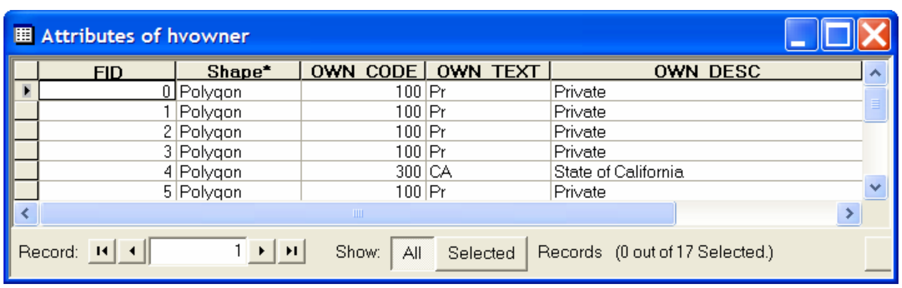
EXERCISE 3: GEOREFERENCE A RASTER

In this exercise, you will learn how to convert vector features to raster, raster features to vector, raster to other raster formats, and how to georeference a raster dataset. This exercise illustrates some of the tools that you can employ to build your raster database and ensures that all necessary data is in the same format, georeferenced, and has the same cell size for analysis and modeling.

STEP 1: CONVERT FEATURE DATA TO RASTER DATA

When converting features to raster, you may specify a cell size for your output raster. Your choice should be based on several factors: the resolution of the input data, the output resolution needed to perform your analysis, and the need to maintain a rapid processing speed. Larger rasters will require longer processing times. A fine resolution (yielding slower processing speeds) may sometimes be essential to your analysis.
You will learn how to use the ArcGIS Spatial Analyst data conversion options by converting a feature layer to raster. You will use a string field for the conversion. Each character attribute value is assigned a unique numeric value during the conversion, which is then given to the value of the output cells.

- ☐ Start *ArcMap* with *A new empty map*.
- ☐ Add ... *Exercise04b\hvowner.lyr* to the map.
- ☐ Right-click *hvowner* and select *Open Attribute Table*.


Attributes of hvowner

FID	Shape*	OWN_CODE	OWN_TEXT	OWN_DESC
0	Polygon	100	Pr	Private
1	Polygon	100	Pr	Private
2	Polygon	100	Pr	Private
3	Polygon	100	Pr	Private
4	Polygon	300	CA	State of California
5	Polygon	100	Pr	Private

Notice the character attributes in the OWN_DESC field.

You will be using the Owner field when you convert this feature class from vector to raster format. You will use a geoprocessing toolbox tool named “Feature to Raster” to convert hvowner polygons to a raster in grid format.

- ☐ Close the Attributes of *hvowner*.
- ☐ Open the *ArcToolbox* window.
- ☐ *Right-click* in the *ArcToolbox* background and select Environments.

☐ Make these Environment Settings:
- Current Workspace: *C: \Student\SPAG\Exercise04b*
- Scratch Workspace: *C:\Student\SPAG\Exercise04b*
- Output Extent: Same as Layer "*hvowner*"
- Cell Size: select As Specified Below and type **30**

☐ Run the Conversion Tools> To Raster> Feature to Raster tool:

☐ Input features: select *hvowner*

☐ Field*: OWN_DESC*

☐ Output raster: type **hrowngrd**

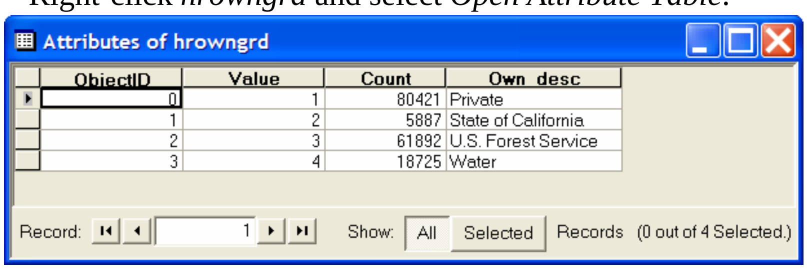
☐ Cell size: type **30**

☐ Turn off *hvowner* and collapse its legend.

☐ Turn on *hrowngrd* and expand its legend.

If you look closely at the new hrowngrd raster in your map, you will notice the generalization of the polygon boundaries. Since the smooth lines are converted to cells, the boundaries between the polygons becomes more jagged. Generalization is unavoidable with raster data but can be reduced by using a smaller cell size

☐ Right-click *hrowngrd* and select *Open Attribute Table*.



ObjectID	Value	Count	Own_desc
0	1	80421	Private
1	2	5887	State of California
2	3	61892	U.S. Forest Service
3	4	18725	Water

Notice how the Own_desc field was used for the conversion. All cells were given the value of the polygon found at the center of that cell. The count field shows you how many cells in the raster each Owner description has.

☐ Close the Attributes of *hvowngrd* table.

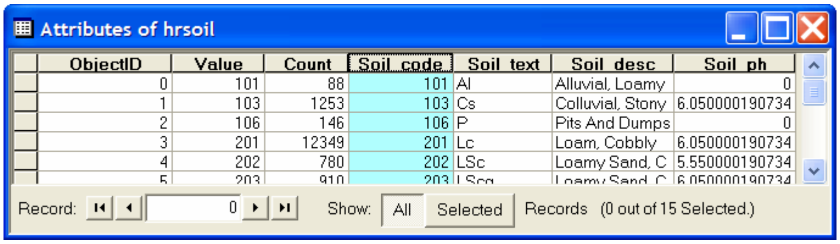
☐ Turn off all layers and collapse their legends.

STEP 2: CONVERT RASTER TO FEATURES

In this step, you will convert raster data to lines and polygons using tools in the ArcToolbox.

☐ Add ...*Exercise04b\hrsoil.lyr* to the map and expand its legend.

☐ Open the attribute table for *hrsoil*.



Attributes of hrsoil

ObjectID	Value	Count	Soil_code	Soil_text	Soil_desc	Soil_ph
0	101	88	101	Al	Alluvial, Loamy	0
1	103	1253	103	Cs	Colluvial, Stony	6.050000190734
2	106	146	106	P	Pits And Dumps	0
3	201	12349	201	Lc	Loam, Cobbly	6.050000190734
4	202	780	202	LSc	Loamy Sand, C	5.550000190734
5	203	910	203	LScg	Loamy Sand, C	6.050000190734

Record: 0 Show: All Selected Records (0 out of 15 Selected.)

This layer represents an integer grid and therefore has an attribute table. It contains several fields describing the soil types found in the raster

☐ Close the Attributes of *hrsoil* table.

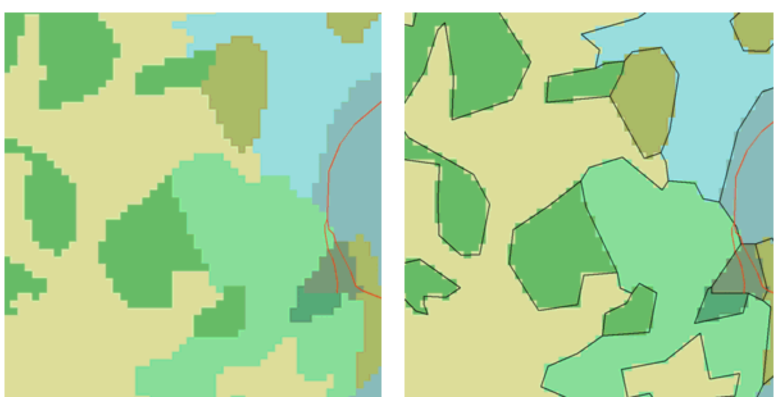
Now you will convert the soils raster data into polygon features. When you convert a raster containing area features, each group of contiguous cells with the same values converts into a polygon. The polygon boundaries are created from cell borders in the raster. Cells that are NoData in the input raster do not become polygons in the output.

☐ Change this Environment Settings:
  ☐ *Output Extent*: select *Same as Layer "hrsoil"*

☐ Run the *Conversion Tools> From Raster> Raster to Polygon* tool.

☐ Input raster: select *hrsoil*
☐ Output polygon features: type **soils**
☐ Simplify polygons: Check the box (accept the default)

☐ Turn on both *hvsoils* and *soils*.
☐ For soils, change the symbol to *Hollow*.
☐ Zoom in on the map.



☐ Compare the boundaries of the *hrsoil* raster to those of the *soils* feature layer.

Notice that the lines do not exactly follow the cell boundaries. The polygon boundaries were generalized to create smooth lines. Next, you will convert the raster lines in the hrstrm layer (streams) into line features.

☐ Zoom to the full extent.

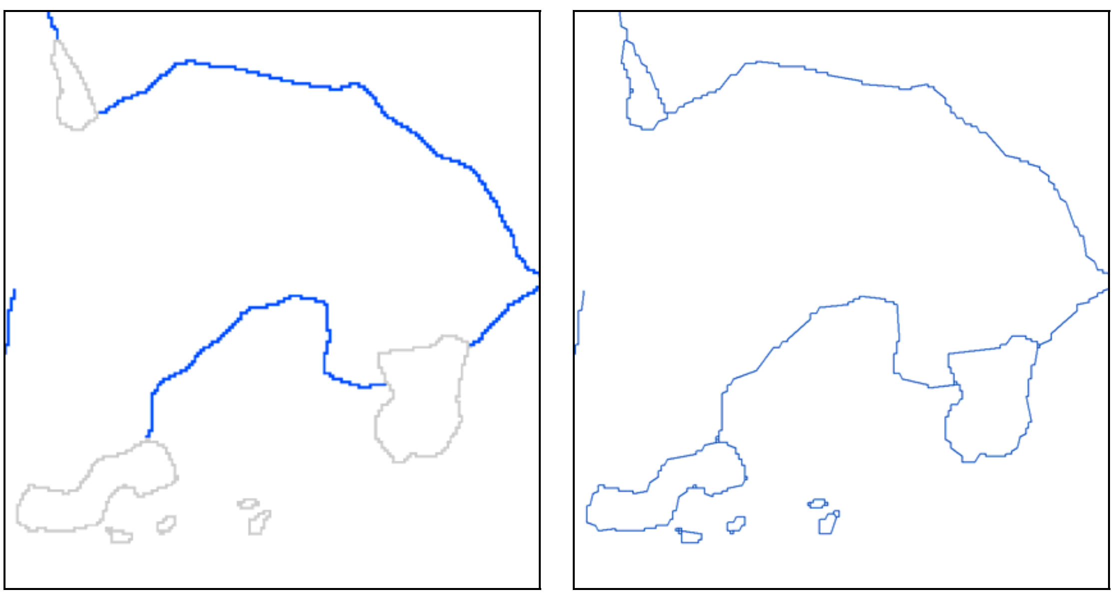
☐ Turn off both the *hrsoil* and soils layers and collapse their legends.

☐ Add ... *\ExerciseO4b\hrstrm.lyr* to the map.

☐ Run the *Conversion Tools> From Raster> Raster to Polyline* tool:

- Input raster: select *hrstrm*
- Field: select *Value*
- Output polyline features: type streams
- Background value: select *NODATA.*
- Minimum dangle length: type **0** (accept the default)
- Simplify polylines: check the box (accept the default)

☐ Turn on both *hrstrm and streams*.



☐ Zoom in on the map.

☐ Compare the input raster streams and the output vector streams in the map. If time permits, run the conversion again without Simplify Polyline to see the difference.

☐ Zoom to the full extent of the map.

□ Turn off all layers and collapse their legends.

STEP 3: CONVERT RASTER TO RASTER

In this step, you will convert a raster in ESRI GRID format to a raster in TIFF format. The new TIFF file will be an 8-Bit unsigned integer with no compression, and it will have the same cell size as the grid from which it was derived.

The TIFF format has widespread use in the desktop publishing world. It serves as an interface to several scanners and graphic arts packages. TIFF supports black-and- white, gray scale, pseudo-color, and true-color images, all of which can be stored in compressed or uncompressed formats.

□ Add ... *\Database\Tahoe\Emer\erdoqgrd* to the map.

□ Right-click *erdoqgrd* and select *Zoom to Layer*.

□ Change this Environment Settings:
- Output Extent: Same as Layer "*erdoqgrd*"

□ Run the *Conversion Tools> To Raster> Raster To Other Format* (Multiple) tool:

□ Input rasters: browse to ... *\Database\Thhoe\Emer\erdoqgrd*

□ Output workspace: browse to ... *Exercise04b*

□ Raster format: select *TIFF*

NOTE: The "Raster To Other Format (Multiple)" tool will convert one or more ArcGIS supported raster dataset formats to a GRID, IMAGINE, TIFF, or geodatabase raster dataset format.

Notice that this tool does not give you the option of naming the output raster; a new raster named erdoqgrd.tiff has been created in your exercise04b folder. Also, it did not add the new TIFF file as a layer to the ArcMap Table of Contents.

You will use erdoqgrd.tif in other steps in this exercise. Now close ArcMap and preview the new TIFF file in ArcCatalog.

□ Exit ArcMap without saving your changes.

□ *Start ArcCatalog*.

□ Navigate to your ... *\Exercise04b* folder.

□ Preview *erdoqgrd.tiff*, build pyramids if you are prompted to do so.

STEP 4: COMPRESS RASTER DATA

Compression reduces the amount of disk space needed to store a raster and often makes drawing faster; however, it slows analysis (e.g., using compressed images in a Map Algebra expression) because the compressed data must be uncompressed before the analysis takes place. The processing time is related to the compression ratio (i.e., the more highly compressed the raster, the longer it takes to decompress).

The MrSID encoder in ArcGIS creates highly compressed rasters in SID format for rasters smaller than 50MB. An additional MrSID license gives you the ability to compress and mosaic multiple images up to 500 MB in total (input) size. You will now compress your DOQ image (currently in TIFF format) into MrSID format.

□ In *ArcCatalog*, right-click *erdoqgrd.tiff* and select *Export> Raster to MrSID.*

You will use the default compression ratio of 10, which will reduce your image to about one-tenth of its original size.

□ For *Output raster*, browse to ... *Exercise04b* and type **erdoqsid**

□ Click *OK*

Your image is compressed and stored in MrSID format. Now you will compare the size of the new MrSID image and the original TIFF image. You must first set an ArcCatalog option so that the Contents tab displays file sizes.

□ On the *Main Menu*, click *Tools> Options* and click the *Contents* tab.

□ For *Which standard columns do you want to show...?*, check **Size**.

□ Click *OK* to close the Options dialog.

□ In the tree view, select ... *Exercise04b*.

□ Click the *Contents tab* and ensure that the *Size* column is visible.

Question 7: What is the size of erdoqgrd.tif?__________________________

Question 8: What is the size of erdoqsid.sid?__________________________

☐ Exit *ArcCatalog.*

STEP 5: GEOREFERENCING A RASTER

In this step, you will register a Digital Orthographic Quadrangle (DOQ) TIFF image to the Emerald Bay quadrangle from the Lake Tahoe study area. The DOQ has a slight shift and must be adjusted so it will fit the other data layers.

Raster data is commonly obtained by scanning maps or collecting aerial photographs and satellite images. Scanned map datasets do not 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 often inadequate, and the data does not align properly with other data you may have. Thus, in order to use some raster datasets in conjunction with your other spatial data, you often need to align it, or georeference it to a map coordinate system.

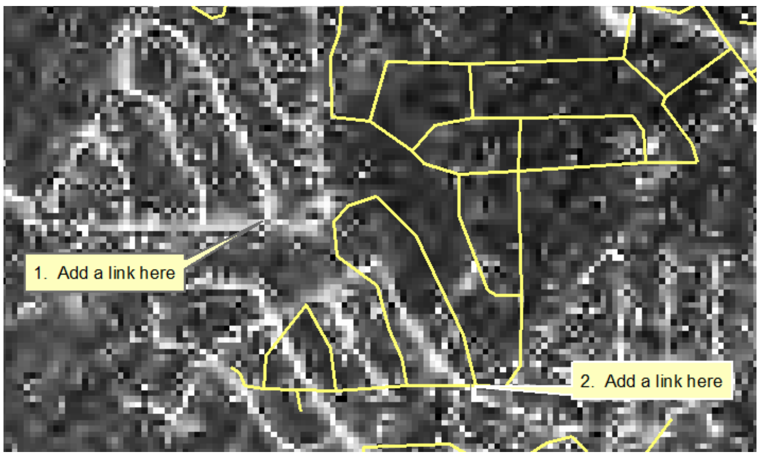
☐ Start ArcMap and open ... *\Exercise04b\Georeferencing.mxd*.

☐ On the *ArcMap Main Menu*, click *View* > *Bookmarks*> *Roads1*.

You will add a link between a street intersection that is visible in the raster and the same intersection in the roads feature layer. First click the raster and then the roads.

☐ On the *Georeferencing toolbar*, click the *Add Control Points* tool

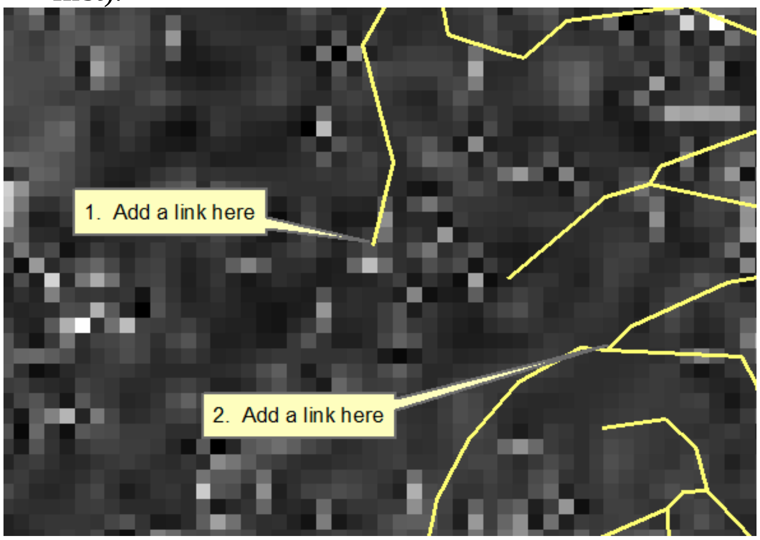
☐ Add a link between the raster and road intersections shown below:



Because this raster is already nearly aligned, it will be easier for you to add several links before you adjust the graphics to one another. If the raster was any closer to the reference data, it would be difficult to find control points on the raster because the vector data would obscure those locations on the raster. Now add the next link.

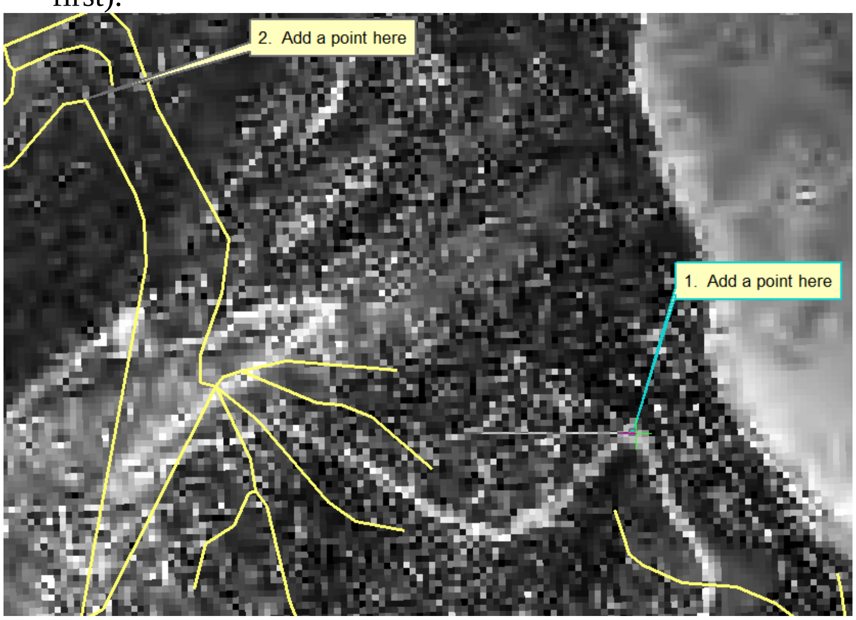
☐ On the *ArcMap Main Menu*, click *View> Bookmarks > Roads2*.

☐ Add the second link using the graphic below as a guide (click on the raster first).



☐ On the *ArcMap Main Menu*, click *View> Bookmarks> Roads3*.

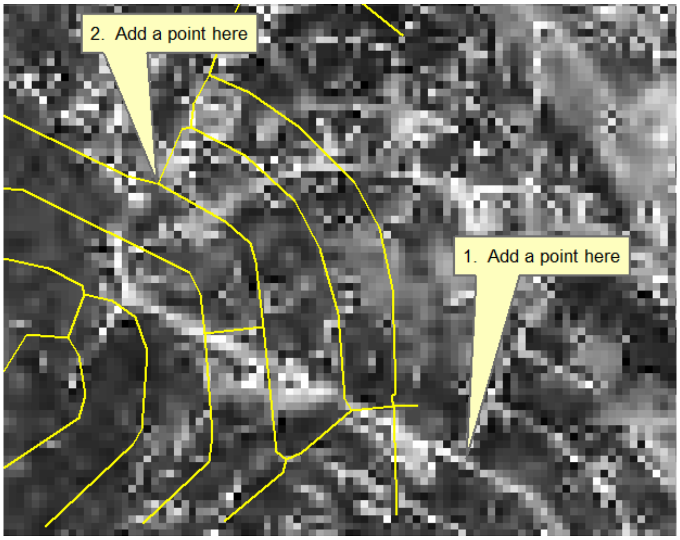
☐ Add the third link using the graphic below as a guide (click on the raster first).



☐ Add the fourth link using the graphic below as a guide (click on the raster first).

☐ On the *ArcMap Main Menu*, click *View > Bookmarks> Roads4.*

☐ Add the fifth link using the graphic below as a guide (click on the raster first).



□ On the *ArcMap Main Menu*, click *View> Bookmarks> Roads5*.

Now add three more links on your own, panning and zooming as needed.

□ **Add three more links. Remember to click the raster first and then the roads.**

Now it is time to adjust the raster and feature graphics to one another. Notice how the map changes as the raster is transformed to fit the features (actually, the links).

□ On the *Georeferencing toolbar*, click *Georeferencing> Update Display*.

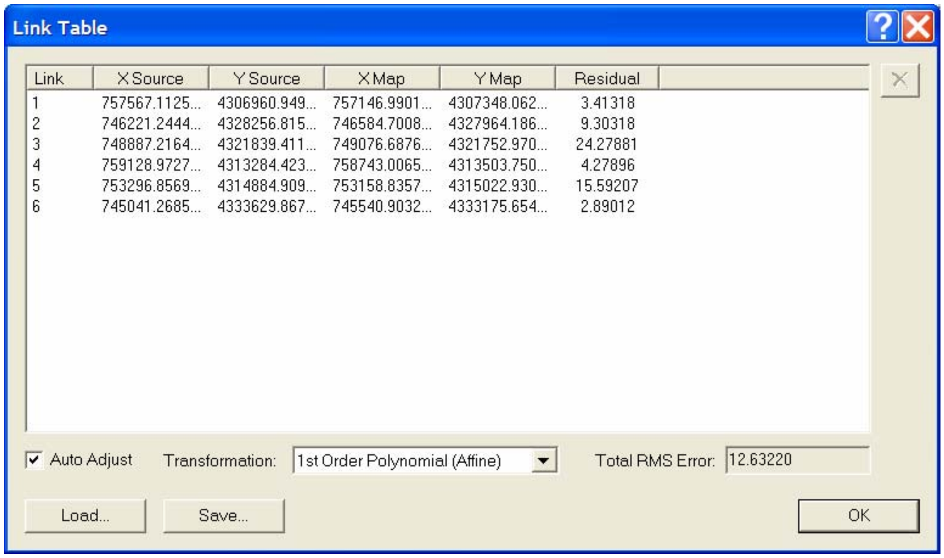
You should now have at least eight links. Next you will examine your links for errors and delete those that are too bad to use in the transformation. If you delete too many, you may need to add more links afterward.

STEP 7: ASSESS THE ERROR

The link table displays the errors for each link and for the average error of all the links. You can use the link table to select and delete links.

□ On the *Georeferencing toolbar*, click the *View Link Table* button

□ On the *Link Table* dialog, check *Auto Adjust*. (The Residual column will fill in if it is empty).



The error for a link is computed by comparing its predicted from-and-to coordinates (calculated with the transformations scale and shift values) with the actual coordinates that you entered. The distance between the two sets of coordinates is the residual error. High residual errors generally indicate that the links from or to point is in the wrong place and that the link should be deleted. The average error for the whole raster is expressed as the Total RMS Error (Root Mean Square). The residual and RMS errors are reported in map projection units.

- □ Review the errors in the *Link Table*.

You will delete the links with the highest residual errors to try to lower your total RMS error. The RMS error is often quite large; the features may not be very distinct, or you could have chosen the wrong points for your links.

- □ Click the row with the highest residual error to select it.

- □ Press the *Delete* button on your keyboard.

The residual error for each link and the RMS error are immediately recalculated, and the graphic moves as the transformation is updated with the remaining links.

Question 9: Did your RMS error get smaller when you deleted the link?___________

- □ Click and delete the link that now has the highest error.

You continue to add and delete links until you have enough links to support the transformation and the RMS error is acceptable. You must have at least four links (more is better), and they should be distributed across the raster, not all clustered together. The links are easier to see if you turn off the raster layer occasionally. An acceptable RMS error is generally a small multiple of the raster's cell size. Your DOQ raster has ten meter cells, so you should try for an RMS of 50 meters or less.

☐ Delete and add links until the RMS error is 50 meters or less and you have at least four links.

NOTE: You may leave the Link Table open while you add links. The new links will be added to the table and the errors will be recalculated.

☐ Click *OK* to close the *Link Table* when you are finished.

STEP 8: SAVE THE TRANSFORMATION

The next task in the georeferencing process is to save the transformation. Do this either by saving the transformation coefficients (scale and shift values) to the raster or by transforming the raster data into the new coordinate space by rectifying it.

ArcMap can read the transformation coefficients for a raster and display it properly with other layers, even if the actual data in the raster is not in the same coordinate space as the other layers.

If the raster will be used frequently in ArcMap graphics or for analysis in ArcGIS Spatial Analyst, it is probably better to transform the raster. Also, not all graphics software recognizes the transformation coefficients. To complete the georeferencing, you will rectify the raster to create a new dataset in the desired coordinate space.

☐ From the *Georeferencing* menu, select *Rectify* to open the *Save As* dialog.
☐ For Cell Size, type **10**
☐ For Resample Type, select *Nearest Neighbor*.
☐ For Output Raster, browse to ... *Exercise04b* and type **Rectifyerdoqgrid.tif**
☐ Click Save. (Rectifying a raster can be slow, so be patient.)

☐ Save the map.

☐ Create a new map and add the following layers from your . . *Exercise04b* folder.
- avroad.lyr
- Rectifyerdoqgrid.tif

☐ Right-click on the *Rectifyerdoqgrid.tif* layer and click *Zoom to Raster Resolution.*

In most cases, the roads visible in the rectified raster are closely aligned with the road features, but the alignment is not perfect. The differences can be attributed to errors in the raster (some parts of the image may be “stretched” more than others) and errors in the roads layer (some roads may not have been digitized well).

This concludes the exercise. You have learned how to convert vector features to raster, raster features to vector, raster to other raster formats, and how to georeference a raster.

- □ Exit ArcMap without saving your map.

<u>EXERCISE END</u>

ANSWERS TO EXERCISE 2 QUESTIONS

Question 7: What is the size of erdoqgrd.tif?
Answer: 6.82 MB

Question 8: What is the size of erdoqsid.sid?
Answer: 616.13 KB

Question 9: Did your RMS error get smaller when you deleted (he link?
Answer: It probably got smaller, but it depends on the links you have created and their errors.