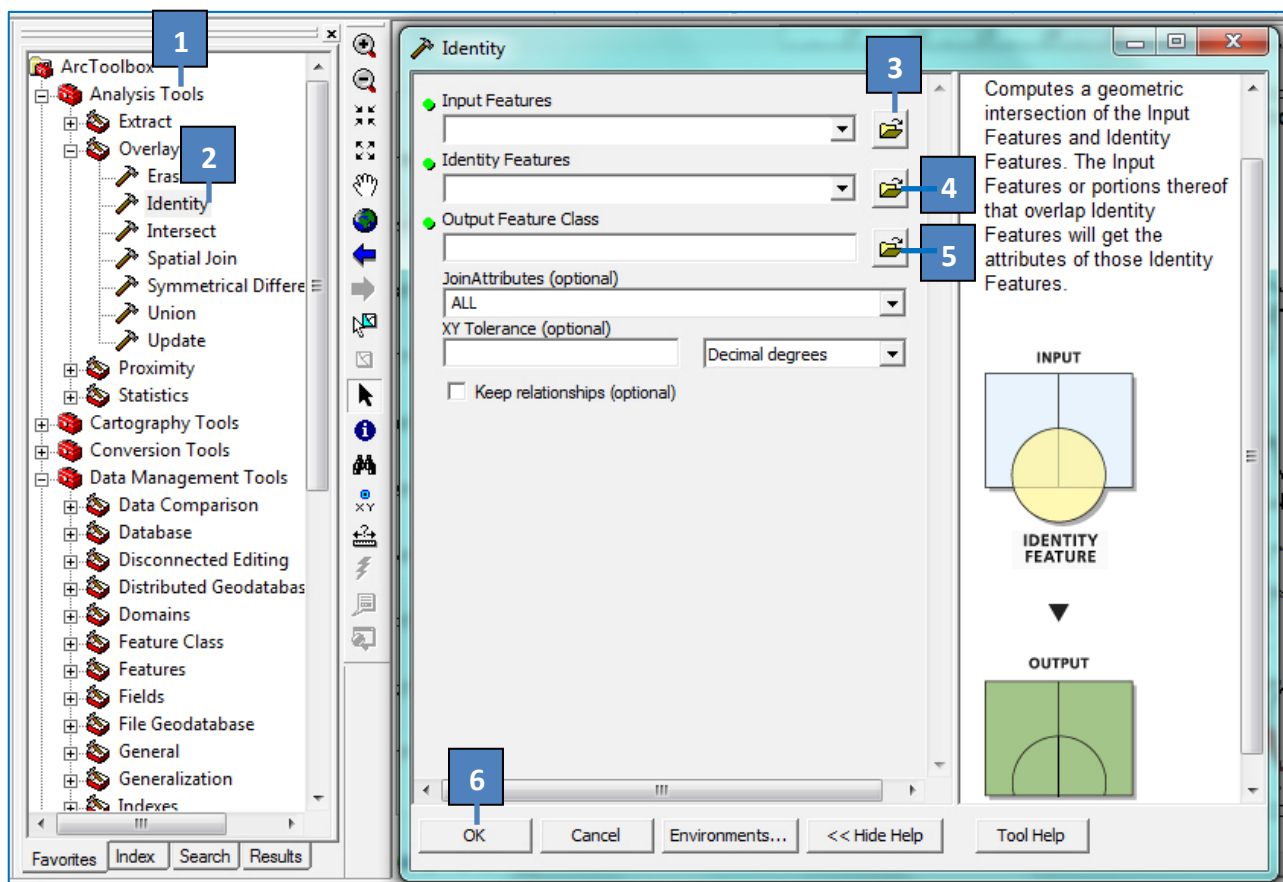
1. Open Arc Toolbox, and Go to Analysis Tools >> Overlay
2. Press Identity tool and get the above dialog box
3. Press open button to select Input features
4. Press open button to select Identity features
5. Press open button to name Output feature
6. Press **OK** button to carry out Identity function

Intersect (Analysis Tool)

Computes a geometric intersection of the Input Features. Features or portions of features which overlap in all layers and/or feature classes will be written to the Output Feature Class

1. Open Arc Toolbox, and Go to Analysis Tools >> Overlay
2. Press Intersect tool and get the above dialog box
3. Press open button to select Input features
4. Press open button to name Output feature
5. Press **Ok** button to carry out Identity function
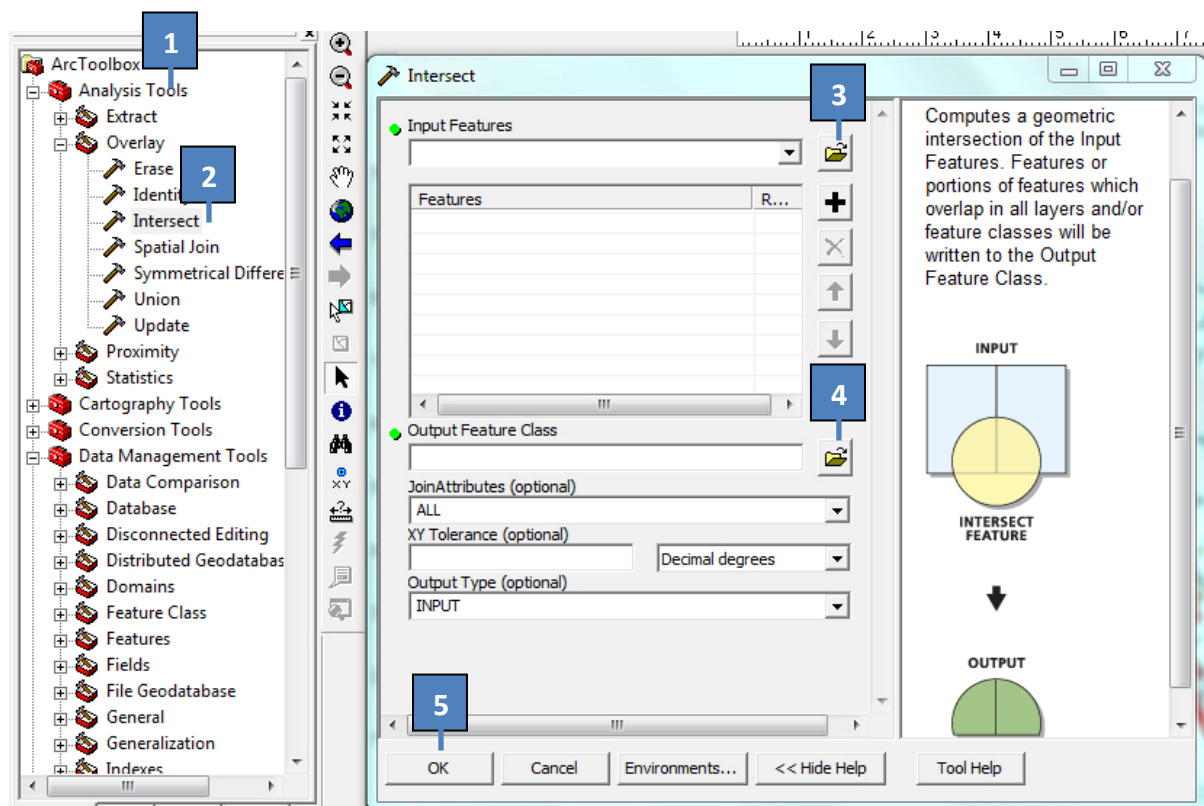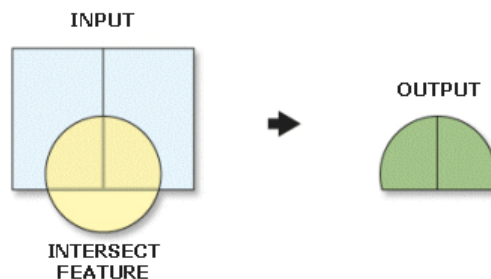
Split (Analysis Tool)

- Split creates new feature classes by overlaying two sets of features. Split performs a series of Clip operations, one for each output feature class. Each output feature class contains only those portions of Input Features that are overlapped by the specified polygons of the Split Features.
- Input Features can be polygons, lines, or points. Split Features must be polygons. The Split Field is used to determine which polygons of the split features will be used to split the Input Features. Each unique value in the Split Field will identify the polygons that will be used to clip the Input Features to create one output feature class. The split field, therefore, must be character data type.
- Output feature class features are of the same type as the Input Features. They are clipped to the boundaries of the split polygons. Topology is built for the output feature classes.
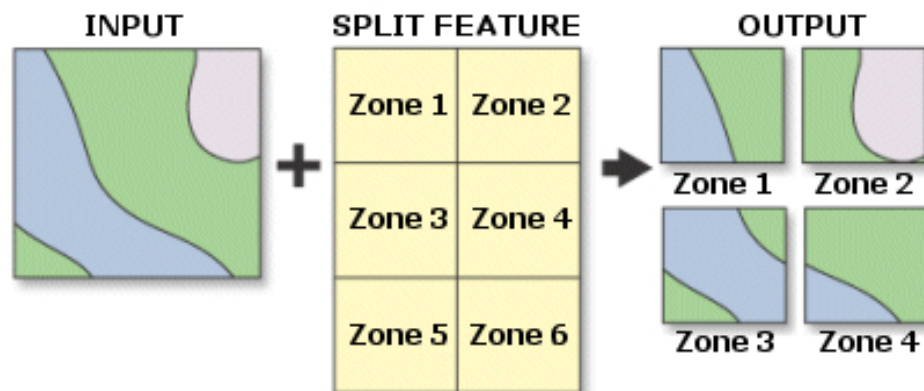
1. Open Arc Toolbox, and Go to Analysis Tools >> Extract
2. Press Split tool and get the above dialog box
3. Press open button to select Input features
4. Press open button to name Split feature
5. Press drop down arrow to select Split Field
6. Press open button to select workspace or folder to store new split data
7. Press **OK** button to carry out Identity function

Buffer (Analysis Tool)
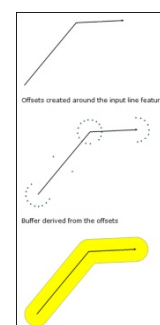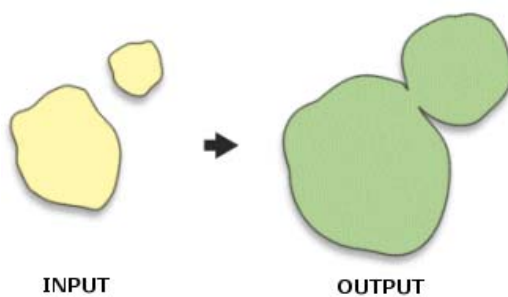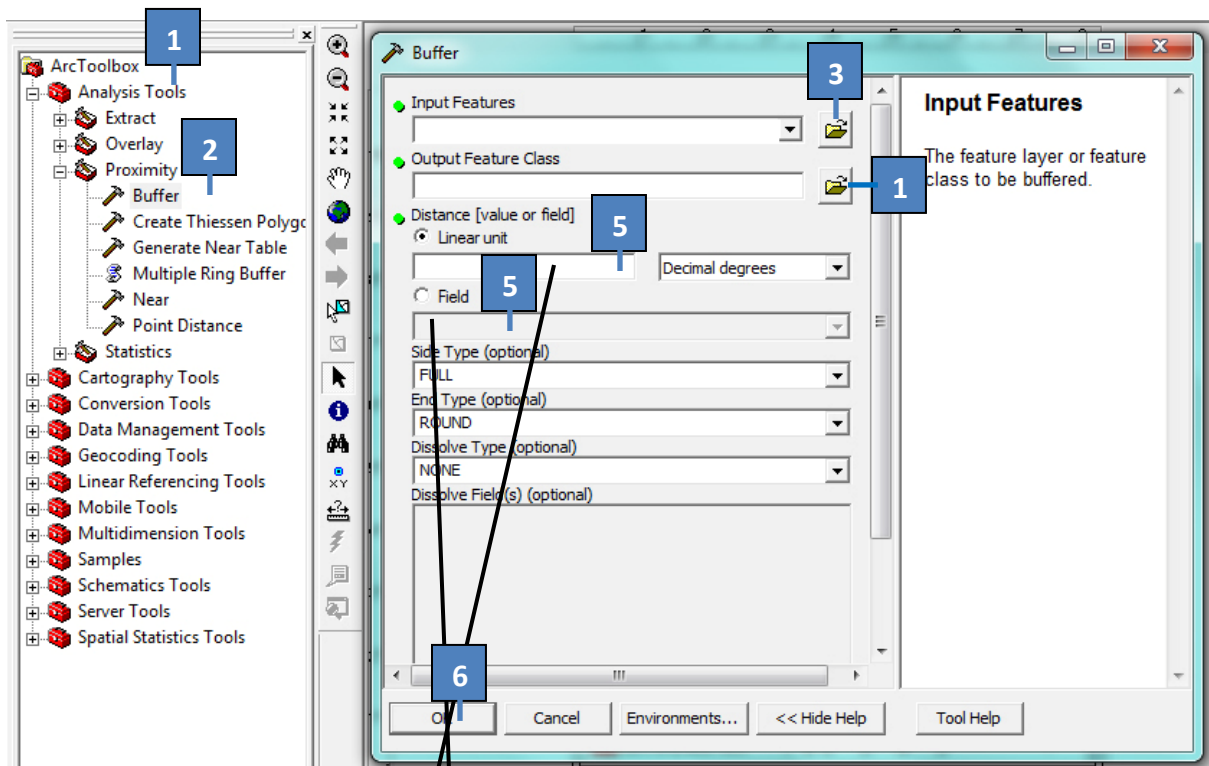
Example 1: Fixed distance

Buffer of a line feature class using a Distance of 20, an End Type of FLAT, a Side Type of FULL, and a Dissolve Type of ALL.

INPUT   OUTPUT
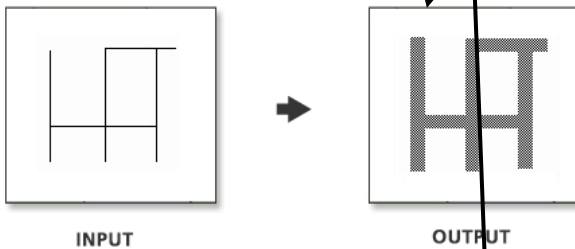
Because the buffer distance is a constant, all features are buffered to the same width.

Example 2: From field

Buffer of a line feature class using a numeric field with values of 10, 20, and 30 for Distance, an End Type of FLAT, a Side Type of FULL, and a Dissolve Type of ALL.

INPUT   OUTPUT

Because the buffer distances are dependent on the field values, various buffer widths can be applied in the same operation.
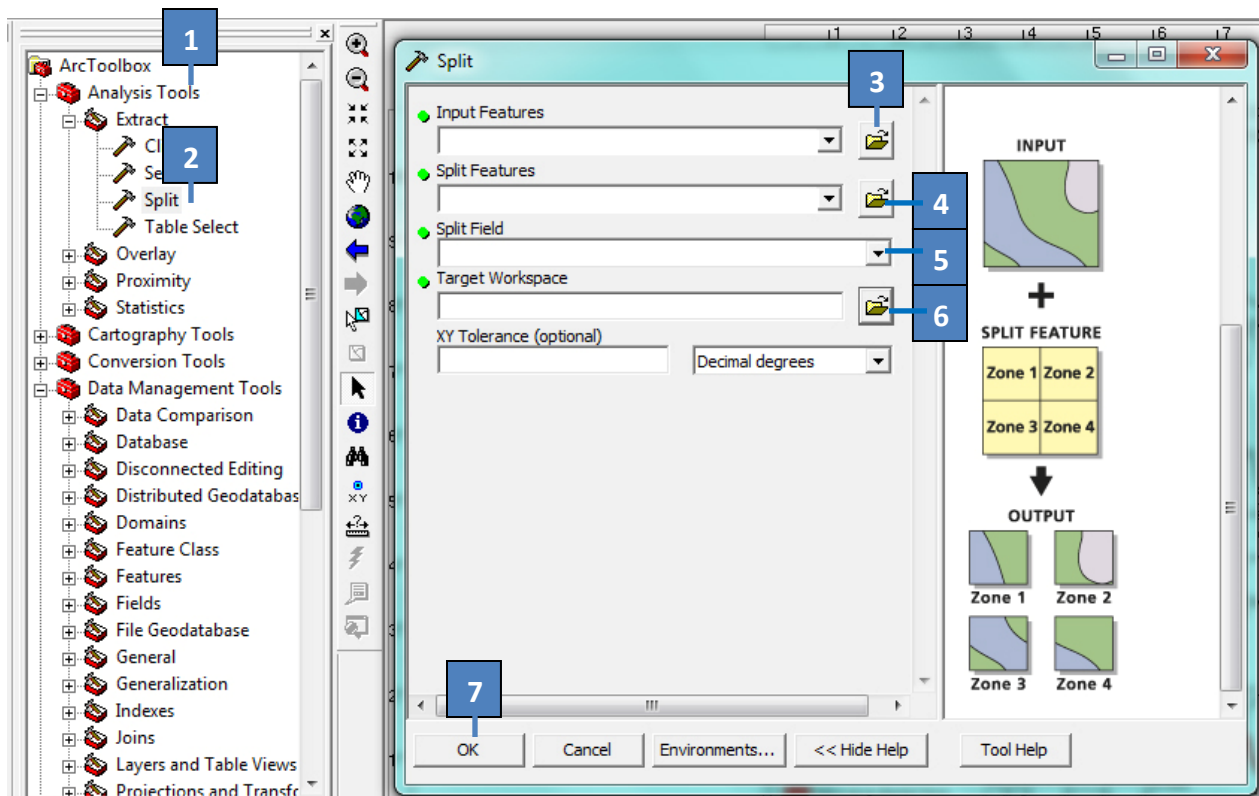
1. Open Arc Toolbox, and Go to Analysis Tools >> Proximity
2. Press Buffer tool and get the above dialog box

3. Press open button to select Input features
4. Press open button to name Output feature
5. Mention buffer distance or field name from attribute table
6. Press **OK** button to carry out Buffering

Selection by Location (Selecting Features by their Locations)

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 1 Km radius of your Overhead water tank and who paid bill up-to-date so that you can send them a new year card. You would first select the customers within this radius (select by location), then refine the selection by finding those customers who have cleared all the bills according to a defaulter 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.
9. If you're finished selecting features click Close.
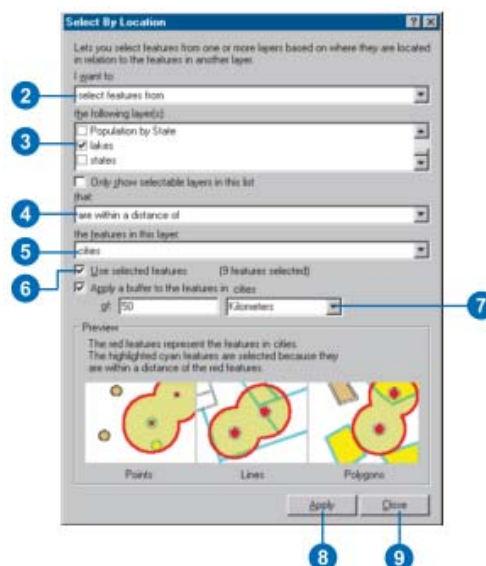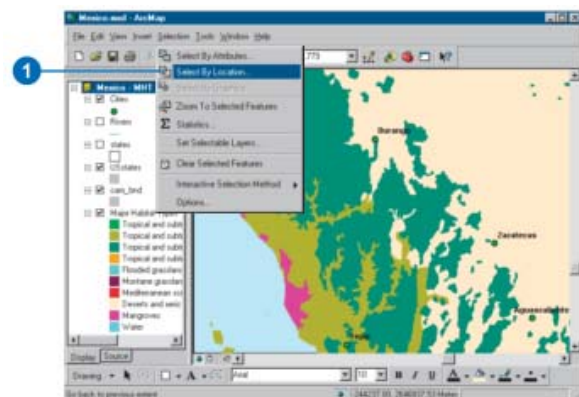
By Location - Intersect
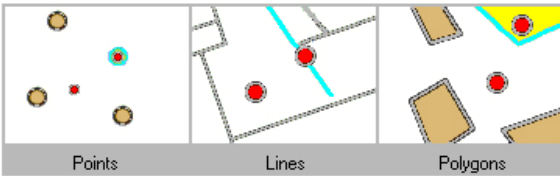
Finding features that intersect with point features
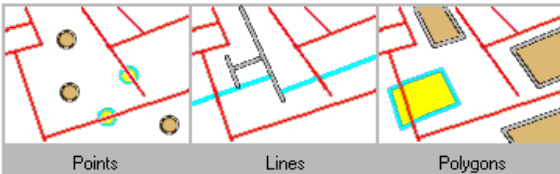
Fiinding features that intersect with line features
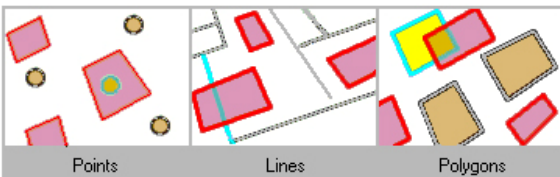
By Location - Contain
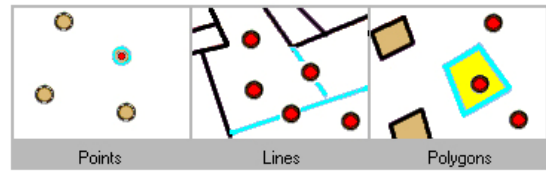
Finding features that contain point features
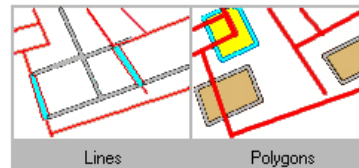
Finding features that contain line features
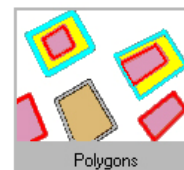
Finding features that contain polygon features

By Location – Completely Contain

Finding polygon features that completely contain point, line, or polygon features

By Location - Within

Finding features that are within (contained by) point features

Finding features that are within (contained by) line features
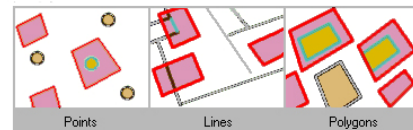
Finding features that are within (contained by) polygon features

By Location – Completely Within	**By Location – Within a Distance**
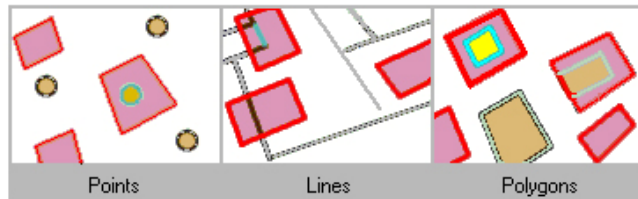
Finding features that are completely within polygon features
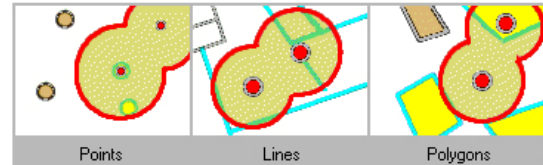
Finding features that are within a distance of point features
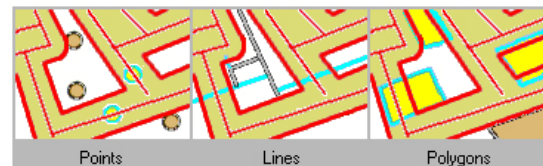
Finding features that are within a distance of line features

Finding features that are within a distance of polygon features

Point Distance (Analysis)

Determines the distances between point features in the Input Features to all points in the Near Features, within the Search Radius.

- The results are recorded in an Output Table containing the following information
  - INPUT_FID : the input feature's ID
  - NEAR_FID : the near feature's ID
  - DISTANCE : the distance from the input to the near feature
- Both the Input and Near Features can be the same dataset. In that case when the Input & Near feature are the same record, that result will be skipped so as not to report that each feature is 0 units from itself.
- If no Search Radius is specified, all Near Features will be used.
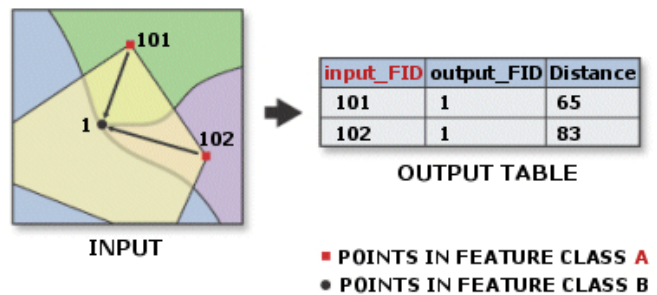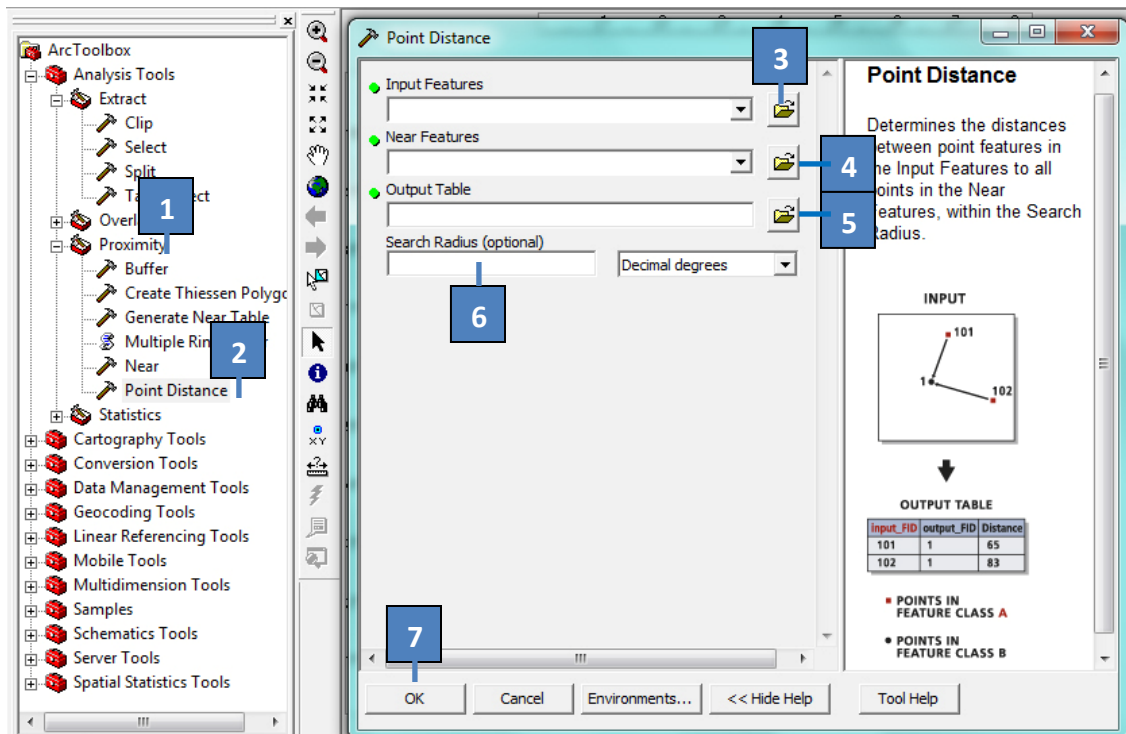
1. Open Arc Toolbox, and Go to Analysis Tools >> Proximity
2. Press Point Distance tool and get the above dialog box
3. Press open button to select Input features
4. Press open button to select Near feature
5. Press open button to name Output Table
6. Insert Search Radius, if needed.
7. Press **OK** button to carry out Point Distance function

Module V

MetaData

Metadata is information that describes your data in the same way a card in a library's card catalog describes a book. After you create new data, you should create metadata to document its contents. When detailed metadata has been created, it can answer your questions and help you make decisions. For example, how accurate the data is, what is the source of the data, how much it costs.

In this Module:
• Exploring Metadata
• Stylesheet
• Adding shapefiles
• Metadata creation and updating
• Metadata Editor
• XML

Exploring an Item's Metadata

1. Click the item in the Catalog tree for which you want to see metadata.
2. Click the Metadata tab.
3. Click a tab on the metadata page to see a different group of metadata elements.
4. Click a group heading to hide its contents

   Click the heading again to show its contents
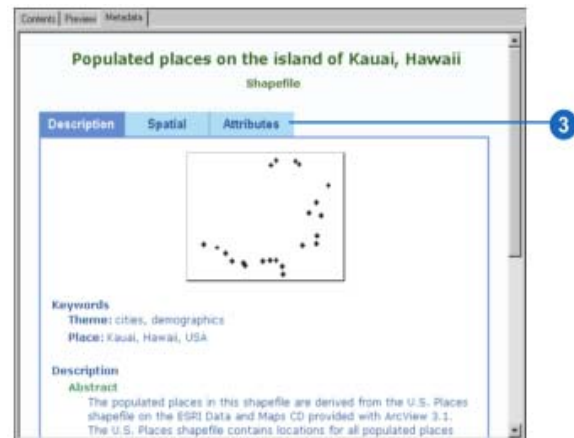
Changing the Metadata's Appearance: A stylesheet is similar to a query, which selects data from a database. Stylesheets select which metadata elements to display and define how their values appear. Each stylesheet in the Catalog presents the same body of metadata using a different set of rules. Four stylesheets are provided: ESRI, FGDC, FGDC FAQ, and XML. You can add your own custom stylesheets to the list. The metadata's default appearance is defined by the ESRI stylesheet. You can change its appearance by choosing a different stylesheet in the dropdown list on the Metadata toolbar. The FGDC stylesheet shows all metadata elements defined by the CSDGM. Authored by the U.S. FGDC, this book refers to it as the FGDC standard. The FGDC stylesheet.s format will be familiar to you if you.ve worked with the FGDC standard or searched for data using the National Spatial Data Institute (NSDI) Geospatial Data Clearinghouse. The FGDC FAQ stylesheet presents a subset of the FGDC metadata elements in question and answer format; it may be helpful if you.re new to metadata. These stylesheets emulate the HTML pages that you can create with the FGDC.s metadata parser utility, mp. The ESRI stylesheet shows many elements defined in the FGDC standard, in addition to detailed properties of the data which are defined by ESRI. The XML stylesheet shows the entire contents of an item's metadata (or any other XML document). Different colors let you easily distinguish between an element's name and its value. XML data is hierarchical by

nature; instead of a value, an element may contain other elements. The XML stylesheet shows plus or minus signs next to group elements; you can click them to hide or show the elements they contain. Every time you start ArcCatalog, metadata is initially presented with the default stylesheet. To change the default stylesheet, use the Options dialog box. The next time you start ArcCatalog, metadata will initially be presented with the stylesheet of your choice. Setting the default stylesheet doesn't prevent you from changing the current stylesheet using the dropdown list on the Metadata toolbar.

Changing the current stylesheet

1. Click the Stylesheet dropdown arrow on the Metadata toolbar and click a different stylesheet.

   The metadata's appearance changes according to the rules of the new stylesheet
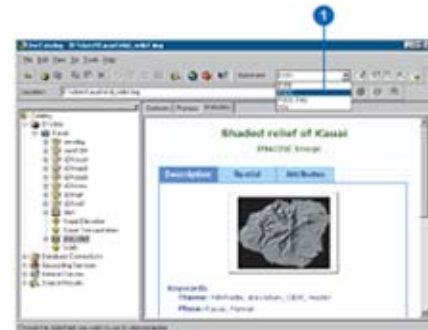
The metadata's appearance changes according to the new stylesheet's rules.

Setting the default stylesheet

1. Click the Tools menu and click Options.
2. Click the Metadata tab.
3. Click the Default Stylesheet dropdown arrow and click the stylesheet that should be the default.
4. Click OK.

The next time you start ArcCatalog, the stylesheet you've chosen will be used as the default.
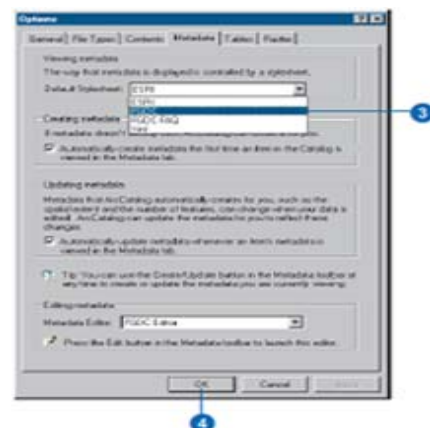
Metadata in ArcCatalog

Metadata in ArcCatalog consists of properties and documentation. *Properties,* such as the extent of a shapefile's features, are derived from the item itself. *Documentation* is descriptive information supplied by a person.

By default, when you attempt to view an item's metadata, ArcCatalog will create it automatically if metadata doesn't already exist; it will then add many of the item's properties to it. Once created, metadata becomes part of the item itself. It is automatically moved, copied, and deleted along with the item.

Every time you view the metadata, the Catalog automatically updates the properties recorded in it with current values. This ensures that the metadata is kept up to date with changes to the data source. For example, the extent and count of a shapefile's features will be current when you look at its metadata, even if new features were recently added.

If you want more control over when metadata is created and updated, you have a few choices. You can turn off automatic updates for individual items - for example, after they have been published. Then, you can choose to create and update metadata manually by clicking the Create/Update Metadata button on the Metadata toolbar.

Writing documentation

Documenting your data protects your organization's investment in that data. Without knowledge of the data's accuracy, provenance, and age, you can't have a high level of confidence in decisions based on that data. Creating detailed metadata describing these qualities ensures that you can continue to use your data and make decisions based on it.

Metadata documentation can be a few lines to a big document according to the needs of different organizations. Fortunately, the *International Standards Organization (ISO)* is creating a unified content standard. With a common standard it will be easier for those within an organization, as well as the GIS community as a whole, to create and use metadata.

Simply because so many different standards exist, metadata in ArcCatalog isn't required to meet any specific one. However, standards can be enforced by a metadata editor. The metadata editor provided with the Catalog lets you document your data following the *FGDC* standard

How metadata is stored

Metadata created with ArcCatalog is stored as XML data either in a file alongside the item or within its geodatabase. XML is a markup language similar to HTML. HTML defines both the data and how it's presented. XML, on the other hand, lets you define data using tags that add meaning. Stylesheets define how XML data is presented. They are created using XSL. XSL elements query and evaluate XML data. A

stylesheet retrieves specific values from an XML document, formats them, and then defines how they are presented. ArcCatalog stylesheets generate HTML pages from XML data. Therefore, you can interact with metadata as you would interact with any HTML page in a browser.

Choosing how metadata is created and updated

By default, metadata is automatically created or updated when you view it in the Metadata tab. However, you can choose to create and update all metadata manually. When you change these settings in the Options tab, it affects how metadata is handled for all items in the Catalog. You can turn off automatic updates for specific items using the Metadata Properties dialog box. You might do this after completing and publishing their metadata so it is not accidentally changed later

1. Click the Tools menu and click Options.
2. Click the Metadata tab.
3. Check the appropriate boxes to have the Catalog automatically create or update metadata.

   Uncheck the appropriate boxes if you prefer to manually create or update metadata.

4. Click OK.
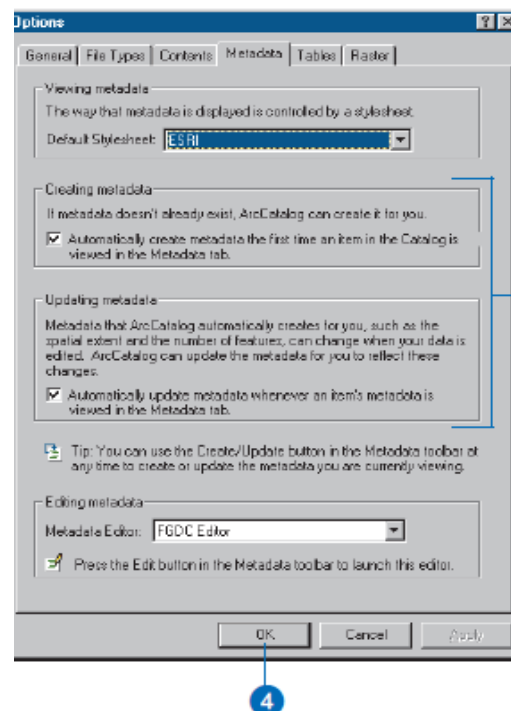
Turning off automatic updates for individual items

1. In the Catalog tree, click the item for which metadata should not be updated automatically.
2. Click the Metadata tab.
3. Click the Metadata Properties button on the Metadata toolbar.
4. Click the Options tab.
5. Check Do not automatically update metadata.
6. Click OK.
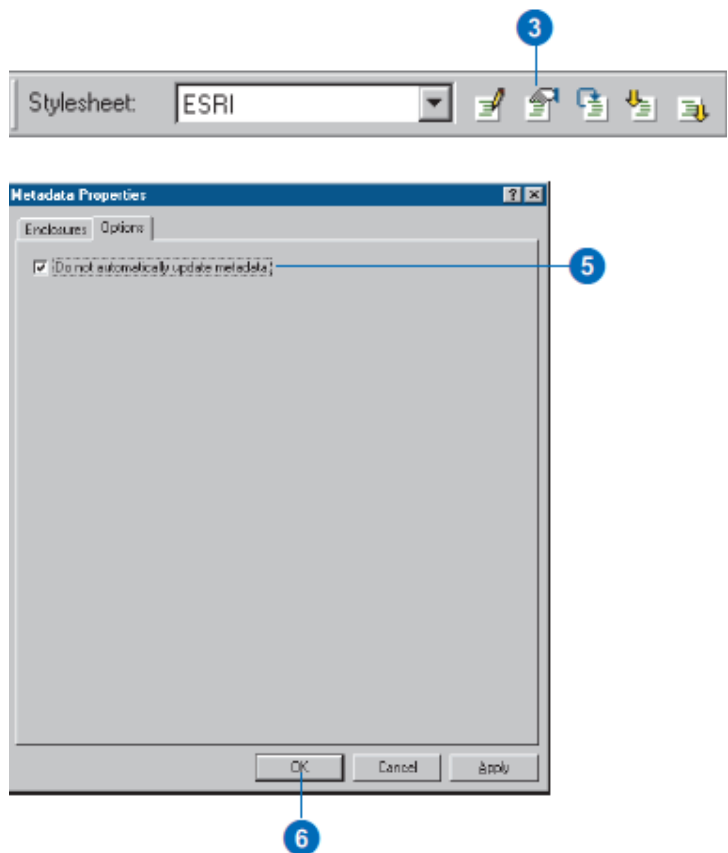
Adding documentation

1. Click the item whose metadata you want to edit in the Catalog tree.
2. Click the Metadata tab.
3. Click the Edit Metadata button on the Metadata toolbar.
4. Document your data using the metadata editor.
5. Close the metadata editor

Choosing a metadata editor

The Catalog comes with an FGDC metadata editor. To start using the FGDC metadata editor, click the Edit Metadata button on the Metadata toolbar. If more than one editor is available - for example, if you've created a custom editor - you can choose to have a different metadata editor appear when you click the Edit Metadata button. The available metadata editors are listed in the Options dialog box.

1. Click the Tools menu and click Options.
2. Click the Metadata tab.
3. Click the Metadata Editor dropdown arrow and click the editor you want to use.
4. Click OK.
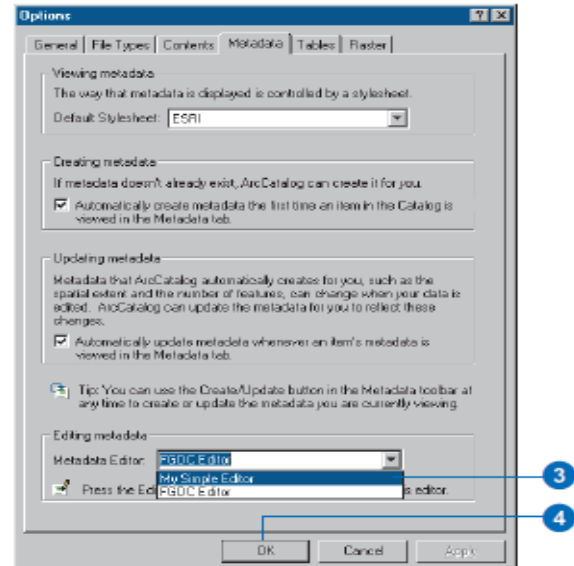
Using the FGDC metadata editor

The FGDC metadata editor lets you create FGDC-compliant metadata for the selected item in the Catalog tree. This is the default metadata editor in ArcCatalog.

The information in an FGDC metadata document is divided into seven main sections: Identification, Data Quality, Spatial Data Organization, Spatial Reference, Entity and Attribute, Distribution, and Metadata Reference. The section titles across the top of the FGDC metadata editor correspond to these sections. Information within each section is divided into subsections. When you click a section title, several tabs appear, with each tab representing a subsection

Click a section title to edit the elements in that section. The selected Section Title has bold text.

Click a tab to edit the elements in that subsection.

Type information for a metadata element or choose a value from a dropdown list.

The Entity Type tab contains a group of elements describing the current feature class. With the toolbar, you can manage metadata for each feature class in a coverage.

This toolbar lets you manage metadata for each attribute in the current feature class. All elements on the Attribute tab describe the current attribute.

Sample XML file


```
<?xml version="1.0" ?>
<!-- <!DOCTYPE metadata SYSTEM "http://www.esri.com/metadata/esriprof80.dtd"> -->
- <metadata xml:lang="en">
  - <Esri>
      <CreaDate>20081112</CreaDate>
      <CreaTime>11453200</CreaTime>
      <SyncOnce>FALSE</SyncOnce>
      <MetaID>{D09F5A30-EF31-4573-9A34-16D51A9FD790}</MetaID>
      <SyncDate>20111014</SyncDate>
      <SyncTime>22405400</SyncTime>
      <ModDate>20111014</ModDate>
      <ModTime>22405400</ModTime>
    - <DataProperties>
      - <lineage>
          <Process Name="Merge_1" ToolSource="C:\Program Files\ArcGIS\ArcToolbox\Toolboxes\Data Management Tools.tbx\Merge"
          Date="20081129" Time="100912">Merge DRoad;uttara_road "D:\ADPC DATA
          BACKUP\VA\Dhaka\Lifeline\Transportation\Road\Road Component\DRoad_Merge.shp" "LAYER LAYER true false false 254
          Text 0 0 ,First,#,DRoad,LAYER,-1,-1,uttara_road,LAYER,-1,-1"</Process>
          <Process ToolSource="C:\Program Files\ArcGIS\ArcToolbox\Toolboxes\Analysis Tools.tbx\Clip" Date="20110706"
          Time="163825">Clip DRoad clip_file "C:\ArcGIS Training\Practice\Data\DRoad.shp" #</Process>
        </lineage>
      </DataProperties>
    </Esri>
  - <idinfo>
    - <citation>
      - <citeinfo>
          <onlink Sync="TRUE">\\SHAHIDULCDMP\C$\ArcGIS_Training_Advance\Data\DRoad.shp</onlink>
          <origin>REQUIRED: The name of an organization or individual that developed the data set.</origin>
          <pubdate>REQUIRED: The date when the data set is published or otherwise made available for release.</pubdate>
          <title Sync="TRUE">DRoad</title>
```
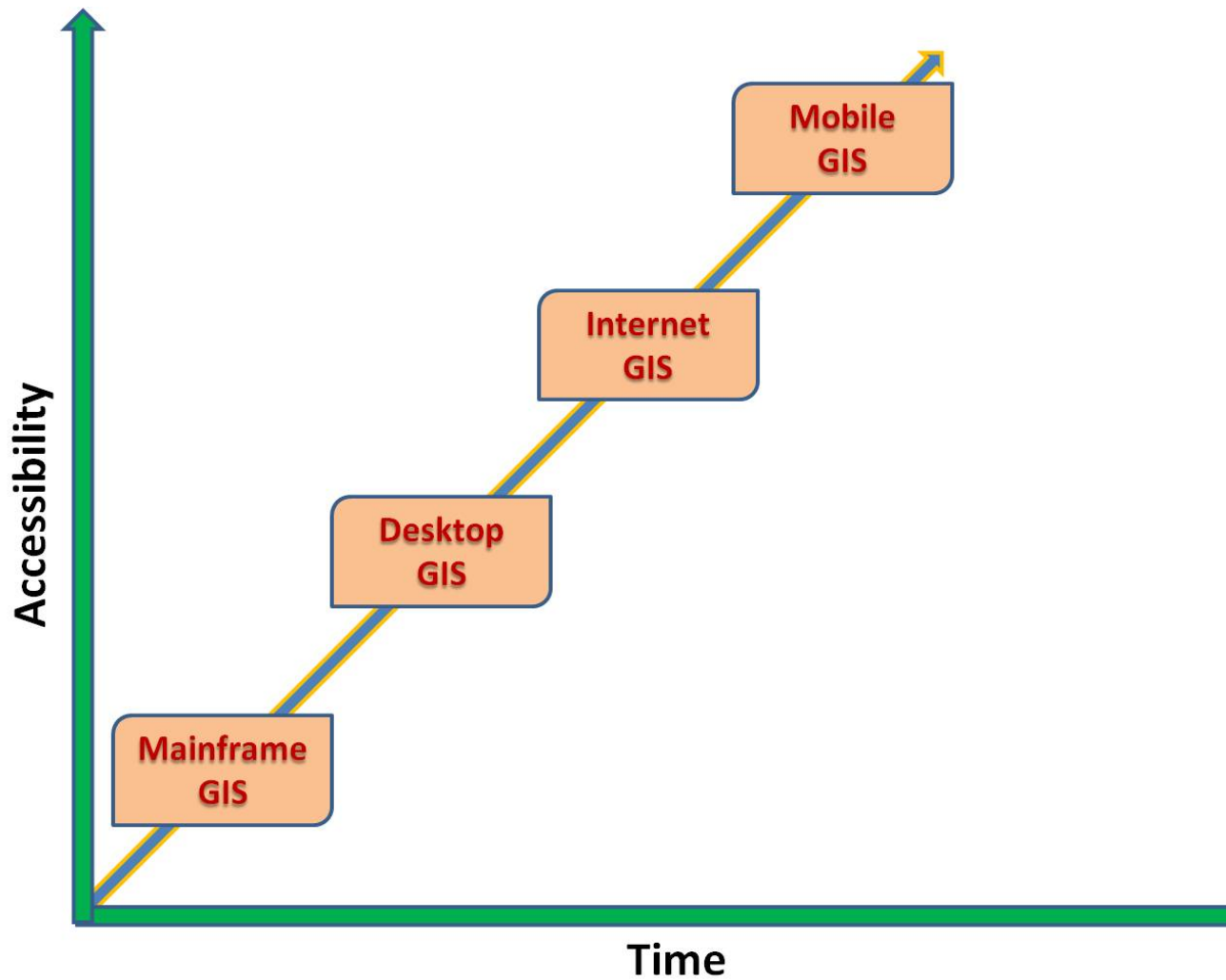
Module VI

Distributed GIS
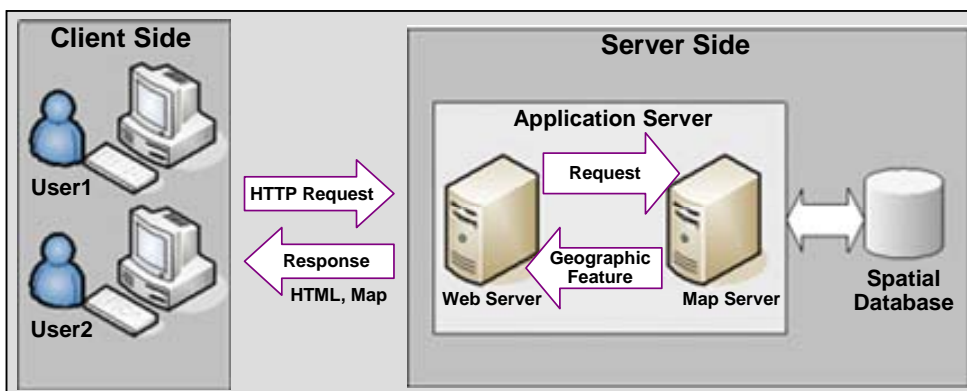## (Internet / Mobile GIS)

In this Module:
- GIS evolution
- Web-GIS Architecture
- Platform / Technology
- Commercial vs. Free Solution
- Mobile GIS
- Example

GIS Evolution

Simple Web-GIS Architecture

Client: Client is a place for users to interact with spatial objects and analysis functions in Internet GIS. It is also a place for Internet GIS Programs to present outputs to the users.

Web Server: The Web Server is also called the HTTP Server; its major function is to respond to requests from Web browsers via HTTP by sending existing HTML document or ready-made map images to the clients.

Map Server: A map server is major workhorse components that fulfills spatial queries, conducts spatial queries, and generates and delivers maps to the client based on the user's request.

Data Server: A data server serves data, spatial and non-spatial in relational or non-relational database structure. A client application such as a Web client or a map server gains access to the database through the SQL

Platform / Technology needed

- o Linux / Windows Server
- o Web Server (Apache/IIS)
- o Map Server (UMN/ArcGIS)
- o Database PostgreSQL/Oracle
- o Scripting Language (PHP/ Python / .Net)
- o Framework   (Ka-Map/Openlayers etc)
- o AJAX Technology

Commercial Solution - Costly

1. ArcGIS Server from ESRI
2. MapGlude from Autodesk
3. MapExtreme from MapInfo
4. GeoMedia from InterGraph

Free and Open Solution – No costly

1. UMN Mapserve
2. Client Interface [Ka-Map, Openlayers]
3. Database [PostgreSQL/PostGIS/MySQL/MyGIS
4. Programming langusge [PHP/Python/Javascript]
5. Vibrant user /developer forum

Mobile GIS

Mobile GIS refers to the use of GIS through mobile and wireless devices such as laptop computers, PDAs, and cellular phones. The architecture of mobile GIS is very similar to the wireline-based Internet GIS. It has three major components; the client, the server [Web, Map and Data server]
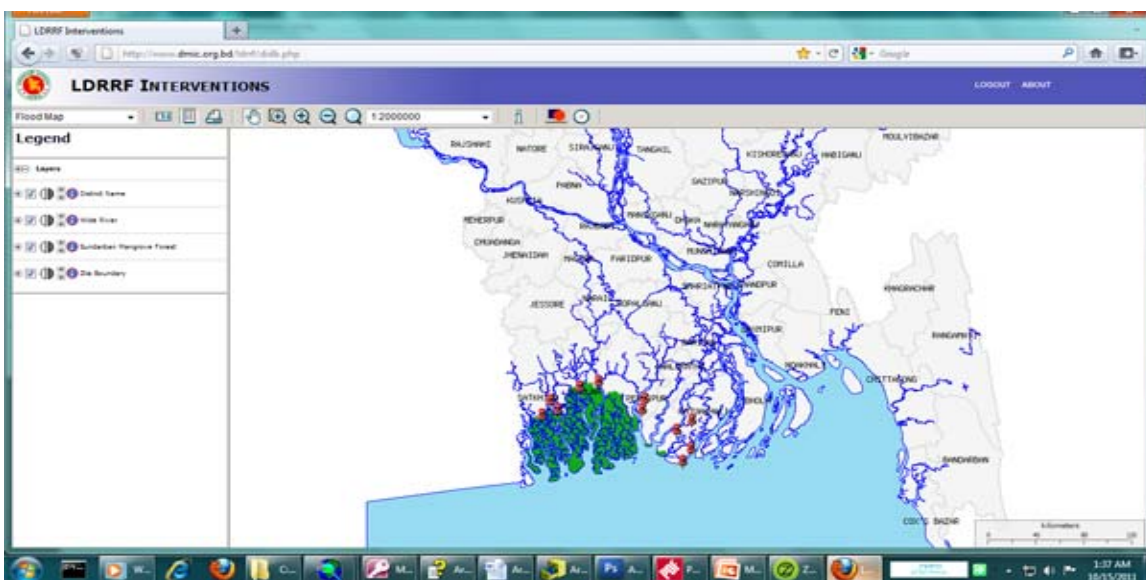
and the network service providers. The major differences are the client device and the wireless communications service providers. The server functions and structures are similar those in Internet GIS.

Example

Web site based on ArcGIS Server
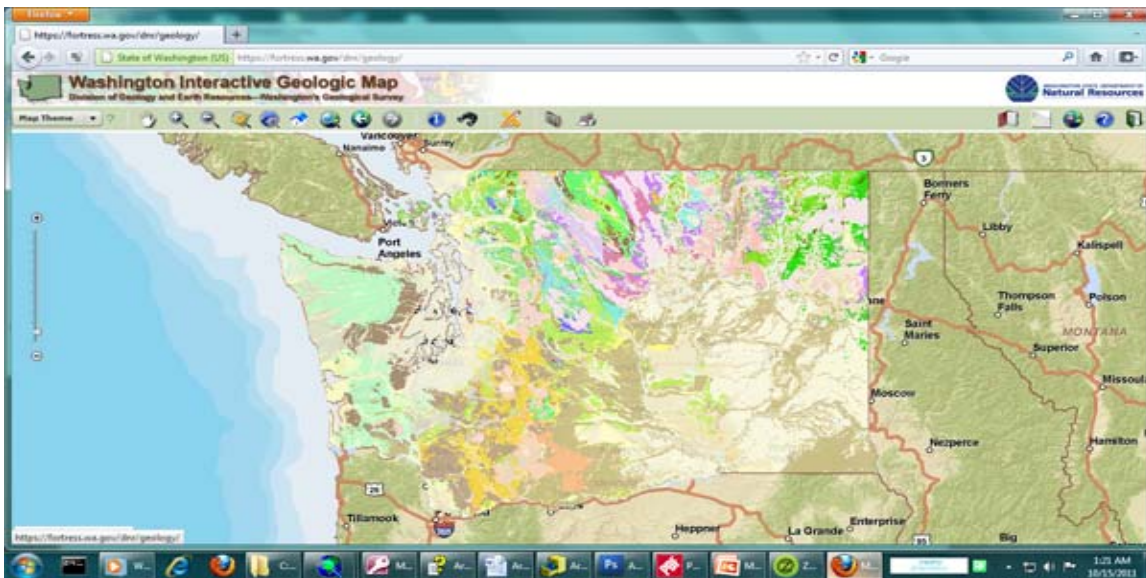
UMN Mapserver

Module VII

Network Analysis:
A. Finding best Route
B. Linear Referencing and
Dynamic Segmentation

In this module:
• Network Analyst Extension
• Network Element
• Building Network Dataset
• Finding the best Route
• Linear Referencing
• Dynamic Segmentation
• Dissolve

Network Analysis

Network Analyst, an ArcGIS extension is used to perform network analysis. ArcGIS Network Analyst provides an intuitive, interactive, easy-to-use, stand-alone interface for calculating routes (shortest path origin to destination), finding the closest facility, reporting the results as directions and finding service areas. It solves network related problems with efficiency – saving time and money. It allows you to perform advanced routing and network analysis. Supports:

- Drive-time analysis
- Point-to-point routing
- Route directions
- Service area definition
- Shortest path
- Optimum route
- Closest facility
- Origin–Destination

How to enable Network Analyst

1. Click the Tools menu and click Extensions.
2. Check the Network Analyst check box.
3. Click Close.

Then to bring the Network Analyst tool bar click View menu >> Toolbars >> Network Analyst.
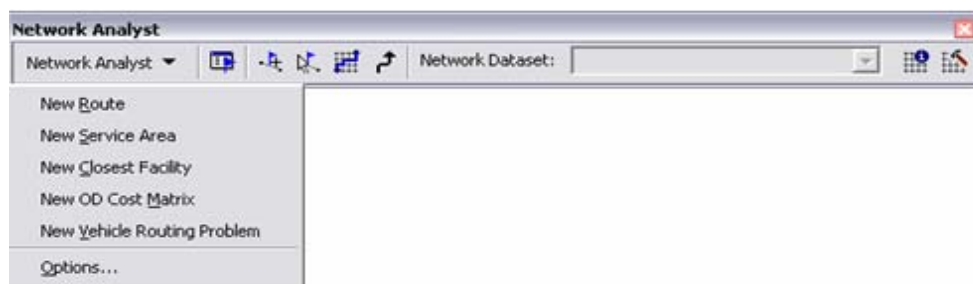
Network Analyst toolbar buttons and their functions

Button	Name	Function
	Network Analyst Window	Shows/Hides the Network Analys
	Create Network Location Tool	Creates a network location
	Select/Move Network Location Tool	Selects and moves network locat
	Solve	Runs the current analysis
	Directions Window	Displays the Directions window
	Network Identify	Identifies network elements
	Build entire network dataset	Builds a network dataset for the

Networks Element

Three types of network sources that participate in the creation of a network dataset are:

- Edge feature sources - Line feature classes participate as edge feature sources.
- Junction feature sources - Point feature classes participate as junction feature sources
- Turn feature sources - Turn feature classes participate as turn feature sources in a network.

A turn feature source explicitly models a subset of possible transitions between edge elements during
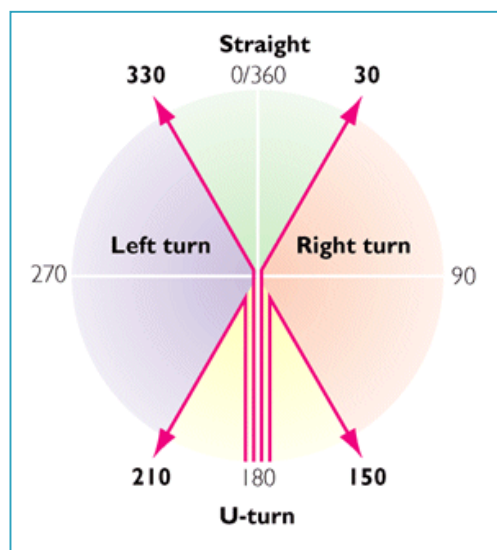
navigation.

Creating a Shapefile-based network dataset [Tutorial-01]

Data Preparation

1. Add the following field in the attribute table of features to be used for Network Analysis. You can add new field in shapefile or you can create in excel file and join it the feature attribute table.

L_F_ADD	L_T_ADD	R_F_ADD	R_T_ADD	CFCC	PREFIX	PRE_TYPE	NAME	TYPE	SUFFIX	Meters	Minutes

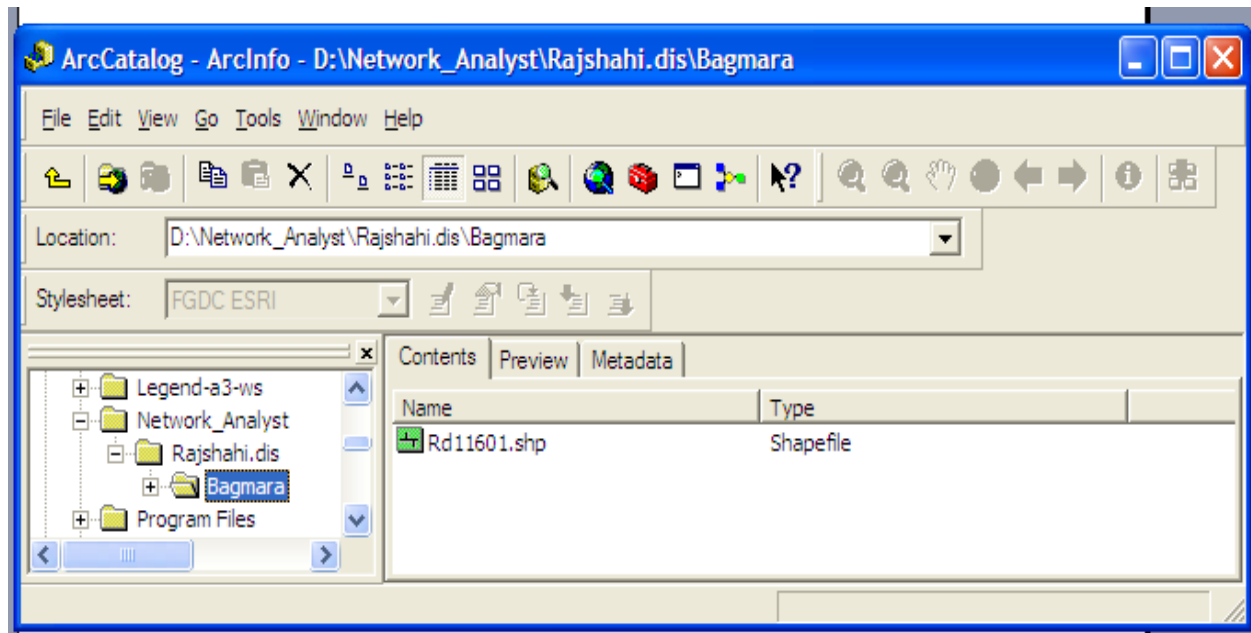| FT_Minutes	TF_Minutes	ShapeID	FNode	DISP_CODE	EDGE_ID	Oneway	F_ZLEV	T_ZLEV

2. Calculate all minutes field with the following formula –

Calculate Minutes = ([Miles] / [SPEED]) * 60   [** Speed Unit is mile/hour and distance is mile]
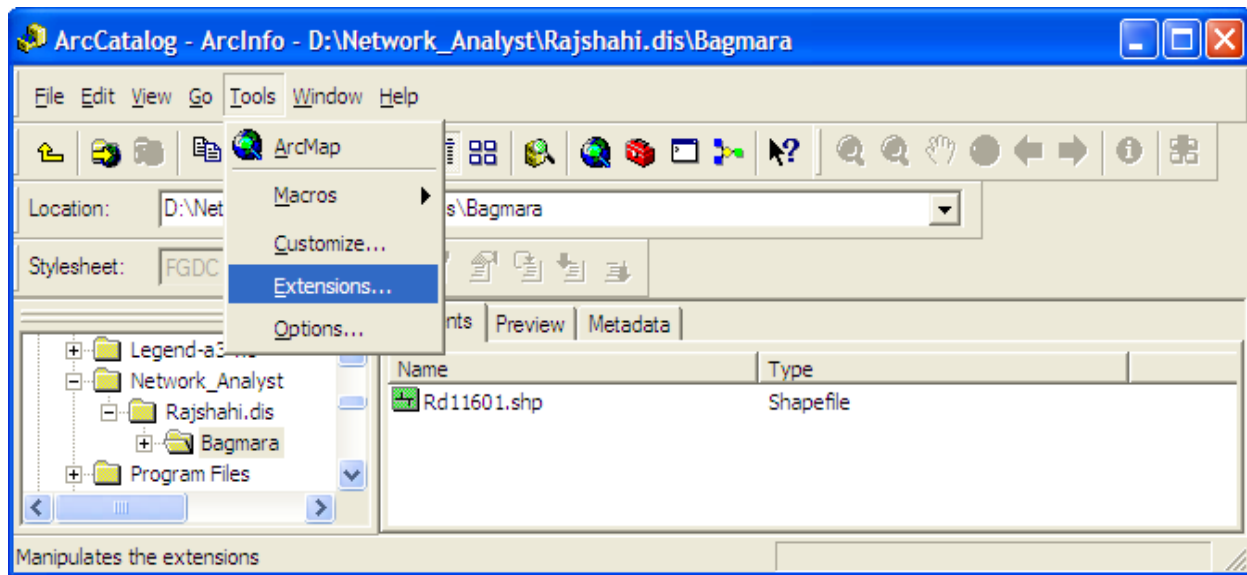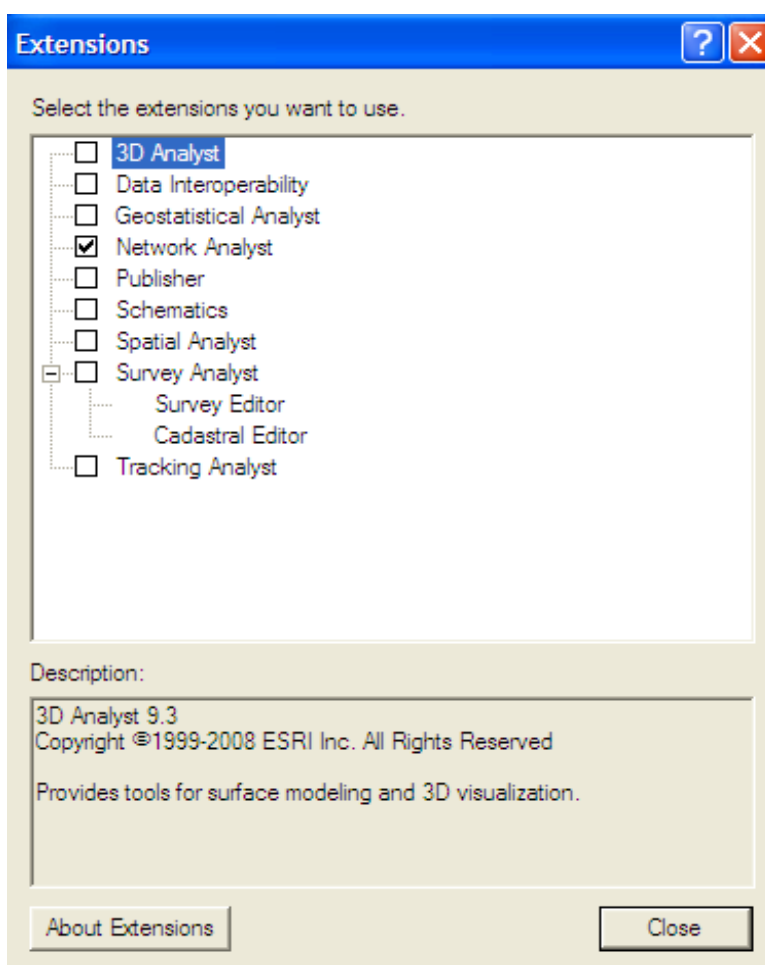
3. Start **ArcCatalog**

4. Navigate to the folder to select the data.

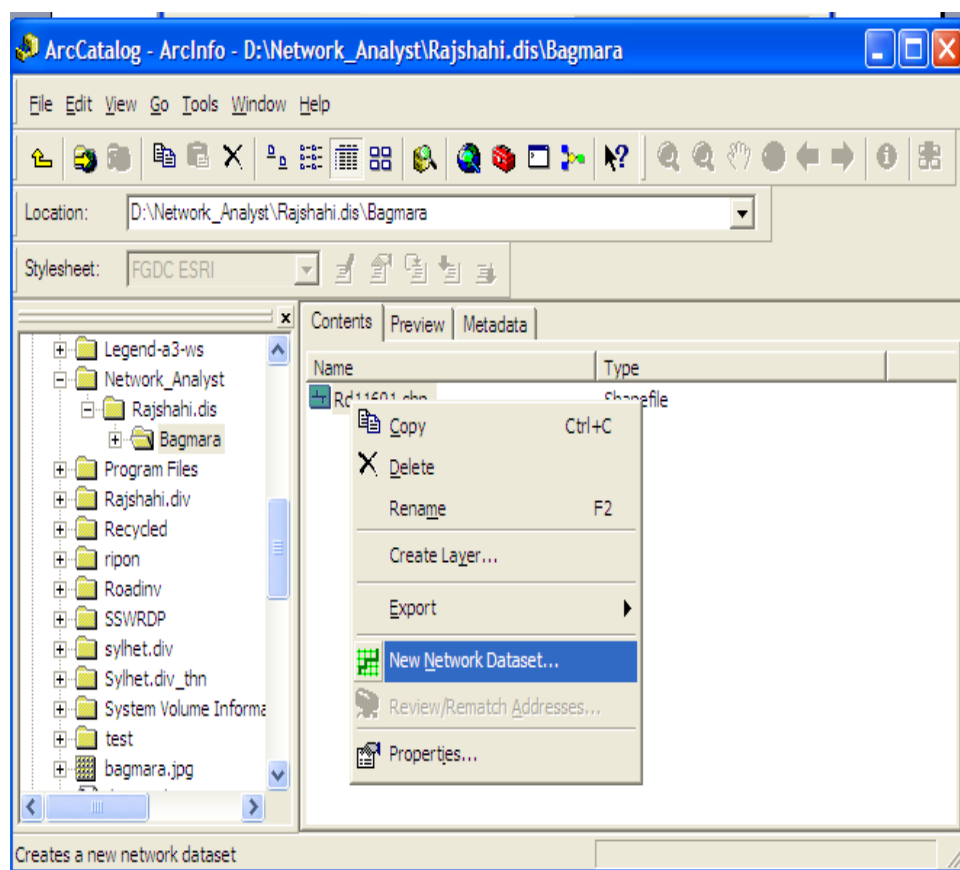5. Click the folder to show its contents.

6. If the Network Analyst Extension is not enabled, on the Tools menu, click Extensions, and in the Extensions dialog box, click Network Analyst and close the Extensions dialog box.
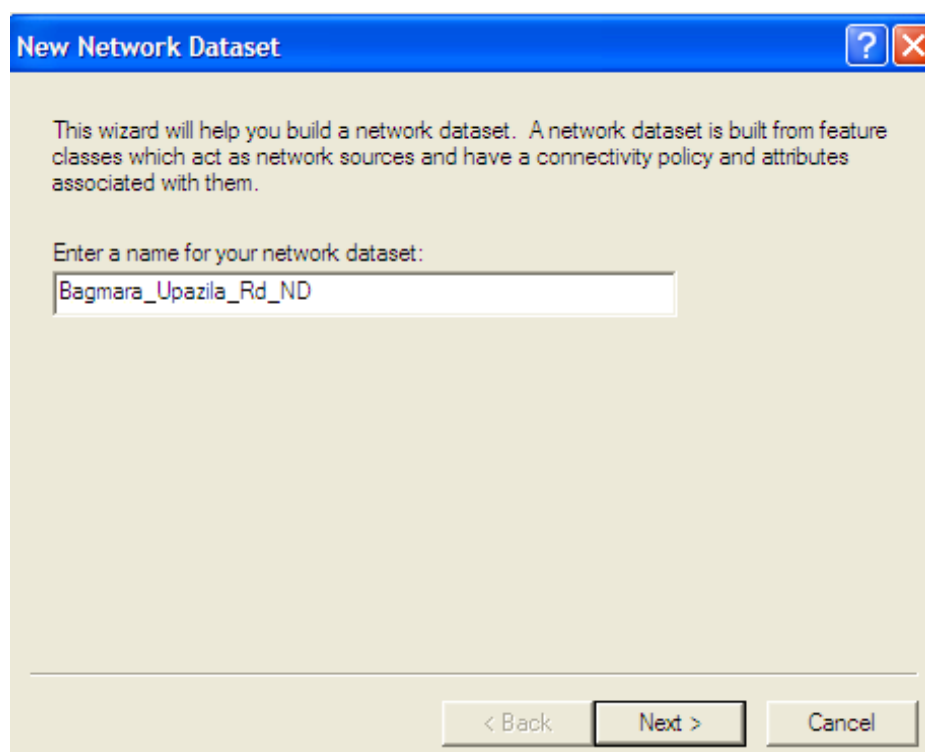
7. Right-click the Rd11601 shapefile and choose New Network Dataset. This shapefile contains Rd11601 data for Upazila Bagmara.

8. The name of the network dataset is set to Bagmara_Upazila_Rd_ND by default. Click Next to continue.

Network Connectivity defines how features that participate in a network connect to each other. The default connectivity for a network dataset places all sources in one connectivity group and assigns all edge sources endpoint connectivity. In a shapefile based network there is only one edge source, hence there is no need for multiple connectivity groups.

9. To accept the default connectivity, click Next to continue.
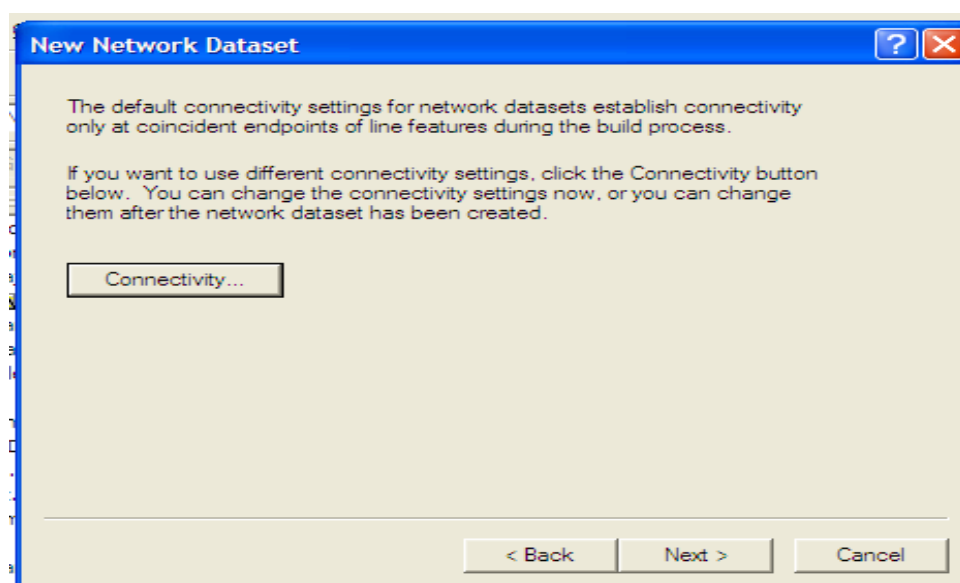
Each feature in a shapefile or coverage would be assigned two Z-elevation values, one for each endpoint. If the endpoints of line features have the same Z elevation value, connectivity is established. If the values are different, they do not connect (e.g., in the case of bridges or tunnels).

The elevation field contains logical elevation values for establishing connectivity only and does not provide height information for the feature. ArcGIS® Network Analyst can use Z-elevation values to further modify the connectivity settings established in the previous step. ArcGIS Network Analyst automatically searches and maps the relevant fields.

10. Click Next to accept the default elevation fields settings. If ArcGIS Network Analyst finds elevation fields data in your shapefile, it automatically chooses the Yes radio button and assigns the appropriate fields.

ArcGIS Network Analyst supports turns in a shapefile based network. Turn information (such as turning restrictions and delays) enhance the quality of network analysis. You will use turn features in Exercise 2.

In addition, by default, Global Turns are selected. Global Turns are rules that can be set, such as all right turns have a delay of 15 seconds. Such a rule gives preference to left turning movements. The advantage of Global Turns is that you do not need to create individual turn features for rules that apply to every turn in the network.

11. Click Yes to model turns in the network.

12. Click Next to continue.
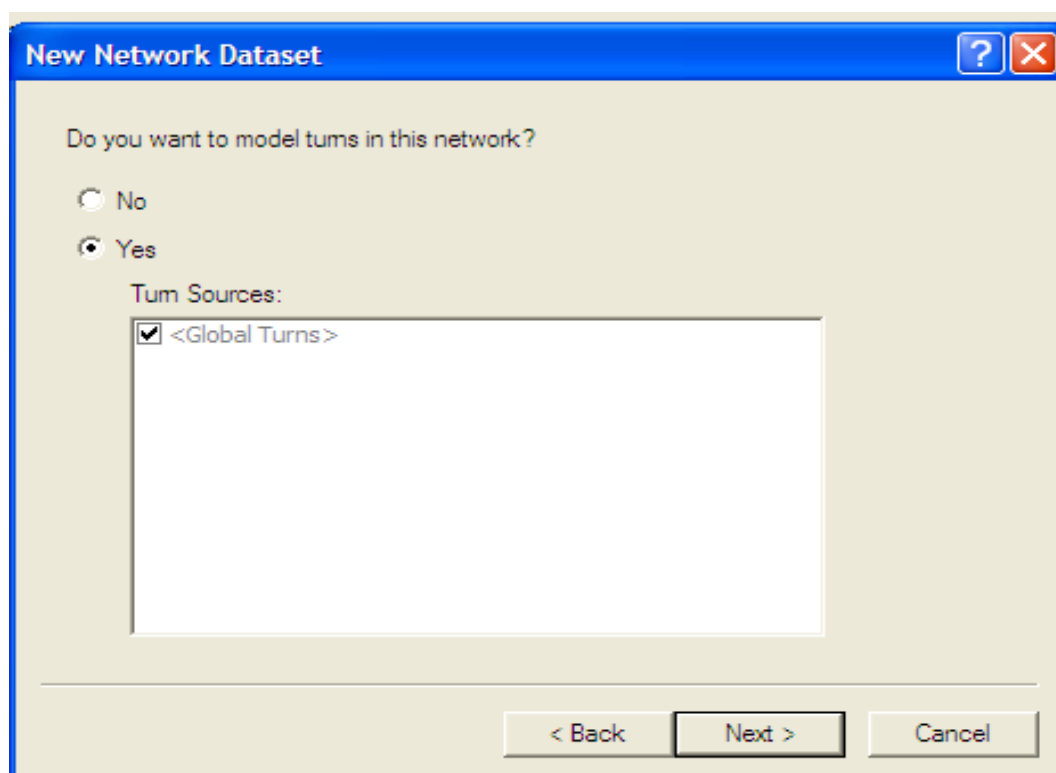
Network attributes are properties of the network that are used to control navigation. Common examples are costs that function as impedances over the network. Restrictions like one-way traversal are also examples of network attributes.

The ArcGIS Network Analyst analyzes the source shapefile and looks for common fields like Meters, Minutes (FT_Minutes and TF_Minutes, one for each direction), and Oneway. Once it finds these fields, it automatically creates the corresponding network attributes and assigns the respective fields to them. (This can be viewed by clicking the Evaluators button.)

13. Since the attributes are automatically defined and assigned values, click Next to continue
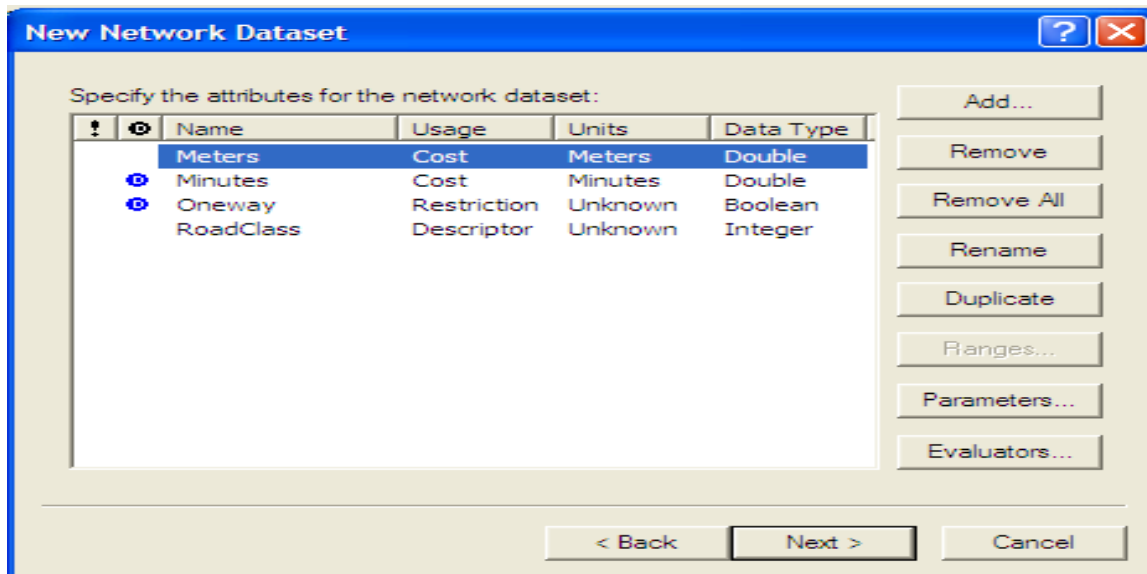
To use driving directions in a network analysis, they should be set in the network dataset.

14. Select Yes to establish driving directions settings for this network dataset. The Network Analyst automatically finds and maps the field in the streets source that will be used to report street names. Additionally Length and Time fields are automatically mapped as well.
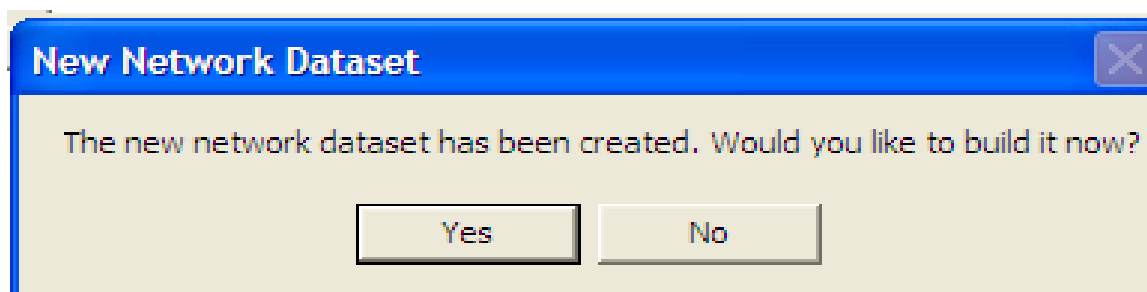
15. Click Next to continue.
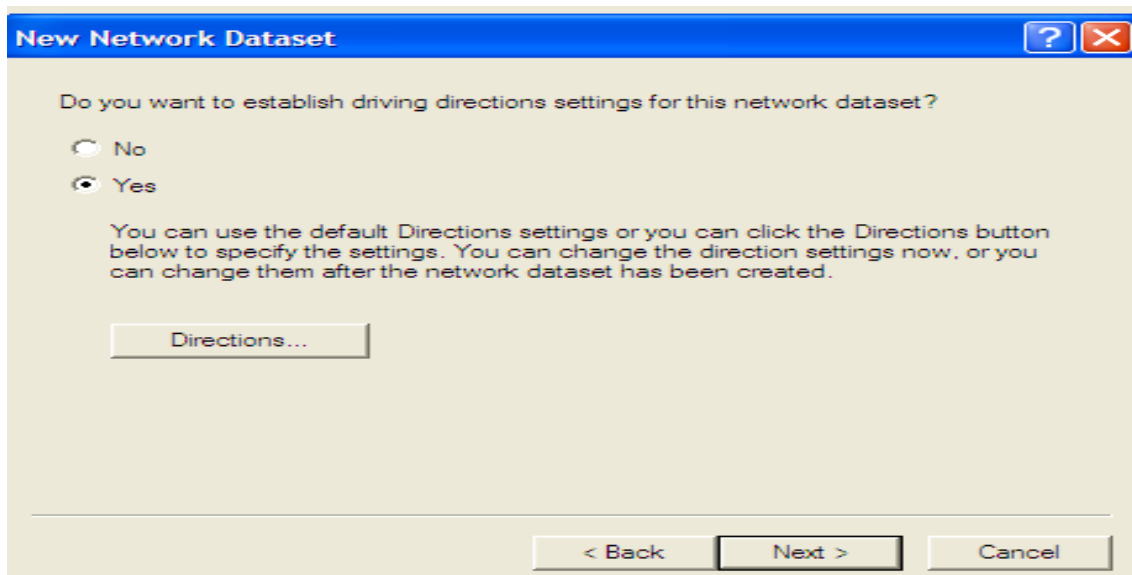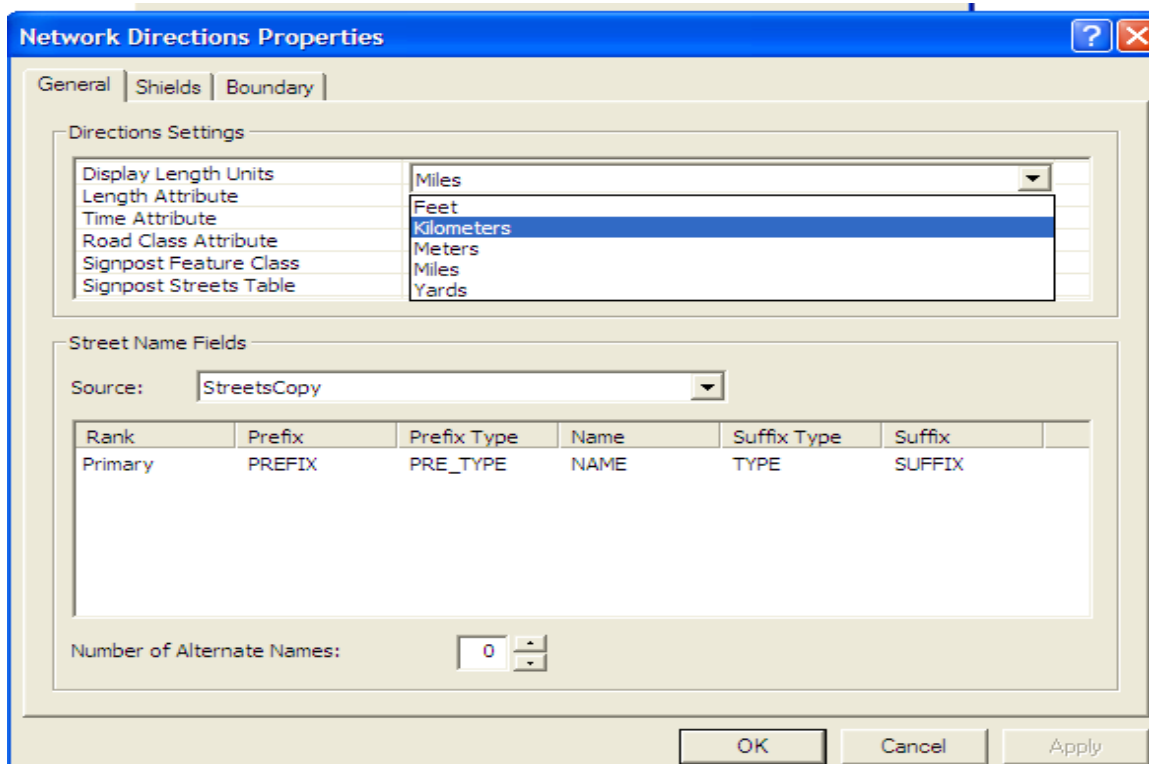
16. A summary of all the settings that have been chosen is displayed in the following window for your review. Click Finish to create the new shapefile based network dataset.
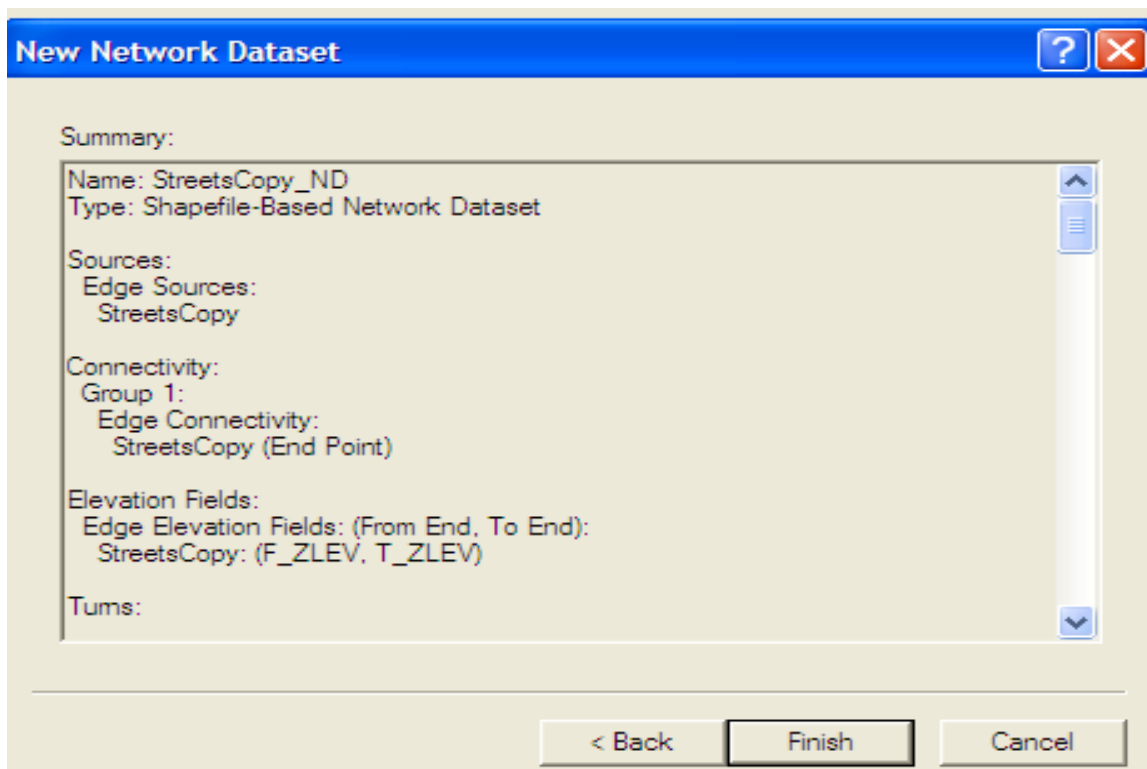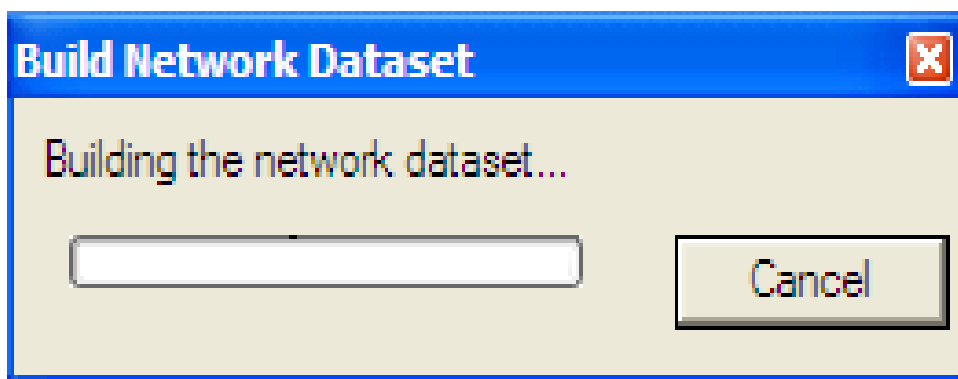
Once created, the system prompts for the network to be built.
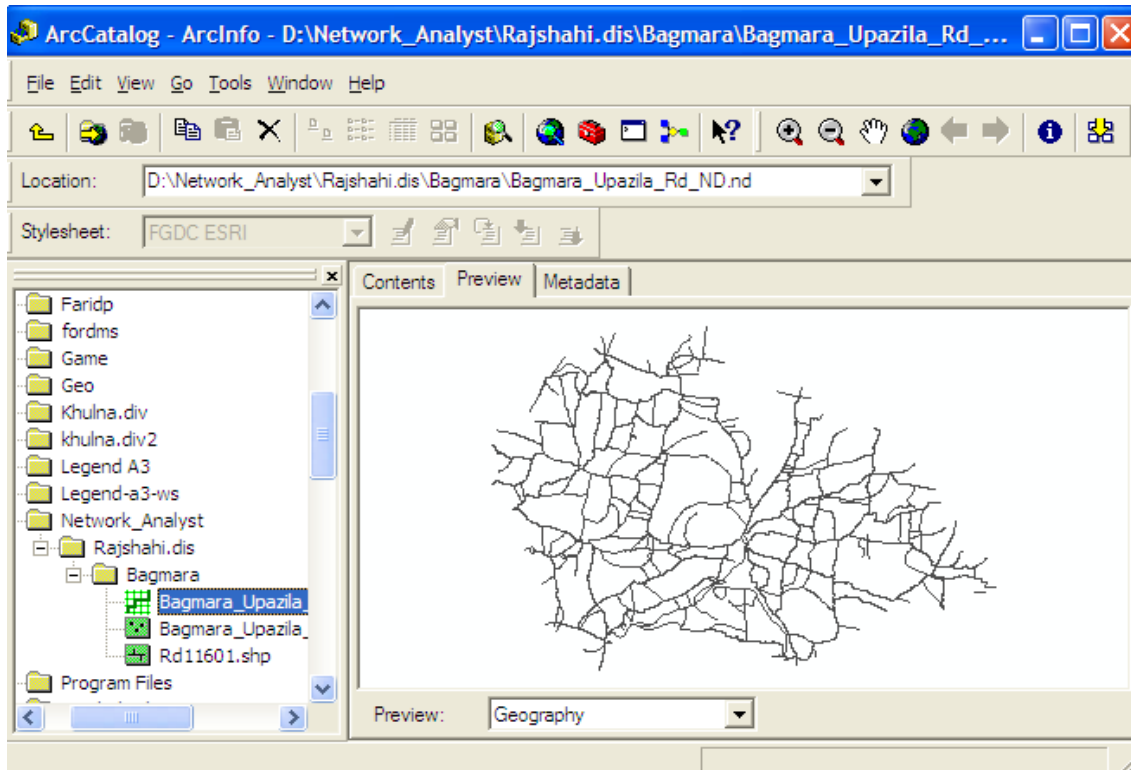
17. Click Yes to build the network.

The network dataset has been built when the progress bar disappears.

The shapefile based network, Streets_ND, is added to ArcCatalog along with the system junctions' shapefile Streets_ND_Junctions.

18. Select Streets_ND and click on the Preview tab to see the built network dataset.

19. Close ArcCatalog.

Finding the best route using a network dataset [Tutorial-02]

In this Exercise you will find the best route for the given order of stops based on travel time.

1. If the Network Analyst toolbar is not already present, on the Main menu, click View, point to Toolbars, and click Network Analyst.
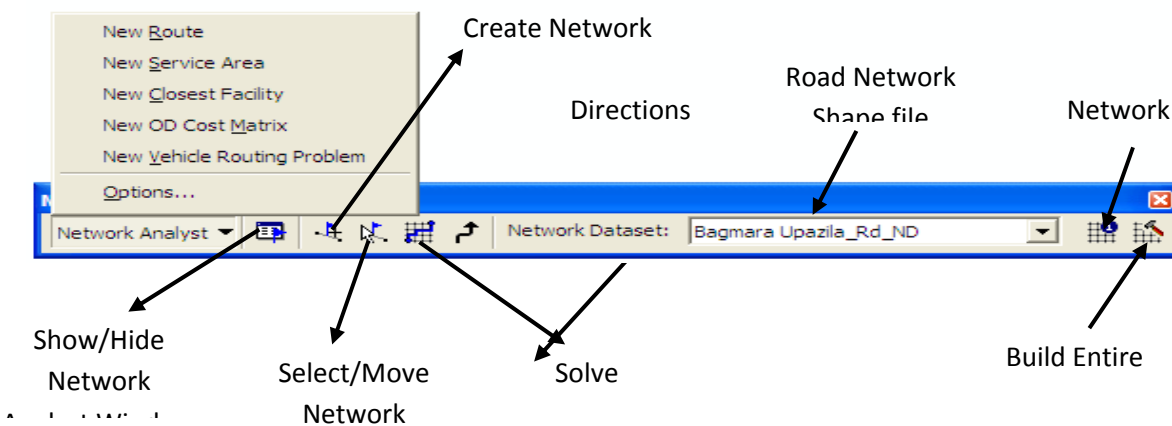
2. If the Network Analyst Window is not already open, click the Network Analyst Window button on the Network Analyst toolbar.

This is a dockable window which you can dock within the ArcMap window or leave undocked. In this Exercise the window is docked below the Table of Contents.
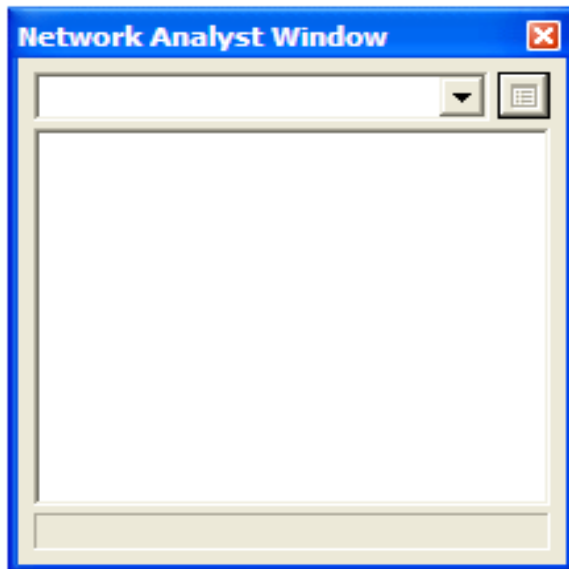
Creating the Route analysis layer

1. On the Network Analyst toolbar, click the Network Analyst drop-down menu, and click New Route.
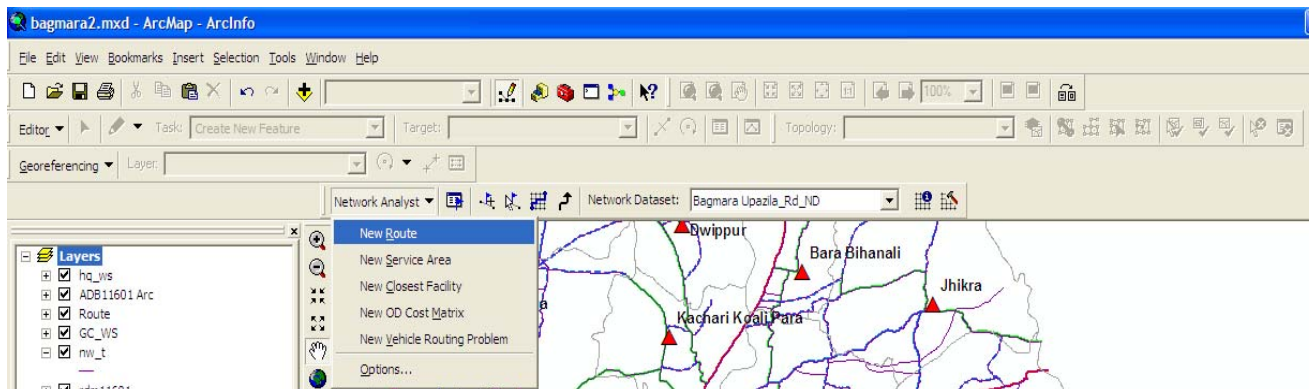
The Network Analyst Window now contains empty lists of Stops, Routes, and Barriers categories.
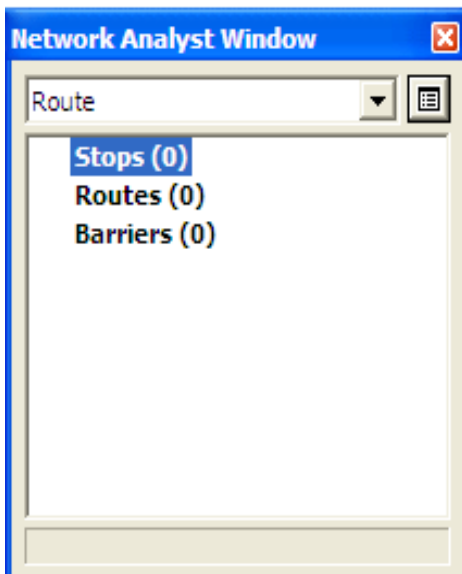
Additionally, the table of contents contains a new Route Analysis Layer.
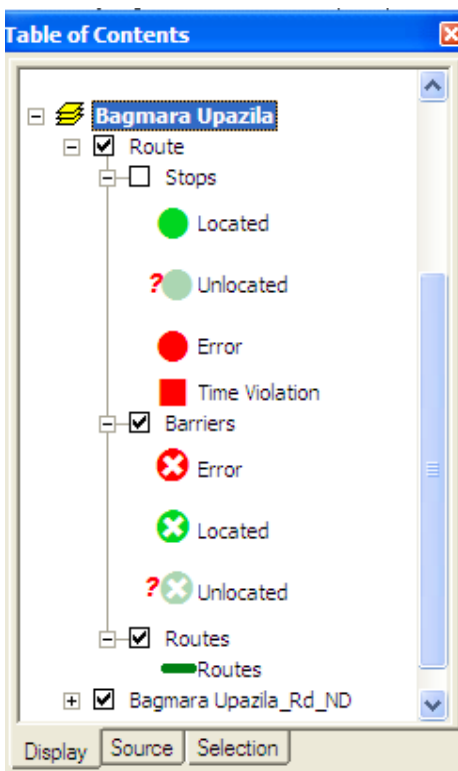
Adding a stop

Next, you will add the stops between which you will be creating the best route.

1. Click Stops (0) on the Network Analyst Window.
2. On the Network Analyst Toolbar, click the Create Network Location tool.

3. Click anywhere on the street network in the map to define a new stop location. The program then calculates the nearest network location and symbolizes the stop with the located symbol. The stop will remain selected until another stop is placed or until it is unselected.
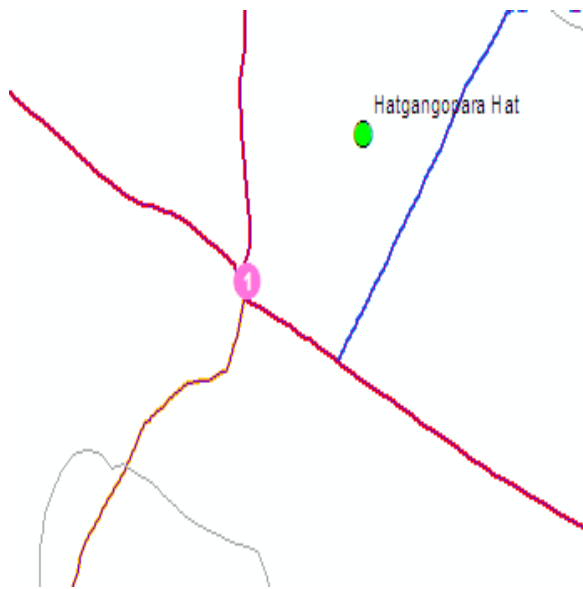
The located stop also displays the number 1. The number represents the order in which the stops will be visited by the calculated route. You will also notice that the Stops category on the Network Analyst Window now lists 1 stop. Expand the Stops category to see the Graphic Pick 1 listed there.
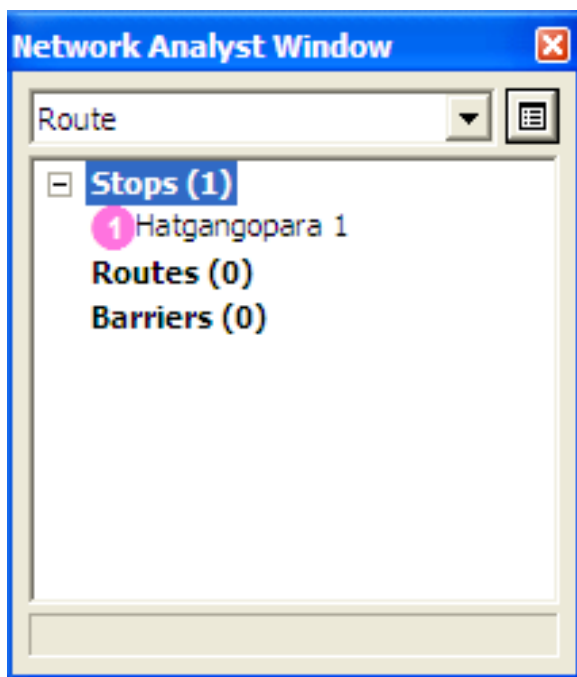
4. Add two more stops on the map. The stops are numbered 2 and 3. The order of stops can be changed on the Network Analyst Window. The first stop is treated as the origin and the last, as

the destination.
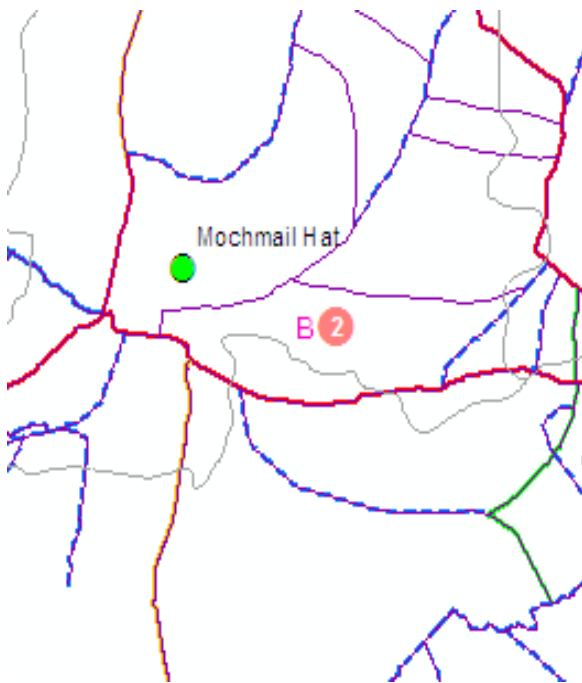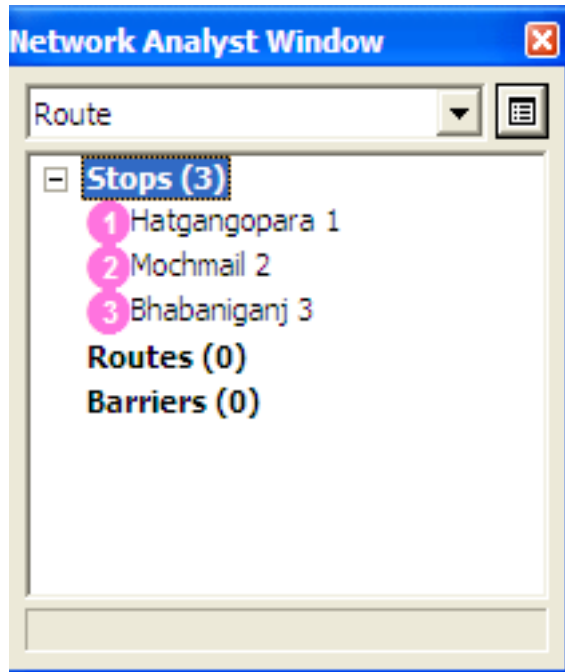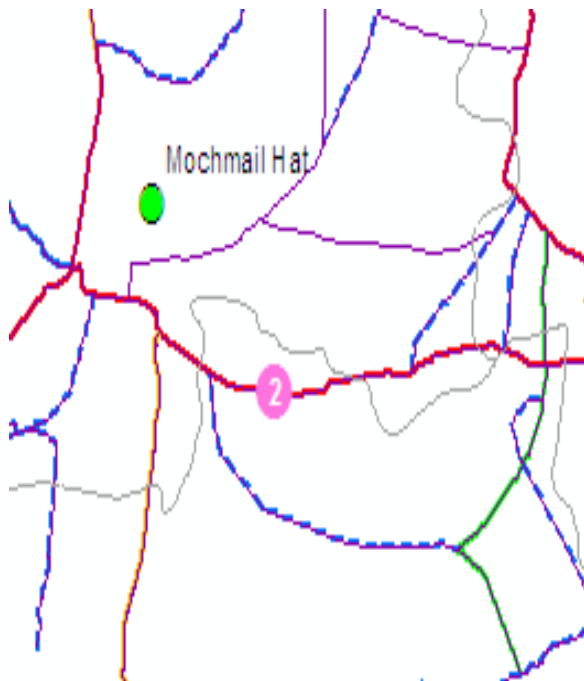
Setting up the parameters for the analysis

Next, you will specify that your route will be calculated based on time (minutes), that U-turns are allowed everywhere, and that one-way restrictions must be followed.

1. Click the Analysis Layer Properties button next to Route layer on the Network Analyst Window to bring up the Layer Properties dialog box for Route.
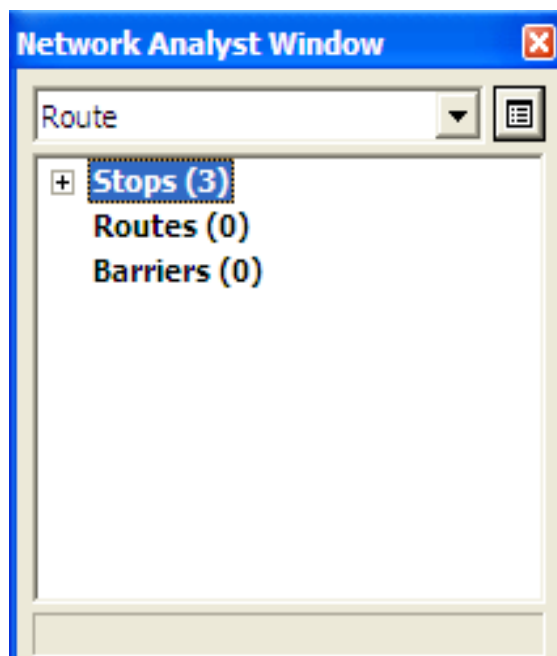
2. In the Layer Properties dialog box, click the Analysis Settings tab. Make sure the impedance selected is
Minutes (Minutes).

3. Do not use time windows. (Leave the box unchecked.) Time windows are used when certain stops can only be visited at certain times.

4. Do not reorder stops. (Leave the box unchecked.) This preserves the order of stops as decided by you, when you created the stops.

5. Choose Everywhere from the Allow U-turns drop-down box.

6. Choose True Shape from the Output Shape Type dropdown box.

7. Check the box labeled Ignore Invalid Locations. This will let you find the best route using located stops. Stops that were not located on the network will be ignored.
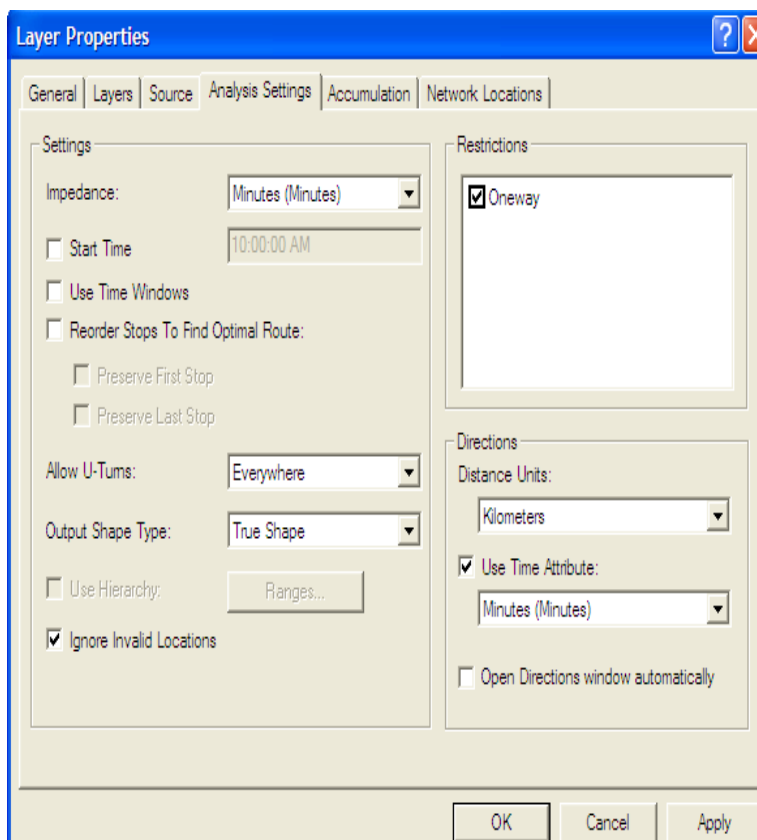
8. Find the Directions section.

9. Make sure the Distance Units are set to Miles, the Use Time Attribute box is checked and the

time attribute is set to Minutes.
10. Click OK.

Run the process to compute the best route

1. Click the Solve button on the Network Analyst toolbar.

The route polyline appears in the map and in the Route category of the Network Analyst Window.
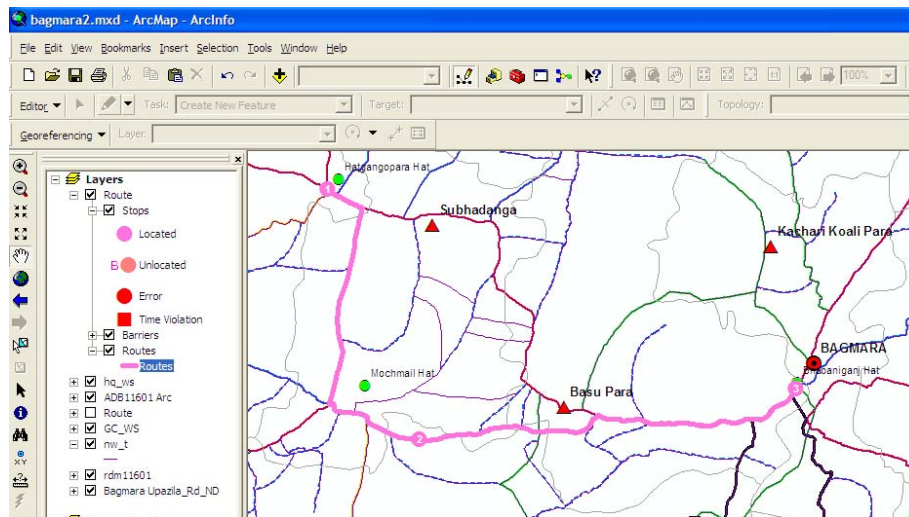
2. Click the plus (+) sign next to Routes on the Network Analyst Window to show the Route.

3. Right-click the new route called 'Graphic Pick 1 -Graphic Pick 3' and click Directions Window to display driving directions.
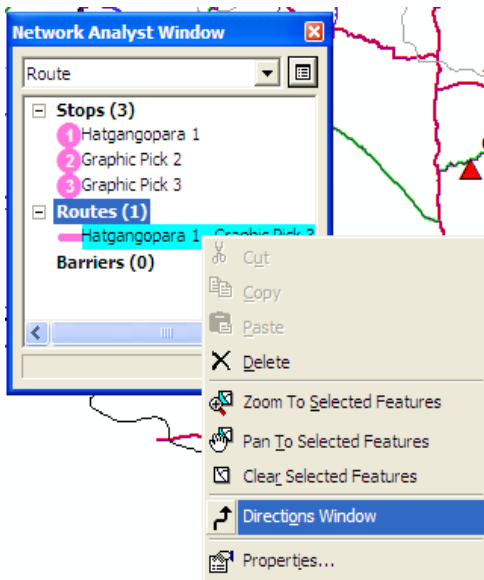
4. The Directions Window can also be displayed with turn -by- turn maps that can be shown by clicking on the Map link.
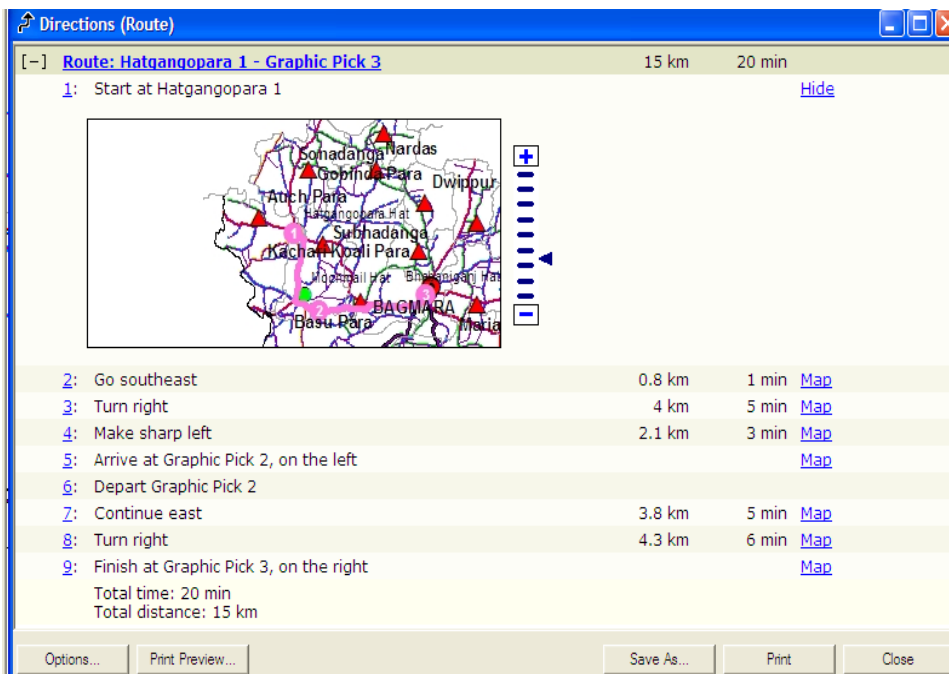
5. Close the Directions Window.

Adding a barrier

In this section, you will add a barrier on the route that represents a road block and will find an alternate route to the destination avoiding the road block.

1. In the Window menu, click Magnifier to bring up the Magnifier window.

2. Click on the title bar of the Magnifier window and drag to reposition the Magnifier window.

3. Move the Magnifier window over the route, to a point where you want to add a barrier. The Magnifier window shows a part of the map where you can add a barrier at a zoom of 100 percent.
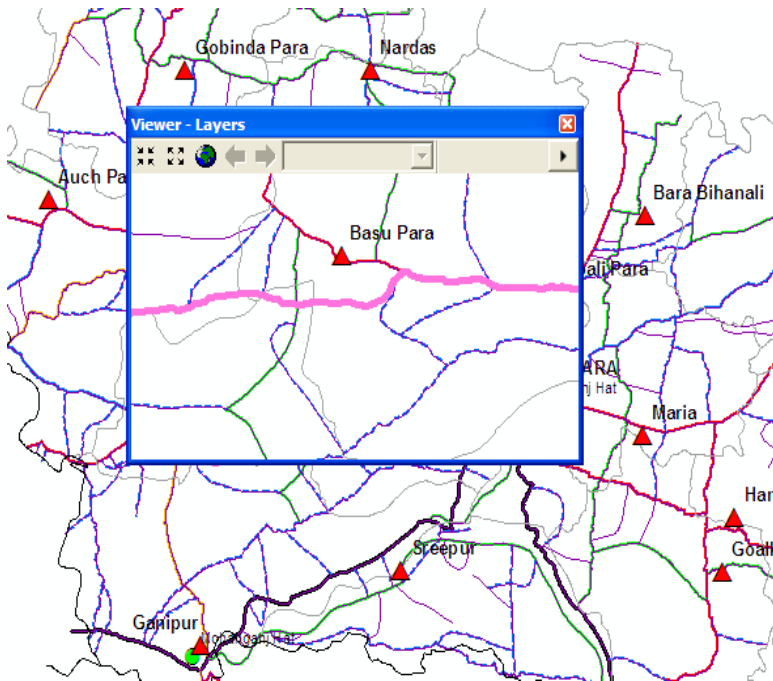
4. On the Network Analyst Window, click Barriers (0).

5. On the Network Analyst Toolbar, click the Create Network Location tool.

6. In the Magnifier window, click anywhere on the route, to place a barrier.
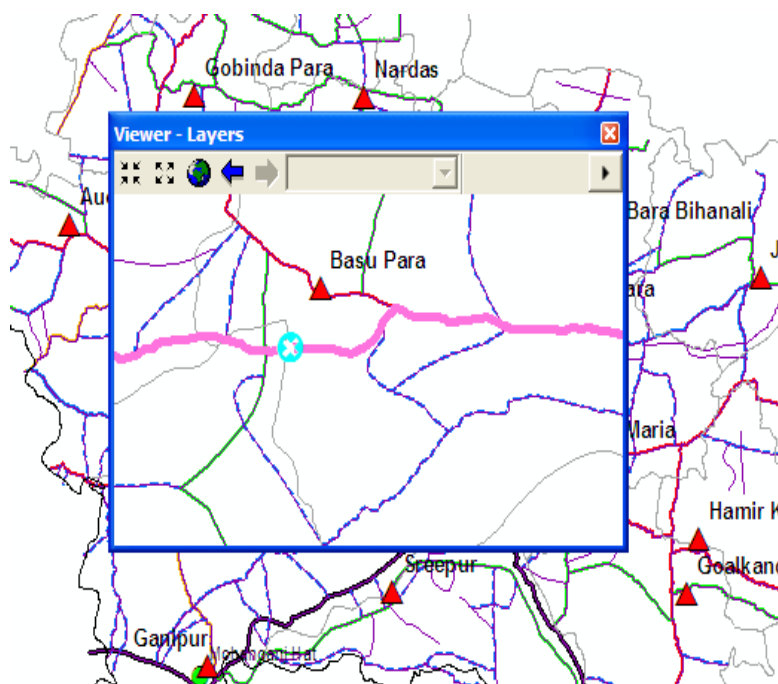
7. Click the Solve button on the Network Analyst toolbar. A new alternative route is computed, avoiding the barrier.
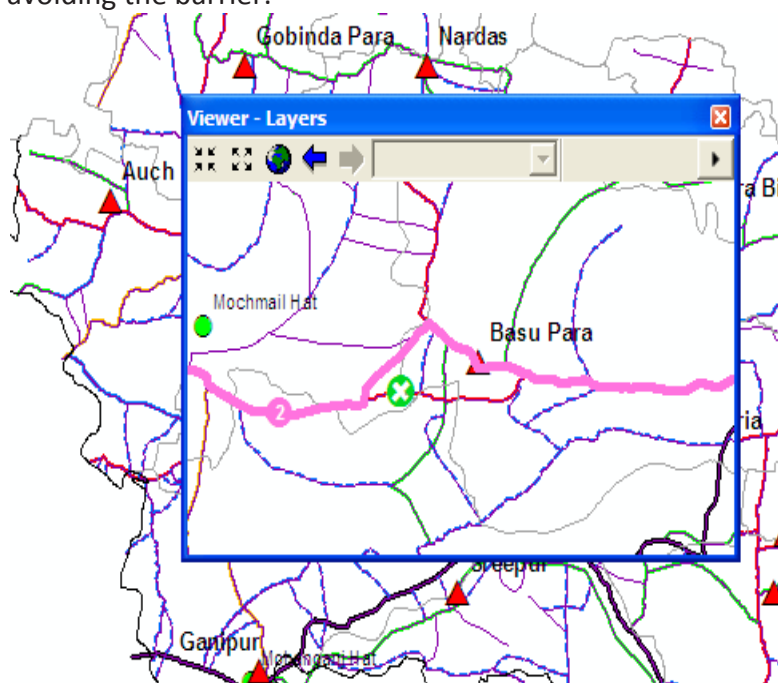
8. Close the Magnifier Window.

Saving the best route

1. Right-click Routes (1) on the Network Analyst Window and click Export Data.
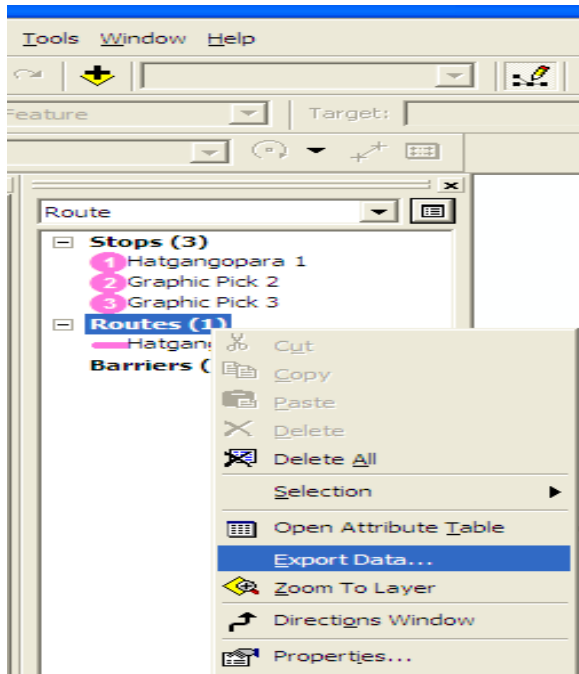
2. Give a name and save the route as shapefile
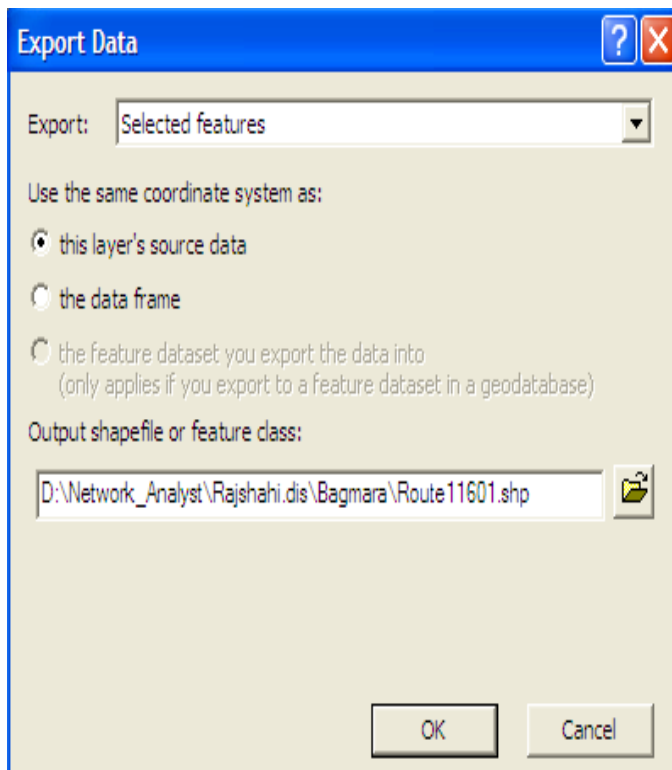
3. Click OK. The best route generated is saved to the specified shapefile.

4. Click Yes when prompted to add the exported data to the map as a layer.
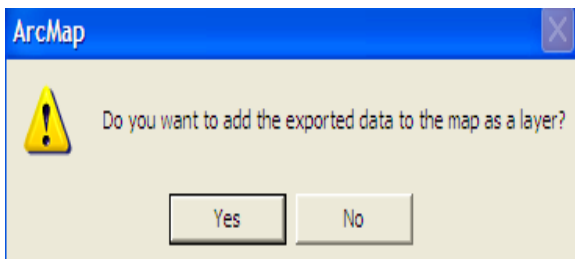
What is Linear Referencing

Linear referencing is the method of storing geographic locations by using relative positions along a measured linear feature. Distance measures are used to locate events along the line:
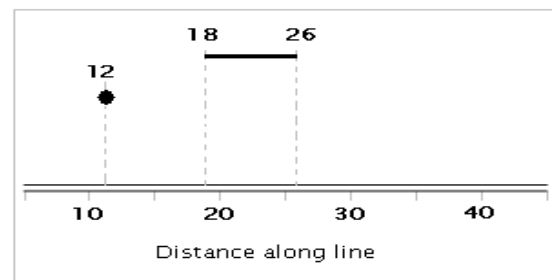
Measurements along features are used to locate point events and line events using a number of conventions. Here are some common examples.
A point can be located along the line in the graph below:
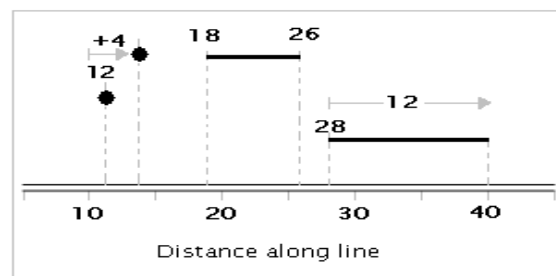
4. At measure 12 along the line
5. 4 units east of measure marker 10 along the line

Line features can be referenced in a few ways. In this example above:

- The line starts at measurement 18 and ends at 26
- The line starts at measurement 28 and continues for 12 units

Why use linear referencing?

Linear referencing is used for many reasons. Two primary reasons include:

- Many locations are recorded as events along linear features -- for example, locations of traffic accidents are recorded using a convention such as 27 *meters east of the reference mile marker 35 along State Highway 287*. Many sensors record conditions along linear features using measures of distance or time along the lines -- along pipelines, along roads, along streams, etc.

- Linear referencing is also used to associate multiple sets of attributes to portions of linear features without requiring that underlying lines be segmented (split) each time that attribute values change. For example, most road centerline feature classes are segmented where three or more road segments intersect and where the road names change.

  Users often want to record many additional attributes about the roads. Without the use of linear referencing, this could require that roads be split into many tiny segments at each location where attribute values change. As an alternative, these situations can be handled as linear referencing events along the roads as in the figure:
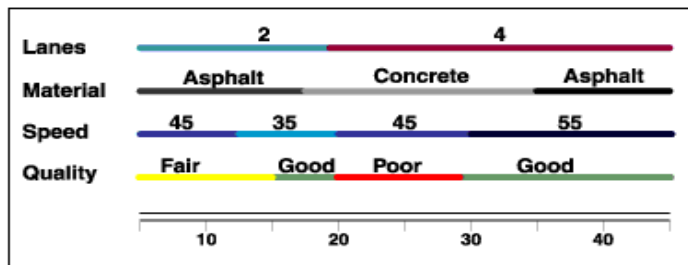
What is *dynamic segmentation*?

Dynamic segmentation is the process of computing the map locations of events stored and

managed in an event table using a linear referencing measurement system and displaying them on a map. The term "dynamic segmentation" is derived from the concept that line features need not be split (i.e.; "segmented") each time an attribute value changes -- you can "dynamically" locate the segment.

Using dynamic segmentation, multiple sets of attributes can be associated with any portion of an existing linear feature independently of where it begins or ends. These attributes can be displayed, queried, edited, and analyzed without affecting the underlying linear feature's geometry.

Linear Referencing [Tutorial-01]

1. First do necessary editing to your data and insert appropriate attribute information. Editing includes undershoot/overshoot/dissolve [to make a complete road from its segments] etc. If you don't dissolve it first, create route command also dissolve the segment with similar ID.
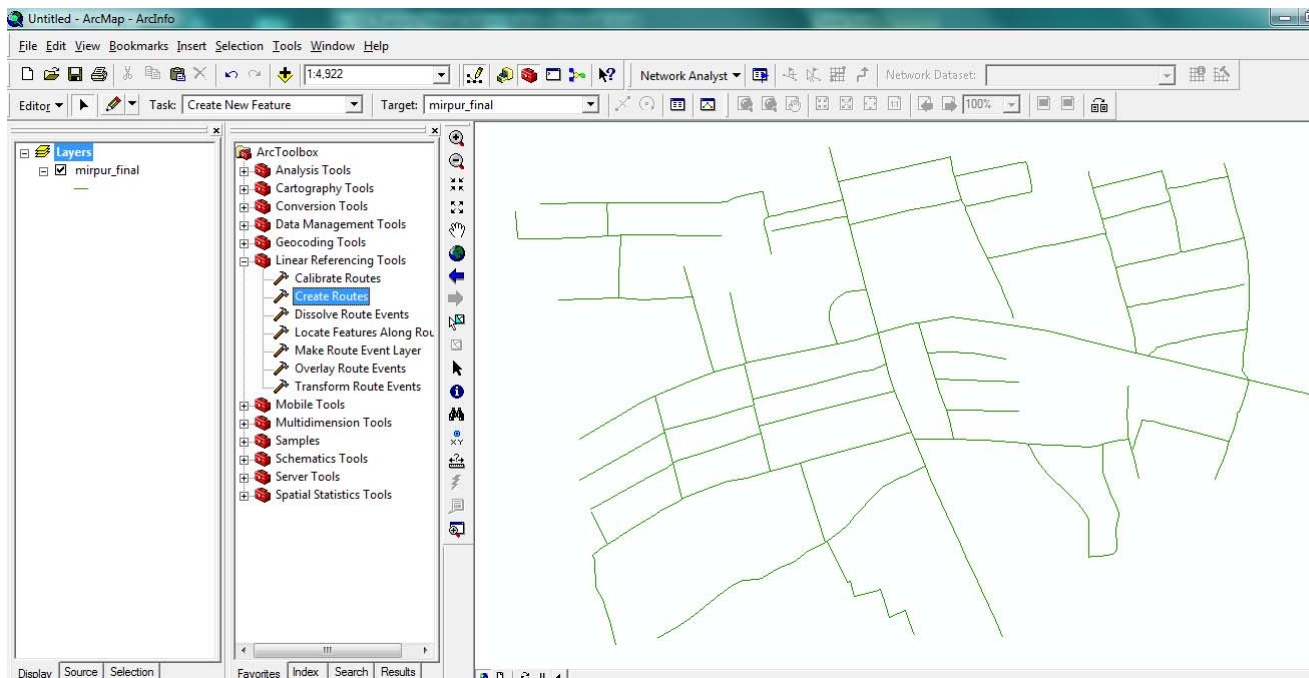
2. To see the start and end point of each features [here it is individual complete road], symbolize with **Arrow at End** and observe, if there is any anomaly, in that case select the road with Edit Tool [double click] and right click the selected road and click **Flip** to convert start point as end point and vice-versa
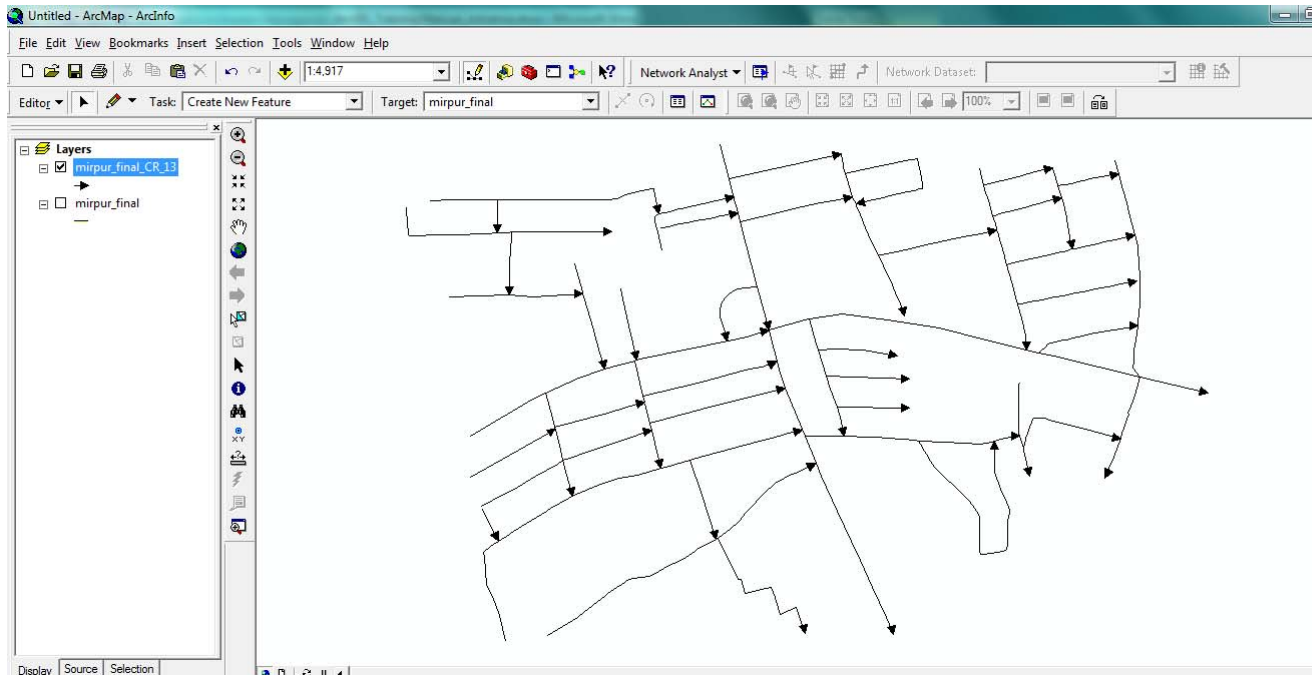
3. From Arc Tool box, select Linear Referencing Tools >> Create Routes.
> a) Select input feature
> b) Select Route Identifier field [normally ID of each complete road]
> c) Give output feature name.
> d) Then press Ok button
> e) **Then the route data will be created and added in the TOC to show the map**
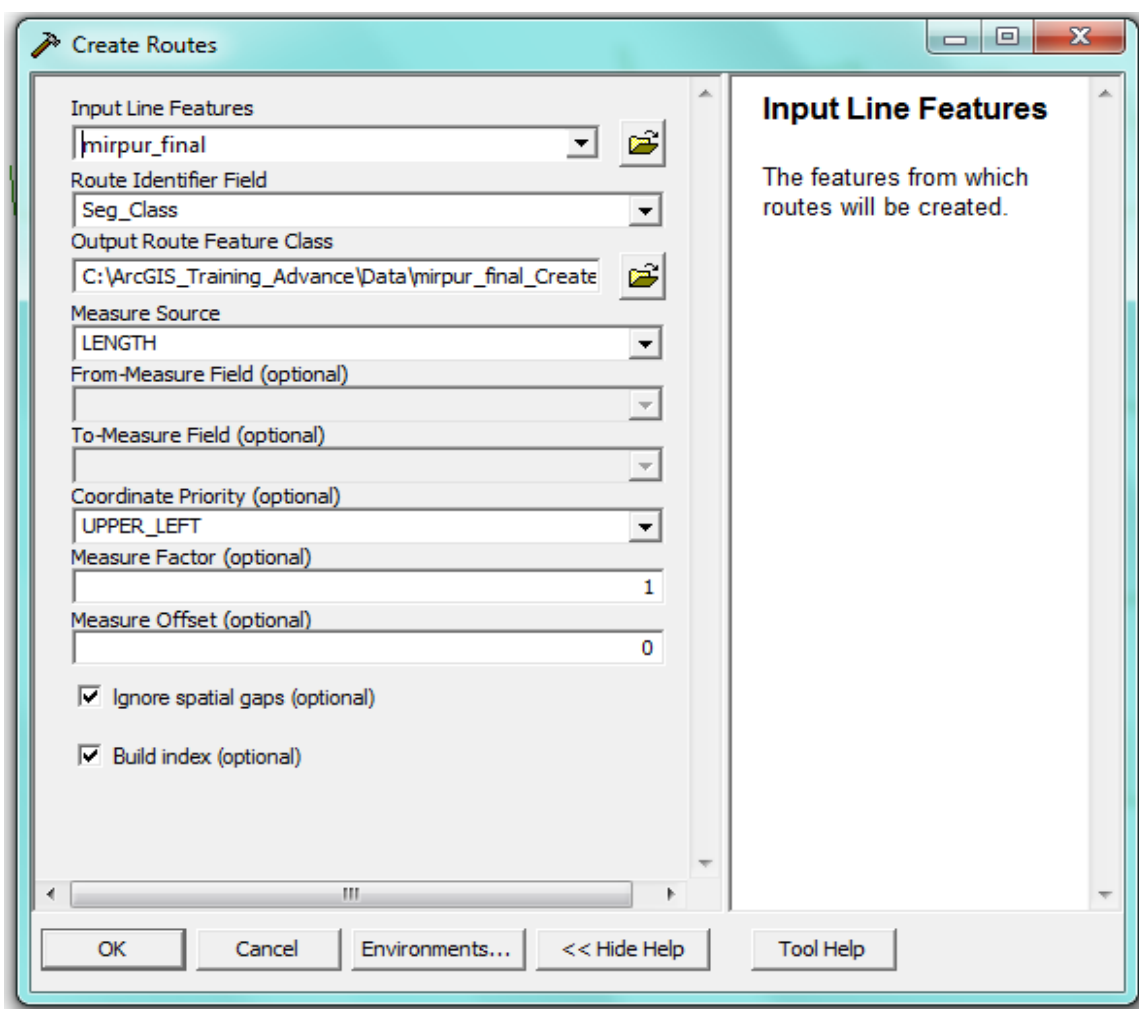
4. Now right click the route layer in the TOC, select properties and then select Hatch Tab and then press Hatch Class to give hatch interval. Check **Hatch features in this layer** option
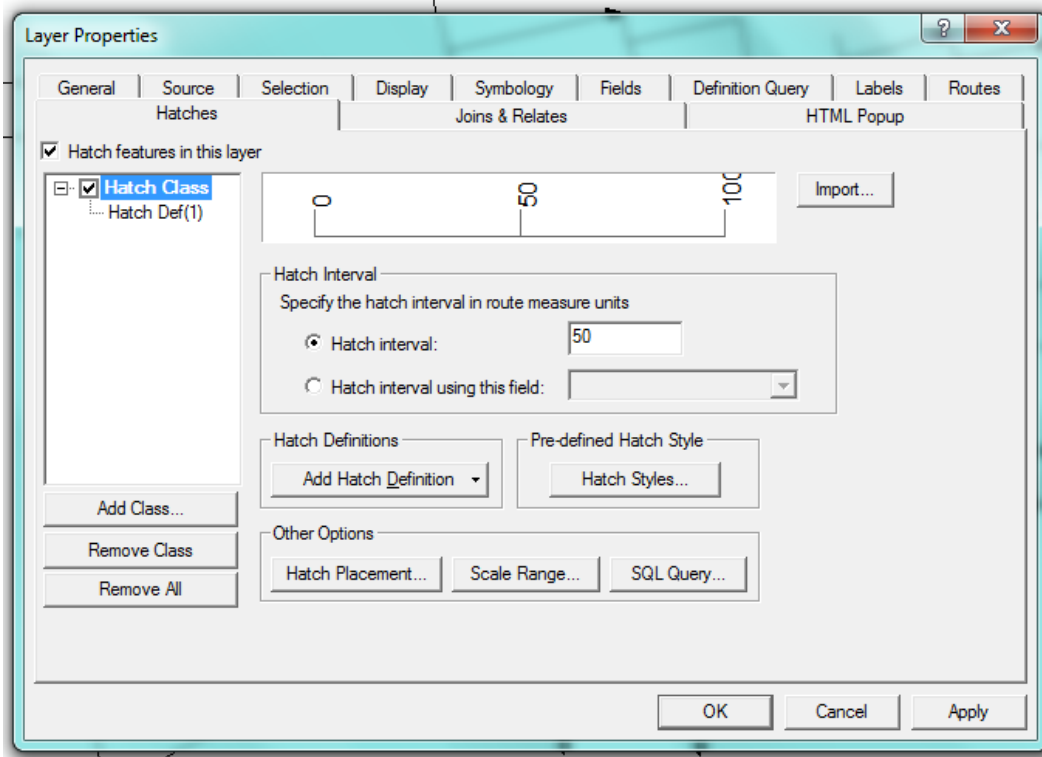
5. Then click Hatch Def and select hatch option as line or marker. If you select Line option then give value for hatch line length or you can select Marker, in the case you can specify marker size and color. Check Label these hatches to see the interval value.
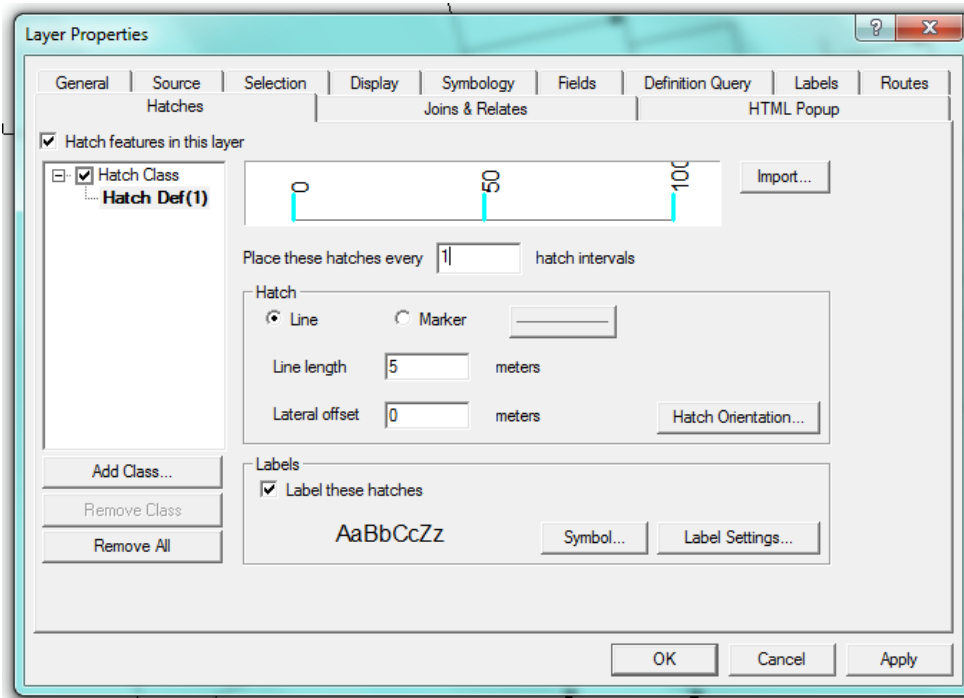
6. If it is found that the hatch value does not comply with the direction then double click the

segment with Edit Tool and right click and then select **Route Measure Editing** >> Set From/To. Then swap the value.
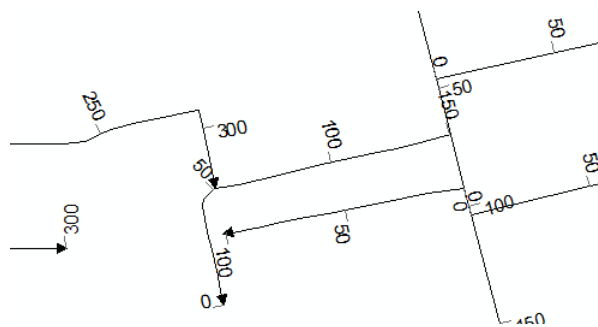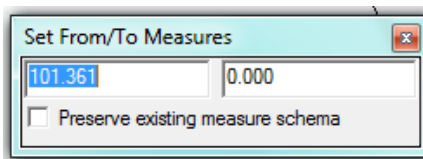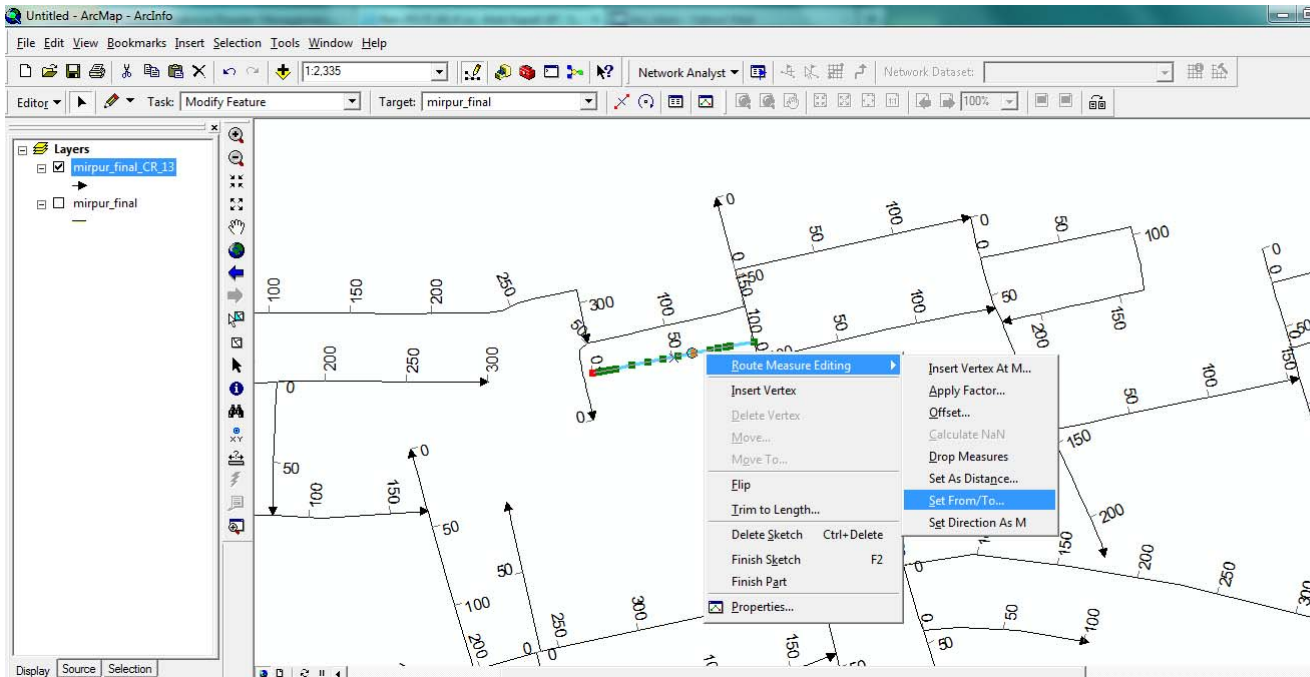
How to make Dynamic Segmentation

Create a table for segment (Road/Pipe) Information

1. In MS Access create a database (.mdb format) and table with the following field

Field Name	Data Type
ID	AutoNumber
RoadID	Text
From	Number
To	Number
Event	Text

General | Lookup

Field Size	Long Integer
New Values	Increment
Format	
Caption	
Indexed	Yes (No Duplicates)
Smart Tags	
Text Align	General

Insert Segmented Information [Point]

1. To make it simple insert segment information for one or two road
2. Sometimes it needs to export the table created to .dbf format to work properly

Table1

ID	RoadID	From	To	Eve
2	M10-M14	0	100	
3	M10-M14	100	200	
4	M10-M14	200	300	Acc
5	M10-M14	300	400	
6	M10-M14	400	450	Acc
* (New)				

Add Route Events

2. From tool menu, select Add Route Events.., to get the following dialog box
2. Choose **Point Events** and other appropriate options from different drop down list
3. Click OK
4. Then an event will be added to TOC
5. Symbolize the event layer
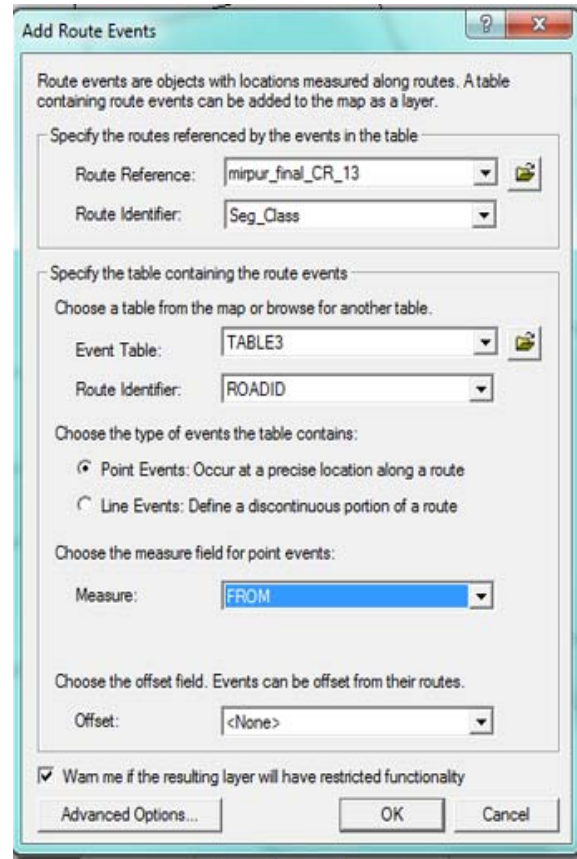
Displaying the Results

1. Event point is added according to the information inserted.
2. Now add some accident point location by inserting word 'Acc' in the event field.
3. Save the table as .dbf if .mdb does not work in your version of windows.
4. From tool menu, select Add Route Events and symbolize with unique values for event field. Remove other points except accident point.
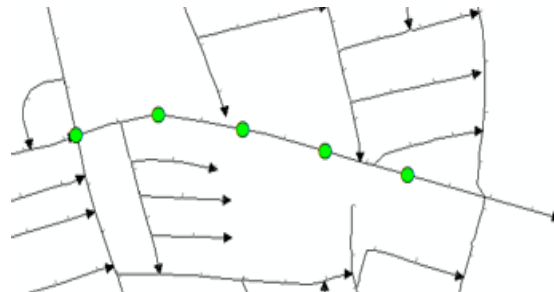
Show Accident Points and update information dynamically

1. Now change the accident location and display it dynamically
2. Change in .mdb table or .dbf table
3. Close the ArcGIS and reload it.
4. see the change
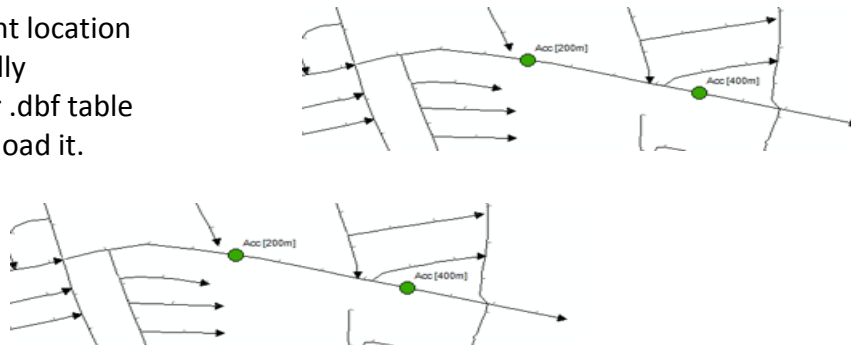
Insert Segmented Information [Line]

1. Use the same database file.
2. Choose Line Event.
3. Choose From-measure and To-measure for line event.
4. Click OK.
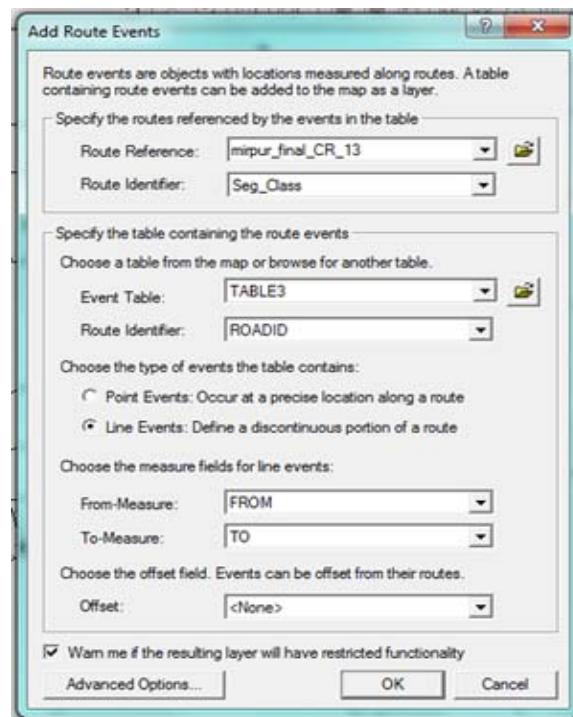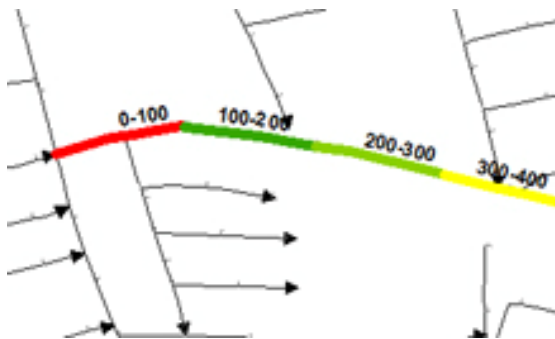
Change the database and get segment dynamically

1. Change the information in below event table and display will update automatically
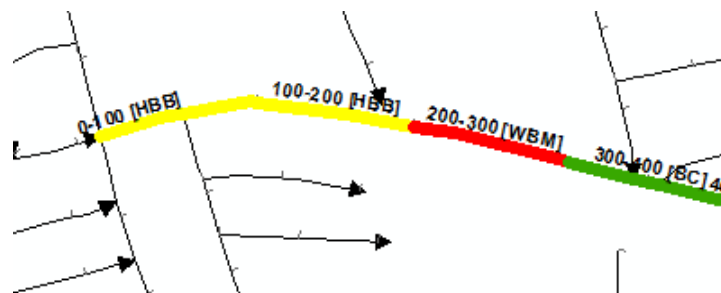
ID	RoadID	From	To	Eve
2	M10-M14	0	100	HBB
3	M10-M14	100	200	HBB
4	M10-M14	200	300	WBI
5	M10-M14	300	400	BC
6	M10-M14	400	450	BC
* (New)				

Module VIII

Geodatabase
Personal Geodatabase

In this Module
• Personal Geodatabase
• How to create personal geodatabase
• Creating new geodatabase
• Populate geodatabase by import/export

Personal Geodatabase

A geodatabase that stores data in Microsoft Access. A Personal geodatabase can be read simultaneously by several users. But only one user at a time can edit the same data.

How to create Personal Geodatabase

A geodatabase is an object-oriented geographic database that provides Services for managing geographic data. These services include validation rules, relationships, and topological associations. A geodatabase contains feature datasets as well as feature classes that can be stored inside a feature dataset or maintained independently. A personal geodatabase is stored inside a relational database mamagement system (RDBMS).

ArcCatalog is the manager for your geodatabase. With ArcCatalog, you can view and edit the contents of your geodatabase. ArcCatalog contains a full suite of utilities to create and manage a geodatabase.

Geodatabases are relational databases that contain geographic information. Geodatabases contain feature classes and tables. Feature classes can be organized into a feature dataset; they can also exist independently in the geodatabase. A feature dataset is a collection of feature classes that share the same spatial reference.

Feature classes store geographic features represented as points, lines, or polygons and their attributes; they can also store annotation dimensions. All feature classes in a feature dataset share the same coordinate system. Tables may contain additional attributes foe a feature class or geographic information, such as addresses and x,y,z coordinates.

Many objects in a geodatabase can be related to each other. For example, tables containing customer addresses and billing information are related, just as state and country feature classes are related

Creating a Personal Geodatabase

Creating a new personal geodatabase involve creating a .mdb file on disk. This is a simple, straightforward process that is performed by using ArcCatalog or geoprocessing tools.

Creating a new personal geodatabase using ArcCatalog

1. Right-click the file folder in the ArcCatalog tree where you want to create the new personal geo database
2. Point to New
3. Click Personal Geodatabase

   ArcCatalog creates a new personal geodatabase in the location you selected and sets its name

to edit mode.

4. Type a new name for this personal geodatabase and press Enter.

Importing and Exporting shapefile to Geodatabase

1. Right-click over Geodatabase >> Import >> Feature class (Single) / Feature class (Multiple)

2. Right-click over shapefile >> Export >> To Geodatabase (Single) / Geodatabase (Multiple)

Module IX

Spatial Analysis

In this Module
- About Spatial Analyst
- Understanding Overlay Analysis
- How enable Spatial Analyst
- Concept of Euclidean Distance
- Calculating Euclidean Distance
- Making Surface [Feature to Raster]
- Overlay

About Spatial Analyst

ArcGIS Spatial Analyst provides a rich set of tools to perform cell-based (raster) analysis. Of the three main types of GIS data (raster, vector, and TIN), the raster data structure provides the most comprehensive modeling environment for spatial analysis.

Cell-based systems divide the world into discrete uniform units called cells, based on a grid structure. Each cell represents a certain specified portion of the earth, such as a square kilometer, hectare, or square meter. Cells are given values that correspond to the features or characteristics that are located at or describe the locations they represent, such as an elevation value, soil type, or residential classification. In a cell-based system, geographic location is not defined as an attribute but is inherent in the storage structure, known as the locational perspective.

Spatial Analyst Toolsets

The following table lists the available toolsets in ArcGIS Spatial Analyst and gives a brief description of each.

Distance	There are two main ways to perform distance analysis in ArcGIS Spatial Analyst: Euclidean distance and cost distance. The Euclidean distance functions measure straight-line distance from each cell to the closest source (the source identifies the objects of interest, such as wells, roads, or a school). The cost distance functions (or cost weighted distance) modify Euclidean distance by equating distance as a cost factor, which is the cost to travel through any given cell. For example, it may be shorter to climb over the mountain to the destination, but it is faster to walk around it.
Overlay	A common spatial analysis query is to identify the suitability of each cell location relative to specific criteria. The criteria can be relative costs, preferences, or risks. Suitability models answer questions such as, Where is the best location to construct a house. What is the cheapest route to build a road? And Which areas should be conserved for deer habitat? The Weighted Overlay tool allows you to easily reclassify your data, weight the datasets, and combine them to create a suitability map.
Reclass	Reclassifying your data simply means replacing input cell values with new output cell values. There are many reasons why you might want to reclassify your data. Some of the most common reasons are: (1) to replace values based on new information, (2) to group certain values together, (3) to reclassify values to a common scale (for example, for use in a suitability analysis or for creating a cost raster for use in the Cost Distance tool), and (4) to set specific values to NoData or to set NoData cells to a value. There are several approaches to reclassify your data: by individual values, by ranges, by intervals or area, or through an alternative value.

Understanding Overlay Analysis

Weighted overlay is a technique for applying a common scale of values to diverse and dissimilar input to create an integrated analysis.

Geographic problems often require the analysis of many different factors. For instance, choosing the site for a new housing development means assessing such things as land cost, proximity to existing services, slope, and flood frequency. This information exists in different rasters with different value scales: Taka, distances, degrees, and so on. You cannot add a raster of land cost (Taka) to a raster of distance to utilities (meters) and obtain a meaningful result.

Additionally, the factors in your analysis may not be equally important. It may be that the cost of land is more important in choosing a site than the distance to utility lines. How much more important is for you to decide.

The Weighted Overlay tool lets you take all these issues into consideration. It reclassifies values in the input rasters onto a common evaluation scale of suitability or preference, risk, or some similarly unifying scale. The input rasters are weighted by importance and added together to produce an output raster. The steps are summarized below.

1. A numeric evaluation scale is chosen. This may be 1 to 5, 1 to 9, or any other scale. Values at one end of the scale represent one extreme of suitability (or other criterion); values at the other end represent the other extreme.
2. The cell values for each input raster in the analysis are assigned values from the evaluation scale and reclassified to these values. This makes it possible to perform arithmetic operations on the rasters that originally held dissimilar types of values.
3. Each input raster is weighted, or assigned a percent influence, based on its importance to the model. The total influence for all rasters equals 100 percent.
4. The cell values of each input raster are multiplied by the rasters' weights.
5. The resulting cell values are added together to produce the output raster.

The Weighted Overlay tool accepts only discrete rasters (integer values) as input. Continuous rasters must be reclassified to discrete rasters before they can be used.

The two input rasters above have been reclassified to an evaluation scale of 1 to 3. Each raster is assigned a percentage influence. The influence of the first raster is 75 percent and the influence of the second is 25 percent. The cell values are multiplied by their influence percentages, then added together to create the output raster. Take the top left cell as an example (2 * .75) = 1.5 and (3 * .25) = .75. The sum of 1.5 and .75 is 2.25. Because the output raster is discrete, the value is rounded to 2.

A weighted overlay example
In the following example, a location for a new urban park is being chosen. Three factors will be considered: land use, population density, and distance to existing parks. The goal is to find an area of suitable land use, such as vacant land, in a neighborhood of high population density, to provide green space in crowded areas that is not already served by an existing park.
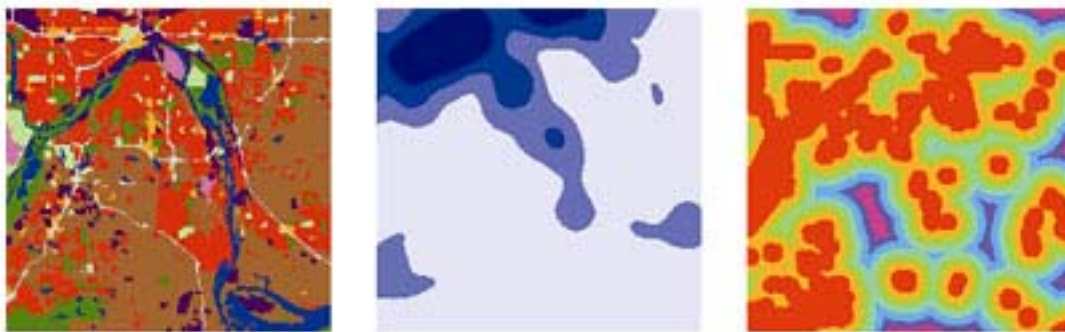

The input rasters to the weighted overlay are displayed in the image above. They are (from left to right): land use, population density, and distance to parks.
The weighted overlay model is displayed in the image below as a process in ModelBuilder.

Each value class in each input raster is assigned a new, reclassified value on an evaluation scale of 1 to 5, where 1 represents the lowest suitability and 5 the highest. For instance, in the land use raster, vacant land is highly suitable, while commercial land is not. In the population density raster, suitability values are high for high-density areas and low for low-density areas. In the distance to parks raster, suitability increases with distance from existing parks because areas far from existing parks are inadequately served.

Any class can also be assigned a restricted value, which means that the corresponding area is unacceptable or cannot be used. Restricted areas are excluded from the analysis. In the land use raster, for example, airports and water bodies are restricted.

Each of the three input rasters is then
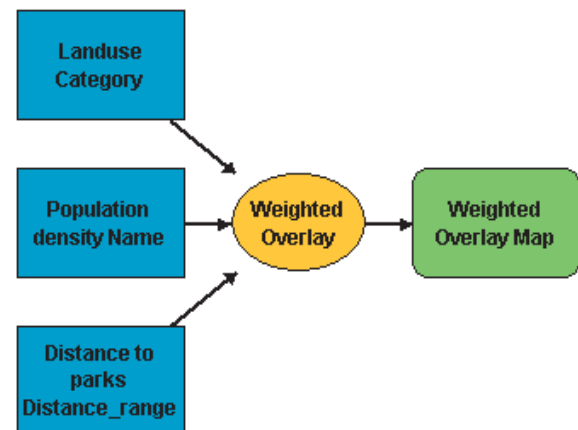
weighted. In this weighted overlay, land use has a 50 percent influence, population density a 15 percent influence, and distance from parks a 35 percent influence.

When the weighted overlay is run, a raster of overall suitability is created.

The most suitable areas are shown in red. Orange areas are next, followed by green. Blue and purple areas are least suitable, and white areas are restricted. Modifying the suitability values or the influence percentages will produce different results.
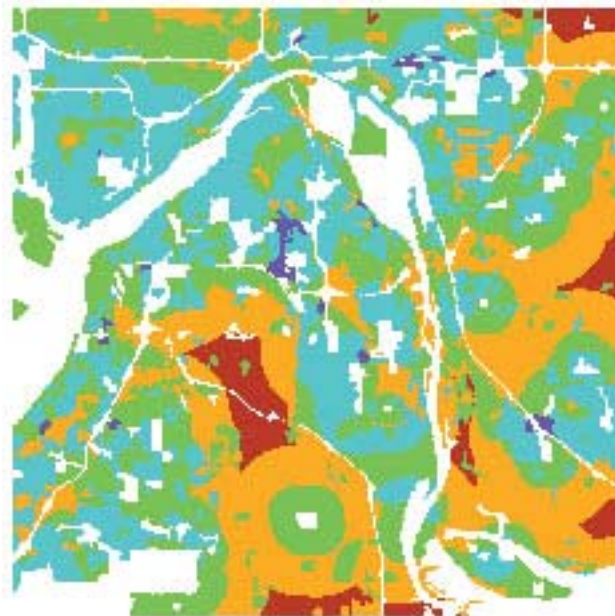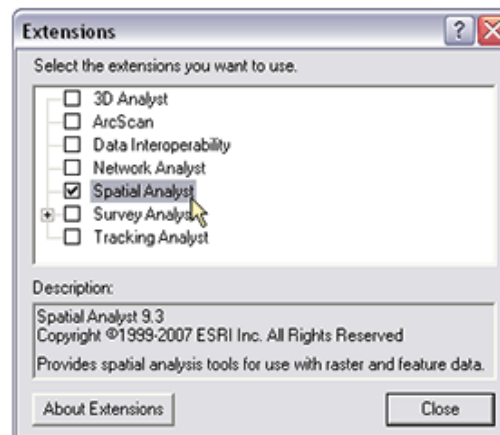
How to enable Spatial Analyst

1. Click on the Tools menu and select Extensions...:
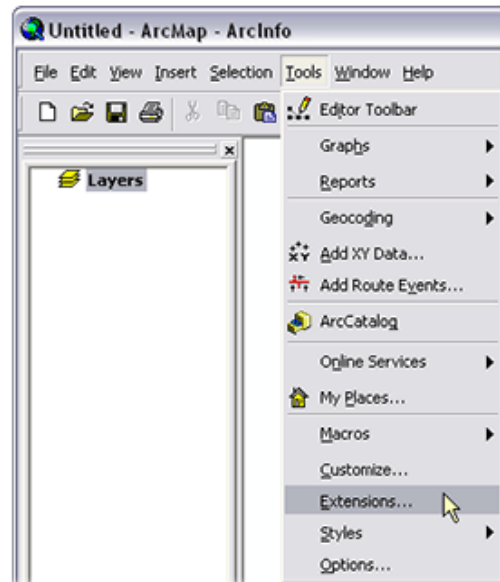
2. In the Extensions dialog, click on Spatial Analyst from the list and Close the dialog:

How to find a suitable location for a new Pump Station [Tutorial]

1. Start a new ArcGIS document
2. Load DPWPump, DStructure, DWaterbody from your Data folder
3. Open Toolbox window and check whether Spatial Analyst Tools are available, if not right-click on blank space of Arc Toolbox and select Add Toolboxes options. Select the tools from Drive/Program files/ArcGIS/ Arc Toolbox/Toolboxes/Spatial Analyst Tools.
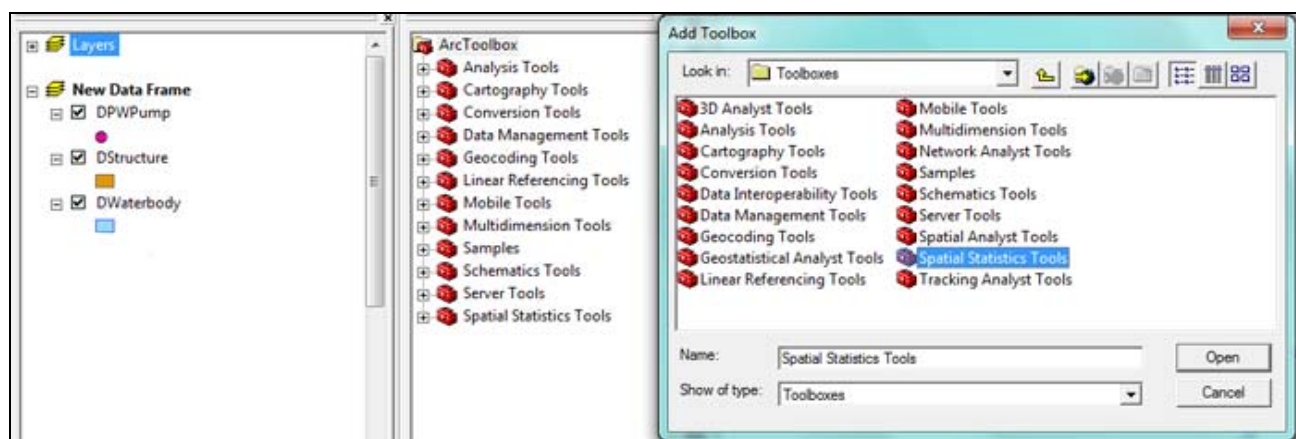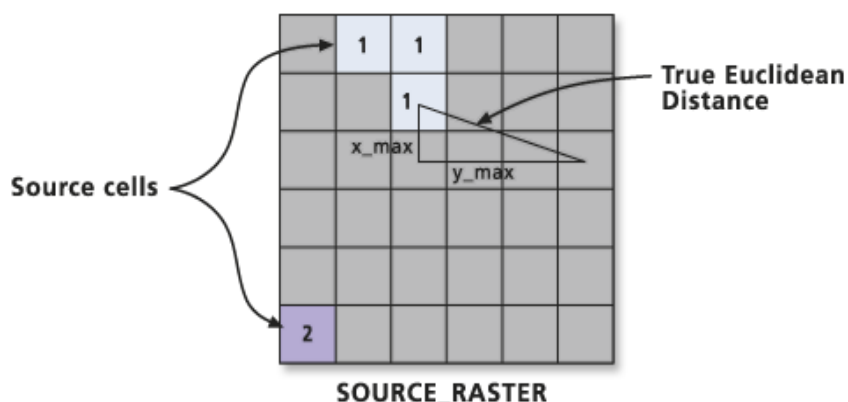
Euclidean Distance

Three output rasters are available from the Euclidean functions. These rasters describe each cell's Euclidean relationship to a source or to a set of source cells. The Euclidean distance raster identifies the distance from each cell to the closest source cell; the Euclidean direction raster gives the direction from each cell to the closest source cell; and the Euclidean allocation raster identifies which cells are allocated to which source based on closest proximity.

Each raster can be derived separately by running one of the three functions, or each function can derive all three rasters as output in Map Algebra. No prerequisites exist between functions, which can be run independently at any time.

Euclidean distance is calculated from the center of the source cell to the center of each of the surrounding cells. True Euclidean distance is calculated in each of the distance functions. Conceptually, the Euclidean algorithm works as follows: for each cell, the distance to each source cell is determined by calculating the hypotenuse with x_max and y_max as the other two legs of the triangle. This calculation derives the true Euclidean distance, rather than the cell distance. The shortest distance to a source is determined, and if it is less than the specified maximum distance, the value is assigned to the cell.

The output values for the Euclidean raster are floating-point distance values. If a cell is at an equal

distance from two or more sources, it is assigned to the source that is first encountered in the scanning process.

The above description is only a conceptual depiction of how values are derived. The actual algorithm computes the information using a two-scan sequential process. This process makes the speed of the function independent from the number of source cells, the distribution of the source cells, and the maximum distance specified. The only factor that influences the speed with which the function executes is the size of the raster.

Euclidean direction assigns the direction of each cell in degrees to its nearest source. A 360 degree circle or compass is used, with 360 being to the north and 1 to the east; the remaining values increase clockwise. The value 0 is reserved for the source cells.

Euclidean allocation produces an output raster that records for each cell the identity of the closest source cell. Each cell in an allocation receives the value of the zone to which it will be allocated.

Calculating Euclidean Distance

1. Click Euclidean Distance tool under Distance folder of Spatial Analyst Tool. Select cell resolution 5m. surface
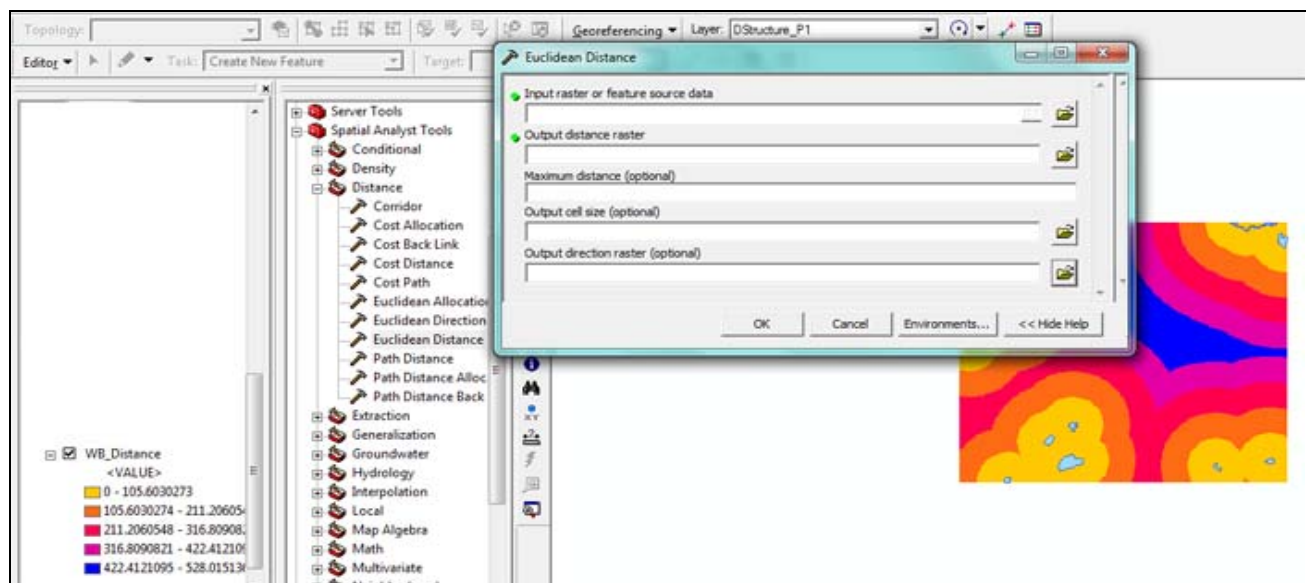
2. Then Reclassify up to 5 class and value it from 1-5
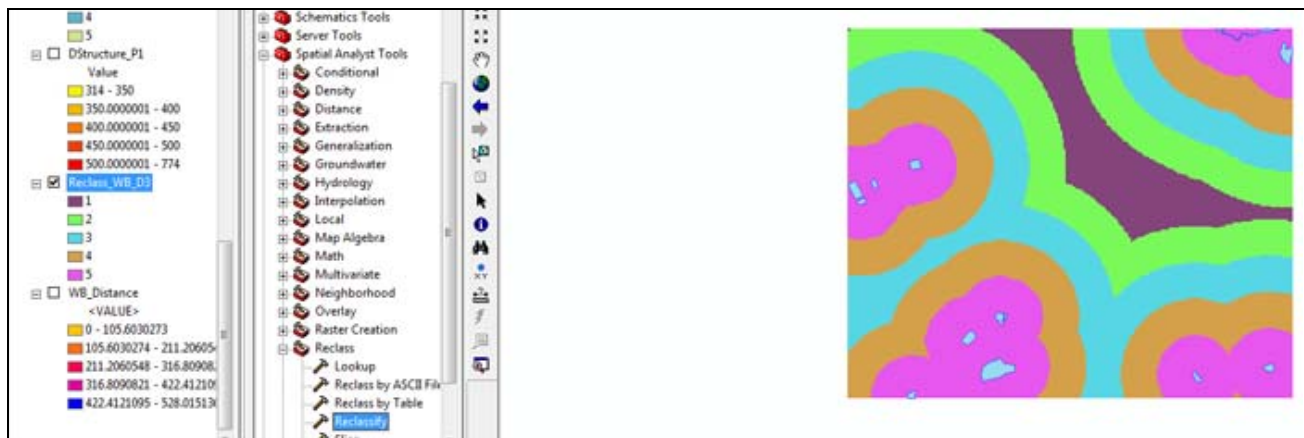
Make Surface (to raster) from Building Footprint layer

1. Select only Tin Shed building whose area is > 300 sqft using Query Builder["STRUCTYPE" = 'Tin Shed' and "Area" >300]
2. Select Polygon to Raster tools from To Raster folder of Conversion Tools. Make Cell size 5m
3. Reclassify the value from 1-5 scale
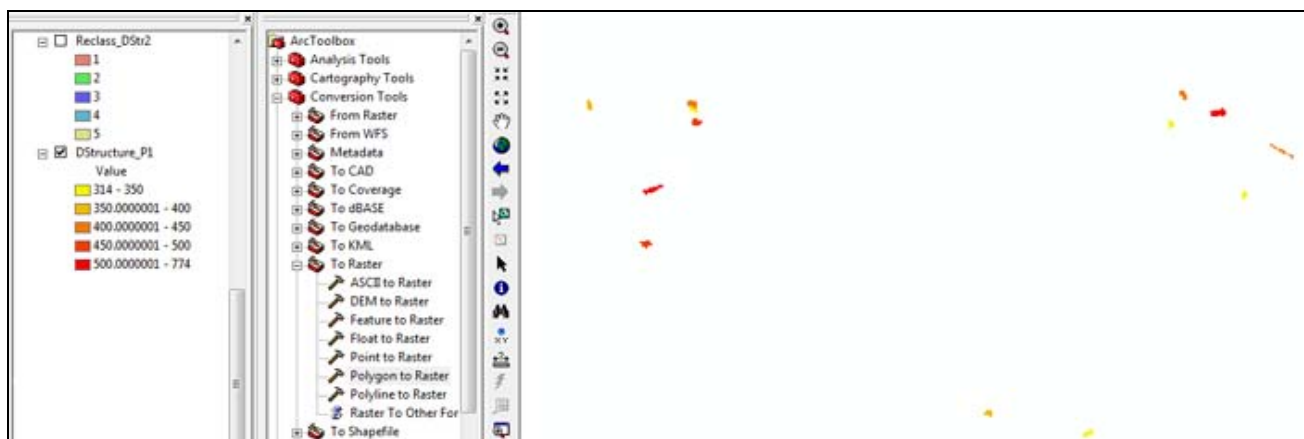
Calculate Distance for Pump Station

1. Make distance surface for DPWPump layer. Assign cell size 5m. Follow the steps for Water body layer.

2. Reclassify the surface from 1-5 range

Overlay the three Surfaces

1. Overlay the surface with equal weight
2. Select Weighted Sum tool under Overlay folder of Spatial Analyst Tools. Reclassify the value with 1-3 range value.
3. You will get best location for constructing new Pump Station [The plot within the Red Circle]

Distance from existing Water body

Distance from existing pump