## Projecting GIS data into the coordinate system of your choice

ArcGIS does project data on the fly. If you are just using data for visualization purposes like map making you do not necessarily need to re-project the data. If you are using your data in geo-processing scenarios or to digitize, you should make sure that your vector based data is in the same projection.

Re-projecting raster data is very processor intensive and might take considerable time.

1. **Click the Search window button in the standard toolbar.**
2. **In the search window click tools**
3. **Enter projection in the search field.**
4. **Click projections and transformations.**
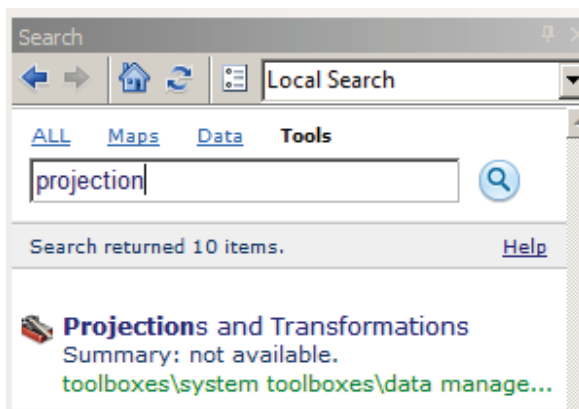
5. **Click Feature.**
6. **Click Project (data management).**
7. **Set the following parameters for the Project window:**
   - **Input dataset:**
     C:\reu_2011\GIS_data\usa\Native_american_land_states.shp
   - **Output dataset:**
     C:\reu_2011\student\project.gdb\reservations_projected
8. **For the output coordinate system click the projection button**
9. **In the spatial reference window click select.**
10. **Choose projected coordinate system / state plane / NAD 1983 (US Feet)**
11. **Select a state plane zone for your area of interest.**
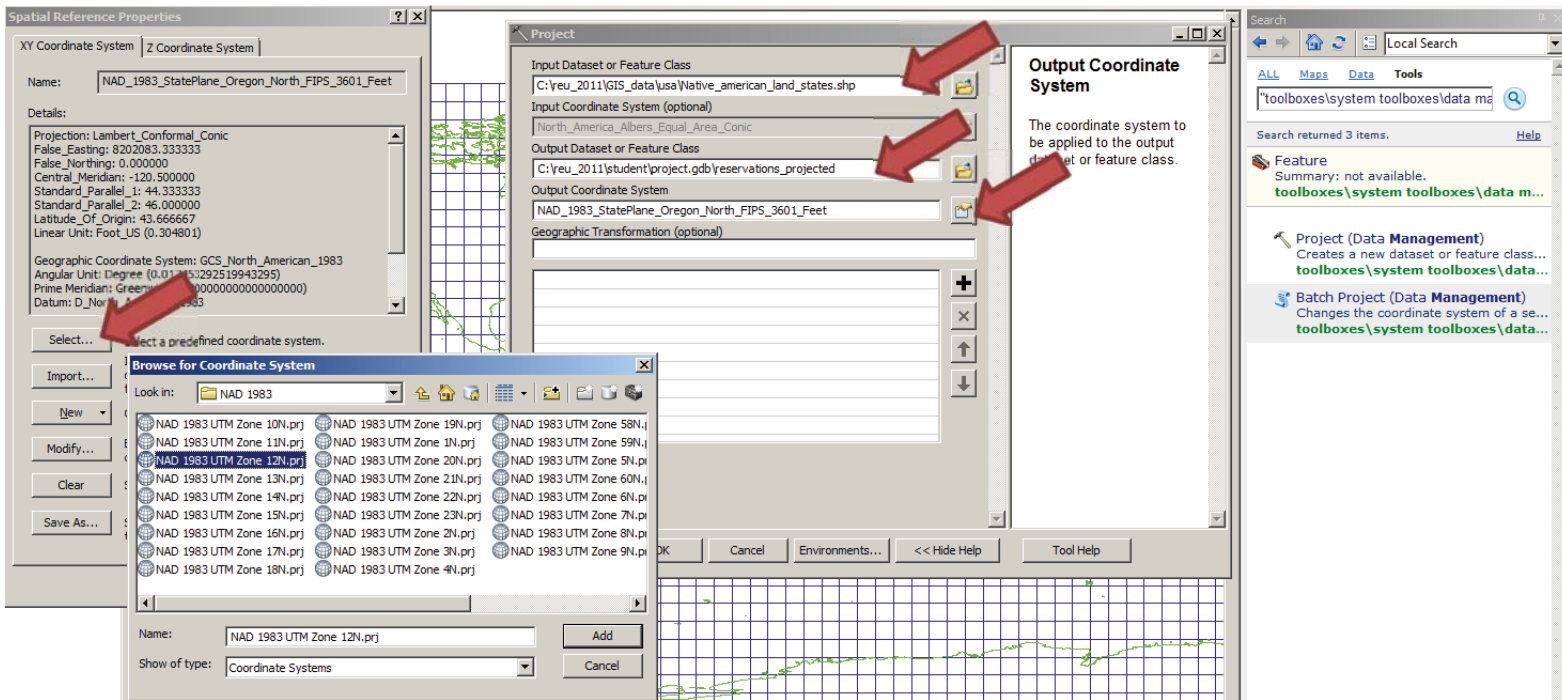
12. Click Add.

13. Click OK to close the Spatial Reference Properties window.

14. Click OK to run the projection tool

15. When the re-projection process is done use your knowledge from the earlier exercise to switch the data frame projection to that of the new feature class.

In some cases the projection process will involve a datum (geographic) transformation. This will be indicated in the Project window with a green dot in front of the Geographic Transformation field. The tool will give you a list of appropriate options for the datum conversion.

The two most often used transformations in the USA are:

NAD_1983_To_WGS_1984_5

And

NAD_1927_To_NAD_1983_NADCON

3.4   Converting xy data from excel tables to a feature class

Your project might require you to import GPS point data into your Geo-database and your maps.
We strongly recommend that you save the GPS coordinates as waypoints (or features) on your
GPS units and import them with programs like DNR-Garmin (if you work with Garmin units),
Pathfinder office (for Trimble units), or ArcPad. The process is covered by chapter 3 of this
document.

In some cases where it is not avoidable you might have to process GPS coordinates which are
given to you in a spread-sheet (or table).

You will now import an (Microsoft excel) spreadsheet into ArcMap and display their x/y
coordinate columns in the map as points.

1. **Open C:\reu_2011\GIS_data\tutorial\kansas\KS_features.xlsx in Microsoft
   Excel.**

The table contains data for all Named geographic features in Kansas. Part of the data is the
location of the feature. The Location information in this table is given in two forms. The fields
Primary_lat_DMS and Prim_long_DMS show the locations in a degrees-minutes-seconds
format, while the fields Prim_lat_dec and Prim_long_DEC show the same data in decimal
degrees. ArcMap can't process degrees-minutes-seconds data, so the decimal degrees data is here
the only choice. If you are getting data from the field in a table like this make sure you know in
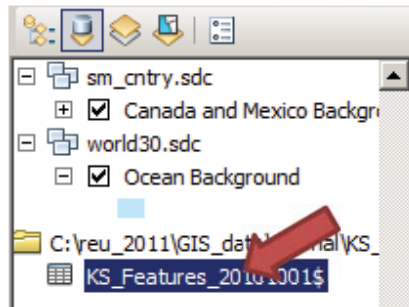what coordinate system it was recorded.

2. **Close Microsoft Excel**
3. **Open the map document C:\reu_2011\GIS_data\Introduction to ArcMap.mxd**
4. **Click add data .**
5. **Navigate to C:\reu_2011\GIS_data\tutorial\kansas\KS_Features.xlsx and
   add the table.**

When you add a standalone table to ArcMap the TOC will switch to the list by source view,
since standalone tables do not show in the ―list by drawing Order" view.

6. **Right click the KS_Features table in the TOC.**

7. **Click display XY Data.**

8. **In the Display XY Data window choose PRIM_LONG_DEC for the x field.**

9. **Choose PRIM_LAT_DEC for the Y field.**

10. **Click Edit for the Coordinate System.**

11. **In the XY Coordinate System window click select**

12. **Navigate to and choose Geographic Coordinate Systems\World\WGS 1984.prj**

13. **Click Add to close the Browse for Coordinate System window.**

14. **Click OK to close the Spatial Reference window.**

15. **Click OK to close the XY Data window and run the process.**
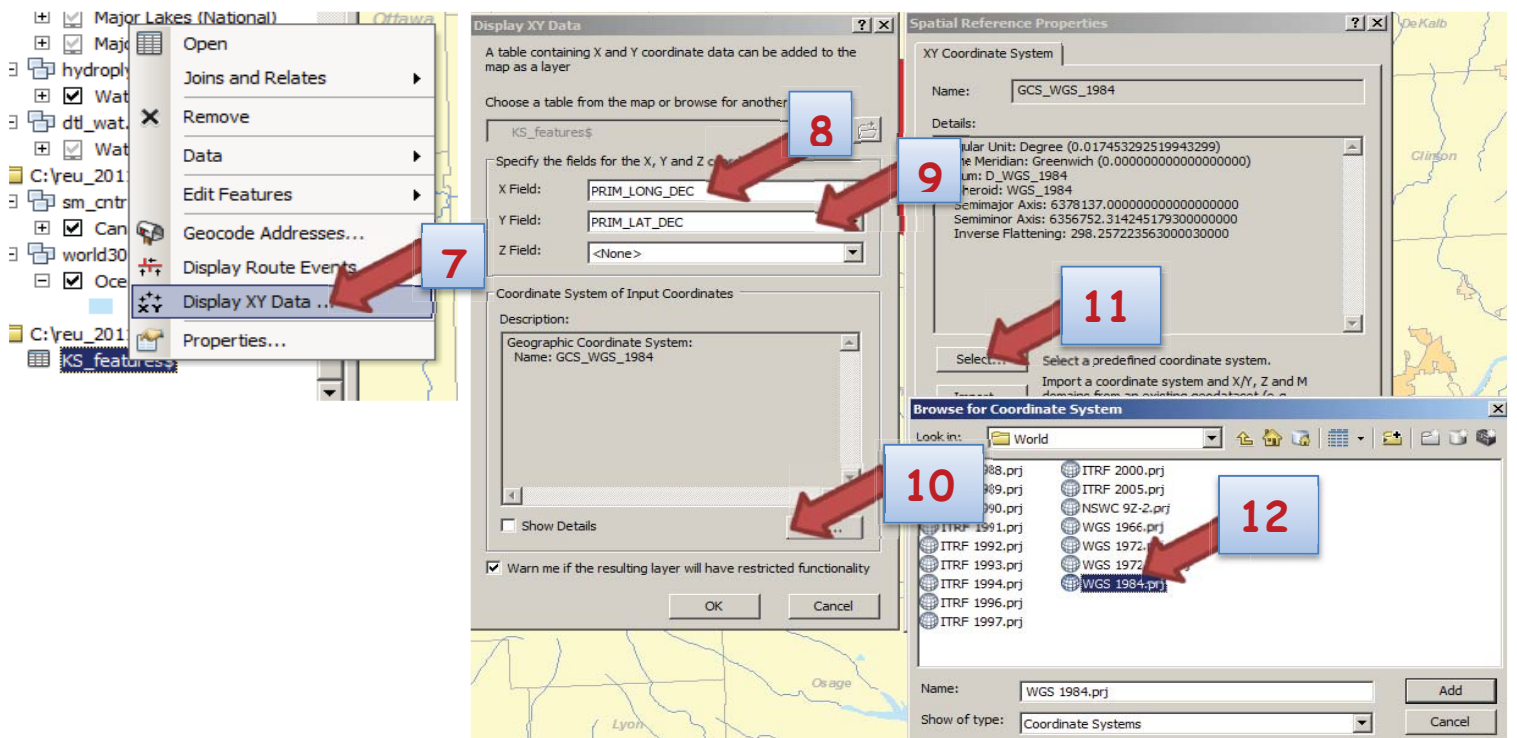
16. A message will show that the table does not have Object-ID field → Click OK.

After processing the map should now show the locations from the table as points.
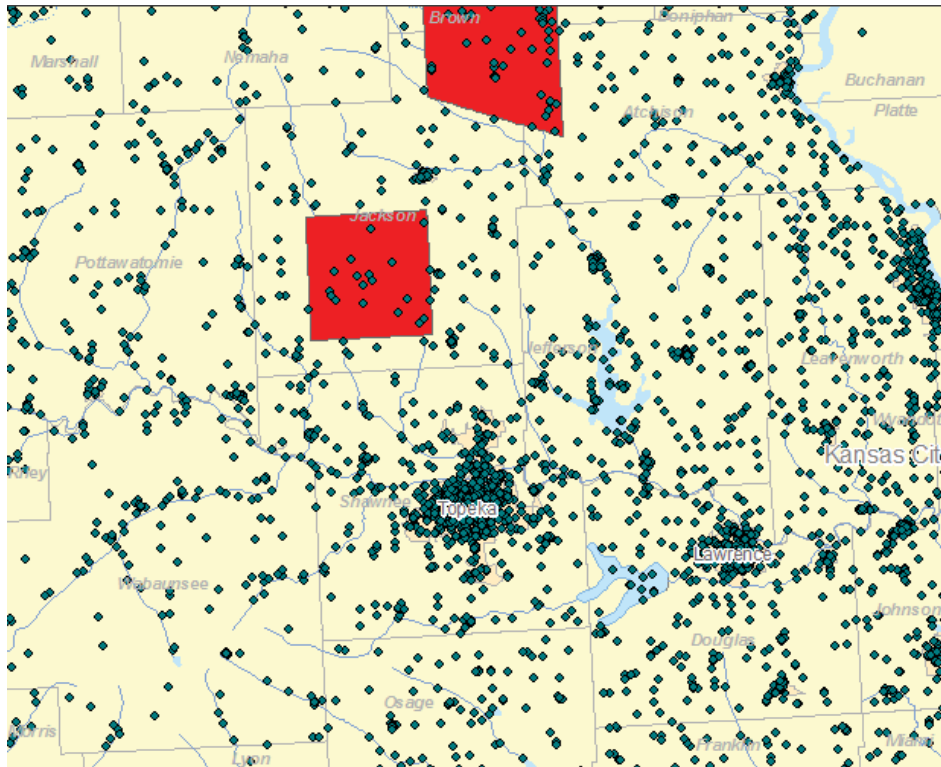
So far the new layer exists just as an event layer in the map document. In the next steps you will make this layer permanent by converting it to a feature class in your geo-database.

17. Right click the KS_features event layer in the TOC.

18. From the drop down list click DATA → Export Data.

19. For the output feature class navigate to the test.gdb you created earlier in the exercise.

20. Name the feature class Kansas_geo_features.
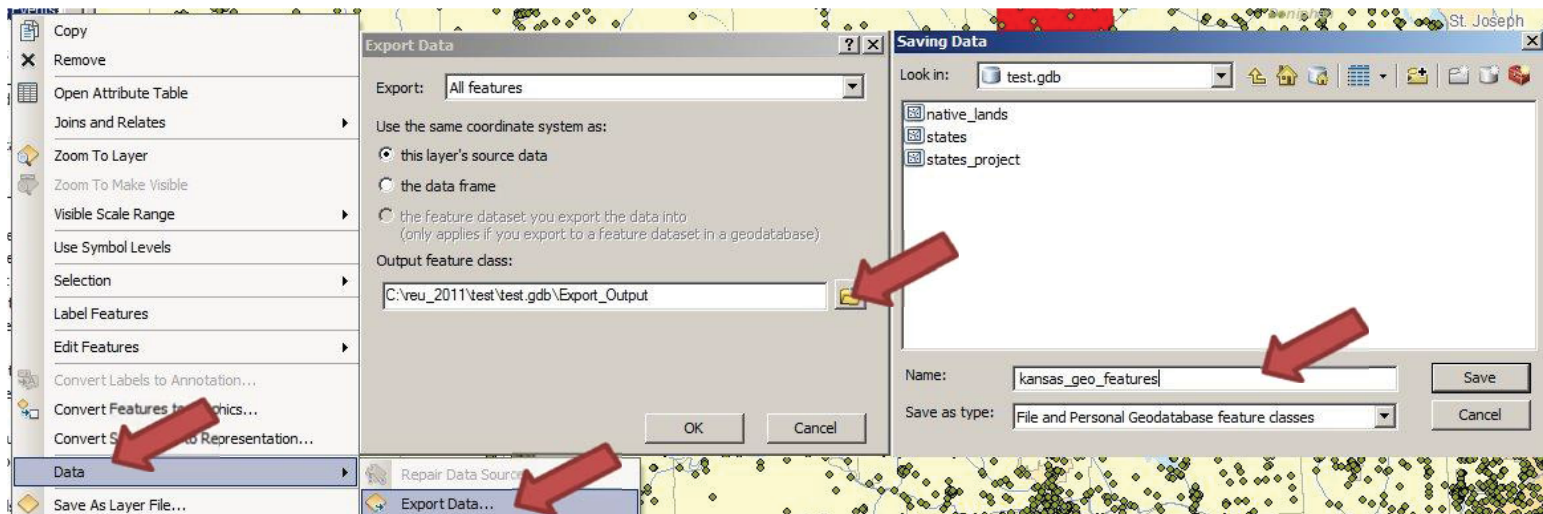
21. Click Save.

22. Click OK.

23. When asked if you want to add the exported data as a map layer click yes.

The TOC in the list by source view should now show the Kansas_geo_features.

24. **Close the map document.**

4. Editing data

In some cases you might want to make an old map fit some of the GIS data you are working with (geo-referencing) or you might want to create (digitize) a point, line or polygon layer from features you see on an old map or aerial photo. The following exercise will introduce you to both activities.

4.1 Georeference Raster data

Geo-referencing old maps or aerial-photos to existing data is common in many GIS processes.

1. **Open the C:\reu_2011\map_documents\Landcover_change.mxd**

2. **Add C:\reu_2011\GIS_data\tutorial\kansas_data\aerial_imagery\dg1966.jpg**

3. **When asked if you would like to build pyramids click Yes.**

From ArcGIS help:

Pyramids are used to improve performance. They are a down-sampled version of the original raster dataset and can contain many down-sampled layers. Each successive layer of the pyramid

is down-sampled at a scale of 2:1. Below is an example of two levels of pyramids created for a raster dataset:
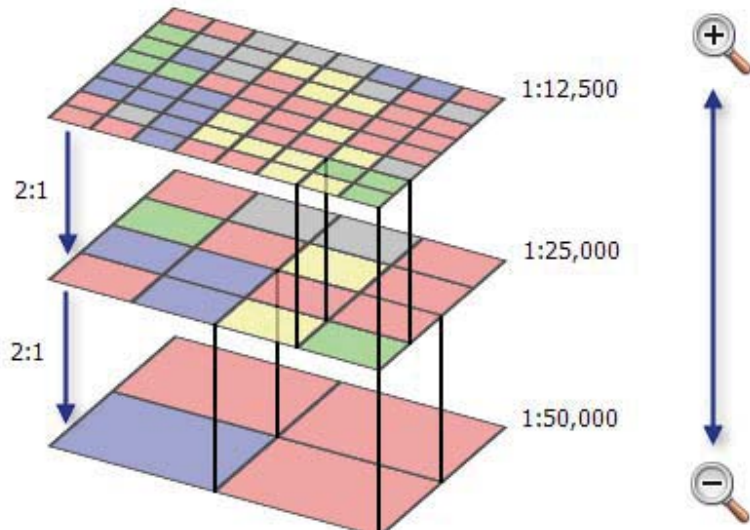
4. **Add C:\reu_2011\GIS_data\tutorial\kansas_data\aerial_imagery\ortho_2008.jp2**

5. **Zoom to the bookmark Lawrence.**

6. **Click Customize from the menu bar.**

7. **Click toolbars and switch on the geo-referencing toolbar.**
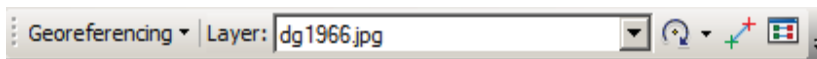

8. **Make sure the dg1966.jpg is on top of the 2008 ortho-photo in the TOC.**

9. **In the geo-referencing toolbar make sure the layer is set to the 1966 image.**

10. **Switch of the USA Base map.**

11. **Move your mouse over the Lawrence area in the map and observe the coordinates for the area in the lower right corner of your screen**

311451.717 4312015.746 Meters

12. **Zoom to the extent of the dg1966 image.**

13. **Move your mouse to the upper left corner of the image and observe the coordinates for the area in the lower right hand corner of your screen.**

14.3 15.805 Meters

65

The 1966 image does not have any coordinates assigned to it (it is not geo-referenced yet) . By default the upper left corner of any unreferenced image loaded into ArcMap is set to 0,0. The following process will create a world file for the image which will reference the upper left corner to coordinate somewhere around Lawrence Kansas.
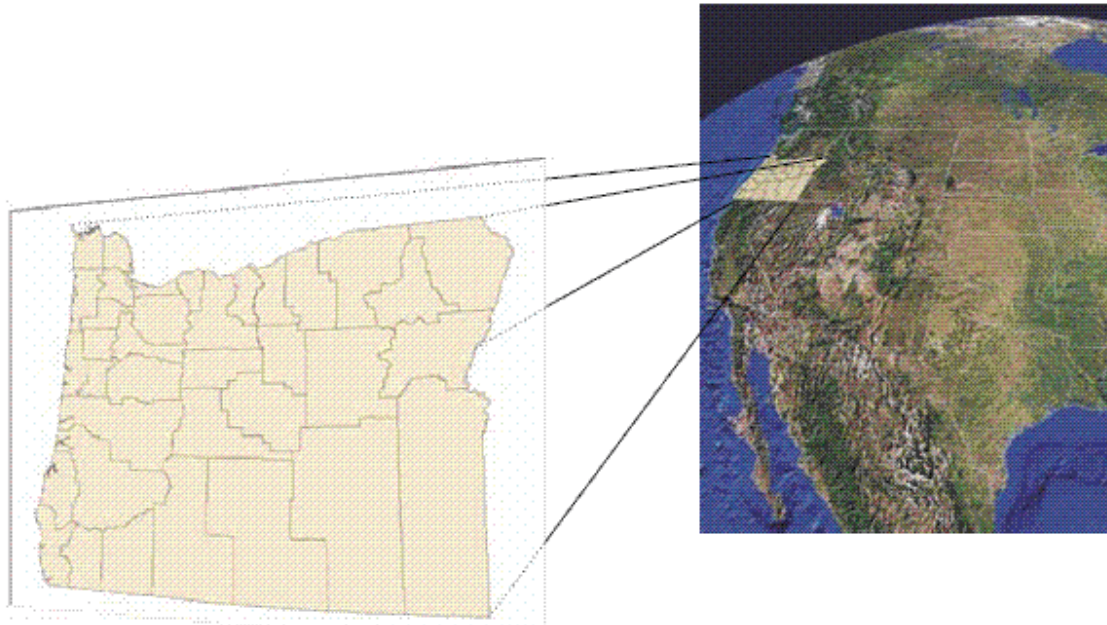
(From ARCGIS 10 Help)

14.Click Georeferencing.

15.Click fit to display

The 1966 image should now be roughly moved over the 2008 image and into the coordinate space.

16. Zoom in to Interstate 70 which is shown in the northern part of both images.

17.Search for a feature you can identify on both images (switching on and off the 1966 image).

18.With the 1966 image visible click the add control points tool from the geo-referencing toolbar.

19.Click the feature (you identified to be visible in both images) on the 1966 image first.

20. Switch of the 1966 image.

21. Click (and set the second of the control point pair) on the 2008 image.

This image shows a set of control points set at the intersection I70 and Hwy 59 on the east side of the Kansas River (use the USA Base map if you want to find the same intersection). The 1966 will adjust a little better to the map with each control point you set.

22. Repeat steps 21-25 for at least 4 more points which should be evenly spread on the 1966 image.

If you set all control points in one line (along I 70 for example) you will get the following message.
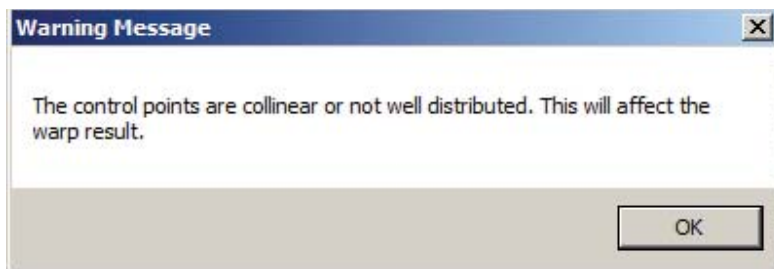
Once you click ok you might see an unwanted warp in the 1966 image.

Regardless if you get this message or you distributed your control points well throughout the image and do not get the above message, the following steps let you adjust your already set control points.

**23. Click the view link table button [icon] in the Geo-referencing toolbar.**

24. If the last of the control points you set was creating the above error message, Highlight the last entry in the control points table and hit the delete button [icon].

Link Table   ?|X|

Link	X Source	Y Source	X Map	Y Map	Residual
1	6247.150067	-1762.077012	306583.901242	4318362.794166	5.75150
2	5205.828852	-1907.716343	304505.724985	4318070.550630	10.38607
3	5038.635223	-2849.781740	304152.661227	4316195.677000	9.24988
4	4845.960951	-2907.436529	303780.707445	4316082.391585	7.22557
5	3861.857923	-2082.431077	301798.426462	4317722.948989	10.45527
6	4997.378528	-4524.623117	304091.962370	4312843.813453	15.34633
7	8611.043593	-5429.976061	311299.660349	4311031.496047	5.17535
8	8599.568818	-5828.867949	311276.750726	4310235.386657	4.48463
9	1038.075380	-1222.446231	296155.964921	4319448.512300	4.57708
10	8292.471443	-585.487038	310676.918607	4320724.040354	5.26895
11	7471.959641	-1366.535914	309027.295692	4319158.197891	3.83435

☑ Auto Adjust   Transformation: 1st Order Polynomial (Affine) ▼

Total RMS Error: 8.16785

Load...   Save...   Restore From Dataset   OK

The Table shows the X/Y source coordinates and the x/y map coordinates for each point. The residual is the amount by which each source point is adjusted to reach the Map point. Low Residuals show that the adjustment is going well. High Residuals show possible problems. By deleting control points with higher residuals the total RMS error might be adjusted.

The transformation can be set to an affine, second order polynomial or third order polynomial.

Original data

Affine   Second order polynomial   Third order polynomial
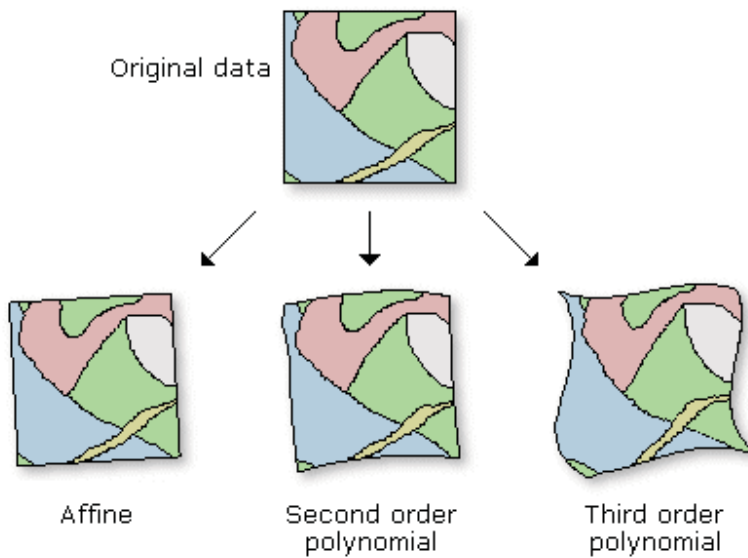
The higher order the transformation the more well distributed control points have to be set.

25. Set at least 10 control points.

26. Once you are satisfied with the results click Georeferencing.

27. Click update Georeferencing.

A dg1966.jgw world file is now written to the folder where the image resides. This world file will reference the image to the coordinate system.

28. Leave the map document open

4.2 Digitizing

You will now digitize the land-cover in 1966 and 2008 around Lawrence.

The land cover will be digitized as polygon feature classes. For training purposes you will also create a point and polyline feature class for features on the Haskell campus.
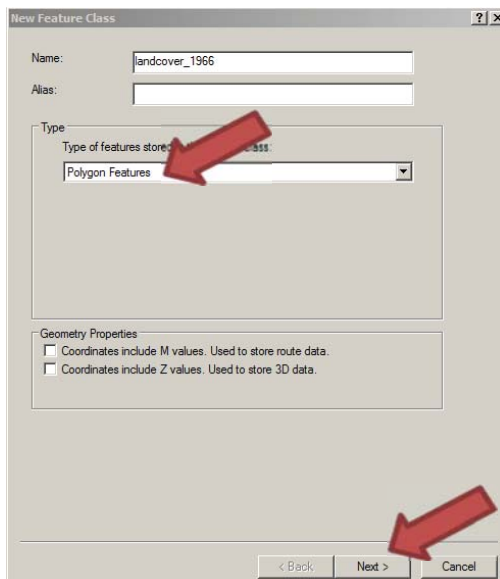
Create feature classes

First you will create the feature classes needed for the exercise.

1. In the ArcCatalog window of the map navigate to the project.gdb under c:reu_2011\student folder.
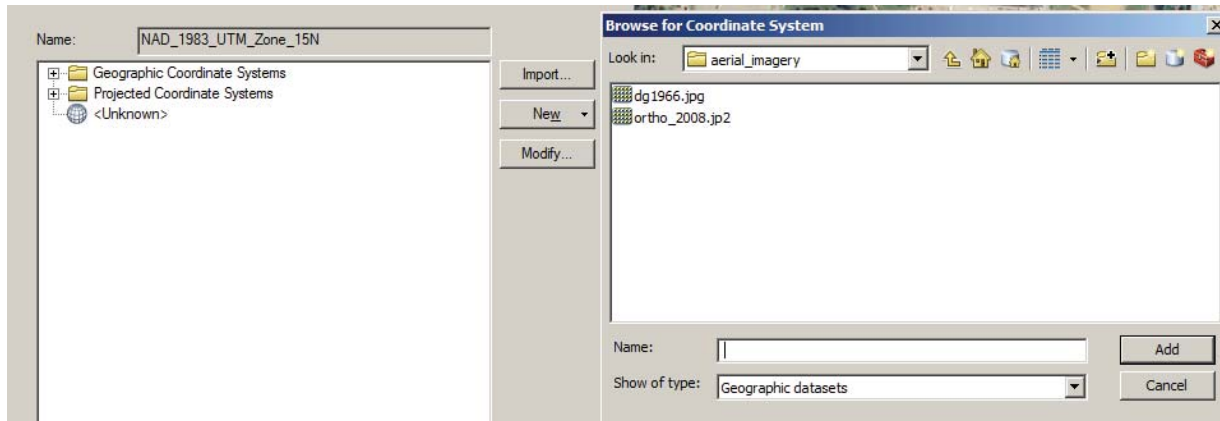
2. Click new → feature class
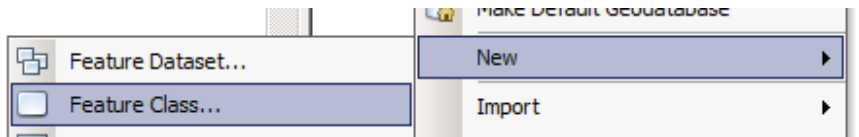
3. In the new feature class window type landcover_1966 for the name.

4. Make sure the feature type is set to polygon features.

5. Click the next button.

6. **In the choose coordinate system window click import.**

7. **Navigate to**

   C:\reu_2011\GIS_data\tutorial\kansas_data\aerial_imagery\ortho_2008.jp2

8. **Click Add**

The coordinate system should now be set to NAD_1983_UTM_Zone_15N.

9. **Click next.**

10. **Leave default value in the XY tolerance field**

11. **Click next**

12. **Leave the default settings in the configuration keyword field.**

13. **Click next.**

14. **In the "Defining fields" window enter landcover under the field name column as a new entry.**

15. **For the data type, choose text.**

16. **Click finish.**

17. **Repeat steps 2-16 to create a landcover_2008 polygon feature class, trees point feature class (name the text field comment) and a transport line feature class (name the text field type).**

All four feature classes should be automatically added to the TOC.

Digitize tree locations on Haskell campus

1. **Zoom to the map bookmark Haskell.**

2. **Make sure the 2008 image is visible.**

3. **Use the auto-hide option for the ArcCatalog window** .

4. **Open the editor toolbar (customize → toolbars).**

5. **Click editor → start editing.**

6. **In the start editing window you can either highlight one of the four feature classes that were added or you can highlight the c:\reu_2011\student\project.gdb**
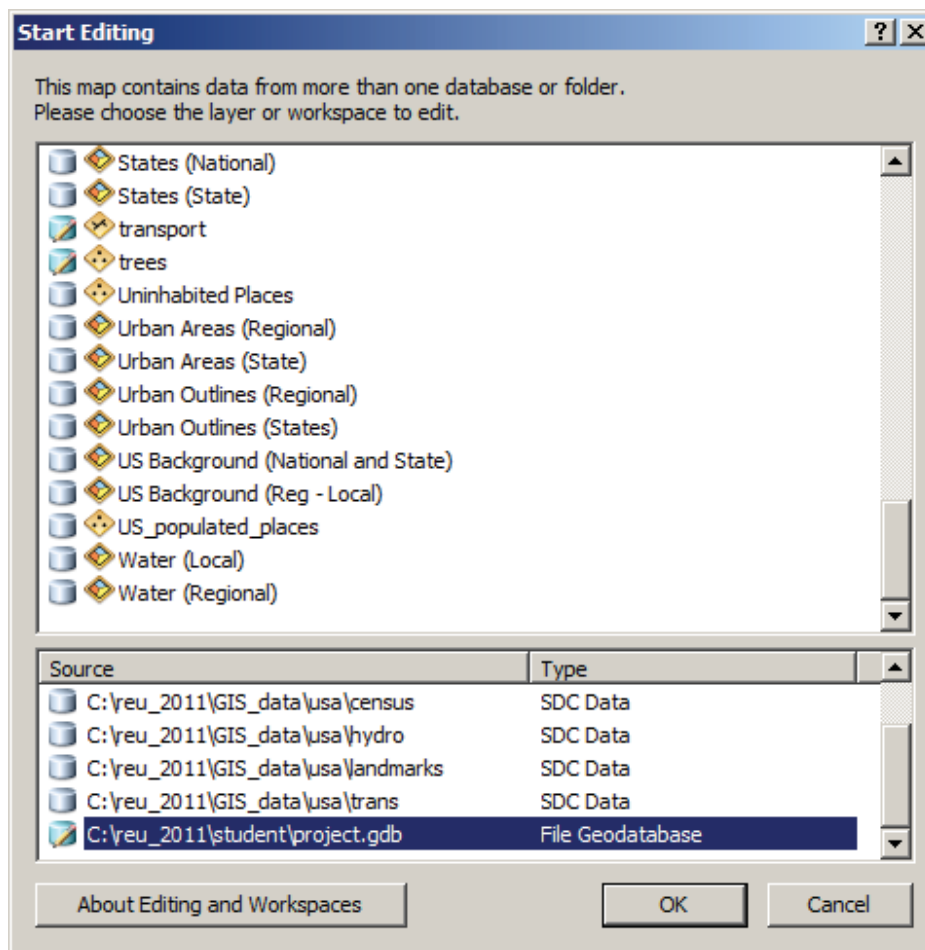
The editable feature classes will be marked as .

7. **Click ok.**

8. **The create features window should now show the templates for all four feature classes from the project.gdb workspace.**
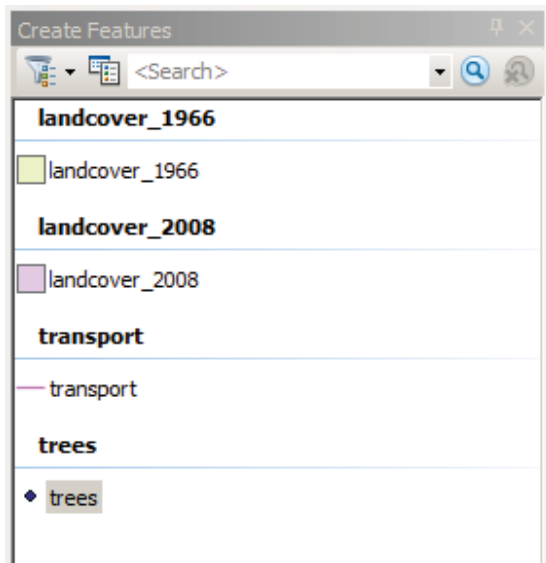
You will digitize points for the trees on the Haskell campus

9. **Highlight the trees template in the create features window.**

10. **You can now use your mouse pointer to set a point on-top of trees you can identify on the 2008 image.**

11. **To make the points you digitized more visible use the symbol selector and choose a tree symbol**
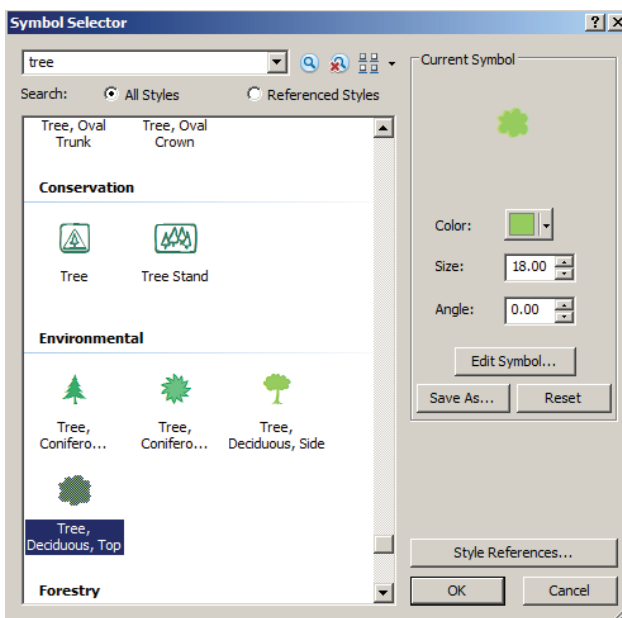
12. **To move or delete a tree-point, use the edit tool [▶] from the editor toolbar.**

13. **Once you have digitized most trees on campus click editor → save edits.**

Digitize roads and pathways on the Haskell campus.

In this exercise you will digitize roads and pathways on the Haskell campus.

1. **Select the transportation layer from the create features window.**
2. **Start digitizing the roads and pathways from the north side of the campus.**
3. **Set one point at the beginning of the road.**
4. **Only set further points when the direction of the road changes.**
5. **Finish each road feature when you come to an intersection.**
6. **When starting a new feature use the automatic snapping to snap the new starting point to an existing endpoint.**

7. **When digitizing a curve use the endpoint arc tool from the feature construction toolbar to set the first and last point of the curve and adjust the curve arc.**
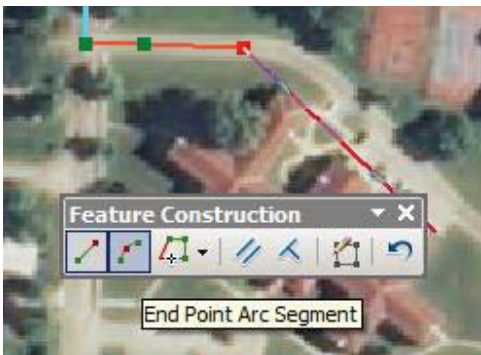
8. **After digitizing a segment click the attributes button.**
9. **In the attributes window type road or pathway for each of the digitized segments.**
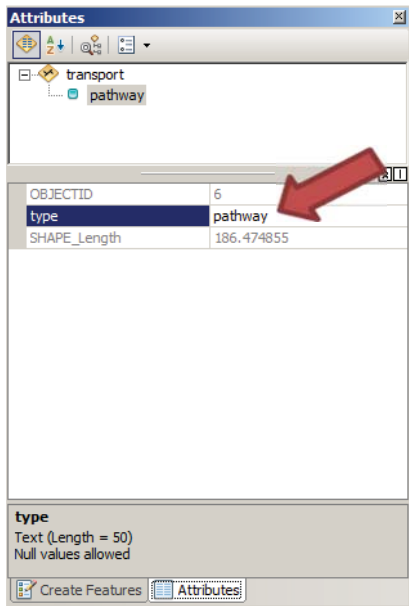
10. To adjust lines use the edit tool ▸ and the edit vertices tool ◸.

11. After you have digitized a couple of roads and pathways change the symbology for the transport layer to.

― <all other values>
   type
―― pathway
―― road

12. Right click the transport layer in the create new features window and click delete.

13. Click the organize templates button 🗔 in the create features window.

14. Highlight transport from the layers list in the Organize Feature Templates window.

15. Click new template

16. Make sure you have transport selected in the create new template wizard window.
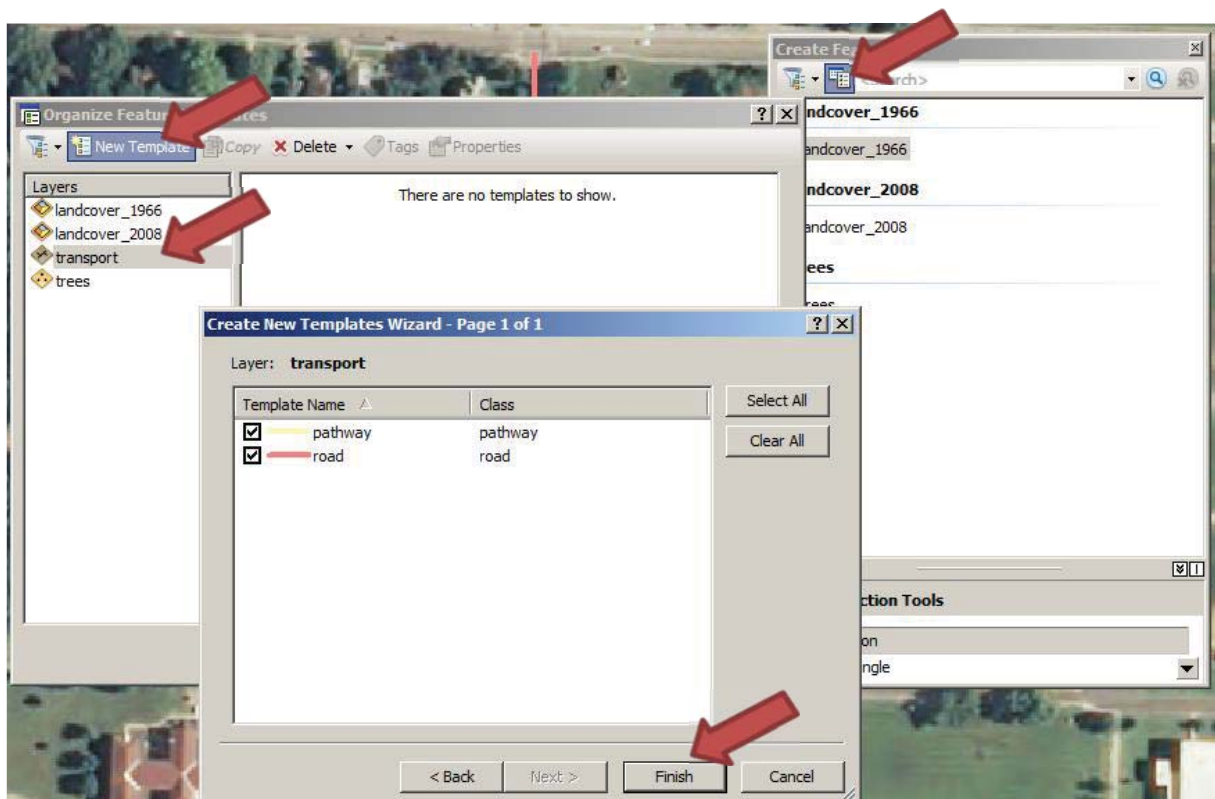
17. **Click next.**

18. **Click Finish.**

19. **Click Close.**

The template for transportation should now show a road symbol and a pathway symbol.

20. **Use the road template to digitize roads and the pathway symbols for pathways.**

21. **If you need to split a road segment use the split tool** **from the editor toolbar.**

22. **To switch of the snapping click editor → snapping → snapping toolbar**

23. **Click snapping and uncheck the "Use snapping" option.**
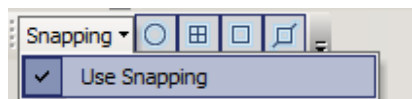
24. **To merge segments, highlight the segments, click editor → click merge.**

25. **When you are satisfied with the features you digitized save your edits and stop the editing process.**

## Create coded value domain in geo-database for land-cover classes

When digitizing in for your project you should define what you are digitizing first. In this case it is advisable to create a list of land cover classes to be digitized and save them as a coded value feature domain in the geo-database that can be used for the 1966 and the 2008 land cover feature class. The coded value domain will limit the possible values that can be entered in the land cover field to the predefined set of values. The classes you are going to digitize are: Forest, Water, Agriculture, Build-up (roads, neighborhoods, industrial areas, campuses).

1. **In the ArcCatalog window of the map navigate to the project.gdb under c:reu_2011\student folder.**
2. **Right click the project.gdb.**
3. **Click the domain tab.**
4. **Enter land cover under domain name**
5. **Under the domain properties section set field type to text and domain type to coded value.**
6. **Under the coded Values section enter: water, agriculture, forest and build up as seen in the image below.**
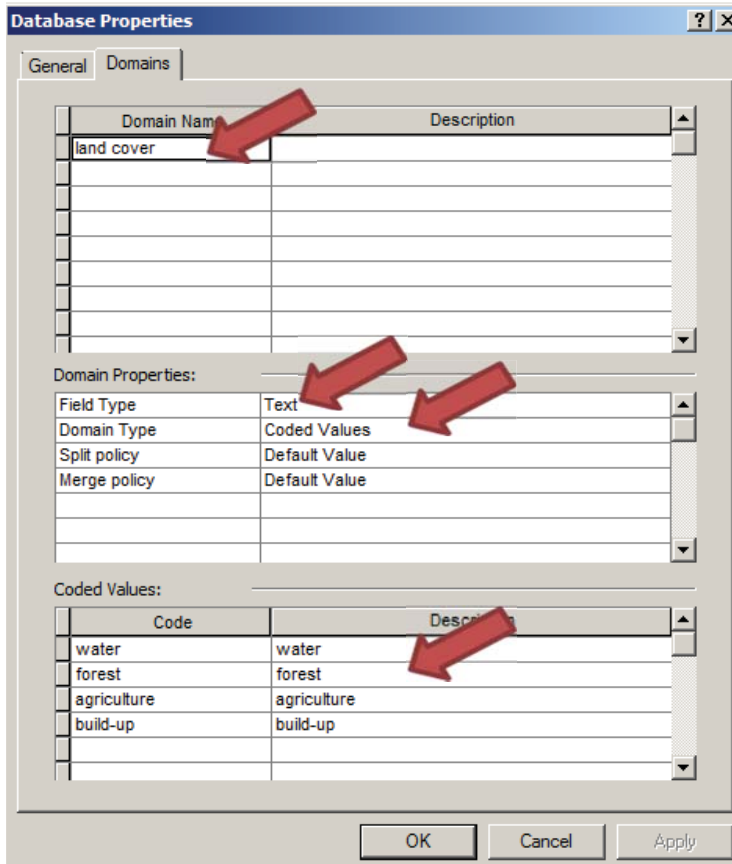
7. **Click OK.**

8. **Open the properties window for the landcover_1966 feature class.**

9. **Click the fields tab.**

10. **Click the landcover field under field names.**

11. **Under the field properties section click the cell next to domain.**

12. **Choose the land cover domain from the drop down menu.**
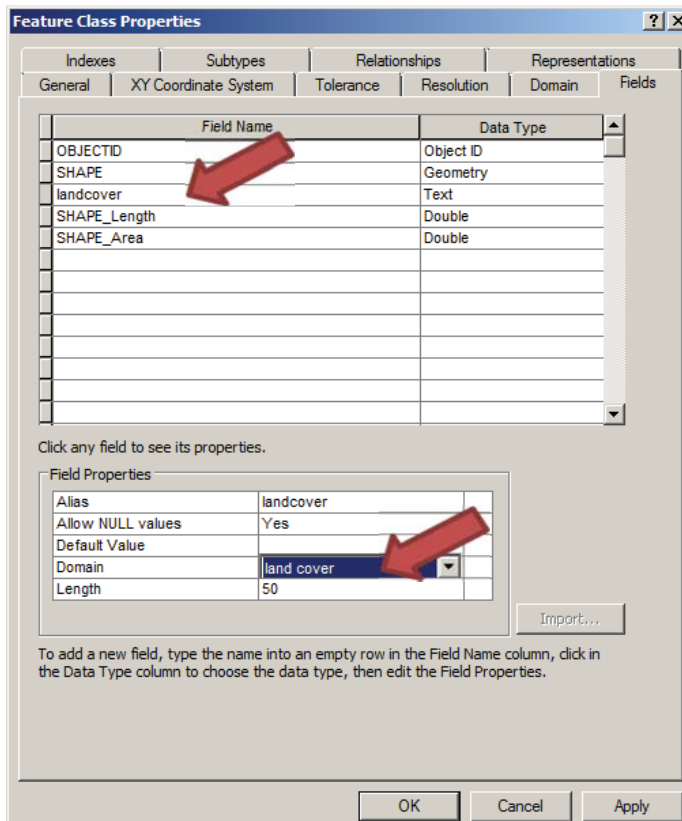
13. **Click OK.**

14. **Repeat steps 8-13 for the landcover_2008 feature class.**

15. **Change the symbology of the landcover_1966 to the settings shown in the image below.**
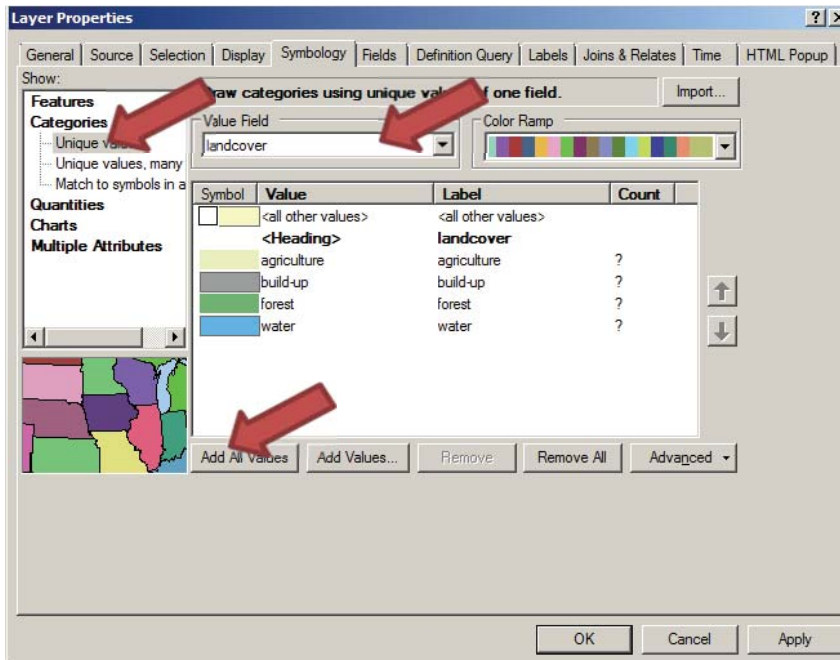
16. Set the transparency of the layer to 50 %

17. Start an editing process for the landcover-1966.

18. Use your knowledge from the "digitize roads and pathway section" to change the template for the landcover_1966 layer to the new symbology.
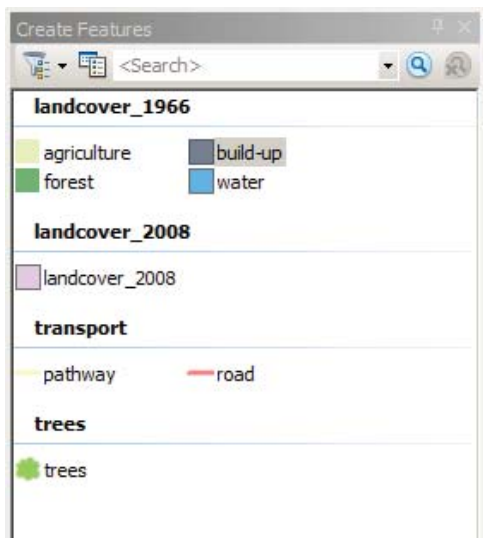
Digitize land cover changes from 1966 to 2008 around Lawrence

1. **Add C:\reu_2011\GIS_data\tutorial\kansas_data\dig_sections.shp.**
2. **Zoom to the dig_sections layer.**
3. **Label the sections with their ID numbers (feature properties → labels)**
4. **Split up into four groups, each group should work on one of the four sections.**

This exercise will use section 1 for an example.

5. **Use a definition query or selection → create layer from selected features process to just show the section you are working on.**
6. **Zoom to the northwest corner of your section.**
7. **Select the landcover class you want to use for the NW corner of your section from the landcover_1966 template in the create features window.**
8. **Use the automatic snapping and the feature and the half transparent feature construction toolbar to create the first land cover polygon.**


9. **Make sure to snap to the section outline polygon where needed.**
10. **Set points with a left mouse click to create a polygon for the land cover.**
11. **You can use the ctrl + Z key combination to delete the last set point.**
12. **Once you have finished lining out the polygon double click to close the sketch.**

The Image below shows a agriculture polygon bounded by Interstate 70 to the south, a smaller forested area to the east and the outline of the section to the north and west.

13. **Choose the next land cover class to be digitized from the template.**

14. **For all the following polygons use the auto complete polygon tool from the construction tools section of the create features window.**
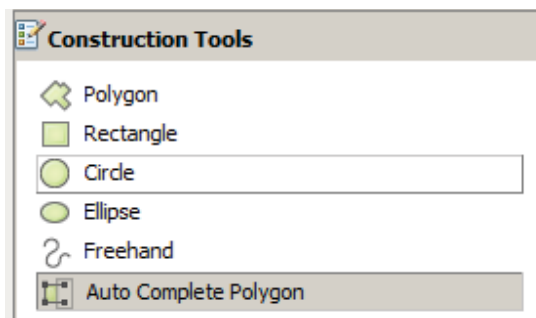
The auto complete Polygon tool makes sure that you don't create any overlaps or gaps between the polygons. The auto Complete Polygon is the most used construction tool when digitizing land-cover, land parcels or vegetation types.

15. **Start digitizing by snapping to a corner point of an existing polygon**

16. **Digitize around the next land-cover area.**

**17.** **Snap again to a corner point of an existing polygon.**

18. **Finish the sketch with a double click**

19. Use the four template options for the 1966 land cover layer and the autocomplete polygons to cover the area of your section with a continuous land-cover layer (don"tforget to pick the right landcover class first and then the auto complete polygon tool).

Below is a screen shot of a rough classification for section 1.
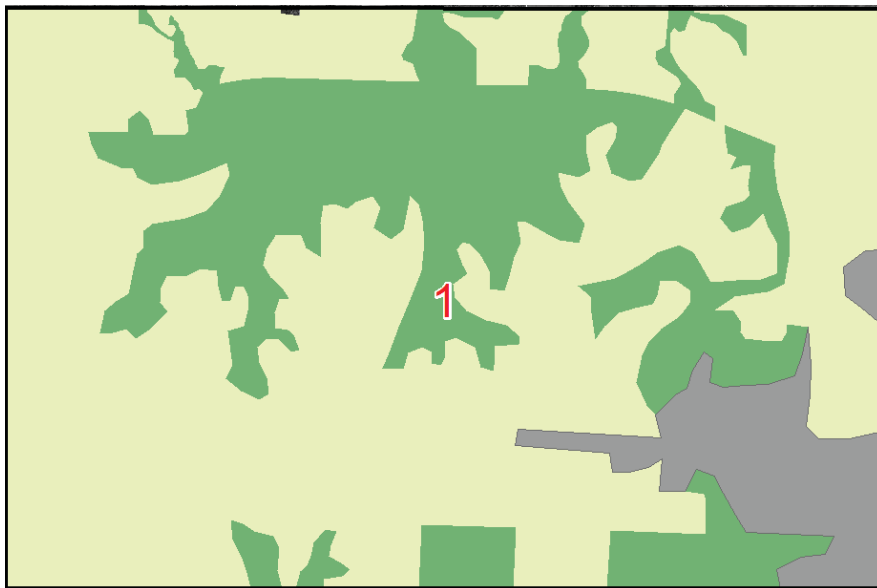
20. When You are done digitizing the land cover for your section save your edits.

4.3 Edit the attribute table

To calculate the area for each land-cover class for your section in acres you will have to create a new field in the table and calculate it to acres.

1. **If your edit session is still open save your changes and close the edit session.**

2. **Open the attribute table for the 1966 land cover layer.**

The Shape_area field records the area for each polygon in the units defined in the Projection information; it is also automatically updated whenever the polygon shape is updated. The units recorded here are square meters (the layer is in a UTM projection).

3. **Click the table options button** 📇 **in the upper left corner of the table window.**

4. **Click add field.**

5. **Name the field acres**

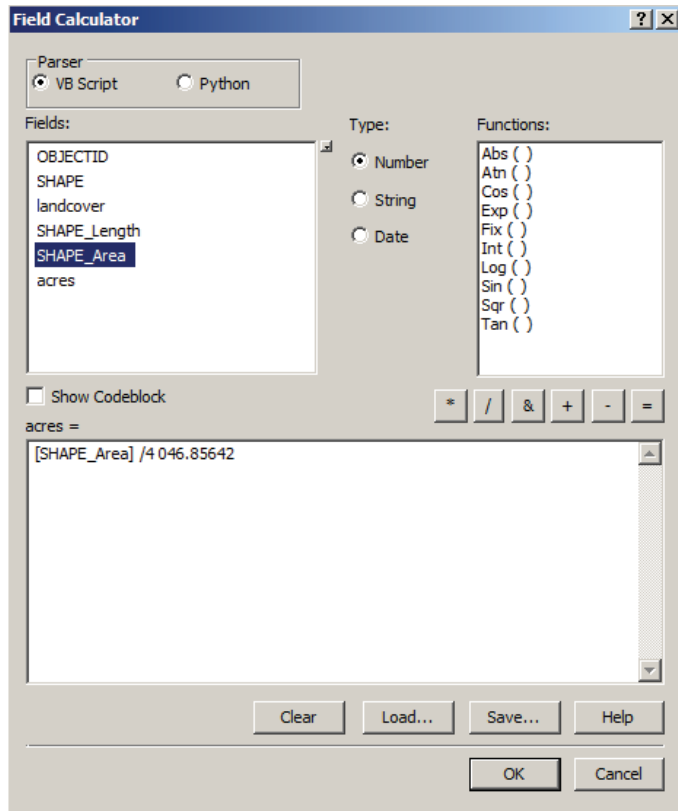6. **Set the type to float.**
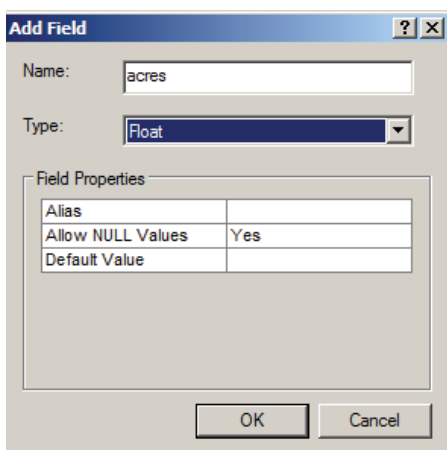
7. **Click OK.**

8. **Right Click the header of the new acres field.**

9. **Click Field calculator.**

The conversion factor from square meters to acres is 4046.86.

10. In the field calculator double click shape_area

11. Type / 4046.85642 (see image below)

12. Click OK.

13. Repeat steps 2-12 for the 2008 land cover class.

> **Now it's your turn:**
>
> Use the Summary Statistics tool to compare the acres by land-cover class of the year 1966 and 2008 for your section.