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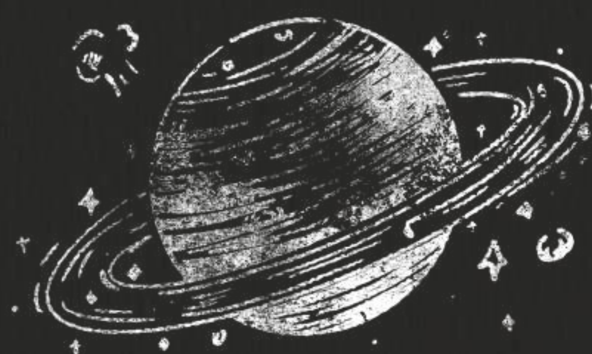


NOTEBOOK

CATCH THE STAR THAT HOLDS YOUR DESTINY, THE ONE THAT FOREVER TWINKLES WITHIN YOUR HEART. TAKE ADVANTAGE OF PRECIOUS OPPORTUNITIES WHILE THEY STILL SPARKLE BEFORE YOU. ALWAYS BELIEVE THAT YOUR ULTIMATE GOAL IS ATTAINABLE AS LONG AS YOU COMMIT YOURSELF TO IT.

GIS and Spatial Analysis

Recap — Maps — GIS Basics — GIS Applications

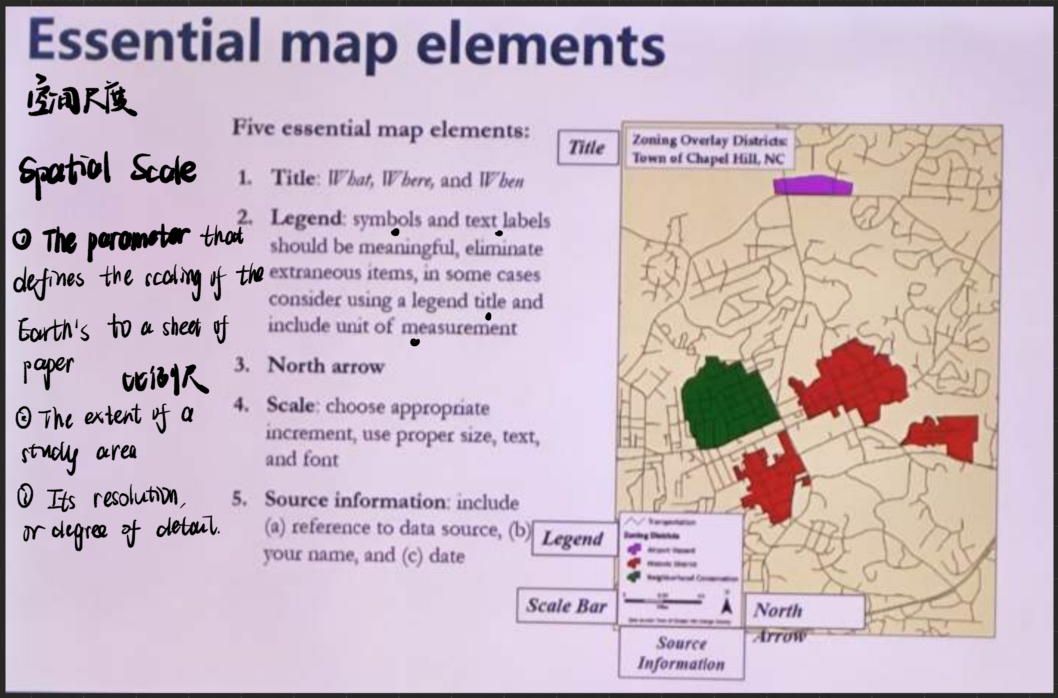
Arc GIS Pro 软件

Introduction of GIS

1 辨析

- **Reference Maps**: determine features of the world in which we live
  - what is there
  - physical / curtural
  - rivers, mountains, geology / towns, roads, time zones
  - e.g. Political maps, Road maps, Zip code maps 邮政编码
- **Thematic Maps**: communicate data about space and distribution to people
  - 特定主题 how it is there
  - choropleth Maps 主题
  - Proportional symbol Maps
  - Dot distribution map
  - Flow maps
  - e.g. Topographic maps 地形, geological maps 地质, Weather maps

2



空间尺度

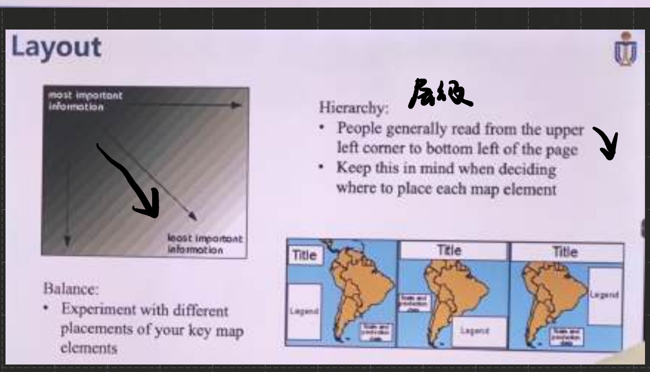
Spatial Scale

① The parameter that defines the scaling of the Earth's to a sheet of paper 比例尺

② The extent of a study area

③ Its resolution, or degree of detail.

3



- Limitation of Maps:
  - abstraction
  - static
  - bias

4 concept **GIS** Geographic Information System

① database containing geographic data, which depict location-based phenomena combined with software tools for managing, analyzing, and visualizing those data

② work with thematic layers of spatial data

③ Important: 1) Geography, Cartography, Geomatics, Computer Science 2) where, what, when

5. History

Roger Tomlinson 1963 — 1960s GIS — 1969 ESRI

G/S

1985 GPS — 2005 3D →

for professional GISystem → GIService via Internet

focus on theory GIScience

1980 1990 2000

6. Components

- Hardware: device
- Software: programs
- Data: digital representation
- People: who
- Procedures: application and activities
- Network: transmit and share

7.

GIS Component - Data

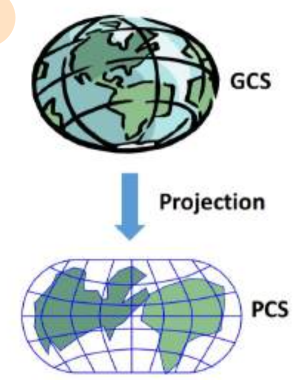
① Spartial Reference systems | PCs | GCs

| Spatial data Models | Object Model & Vector Data | Field Model & Raster Data

Spatial Reference Systems
- Frameworks used to precisely measure locations on the surface of the Earth as coordinates.
- Abstract mathematics of coordinate systems and analytic geometry to geographic space
- Types of systems:
  - Geographic coordinate systems (GCS)
  - Projected coordinate systems (PCS)

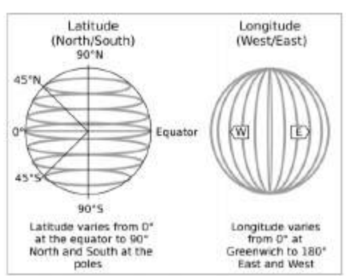
GIS Component - Data

Projected Coordinate Systems (PCS)
- Projected coordinate systems represent locations on the Earth using Cartesian coordinates (x,y) on a planar surface created by a particular map projection
- For example
  - Universal Transverse Mercator (UTM)
  - Web Mercator, a variant of the Mercator map projection, the de facto standard for Web mapping applications (e.g., Google Maps)



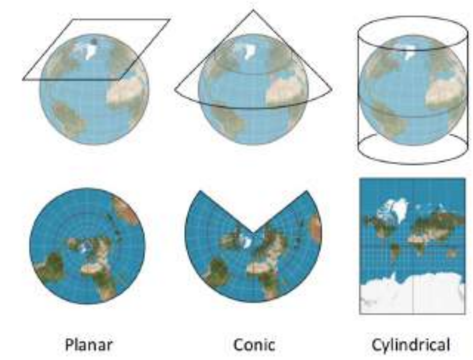
GIS Component - Data

Geographic Coordinate Systems (GCS)
- Spherical coordinate systems measuring locations directly on the Earth models (sphere or ellipsoid) using latitude and longitude.
  - Latitude: degrees north or south of the equator
  - Longitude: degrees west or east of a prime meridian 本初子午线
- For example, World Geodetic System (WGS 84), used for the Global Positioning System (GPS)



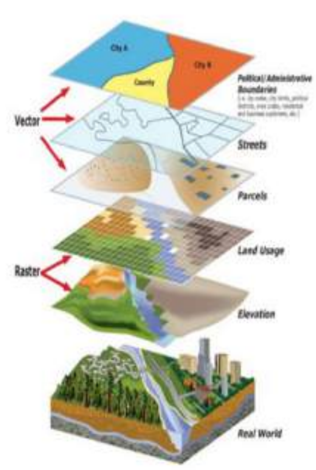
GIS Component - Data

Map Projection
- Flatten a globe's surface into a plane in order to make a map
- All map projections will cause distortions 扭曲
- Select the appropriate projection by application needs



GIS Component - Data

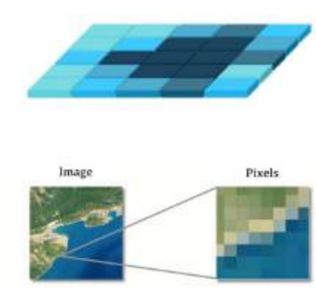
Spatial Data Models
- Geographic data link place, time, and attributes
- The world is infinitely complex, but computer systems are finite
- Representations must somehow limit the amount of detail captured
- The two fundamental ways of representing geography are discrete objects and continuous fields



Digital representation of the world

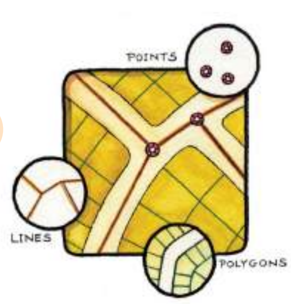
GIS Component - Data

Field Model & Raster Data
Scan Pattern
- The continuous field view represents the real world as a finite number of variables, each one defined at every possible position
- Raster representations divide the world into arrays of cells and assign attributes to the cells
- Typical examples include remote sensing imagery and digital elevation models (DEM)



GIS Component - Data

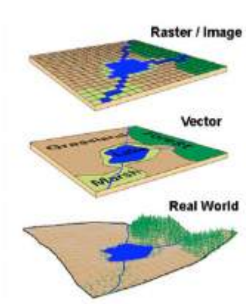
Object Model & Vector Data
- The **discrete** object view represents the geographic world as objects with well-defined **boundaries** in otherwise empty space
- Vector data represent the world as **points, lines and polygons**. 点,线面
- Lines are captured as points connected by precisely straight lines, while an area is captured as a series of points or vertices connected by straight lines



GIS Component - Data

辨析.

Vector vs Raster
- Raster and vector are two methods of representing geographic data in digital computers
- Select the appropriate data types by application needs



8. Software: GIS Functions: Capture - Store - Query - Analyze - Display - Output

GIS Mapping: Map body, Scale, North arrow, Legend

Tools: ArcGIS Pro, Database: PostgreSQL + PostGIS, Programming: R + Python

Notes / 25 50 75 100

Title

Chapter Date

Review

Rating

9. Application: ① Digital Map Services, Localization & Navigation
② Urban Planning and Management
③ Utility Management
④ Intelligent Transport Systems
⑤ Natural Resources Management (e.g. Land Management)
⑥ Air Pollution
⑦ Spatial Epidemiology
⑧ Crime Mapping and Analysis
⑨ Business Intelligent Analysis (e.g., store location selection)
⑩ Tourism Management

Lab2a: Basics on Projections

OVERVIEW

In this exercise, you will learn to define and manipulate map projections. The ultimate objective of this exercise is to determine the Census tract containing each of the single-family units in the dataset provided and to examine the data attributes of that tract. Two primary spatial datasets will be used to complete the exercise:

1. Centroids of single-family residential units built in the year 2000: *sfamily_2000.shp*
2. Latest block groups polygons shapefile: downloaded from the U.S. Census Bureau website

Task 1: Examine and Modify Map Projections

ArcGIS automatically reprojects datasets “on-the-fly,” which means that when two or more datasets are added and they do not share a common projection, the dataset added second is modified so that it properly overlays the dataset added first. However, this reprojection is only performed for display purposes and the file saved on the hard disk is unchanged. This can become problematic, for example, if distance or area calculations (or spatial joins) are performed without properly reprojecting the actual data. Stated differently, although the two datasets seem to align properly, they are in fact in two different map projections. To proceed, you will need to change the projection of one spatial dataset to match that of the other. Then, you will need to perform spatial join to identify the Census tract identifiers for those single-family units.

Step 1.1: Create a new project in ArcGIS. Open **Toolbox** by clicking on the red **Tools** icon under **Analysis** ribbon. Next, switch to **Toolboxes** tab, expand **Data Management Tools**, expand **Projections and Transformations**, and click **Define Projection**. Click the browse icon, then navigate to where you saved the data for this exercise, select *sfamily_2000.shp* and click the **OK** button to choose this dataset.

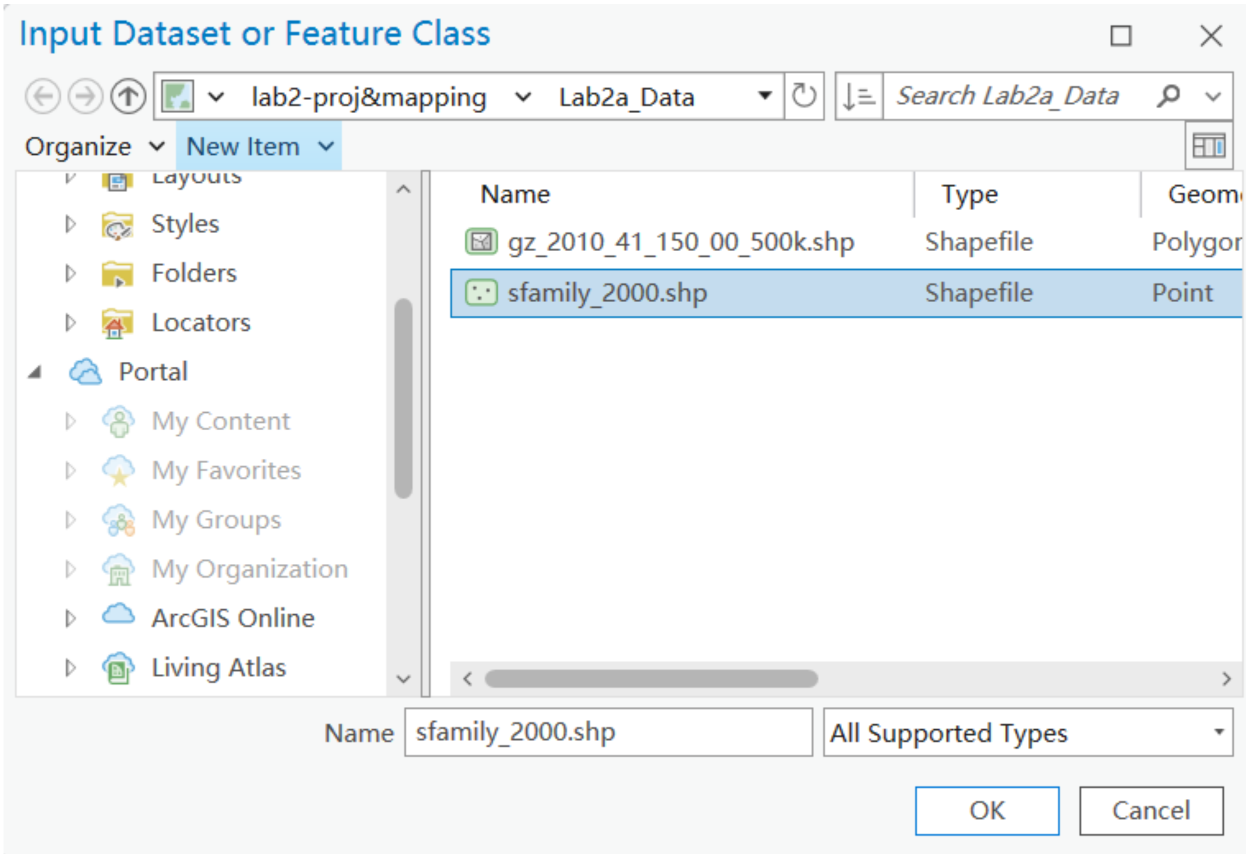


Figure 1.1

Then, click the icon next to the **Coordinate System** drop-down field, in the new window, choose **Projected Coordinate Systems**, choose **State Plane**, and **NAD 1983 (US feet)**. Scroll down the list of map projections and highlight *NAD 1983 StatePlane Oregon North FIPS 3601 (US Feet)* with your cursor and click the **OK** button to specify this in the **Coordinate System** drop-down field.

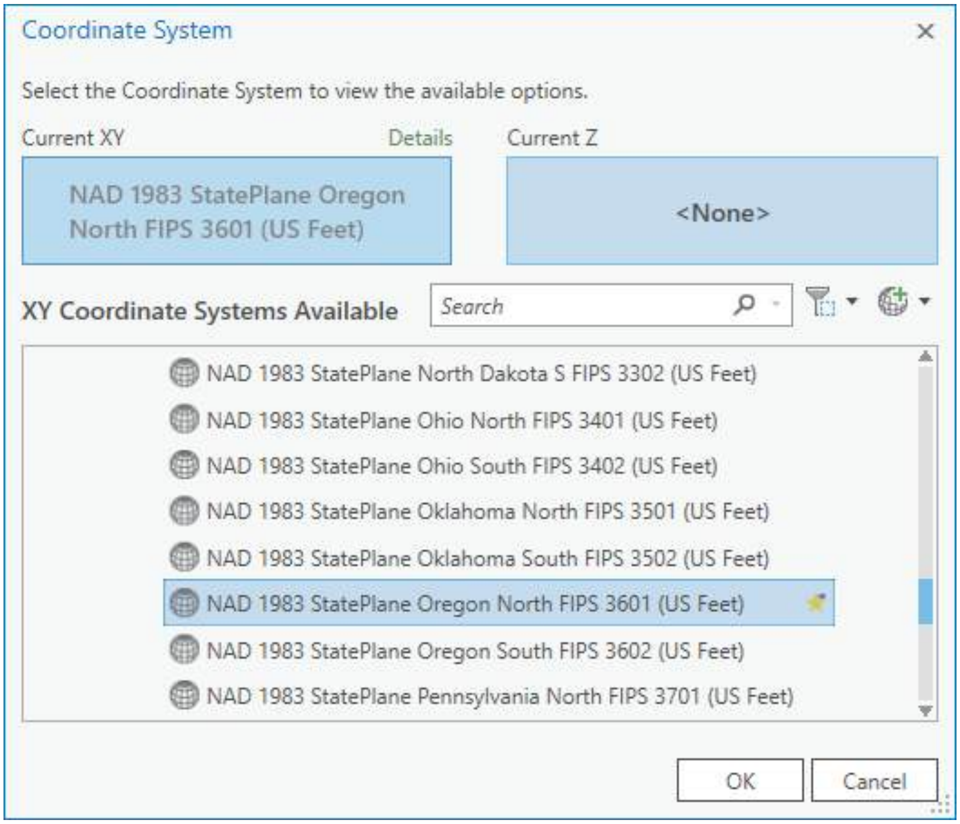


Figure 1.2

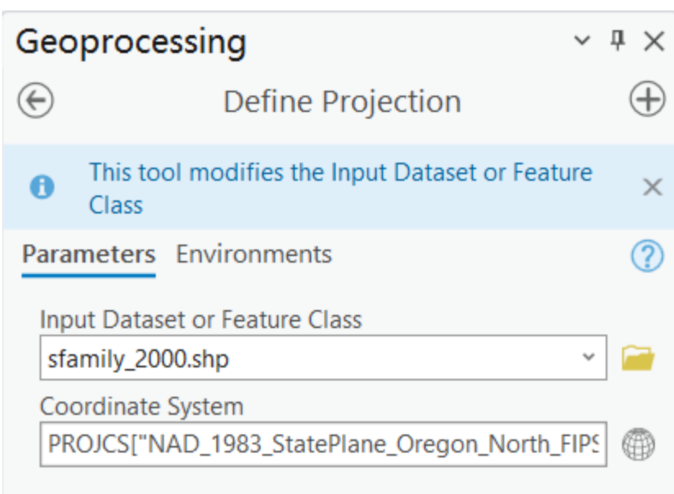


Figure 1.3

Finally, click the **Run** button to perform the operation. Thus far we have specified the map projection for *sfamily_2000.shp* as *NAD 1983 StatePlane Oregon North FIPS 3601 (US Feet)*, which allows **ArcGIS** to properly display, reproject, and analyze the dataset.

Step 1.2: Then use the same method to define projection for *gz_2010_41_150_00_500k.shp*. Click **Tools**, switch to **Toolboxes** tab, expand **Data Management Tools**, expand **Projections and Transformations**, and click **Define Projection**. Click the browse icon, then navigate to where you saved the data for this exercise, select *gz_2010_41_150_00_500k.shp* and click the **OK** button to choose this dataset. hit **OK** .

Then, click the icon next to the **Coordinate System** drop-down field, click the Select button, choose **Geographic Coordinate Systems**, and choose **North American--USA and territories**. Scroll down the list of map projections and highlight *NAD 1983* and click the **OK** button. Finally, click the **Run** button to perform the operation.

Task 2: Reproject the Census Block Groups

We now have two shapefiles with correctly defined map projection information. However, in order to perform our analyses, these shapefiles need to share a common map projection. We will reproject the block groups dataset, which is currently in latitude and longitude coordinates, to the state plane projection of the single-family residential units dataset.

Step 2.1: Run tool **Project**, which is located under **Data Management Tools**, **Projections and Transformations**, the **Project** window appears. Use the browse icon to navigate to *gz_2010_41_150_00_500k.shp* and click the **OK** button to choose this dataset as **Input Dataset or Feature Class**. Change the name of the output dataset to *bgroups_project.shp* and click the icon beside the **Output Coordinate System** field. Click the Add Coordinate System Button (**Figure 2.1**) then select **Import Coordinate System** button, select *sfamily_2000.shp*, and click **OK**.

Now, click the **Run** button to perform the operation.

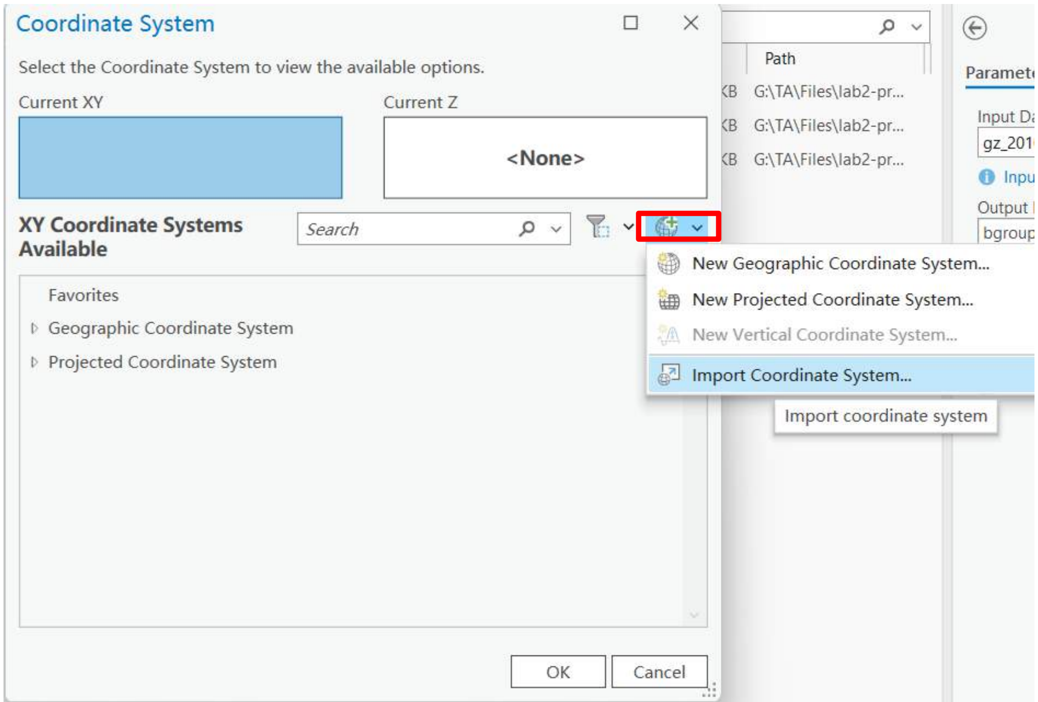


Figure 2.1

Now, both the single-family residential units shapefile and the census block groups shapefile are in the same map projection.

Task3: Perform Spatial Join

The final task of this short exercise focuses on using a spatial join to identify which census tract contains each of the single-family residential units in the dataset.

Step 3.1: Create a Map in the current project if you didn't. Click **New Map – New Map** under **insert** ribbon.

Step 3.2: Click the **Add Data – Data** on the ribbon.

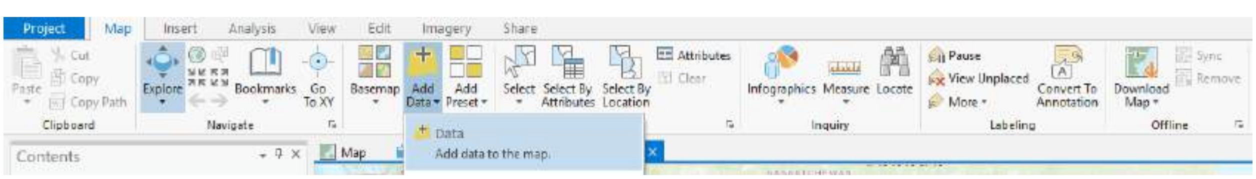


Figure 3.1

The **Add Data** window will open. Navigate to the directory where the datasets have been stored. Click the **Connect to Folder** icon to navigate to the folder if needed. Select *sfamily_2000.shp* and *bgroups_project.shp* with the cursor and click the **Add** button.

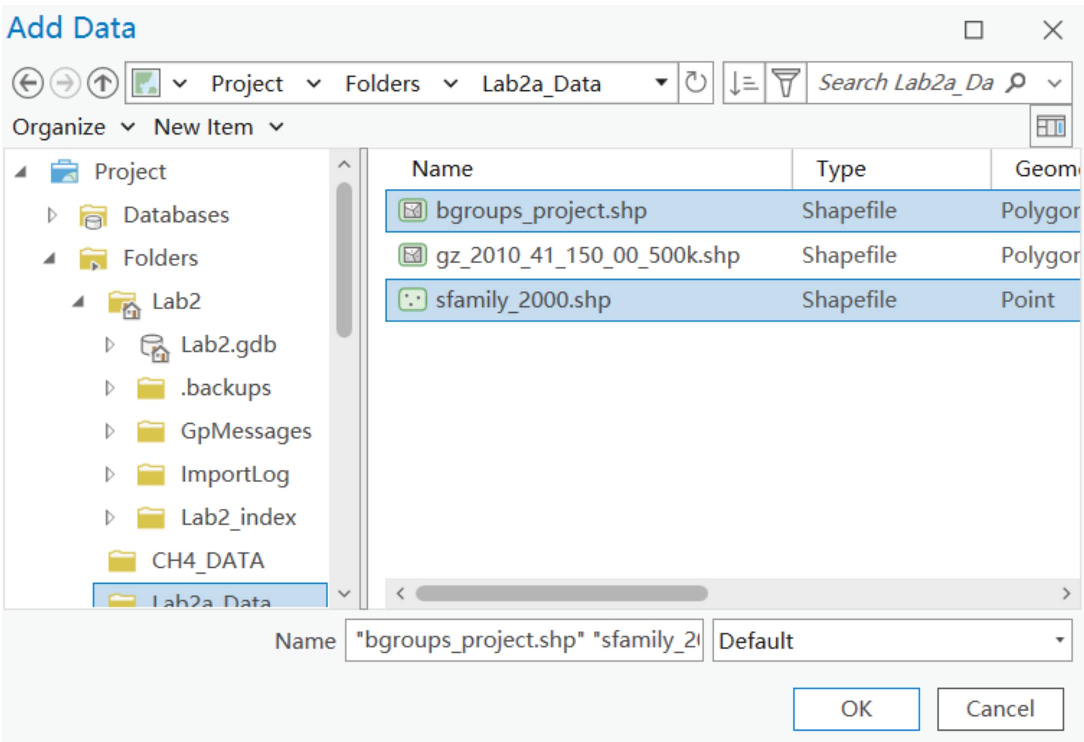


Figure 3.2

Step 3.3: In the **Geoprocessing** tools, search for the **spatial join** tool. Click the **Spatial Join** tool, and the **Spatial Join** window will appear. (**Figure 3.3**)

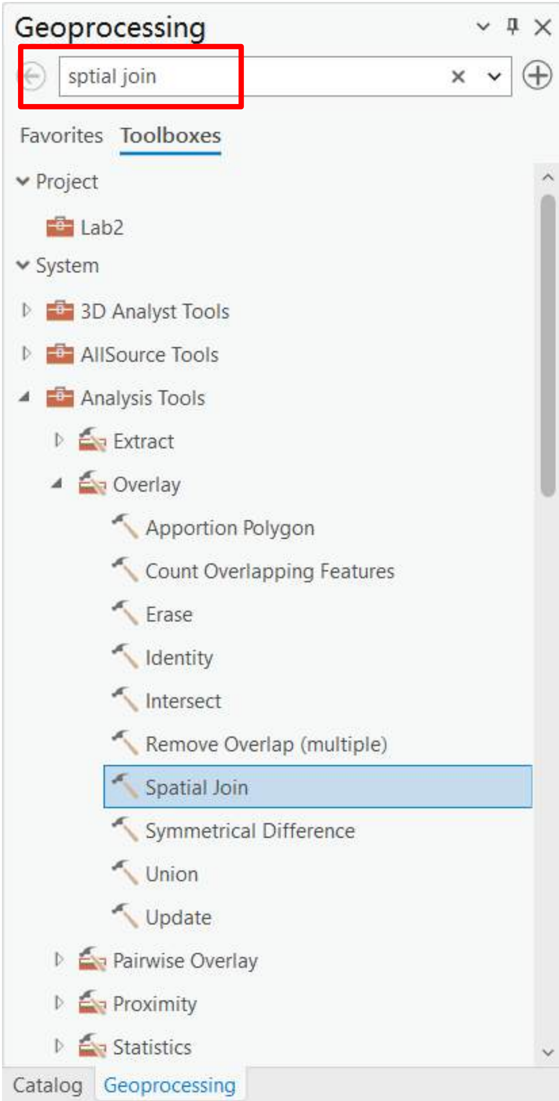


Figure 3.3

Specify *sfamily_2000.shp* as **Target Features**, and *bgroups_project* as **Join Features**. Be sure to select *Completely within* for **Match Option**, and rename *sfamily_bgroups.shp* for the **Output Feature Class**. (remember to direct the save file path to *Lab2a*)

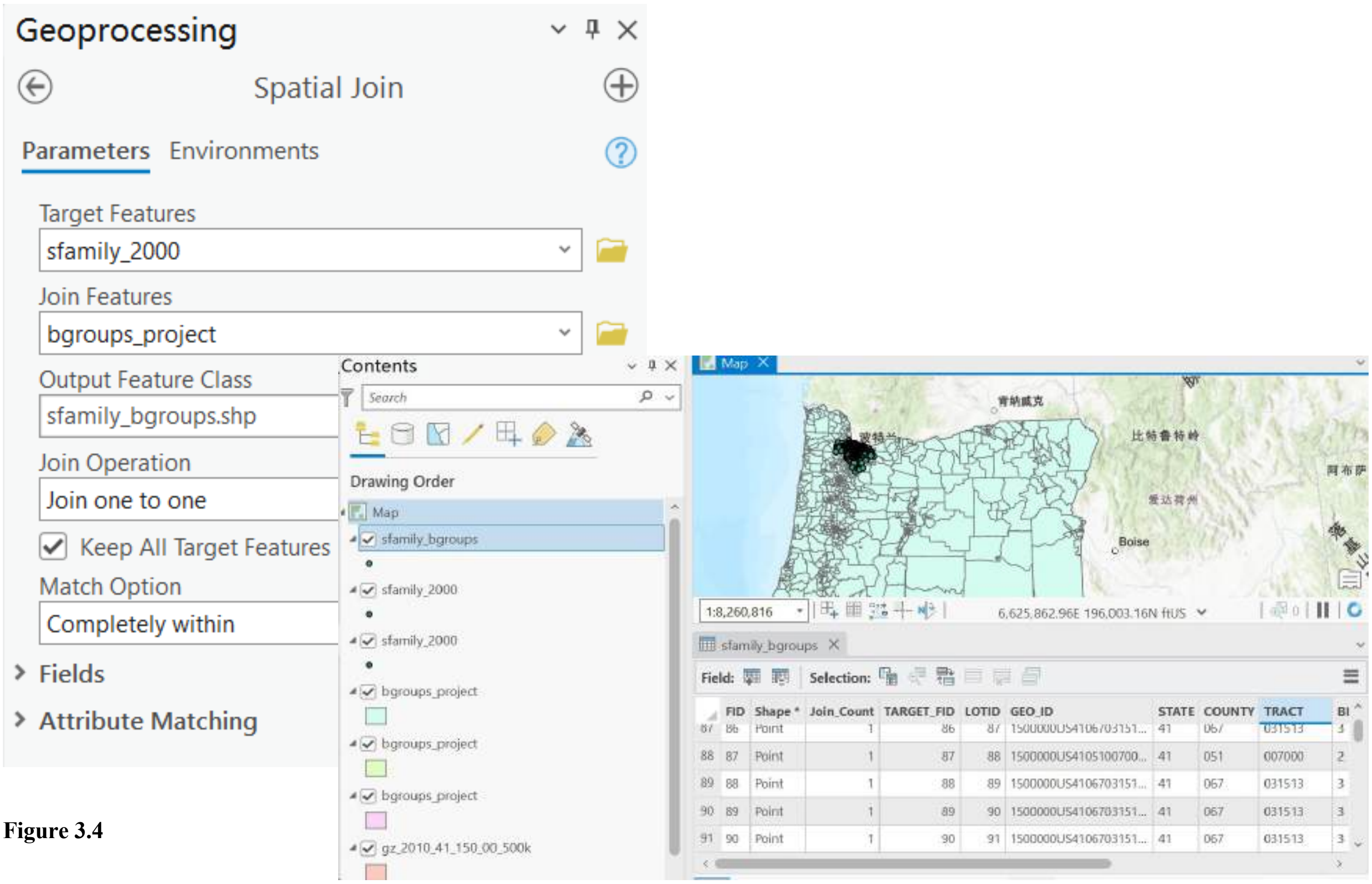


Figure 3.4

Finally, click the **RUN** button to execute the spatial join.

Step 3.4: Right-click *sfamily_bgroups.shp* in the **Contents** and select **Attribute Table** to view the Census block group number associated with each of the single family residential units. You can compare the attribute tables between the original *sfamily_2000.shp* and the processed *sfamily_bgroups.shp* for a clear insight.

SUMMARY

This exercise focused on introducing the functionality available to manage map projections, including transforming a given dataset from one map projection to another. The importance of maintaining a common and consistent projection across all spatial datasets used in an analysis was demonstrated. The use of spatial join operations was also introduced and contrasted with attributes-based join methods.

分析中使用的所有空间数据保持共同一致的投影

空间连接操作

Lab2b: Creating Thematic Maps

OVERVIEW

In this exercise, you will learn the basics of the ArcGIS Pro software package. The task is to create a thematic map that documents and conveys the historic pattern of single-family residential development in Washington County, Portland metropolitan area. The data provided are taxlots[1] (parcels) for the area. There are four primary components of the exercise and detailed instructions, along with screen captures are provided to guide you through each of them:

1. Define and change projection;
2. Identify the taxlots that are within Washington County and that are single family residential use;
3. Obtain information on time of development of single-family houses and major highways;
4. Create a thematic map showing the geographic distribution of taxlots that were built in different time periods. 不同时期建造税区的地理分布

In addition to introducing fundamental functionality available in the ArcGIS Pro software, this exercise also demonstrates how GIS can be used to better understand the temporal and spatial characteristics of residential development. Since World War II, the dominant trend in urban growth has decentralization or movement away from central city areas, so pay special attention to the location of recently built taxlots with respect to the central business district and established (older) residential areas. CBD

Task 1: Create a Project

In **ArcGIS Pro**, a project must be created to save all your working documents including shapefiles, data tables, customized toolboxes, and project files. As shown in 错误!未找到引用源。, a 样板 template can be selected from **Map**, **Catalog**, **Global Scene** and **Local Scene** when creating a project. The four interfaces work in similar ways as **ArcMap**, **ArcCatalog** and **ArcScene** in the old ArcGIS Desktop package. **ArcGIS Pro** combines all those applications in one window and allows users to switch easily. You can also start your work first and save the project later by

---

1 In Chinese, taxlots means '税区'.

clicking "*Start without a template*", all the working files will be saved in a temporary folder in this case.

For this lab, please create a project with **Catalog** Template and save it in a convenient location on your local drive.

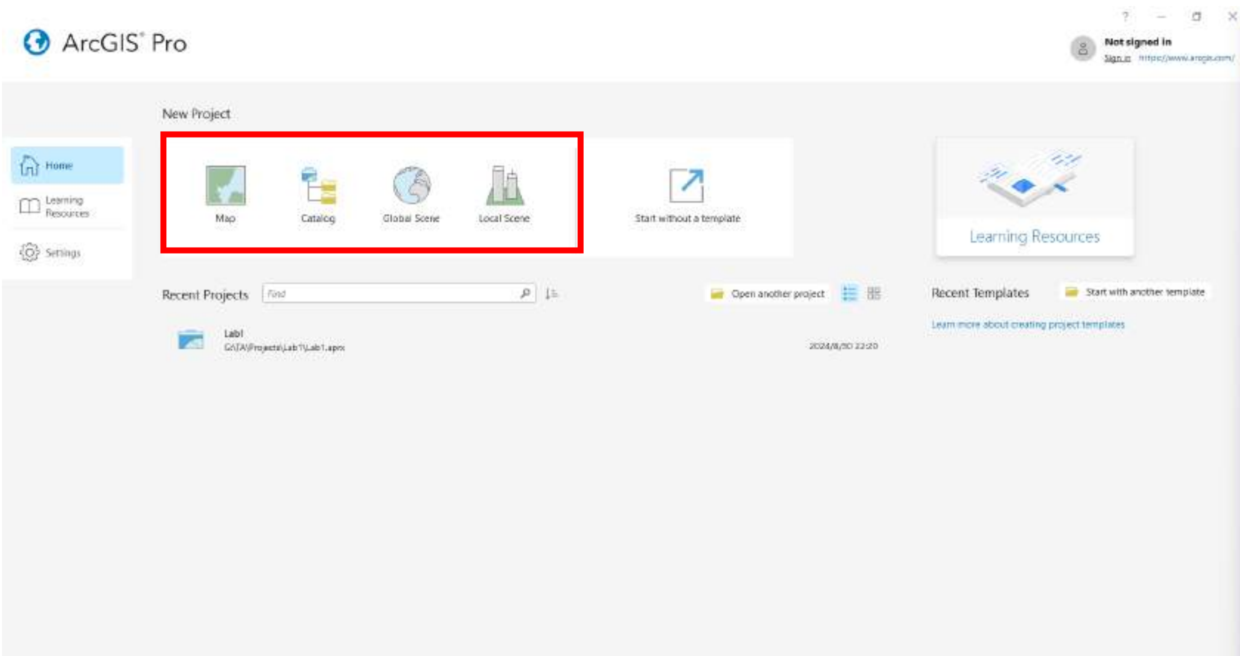


Figure 0.1

Task 2: Define and Change Projection

三维→二维

The Earth is round, and maps are planar, so in order to represent a three-dimensional orb on a two-dimensional surface a mathematical transformation called a projection is required. The functionality for managing projections resides in **ArcGIS Toolbox** (which is also available in **other templates**), but **Catalog** is the most appropriate place to perform these kinds of operations owing to its **Preview** and **Metadata** capabilities. Ensuring that all datasets and layers share a common projection is critical to successfully displaying spatial information and performing analyses.

Step 2.1: Create a new project with **Catalog** template from **ArcGIS Pro** start menu and take a few minutes to explore the interface. The left side of the interface is called the **Contents** and displays the directory structure and is used for navigation. The right side of the interface consists of two framed views: file list and file details. The **file list** window is used for navigation and to manipulate datasets. The **file detail** window is used to display and edit metadata (documentation), show the general geography of spatial dataset, and quickly examine the attributes table and features of a given spatial dataset.

Step 2.2: Change the default *metadata style* so that more metadata can be displayed and edited in the **File Detail** window. Click **Project** button on the top-left corner, then select **Options** from the **Menu** window, the **ArcGIS Pro Options** dialog box appears. Click the **Metadata** tab, then click the drop-down arrow and select *North American Profile of ISO19115 2003*, click the **OK** button.

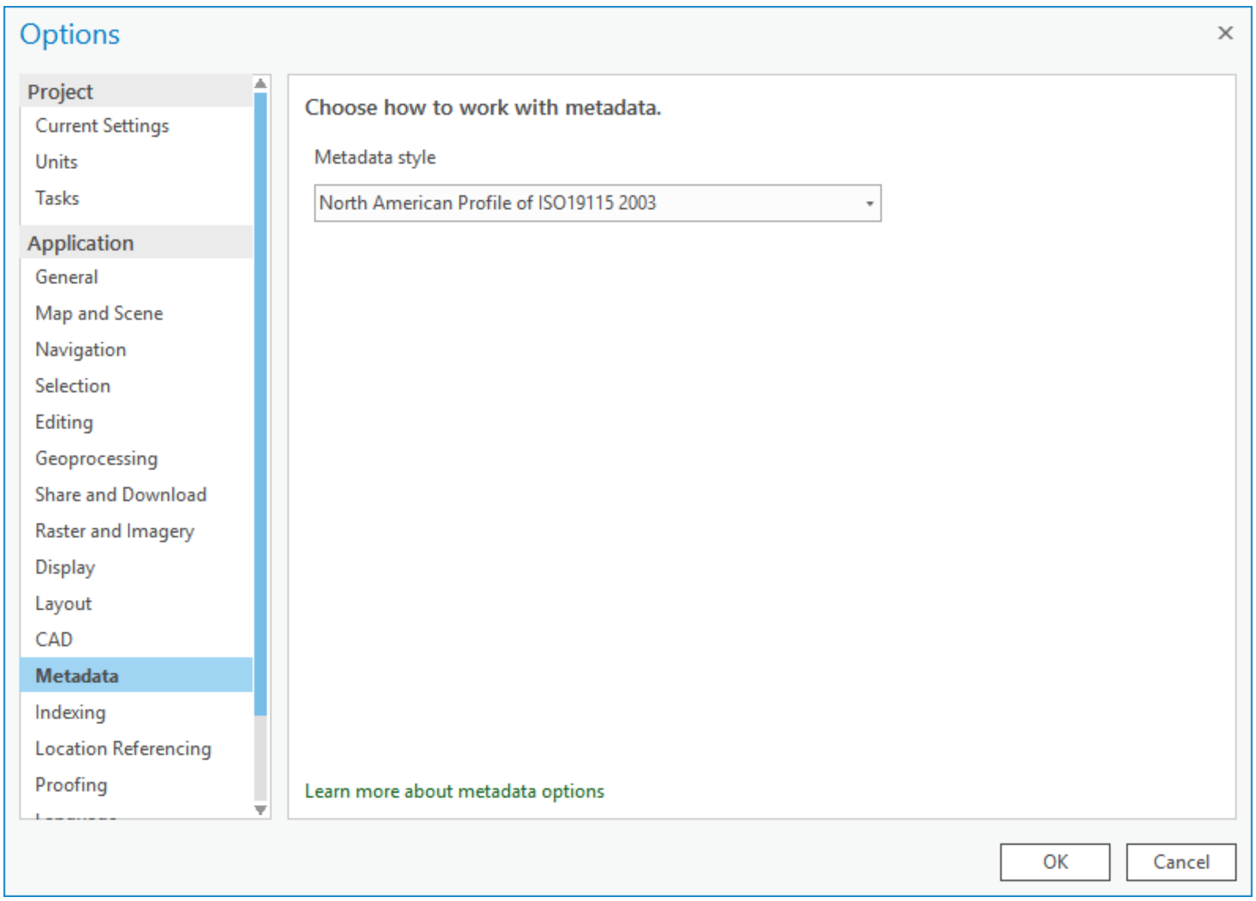


Figure 0.1

Step 2.3: Establish a direct path to the directory folder where the data for this exercise are stored by right clicking **Folders** in **Content** window and **Add Folder Connection** from the menu bar.

Navigate to the proper folder, highlight the name of the folder with the cursor and click the **OK** button.

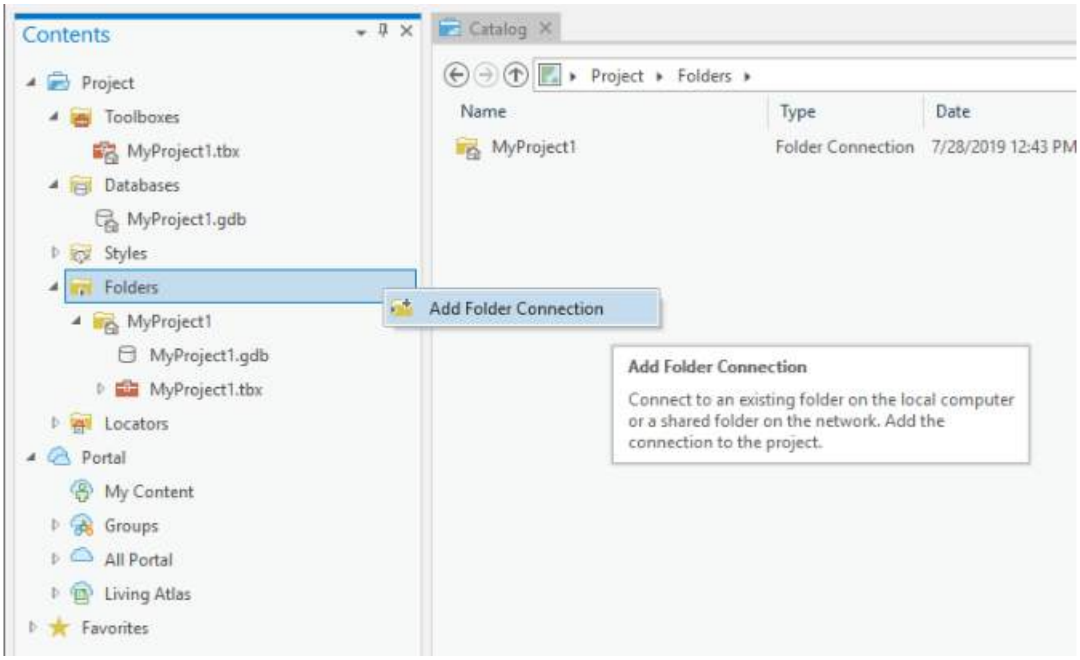


Figure 0.2

Step 2.4: In the **Contents** tab, highlight the *TAXLOTS.shp* dataset and click the **Metadata** tab in the **File Detail**. Scroll to **Spatial Reference** section.

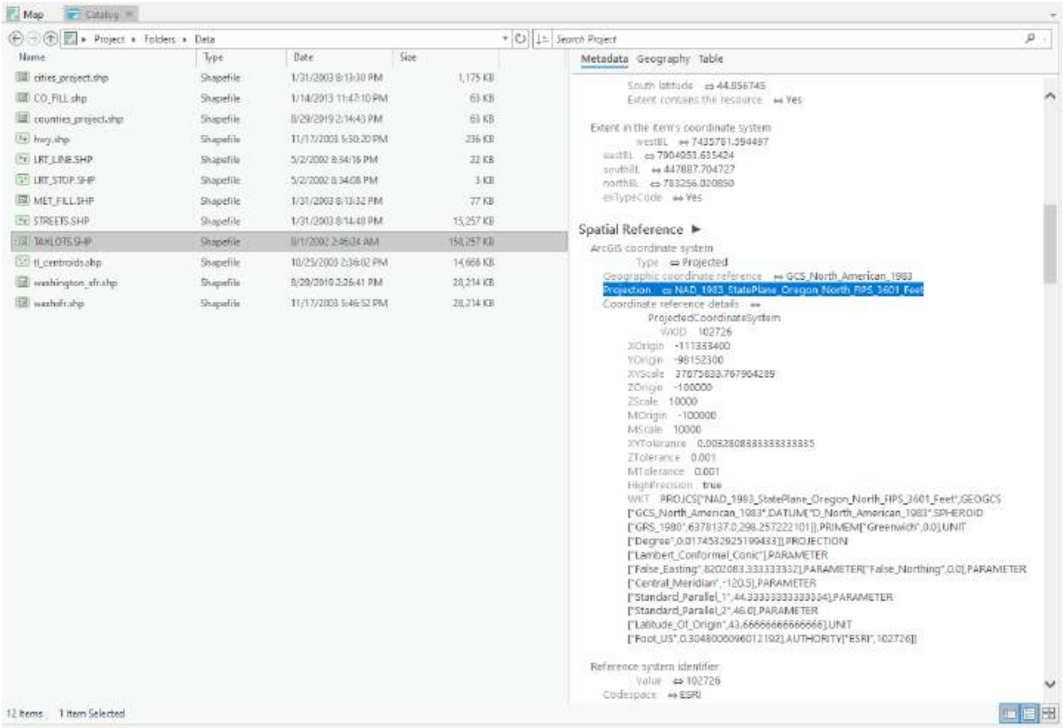


Figure 0.3

You will find the taxlots polygons and centroids files are projected:

(NAD_1983_StatePlane_Oregon_North_FIPS_3601_Feet).

In the **File List** window, highlight the *CO_FILL.shp* dataset and click the **Metadata** tab. You will find there is no **Spatial Reference** for it. (You are told that the coordinate system is *GCS_North_America_1983* coordinate system).

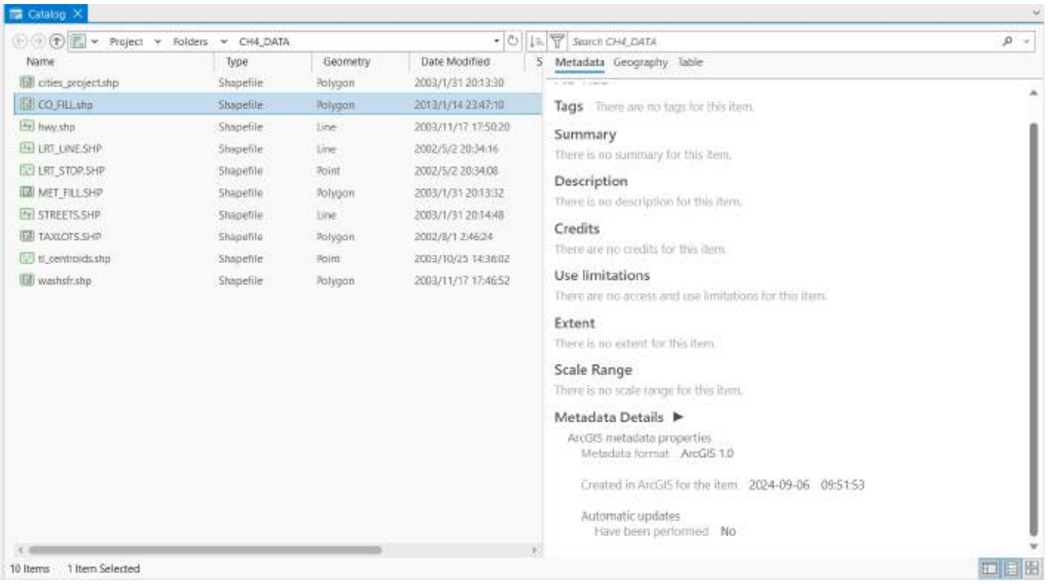


Figure 0.4

In order for the data layers to properly overlay, they must share a common projection. We will project the county and city boundary shapefiles to match that of the cadastral datasets.

Step 2.5: Open **Geoprocessing** window (Click **Analysis** on the ribbon then **Tools**) if it is not already displayed. Switch to **Toolboxes** tab, Expand **Data Management Tools, Projections and Transformations**, within the **Toolboxes** navigation tree.

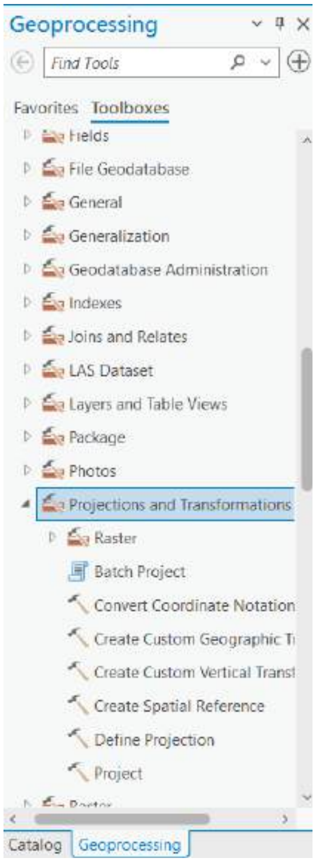


Figure 0.5

Click **Define Project** and the window shown below will open.

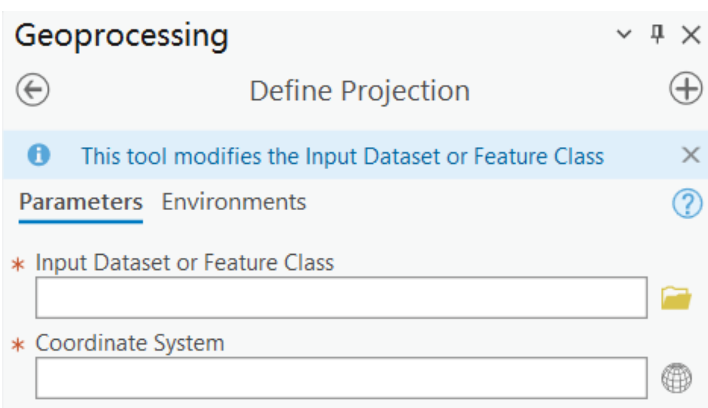


Figure 0.6

Click the **Browse** button next to **Input Dataset or Feature Class**, and navigate to the *CO_FILL.shp*, select it and click the **OK** button.

Click the icon beside the **Coordinate System** field, the **Spatial Reference Properties** window will appear. Expand the *Geographic Coordinate Systems* folder, then select *North America – USA and Territories*; under *USA and Territories*, select *NAD 1983* (**Figure 0.6** below), Click the **OK** button to select *GCS_North_America_1983* coordinate system for *CO_FILL.shp* file. Now, click the **Run** button on the bottom to define projection for the file.

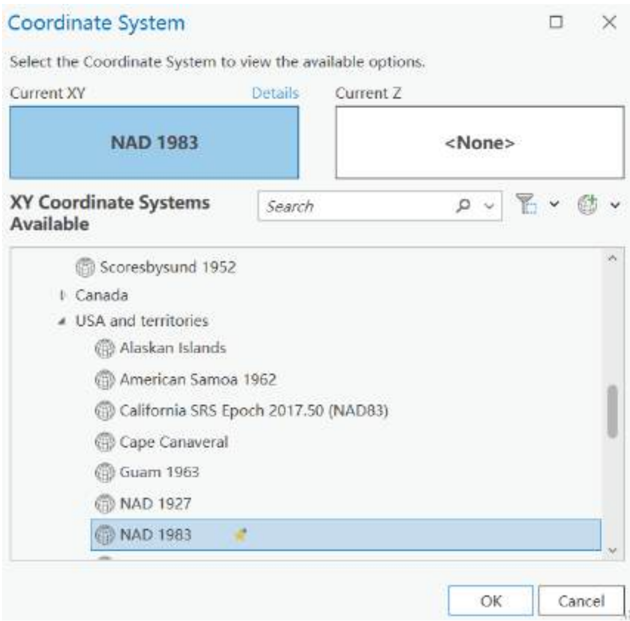


Figure 0.6

Next, still in the **Projection and Transformations** toolbox, click **Project**. The Project window will pop up (**Figure 2.8**).

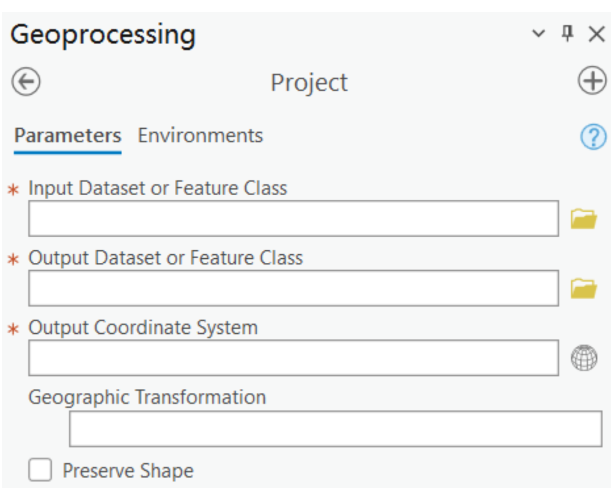


Figure 0.8

For **Input Dataset or Feature Class**, choose *CO_FILL.shp*. Under **Output Dataset or Feature Class**, change the name of the output dataset to *counties_project.shp* (make sure you specify the folder you want to store the output file, the output file will be saved in the project folder but not the input data folder by default) and click the icon beside the **Output Coordinate System** field. The **Spatial Reference Properties** window will appear. Select the **Add Coordinate System** icon (globe-shaped to the right of the search bar) and click the **Import Coordination System** button, highlight *TAXLOTS.shp*, and click **OK**.

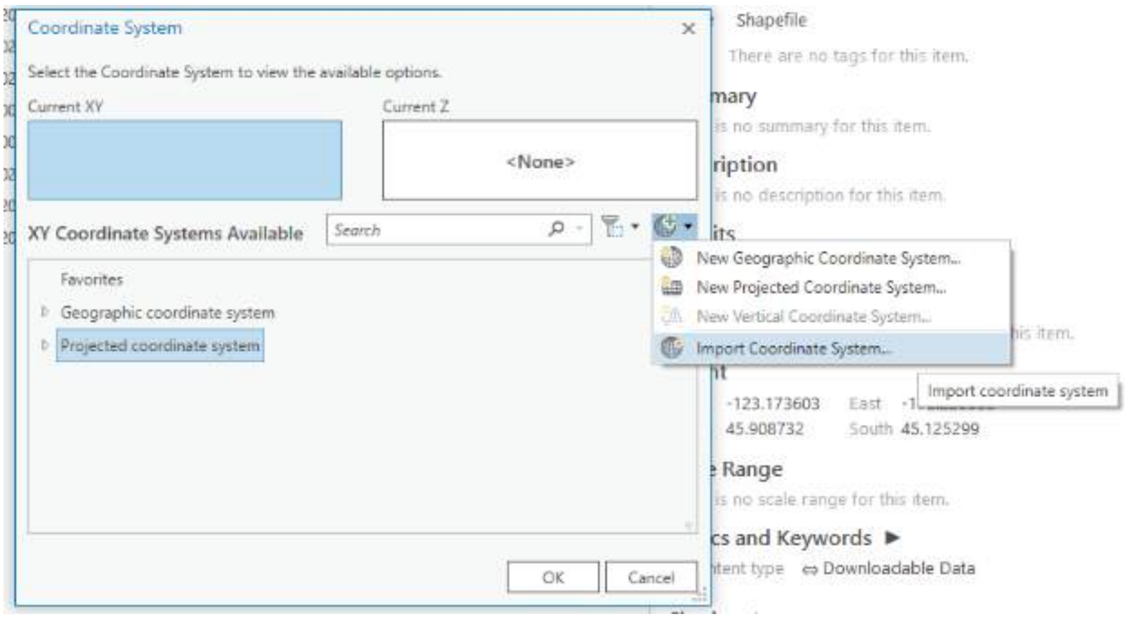


Figure 0.9

Now, click the **Run** button on the bottom to perform the operation.

Thus far, we have specified the input feature class (shapefile of *CO_FILL*) to be projected, the name of the new projected dataset (*counties_project.shp*) to be created, and the projection to apply to the new dataset (imported from *TAXLOTS.shp*).

Step 2.6: Explore the dataset, identify the taxlots that are within Washington County;

Now that we have consistently projected datasets at our disposal, we will familiarize ourselves with the study area and spatial information for this exercise. We will launch **Map** interface from within **ArcGIS Pro**, add the projected datasets, and briefly examine their attributes and spatial characteristics.

Launch **Map** interface by right clicking **Project** in **Contents** window, then select **New Map.** A topographic map will be added automatically as a background, you can remove or change it later.

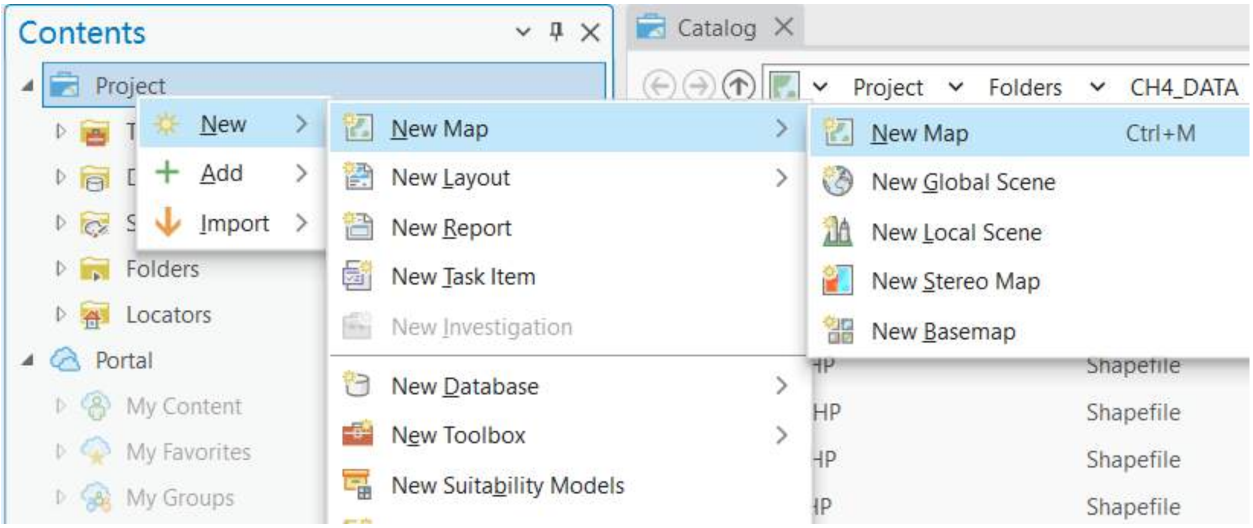


Figure 0.10

Click the **Add Data** icon under **Map** ribbon. Select *tl_centroids.shp, STREETS.shp, TAXLOTSs.shp, counties_project.shp* and *cities_project.shp* with the cursor while holding the **Ctrl** button and click the **OK** button.

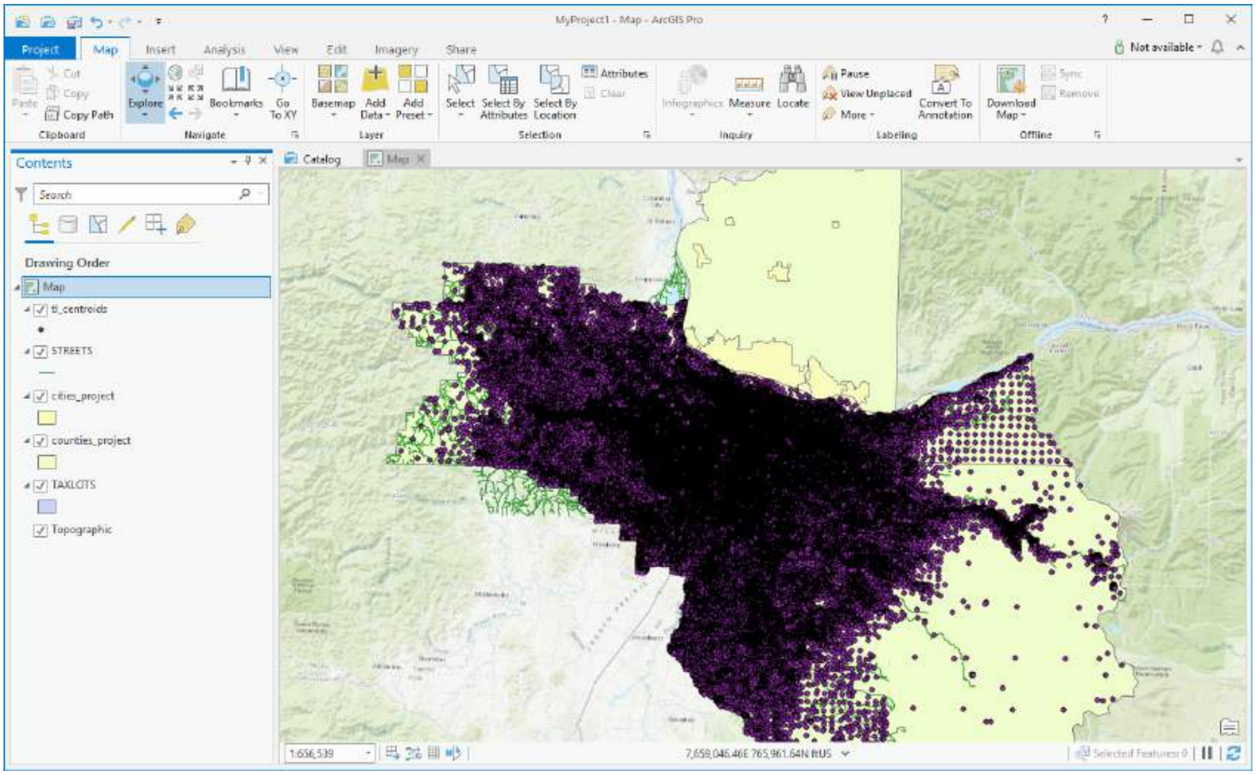


Figure 0.7

The datasets are now displayed within the **Map** document and are listed by name in the **Contents** on the left side. These datasets represent the taxlots (land parcels), taxlot centroids, street network, county boundaries and city boundaries, respectively.

Note: Your colors may be different from screen shot above because ArcGIS selects random colors as default, that's ok

Turn off the taxlot centroids, streets, and taxlots data layers by removing the check beside each of these in the **Contents**. Click the city boundaries (*cities_project*) data layer in the **Contents** and drag it above the county boundaries layer (*counties_project*). The boundaries of the cities within the region are now visible and displayed on top of the county boundaries.

Right-click on the city boundaries file in the **Contents** and select **Symbology**.

The **Symbology** window will appear on the right side of **Map** window. On the **Symbology** window, under **Primary Symbology**, select and **Unique values** in **Symbolize Your Layer by Category** tab. Specify *CITYNAME* in **Field 1** display the city boundaries as a thematic map.

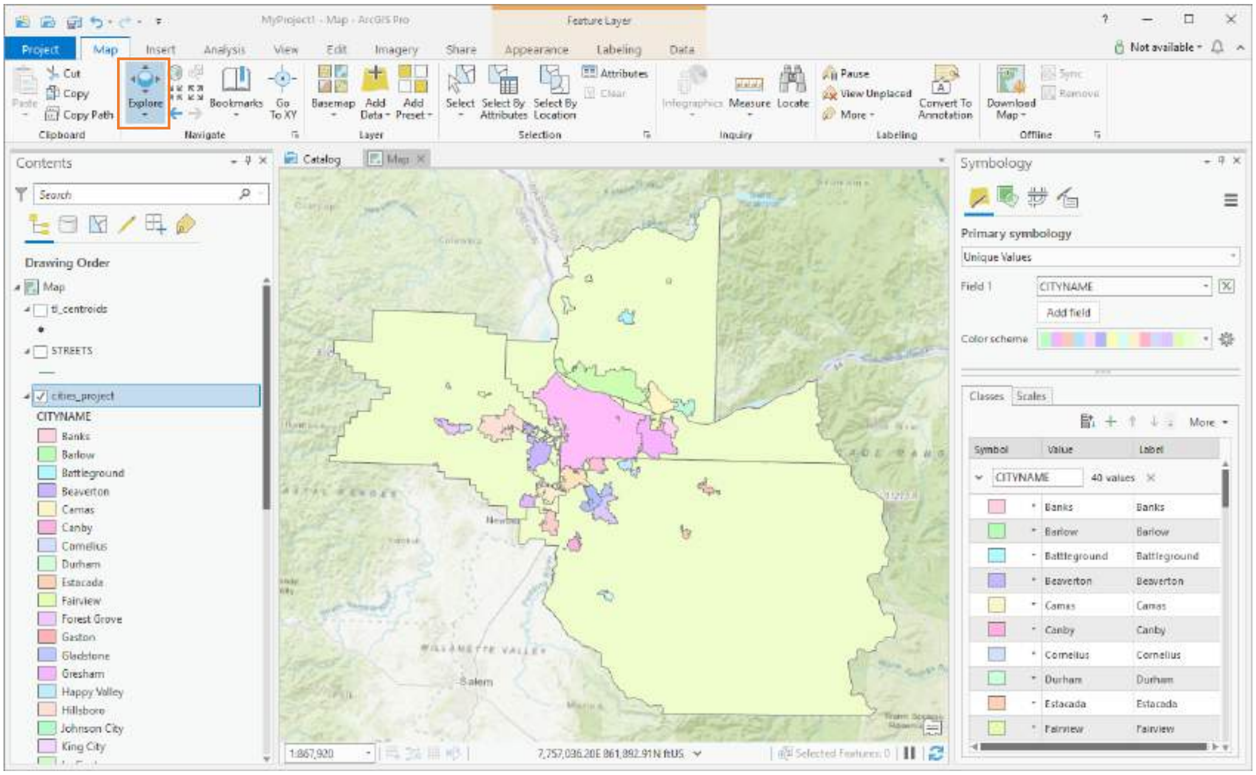


Figure 0.8

Click on the icon for the **Explore** tool (four arrows around a white-blue sphere) under **Map** ribbon and use the cursor to identify any of large cities and pull up information about it. See example below.

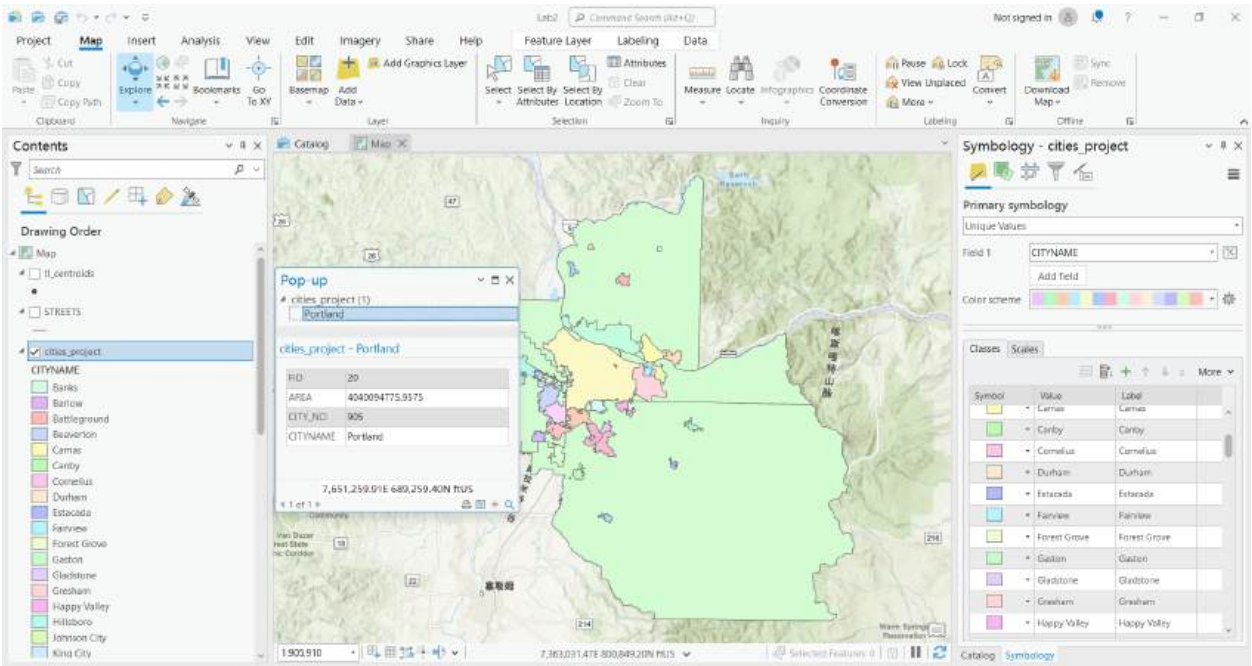


Figure 0.9

Use the **Explore** tool to explore other city and county polygons. Click on the county located in the northwest corner of the display window. This is Washington County, Oregon and will be the focus of the remainder of this exercise.

Task 3: Identify the Taxlots that are within Washington County and that are Single-family Uses

Step 3.1: Right-click on the county boundaries (*counties_project*) layer in the **Contents** and select **Attribute Table**. Next, highlight the row for *Washington Co. (with COUNTY_NO 67)* by selecting the grey cell at the very left. Note that the corresponding polygon is also highlighted in the display window behind your table.

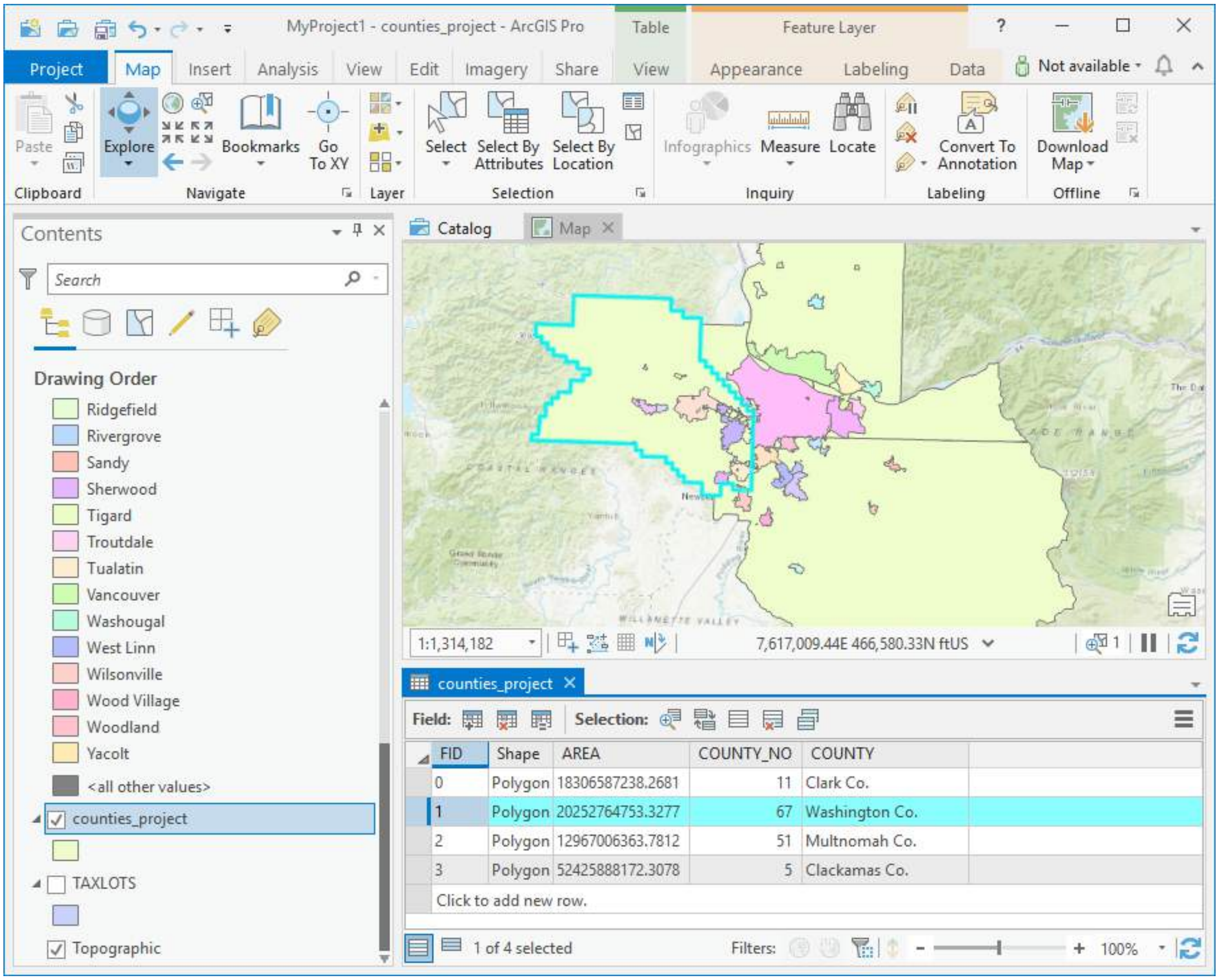


Figure 0.1

Step 3.2: From the **Map** ribbon, choose **Select By Location.** In the **Select by Location** window, specify **Input Features** in the first drop-down field, select *TAXLOTS* in the list. Set your **Relationship** to *completely within.* Then Set your **Selecting Features** to *counties_project* (the county boundaries) and click the **OK** button. The software will execute the selection (i.e., taxlots that are located entirely within the boundary of Washington County). In the attributes table of *taxlots*, a total of 152,425 records should be selected.

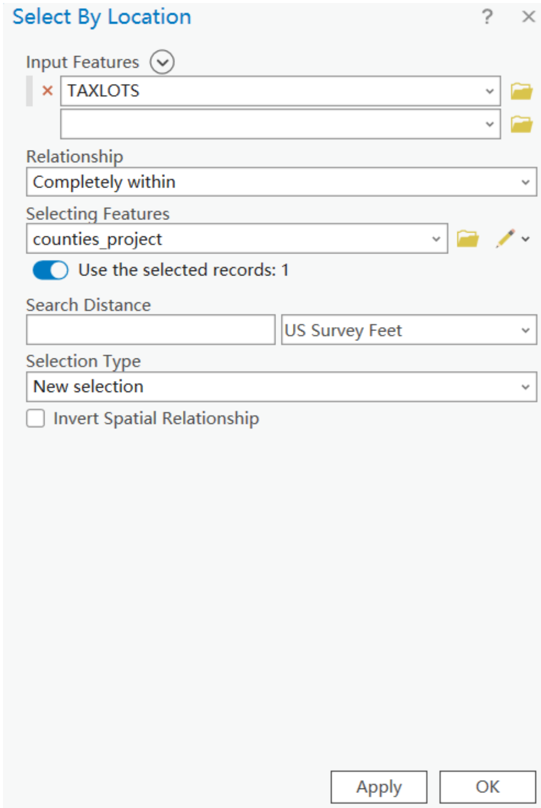


Figure 0.2

Step 3.3: We have successfully selected the taxlots within Washington County. Now, let's further refine the selection to include single-family residential taxlots. From the **Map** ribbon**,** choose **Select By Attributes**. Then specify *TAXLOTS* in the **Input Rows** and choose **Select subset from current selection** in the **Selection Type** field.

Define a new selection clause as shown in 错误!未找到引用源。**.**

Select *"LANDUSE"* from the list of attributes displayed underneath the first field, then specify "*is equal to"* in the second field, also select *"SFR"* in the third field. Click the **OK** button to execute the query.

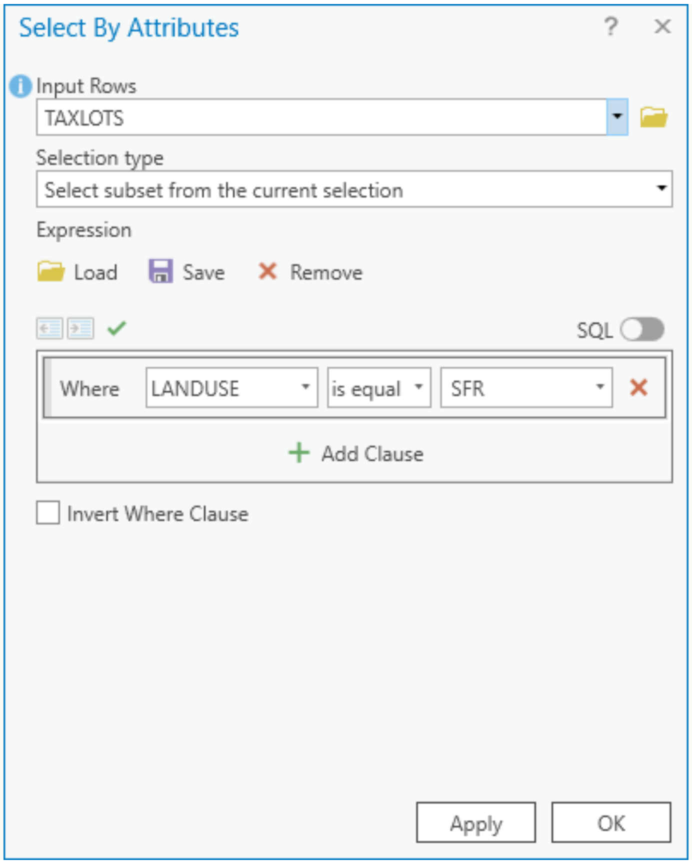


Figure 0.3

Step 3.4: In the attributes table of the *TAXLOTS* shapefile, there are now 106,638 records selected because we have limited the selection to parcels in Washington County that are also under single-family residential use.

In order to preserve our work, we will export the selected tax lots to a new shapefile. Right-click *TAXLOTS* in the **Contents** and select **Data** and **Export Features**. (**Figure3.4**)

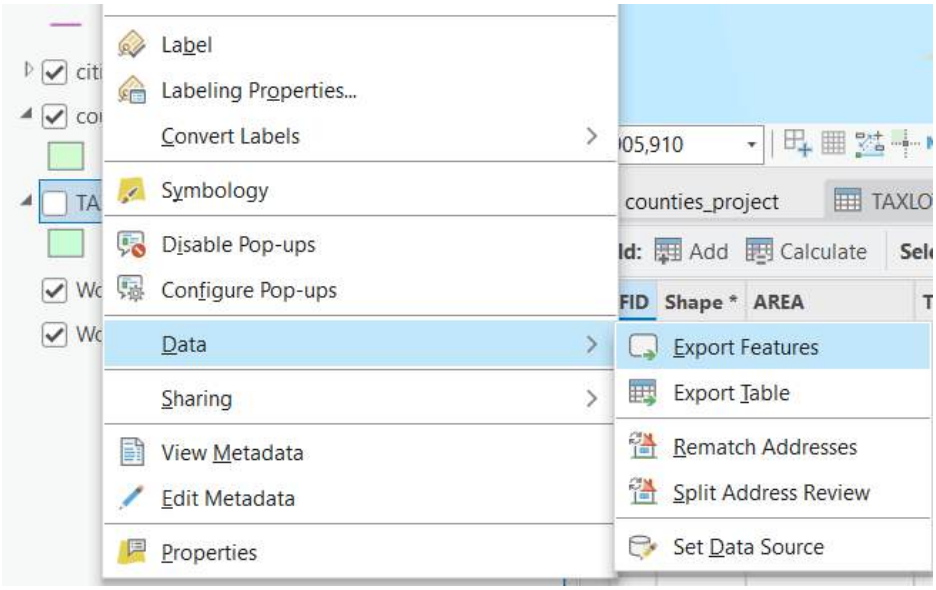


Figure 0.4

In the **Export Features** window, name the newly created shapefile as *washington_sfr.shp* under the **Output Feature Class** field and click **OK**.

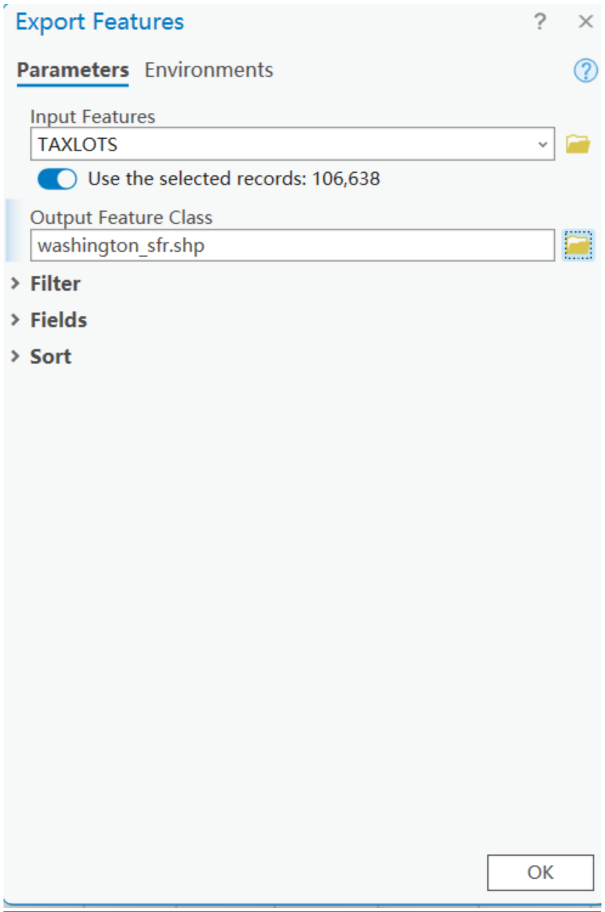


Figure 0.5

The exported data will be added to the map as a new layer automatically, you can find it in the **Contents** window of Map interface.

Task 4: Obtain Information on Time of Development of Single-family Houses and Major Highways

Information on the year in which each taxlot was built (developed) is available from the shapefile of taxlot centroids (*tl_centroids*). Here we need to join the attributes of the *tl_centroids* dataset to the newly created *washington_sfr* dataset and to extract major highways from the *STREETS* dataset.

Step 4.1: Right-click *washington_sfr* in the **Contents** and select **Joins and Relates** and **Add Join**.

In the **Input field**, select TLID as the target field.

In the **Join Table**, specify *tl_centroids* and in the **Join field**, choose *TLID*.

Both shapefiles share a common attribute, which is the unique identifier for each taxlot. This is the attribute that will be used to execute the join. Uncheck the box in front of "**Keep all input records**", so only the matched records will be shown after join. Click the **OK** button to perform the join operation.

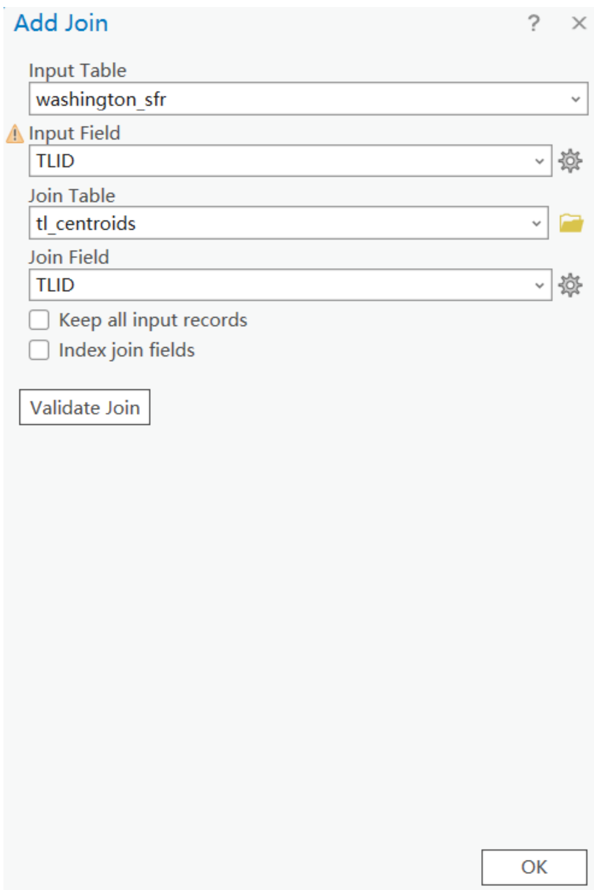


Figure 0.1

Now the *washington_sfr.shp* will have *YEARBUILT* field identifying the year in which each taxlot was built.

Step 4.2: Next, we will extract major highways from the street network shapefile.

From the ribbon, choose **Select By Attributes**. In the **Select By Attributes** window specify *STREETS* in **Input Rows** field and **New selection** in the **Selection Type** drop-down field.

Begin building the select statement by clicking **New expression,** select *"FTYPE"* from the list of attributes displayed underneath the first field, then specify "*is equal to*" in the second field, also select *"HWY"* in the third field. Click the **OK** button to execute the query.

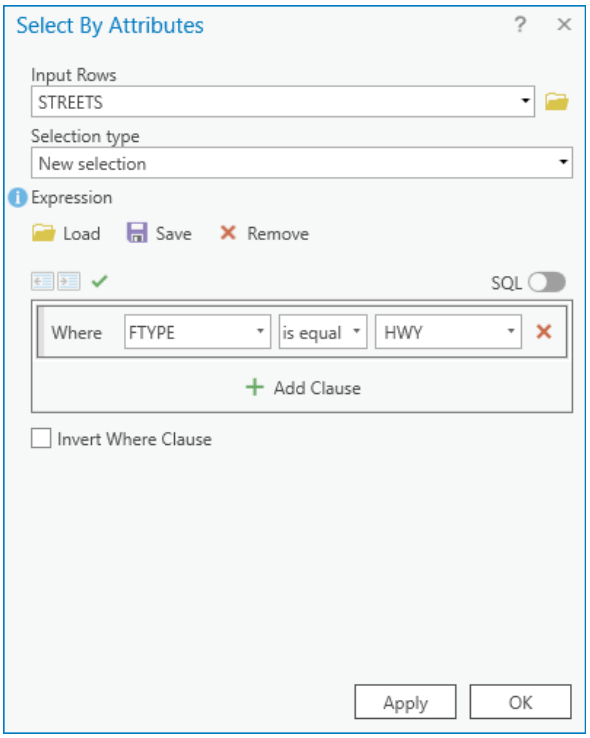


Figure 0.2

Step 4.3: In order to preserve our work, we will export the selected highways to a new shapefile.

Right-click *STREETS* in the **Contents** and select **Data** and **Export Features**. Use *freeways.shp* as the name for the newly created shapefile and make sure Output Location is specified as the location of data for this exercise.

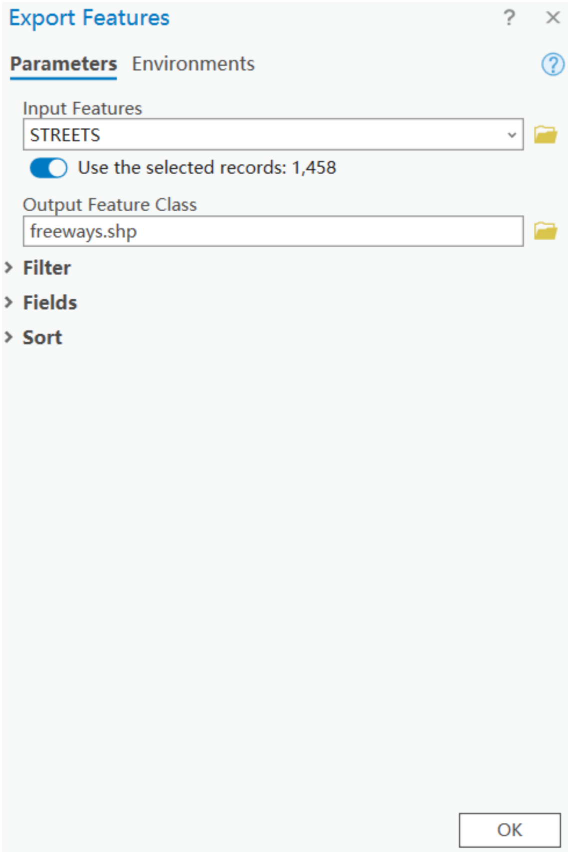


Figure 0.3

Finally, click **OK** to add the newly created shapefile to **ArcGIS Pro** .

Task 5: Create a Thematic Map

The final task is to create a thematic map documenting and communicating temporal and spatial trends in single-family residential development within Washington County. These guidelines are meant to serve as general instructions, so be creative in the design and presentation of the data.

Step 5.1: Right-click the *washington_sfr* data layer in the **Contents** and select **Symbology** to color the map. On the **Symbology** window, select **Symbolize your layer by quantity – Graduate Colors** and specify *YEARBUILT* in the **Field** drop-down field.

By default, the field is classified by *Natural Break(Jerks)* method with 5 classes. The break values are shown under **Classes** tab.

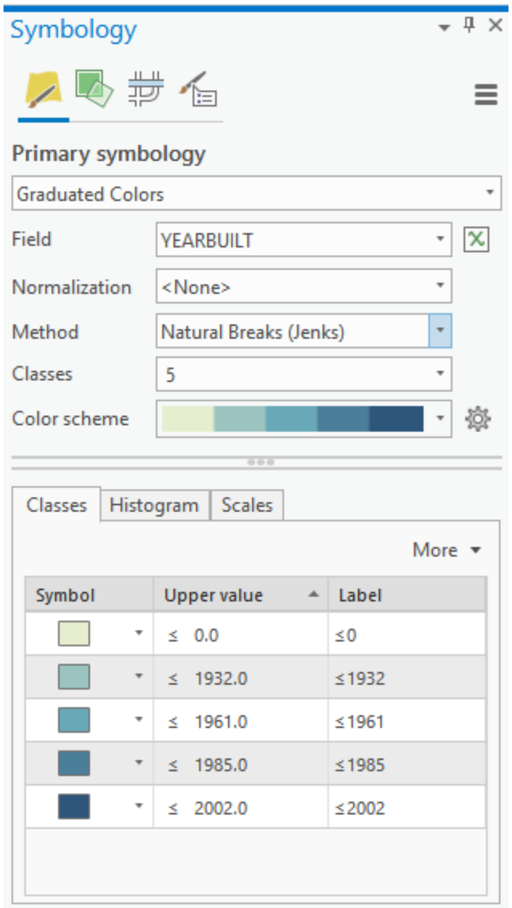


Figure 0.1

In order to optimize the break values, please change **Method** to Manual Intervals, and overwrite the existing **Break Values** under Classes Tab with these: *1934, 1954, 1974, 1994, 2003* (change the second value first, from *1932* to *1954*, then change the first value from *0* to *1934*, *1961* to *1974*, *1985* to *1994*, and *2002* to *2003*).

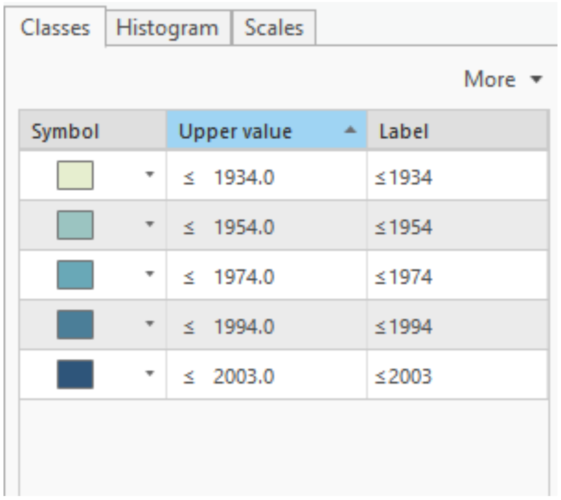


Figure 0.2

Step 5.2: Now, we can modify the colors used to shade the taxlots. Click each of the symbols underneath the **Symbol** to format symbol (**Figure 5.3**).

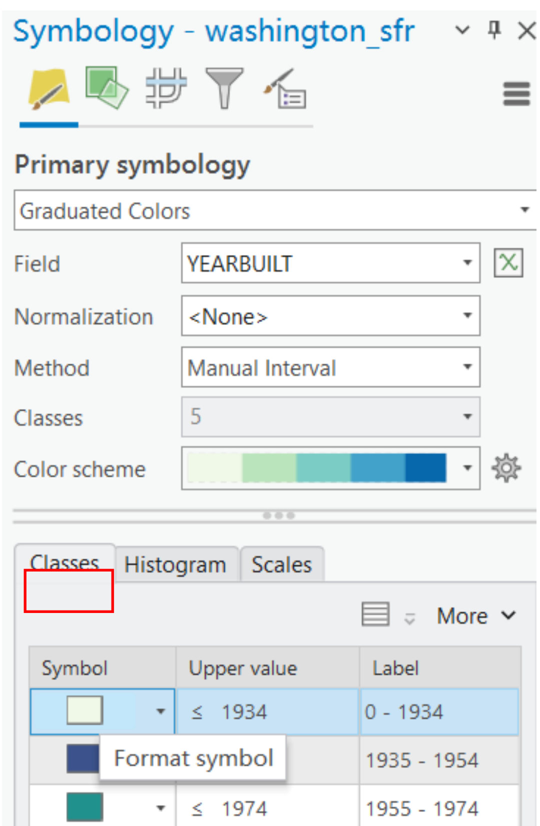


Figure 0.3

Then switch from default **Gallery** tab to **Properties** tab. Set the **Outline Color** for each of the symbols to **No Color** to avoid displaying the outline of each taxlot in the map, then click **Apply** button.

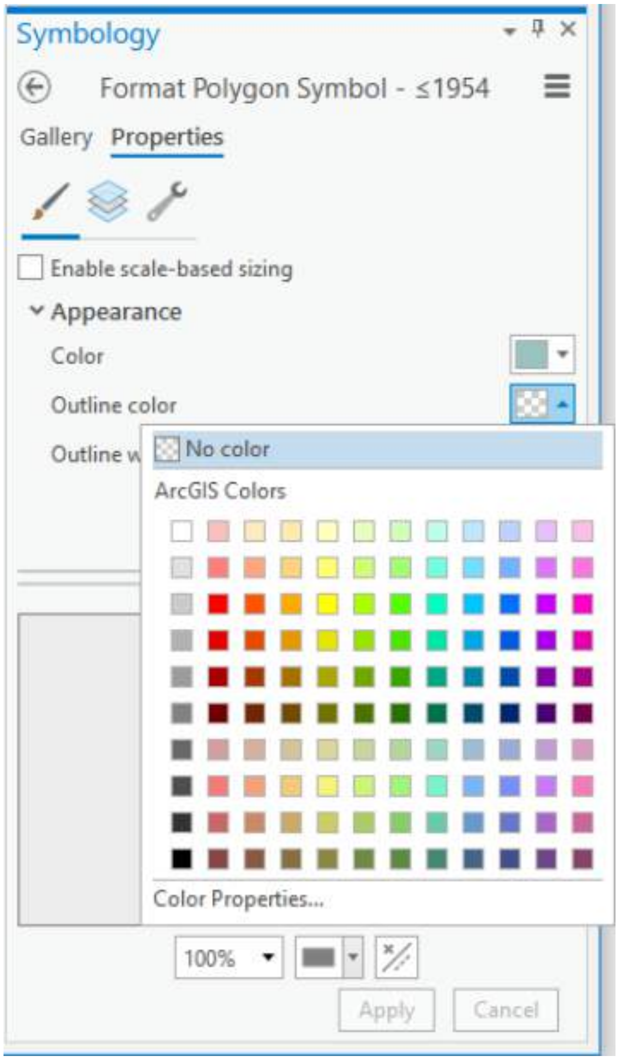


Figure 0.4

Be creative in your choice of colors for each of the time periods you will be displaying in your thematic map.

Step 5.3: Right-click the *cities_project* data layer in the **Contents** and select **Symbology** to bring up the **Symbology** window.

On the **Symbology** window, select **Symbolize your layer with one symbol – Single Symbol** in **Primary Symbology**. Click the **Symbol** patch button and change the **Color** to *Yellow*, for example.

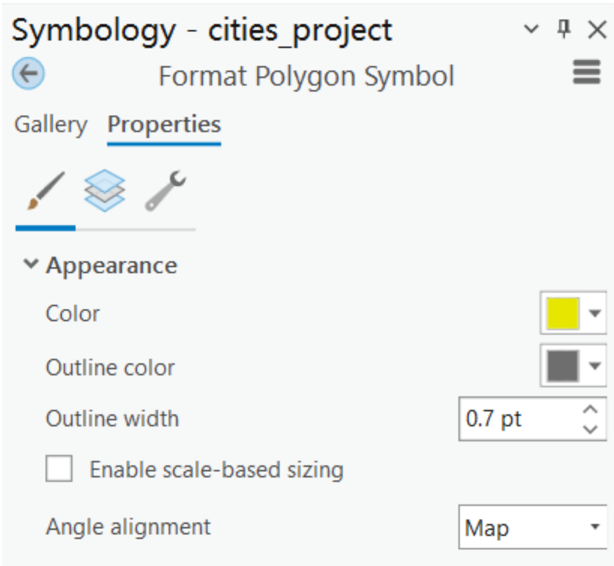


Figure 0.3

Step 5.4: In order to prepare the map for print purpose, a **Layout** has to be created for organizing all elements (map, legend, title, etc.).

Switch to **Insert** tab on the ribbon and click **New Layout** to create a paper space. After that, choose **Letter Size** under **ANSI-Landscape**.

When the layout is created, you can use **Map Frame** under **Insert** ribbon to place our map onto the paper, then draw a box on the map to determine the approximate location of your map. The map content should appear in the **Contents** window.

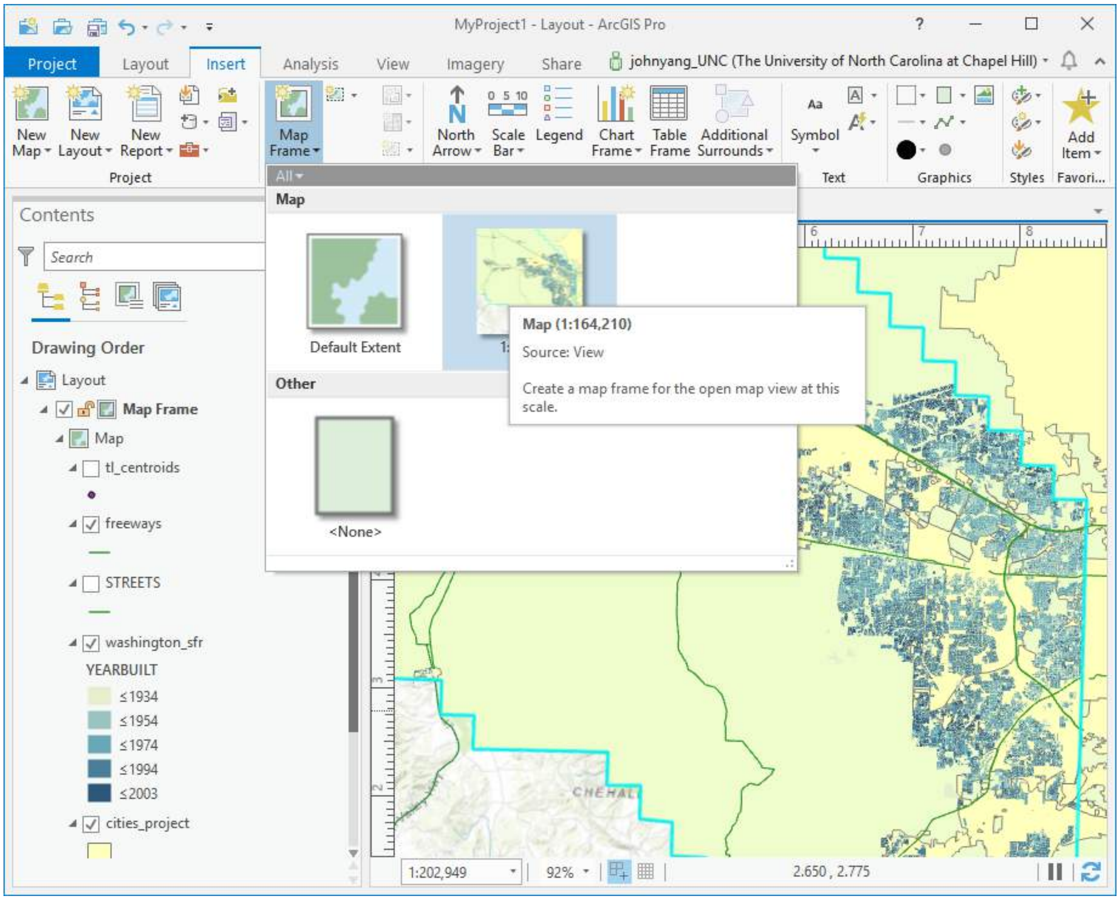


Figure 0.4

Step 5.5: Right-click on the **Map Frame** in **Contents** window and choose **Properties**. Next, click on the **Placement** tab and enter *9 in* and *7 in* in the **Width** and **Height** fields.

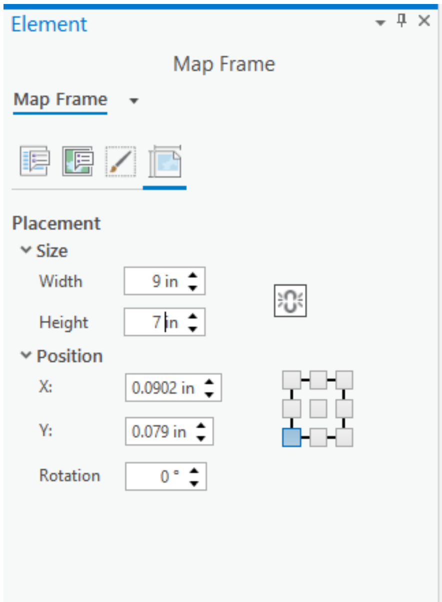


Figure 0.5

Step 5.6: Next, we will add a second map frame to show the location of current mapping area (Washington County) in relation to the larger region.

To add a new map frame, select **Insert** then **New Map – New Map** from the ribbon, a new map tab should pop up. Then, add *counties_project.shp* and *MET_FILL.shp* (this is metropolitan area boundary) to the new map frame by clicking **Add Data – Data** button on the ribbon**.**

At last, right click **Map1** in **Content** window and select **Properties.** Rename the name field to "Inset Map" in General tab, then click "OK" button to continue.

After the inset map is prepared, we will insert it into the previous layout. Switch to **Layout** tab in the working area. Next, click **Map Frame** button under **Insert** ribbon, select the map under "**Inset Map**" and locate it on the paper space (**Figure5.7**).

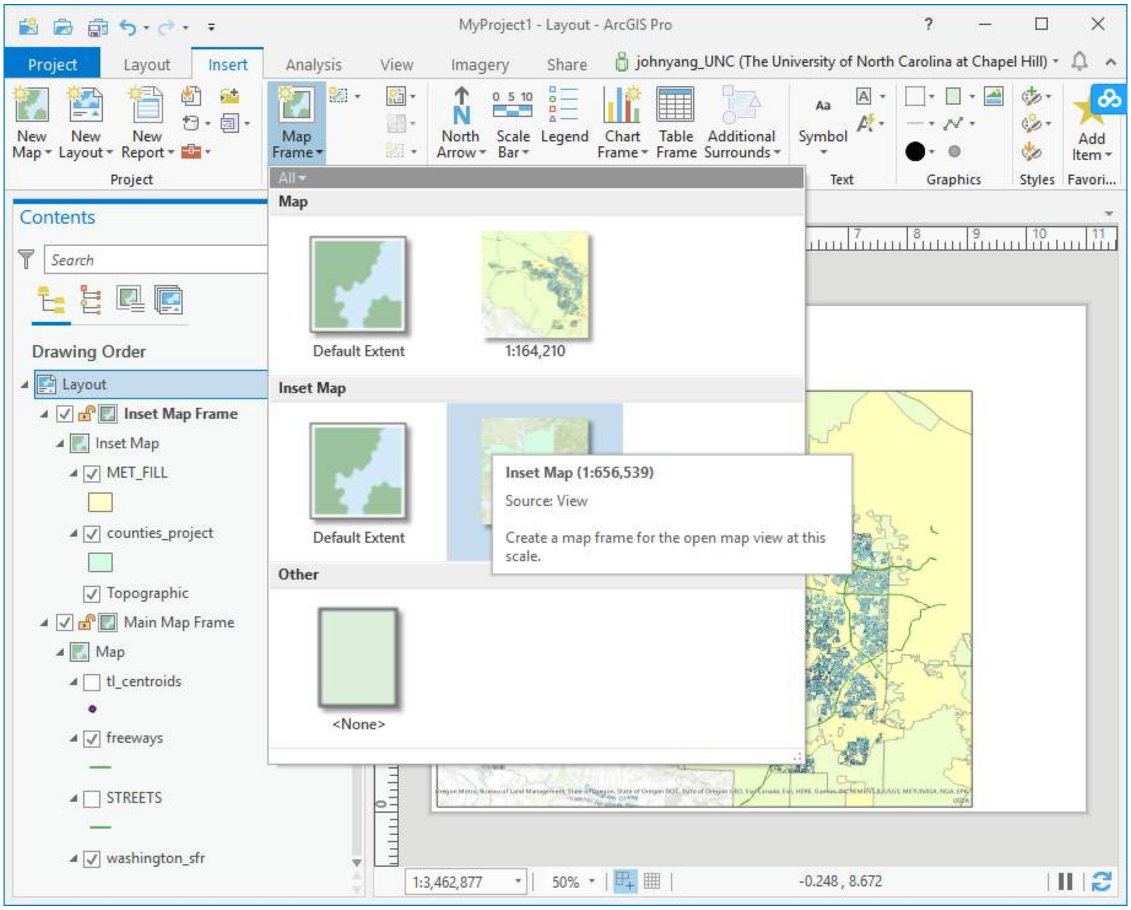


Figure 0.6

Then, rename the main map frame to "*Main Map Frame*" by clicking "*Map Frame*" and type the new name. Please rename the inset map frame name to "*Inset Map Frame*" in the same way.

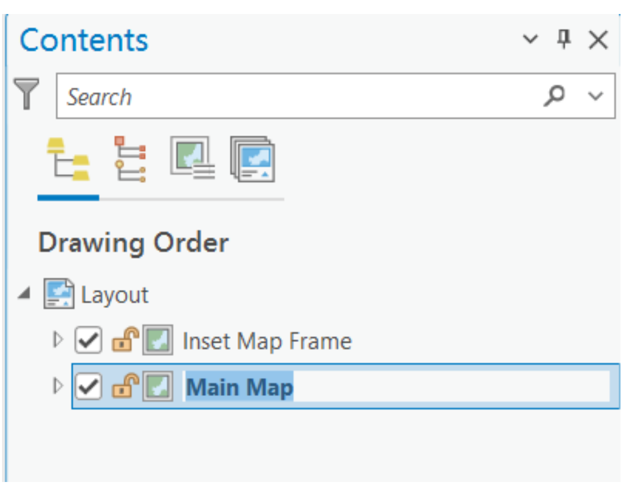


Figure 0.8

Step 5.7: We want to show Washington County's location within the region as an inset of the larger thematic map.

To accomplish this, click **Inset Map Frame** in **Contents** window to select it, then click **Extent Indicator** button under **Insert** ribbon, and select *Main Map* Frame (the name of your first map frame) in the drop-down list. The location box of main map will show up in the inset map.

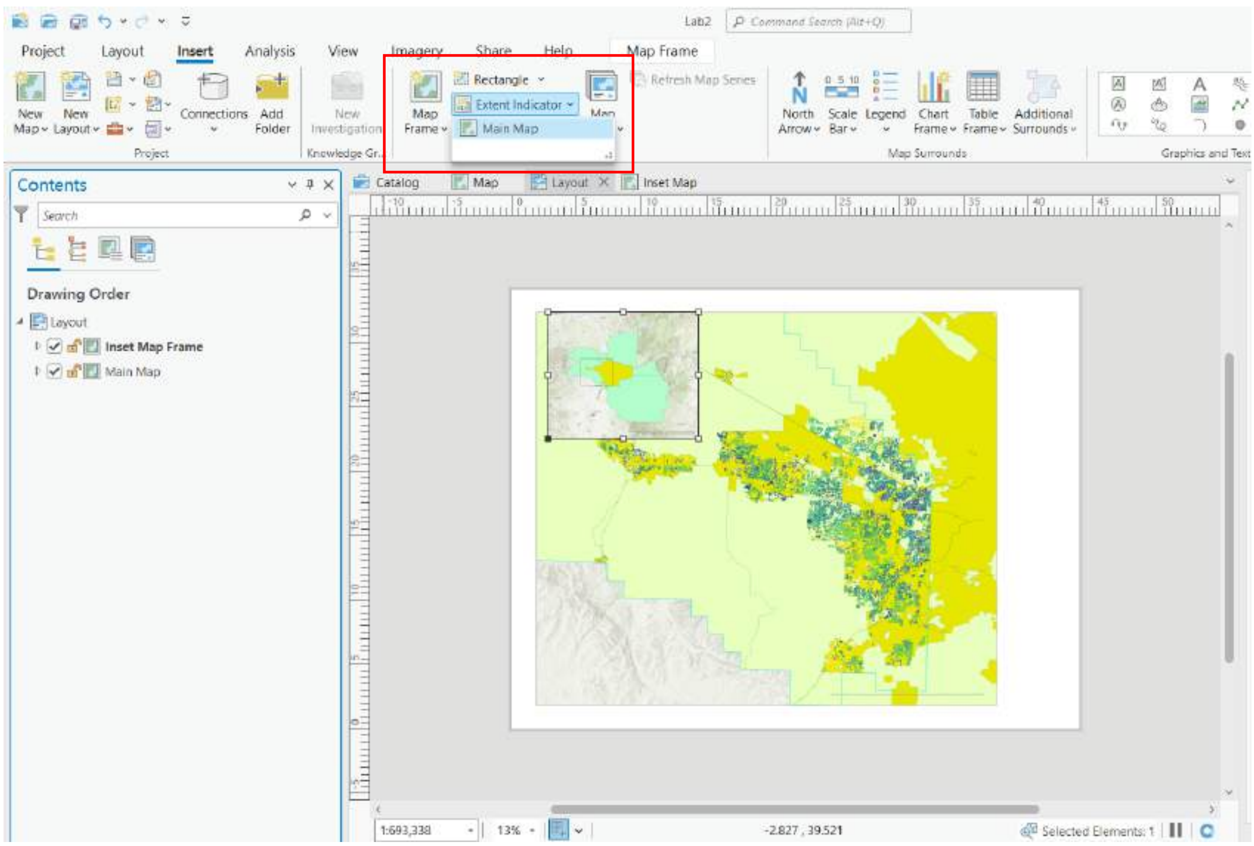


Figure 0.7

You can right click "Extent Indicator of Main Map Frame" and select **Properties** to change the look of the extent indicator.

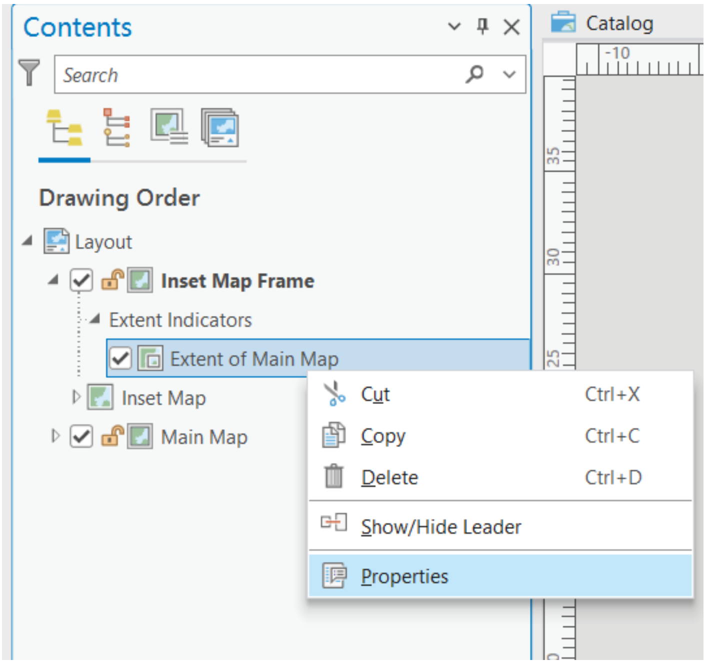


Figure 0.9

Step 5.8: Select the inset map frame in the working area with the cursor and drag it to the upper left side of the **Layout**, then move main map frame to the center of the **Layout**.

You may also choose to modify the inset by: changing the order of shapefiles in **Contents** (First select Inset Map Frame**,** then move *MET_FILL* up by drag-and-drop it before *counties_project*), changing the symbol of the shapefile (**Symbology**), etc.

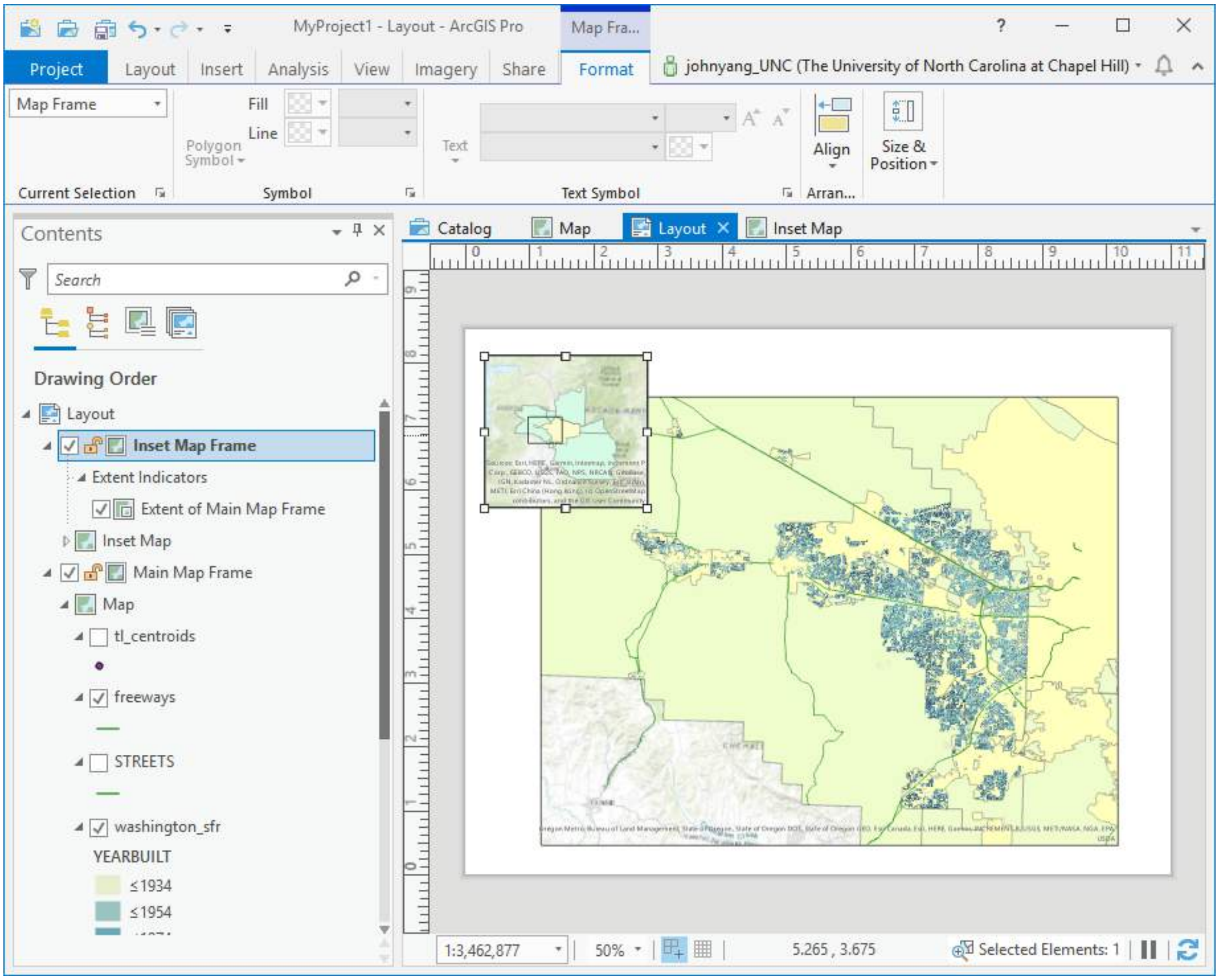


Figure 0.8

Step 5.9: In the **Contents**, highlight **Main Map Frame**. Add a North arrow by clicking **Insert** ribbon then **North Arrow**.

Choose a North arrow, and click any location on the paper space, a North arrow will appear in the map. Use the cursor to resize and drag the North arrow into place on the map.

Add a scale bar by clicking **Insert** then **Scale Bar** from the ribbon. Optionally, click **Properties** to modify the scale bar's properties and use the cursor to select and reposition within the paper space.

Make sure the layers, *washington_sfr*, *cities_project* and *freeways* are checked under **Main Map Frame** in the **Contents**. Add a legend by clicking **Insert** then **Legend** and following along with the **Legend** window.

In the **Contents** window, you can uncheck the layers you don't need legend under **Legend** layer below **Layout.** For this exercise, we only need to check *washington_sfr, cities_project,* and *freeways.*

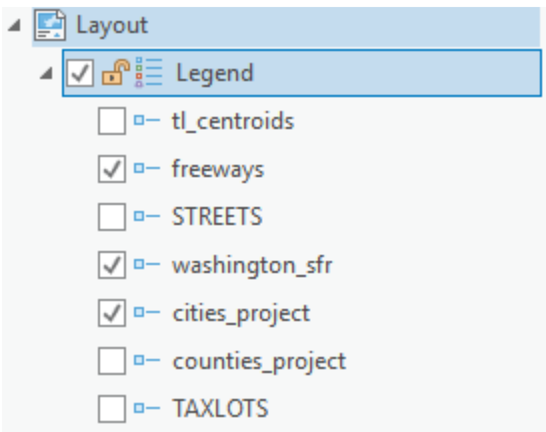


Figure 0.9

We will also rearrange the elements in the **Legend** window on the right side, see for detail settings.

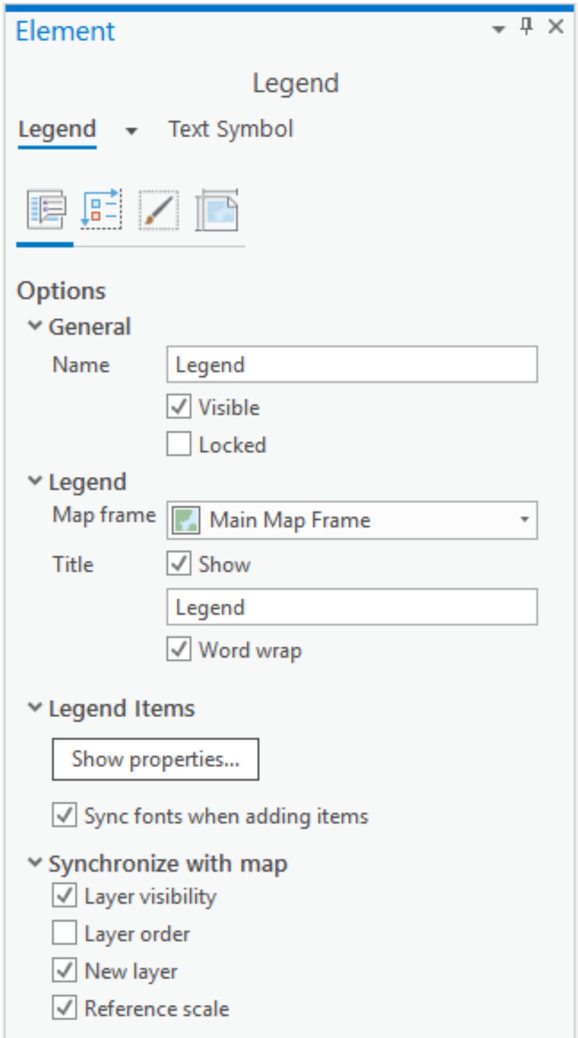

Element
Legend
Legend
Text Symbol
Options
General
Name
Legend
Visible
Locked
Legend
Map frame
Main Map Frame
Title
Show
Legend
Word wrap
Legend Items
Show properties...
Sync fonts when adding items
Synchronize with map
Layer visibility
Layer order
New layer
Reference scale

Figure 0.10

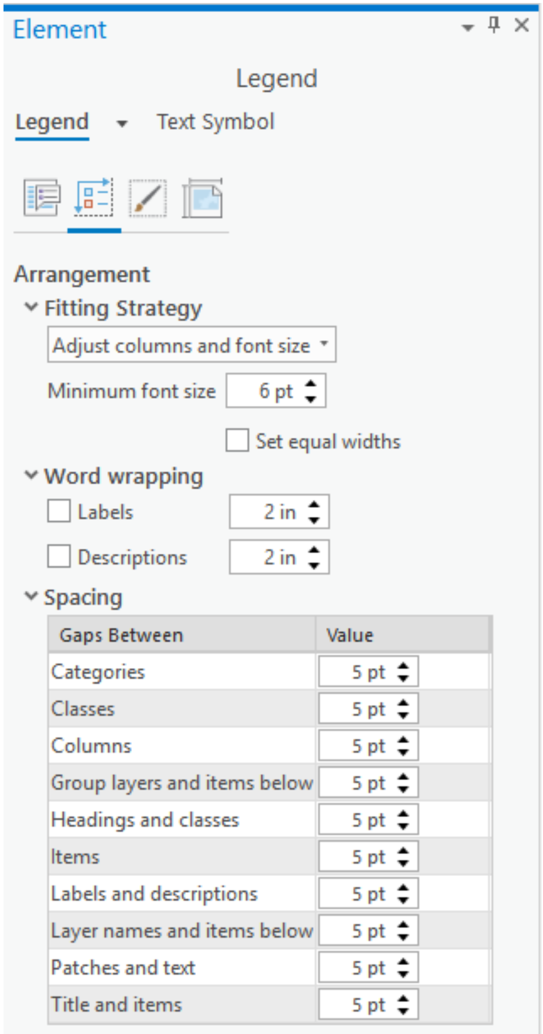


Figure 0.11 Arrangement Settings

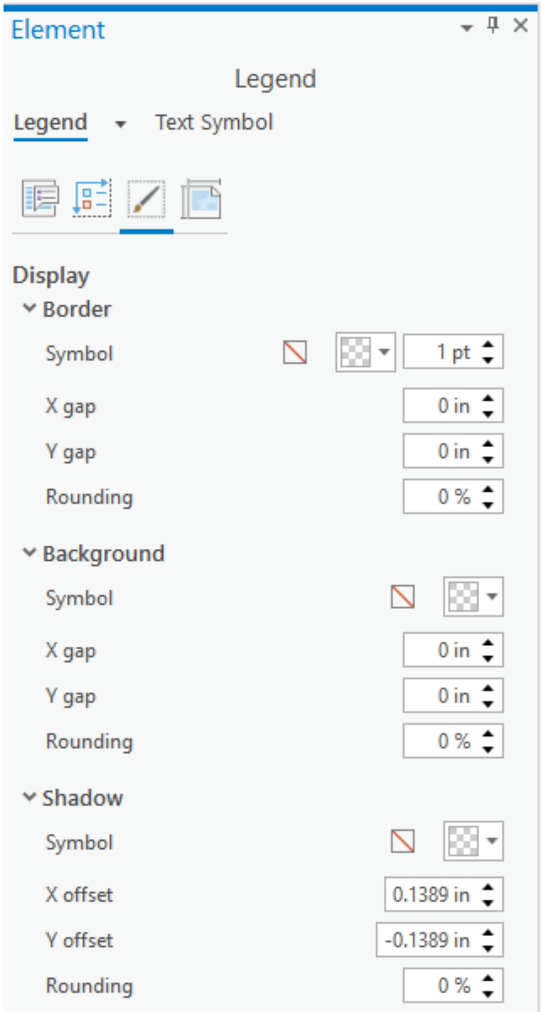


Figure 0.12 Display Settings

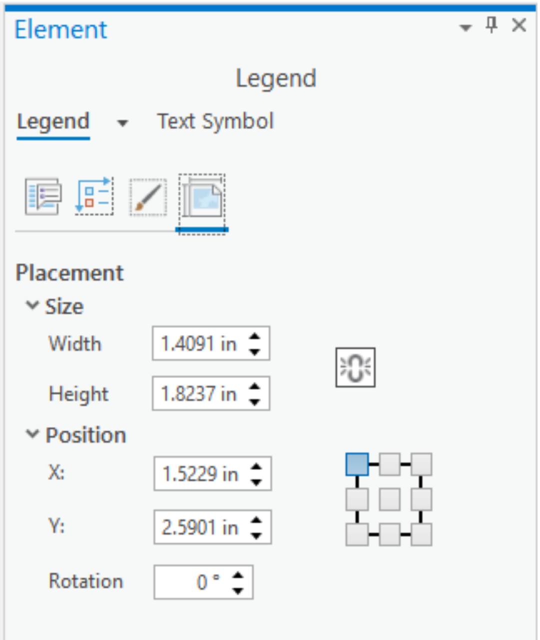


Figure 0.13 Placement Settings

Step 5.10: Use the cursor to drag the legend to an appropriate location within the **Layout**. We need to modify the legend, but first we must convert it to graphics by right-clicking on it and selecting **Convert To Graphics**. Then right-click again and select **Ungroup** so that each element of the legend can be manipulated individually.

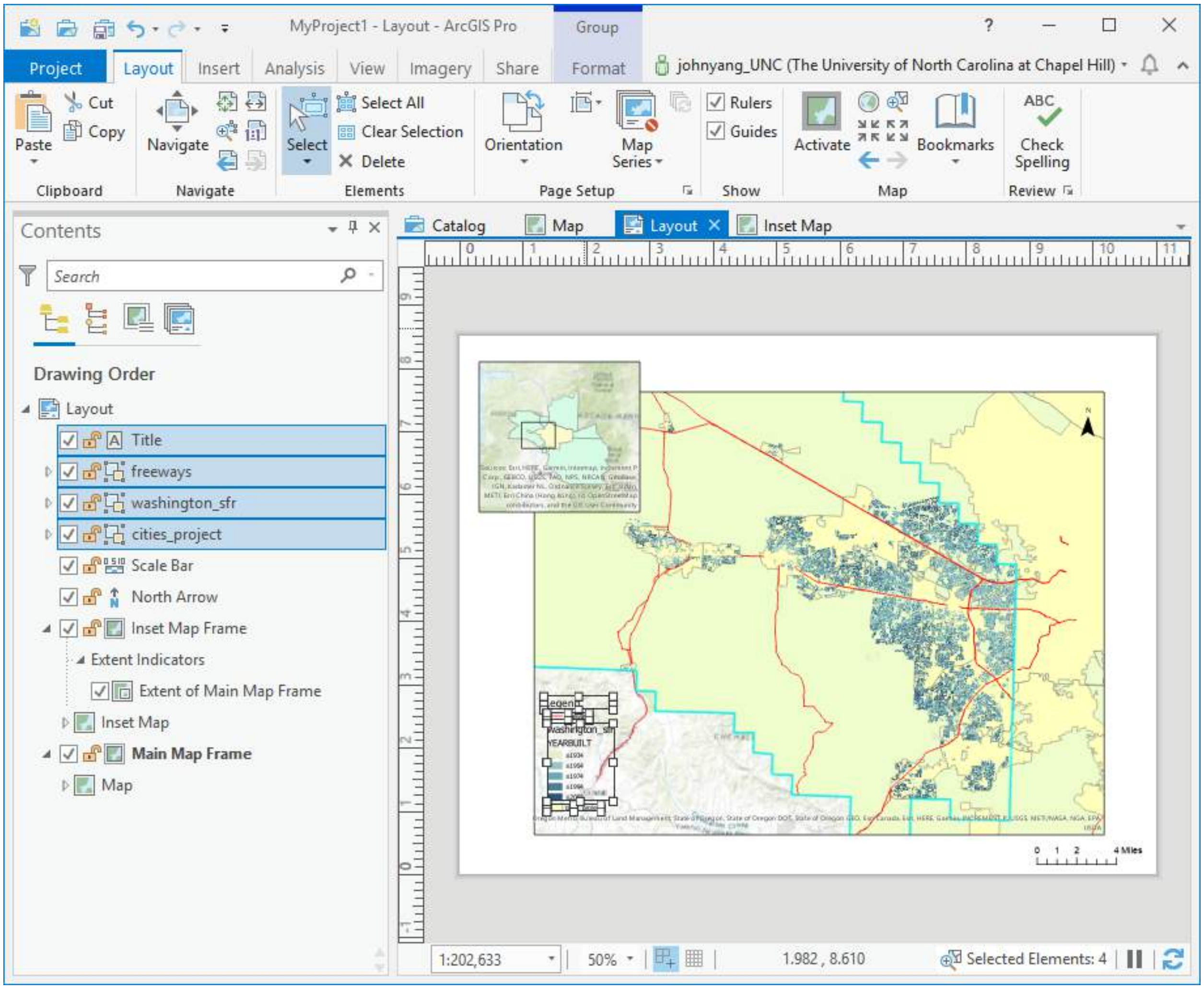


Figure 0.14

For example, change the default legend entry *YEARBUILT* to *Developed Parcels* by UNGROUP again to separate the symbol and text, then right clicking the text component. Select **Properties** and replace the existing text with *Developed Parcels* (for example). Or, an easier way to change legend text is simply double clicking the target text to activate rename.

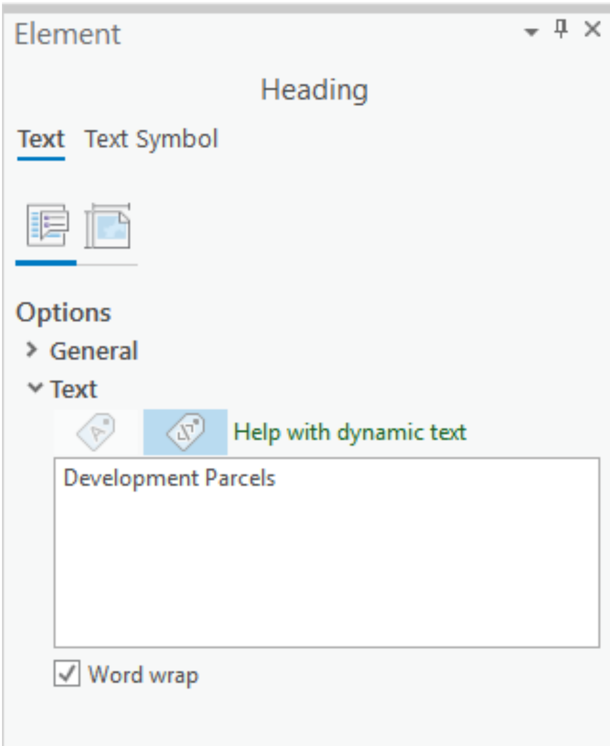


Figure 0.15

To change label *cities_project* to *City Boundary*, first select *cities_project* legend component, right-click to select **Ungroup**, then right-click the text component. Select **Properties** and replace the existing text with "*City Boundary*".

Use the same approach to change label *freeways* to *Major Highways*. Select the legend entry **washington_sfr** and delete it and move the other parts of legends to appropriate location. Finally, use the cursor to select all the elements of the legend (selecting each while holding *alt* key), right-click and select **Group**. You can now move the legend as a single entity again.

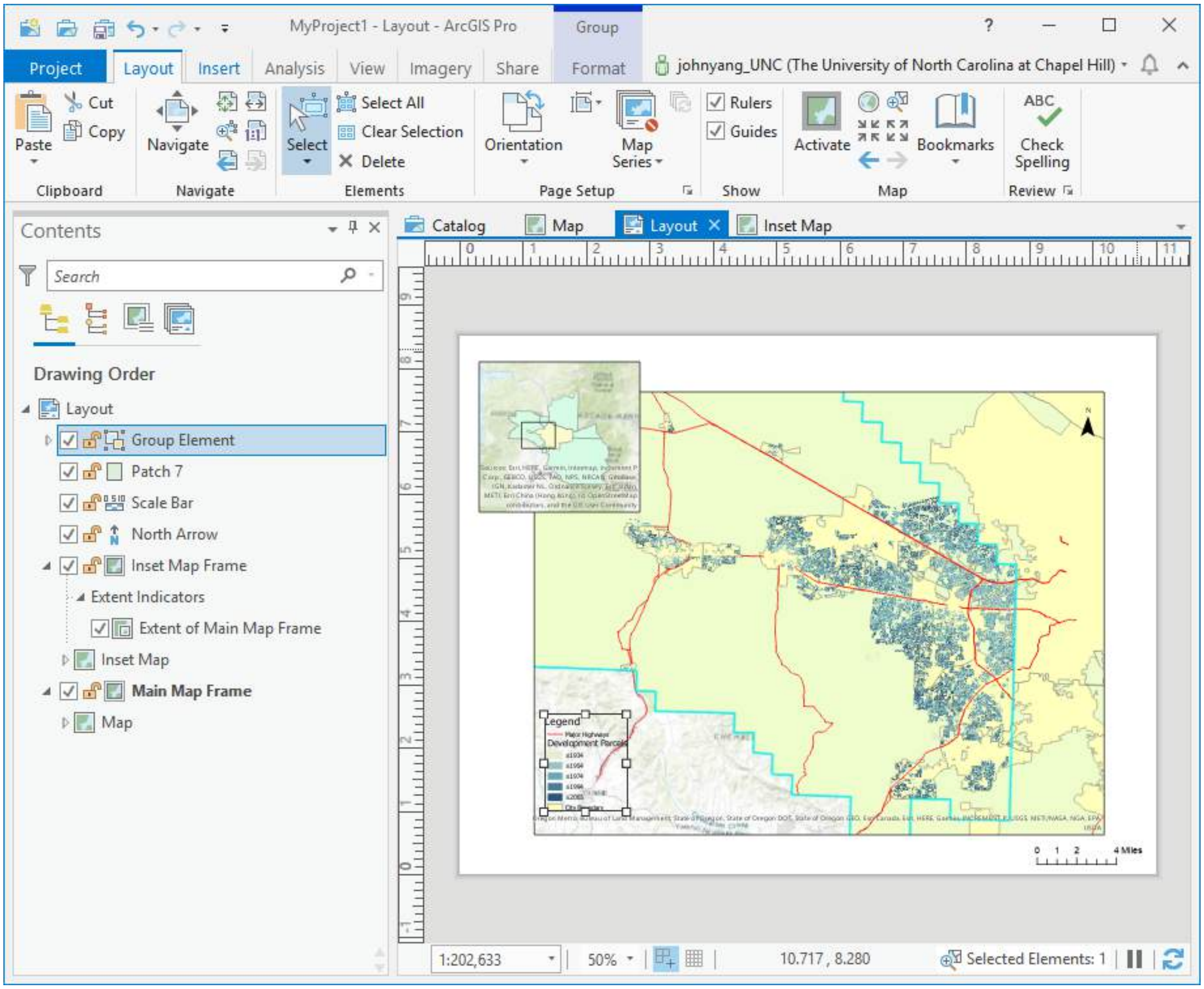


Figure 0.16

Step 5.11: Right-click *cities_project* in the **Contents** and select **Label**, so that we can see the name of cities on the map.

Edit the labels by right clicking *cities_project* in the **Contents** and select **Label Properties.** The **Label Properties** window have three tabs, you can change the labeling field in **Class** tab, modify the symbology of labels in **Symbol** tab, and choose label locations in the **Position** tab.

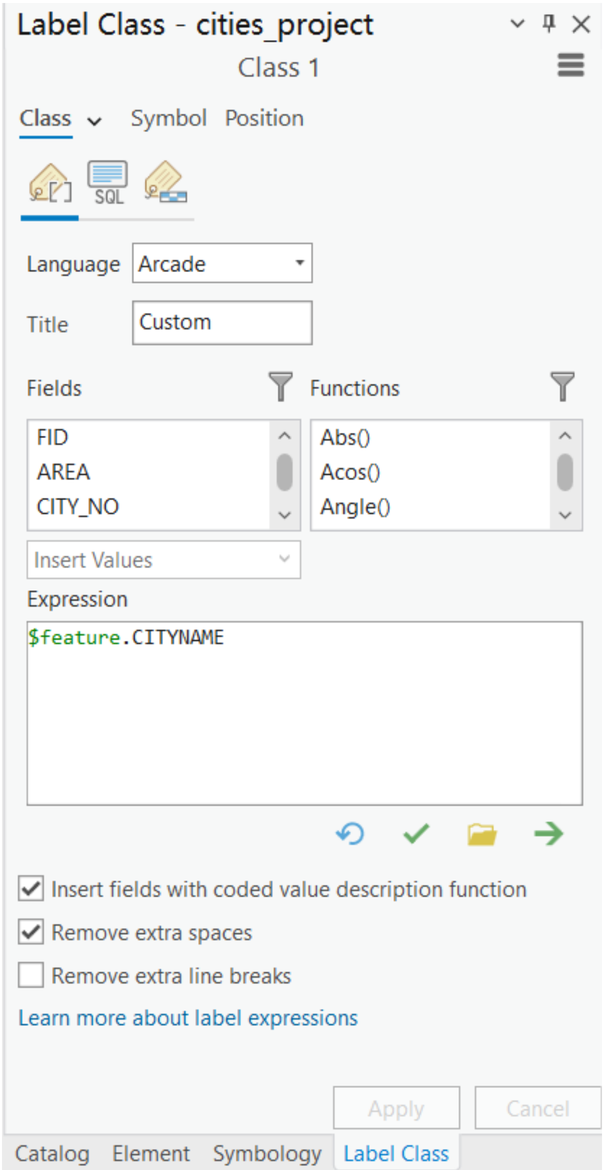


Figure 0.17

Step 5.12: You can move the topographic map credit out of the map by selecting **Dynamic Text** then **Service Layer Credit** in the **Insert** Ribbon. Then the credit text will be a moveable text box, you can relocate it to the corner of the **Layout**, so that the credit text will not interfere with other map contents **(Figure 5.21**).

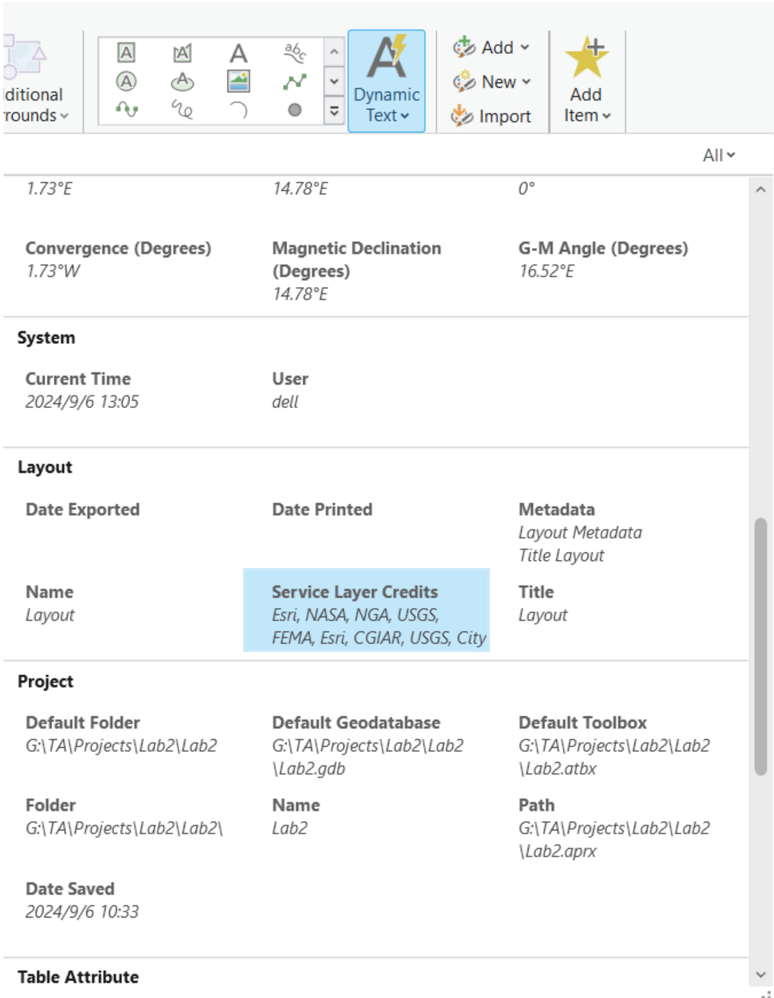


Figure 0.18

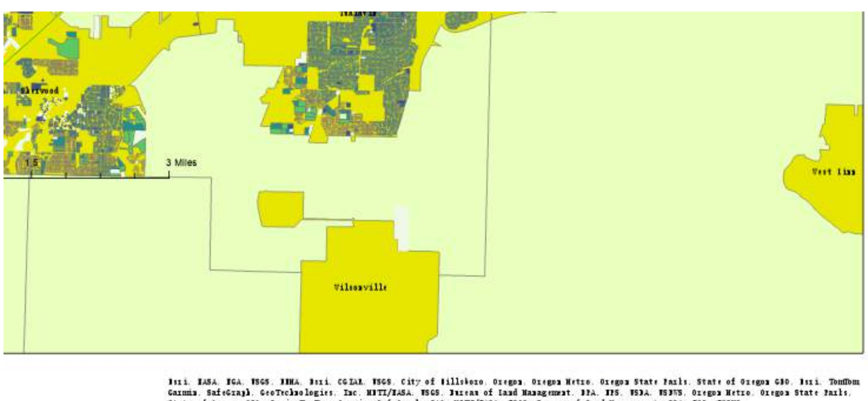


Figure 0.21

Step 5.13: You can also annotate the map by adding a textbox, select rectangle text in **Graphics and Text** under **Insert** tab.

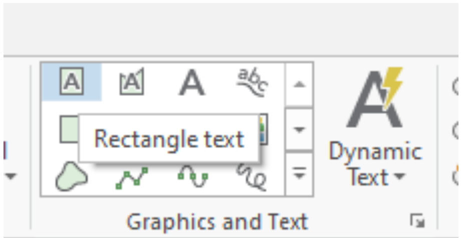


Figure 5.22

The **Group** function (by right clicking object in the layout) can combines two or more objects and treats them as a single object. This is useful for rearranging map elements such as annotation text in the overview map (inset).

Finally, you can also use **Rectangle Text** to specify a title for your thematic map.

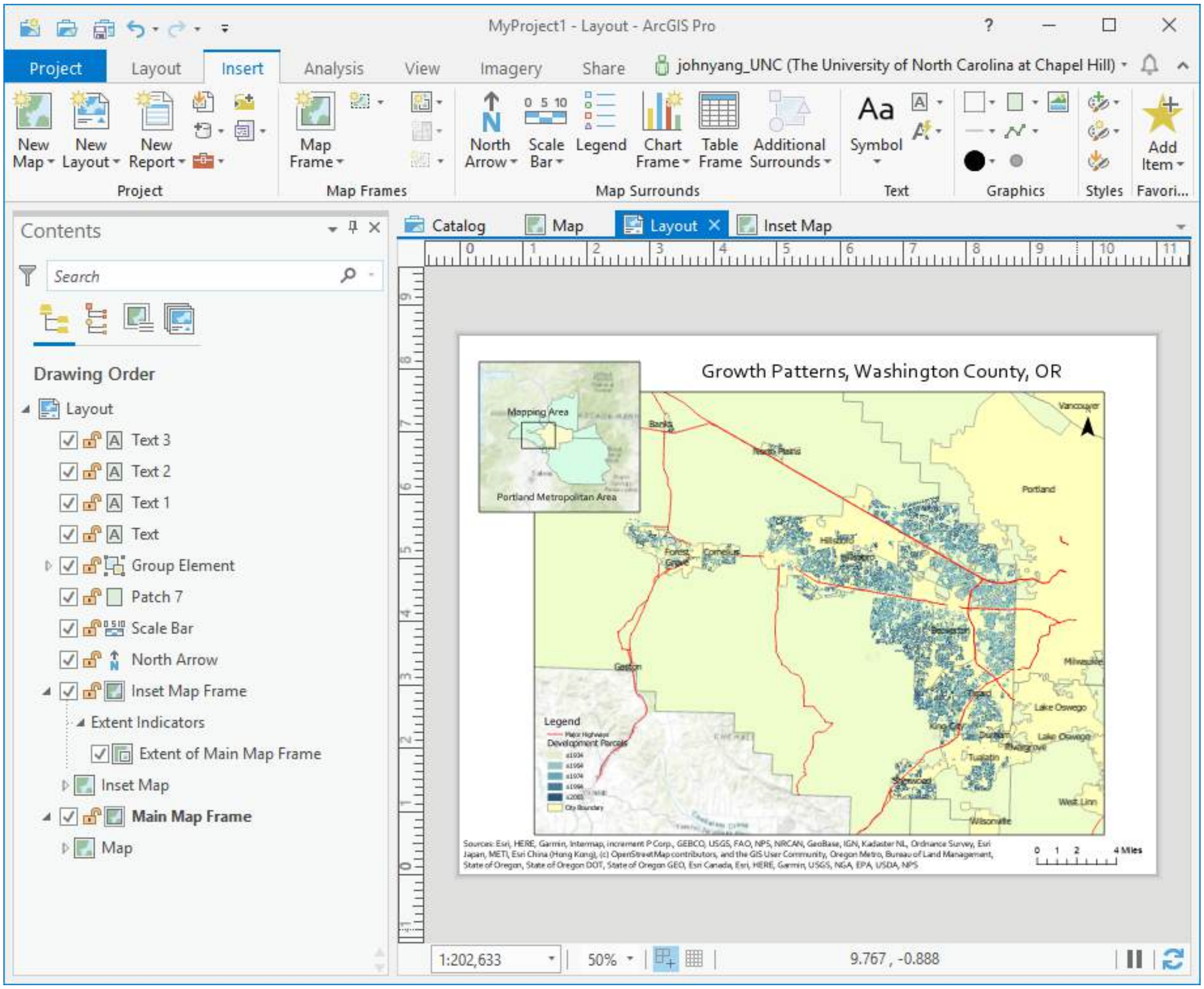


Figure 0.23

Step 5.14:

- The final map should contain single-family residential taxlots within Washington County shaded according to the year in which they were built (developed).
- It should also display the names of cities within Washington County and the immediate vicinity, as well as major highways.
- The map should include an inset that shows the location of Washington County within the larger four-county region along with appropriate annotation text.

- Finally, standard map elements such as a title, north arrow, legend, and scale bar should be included.

- The final map can be exported to variety of graphics formats including: JPEG, GIF, TIFF, and EMF. This is accomplished by choosing **Share** from the ribbon and selecting **Export Layout**.

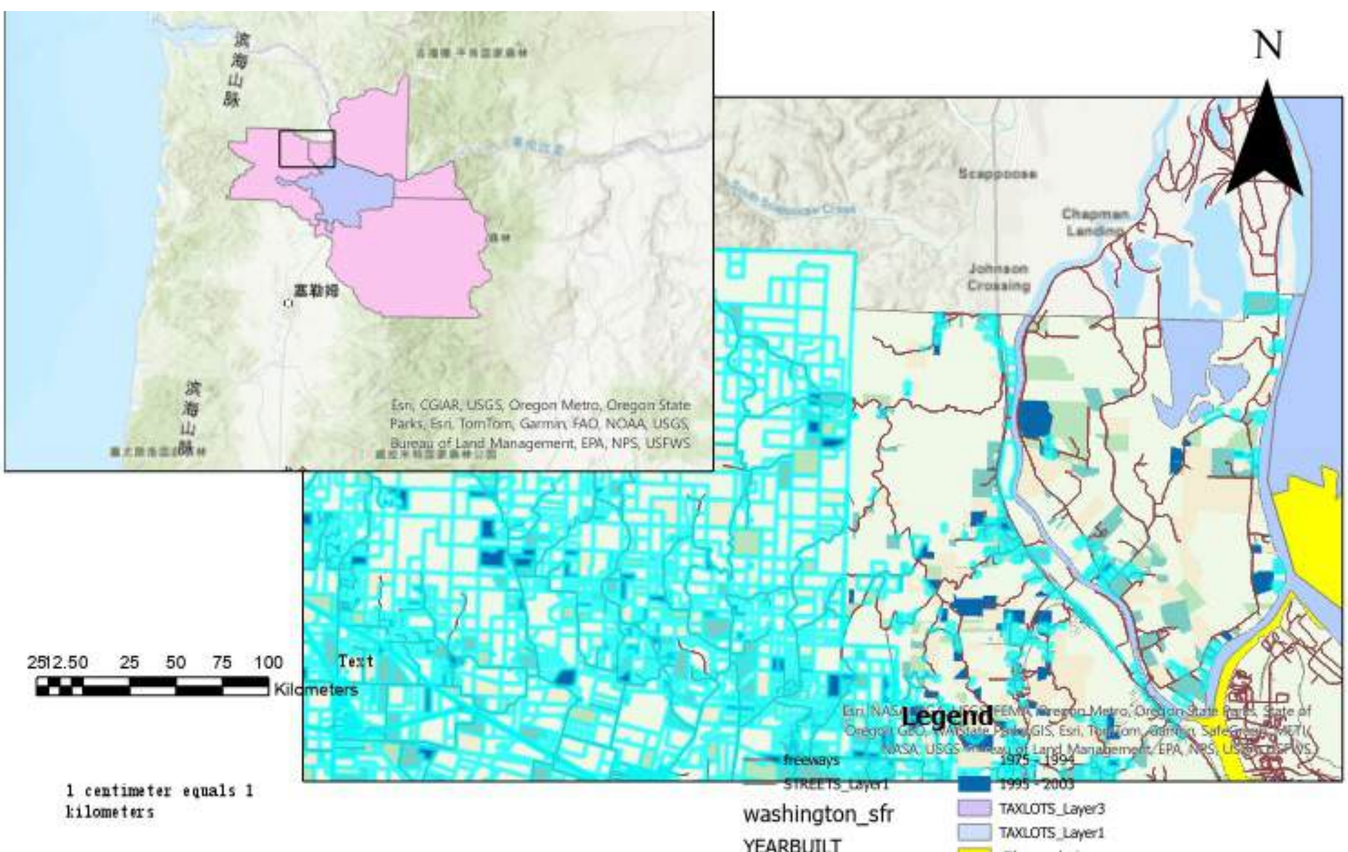
SUMMARY

This exercise introduces many of the basic functions and features of the **Map** and **Catalog** components of the **ArcGIS Pro**. The exercise used data at a variety of scales to explore and document temporal and spatial trends in the pattern of single-family residential development within Washington County, Oregon. This exercise also demonstrates the utility of spatial data and geographic information systems for planning practice as a tool for monitoring and understanding urban growth.

ASSIGNMENT

Submit a map to be graded after Step 5.14, and a **short paragraph** explaining your findings.

Please compile the map and accompanied explanation into a document named ***studentID_name_lab2.docx***, and then submit it through the **Canvas** platform in the '*Lab2 Assignment*' task before the deadline.



Spatial Data Representation

Spartial Data Representation

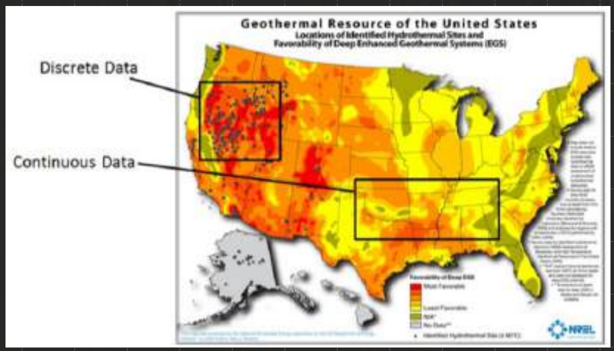
· Geographic data link place, time and attributes

e.g. Information in right graph: The temperature at local time noon on December 2, 2014, at latitude 34 degrees 45 minutes north, longitude 120 degrees 0 minutes west, was 19 degrees Celsius. specific location attributes

· Mount Everest is 8848 m high

Note: ① The world is infinitely complex, but computer systems are finite. ② Representations must somehow limit the amount of detail captured

· Two Conceptual Views 概念的 < discrete objects / continuous fields



Discrete: boundary, scattered points 散点, commutable 可数

Continous: coverage

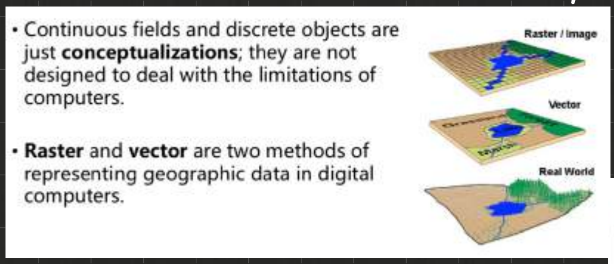
Discrete object view: the geographic world as objects with well-defined boundaries in otherwise empty sapce

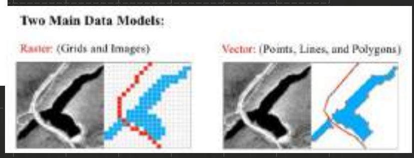
Road Map

Continuous field view: the real world as a finite number of variables, each one defined at every possible position

Topographic maps

· Vector and Raster Representations

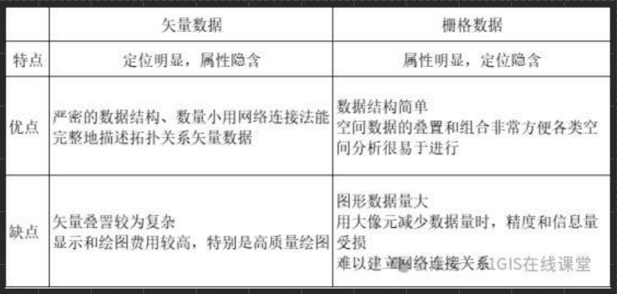




· Spartial Data Models

simplify real world objects and phenomenon into abstractions

Rooster



	矢量数据	栅格数据
特点	定位明显，属性隐含	属性明显，定位隐含
优点	严密的数据结构、数量小用网络连接法能完整地描述拓扑关系矢量数据	数据结构简单 空间数据的叠置和组合非常方便各类空间分析很易于进行
缺点	矢量叠置较为复杂 显示和绘图费用较高，特别是高质量绘图	图形数据量大 用大像元减少数据量时，精度和信息量受损 难以建立网络连接关系

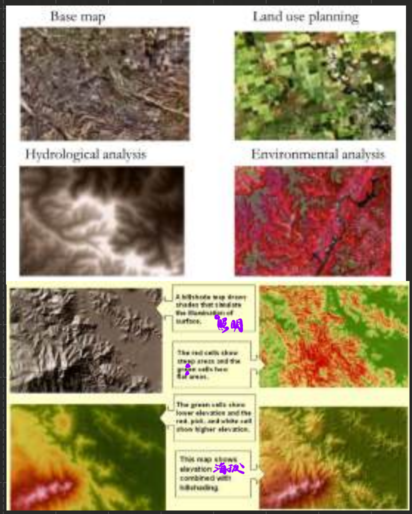
· Rooster vs Continuous
discrete / fix definite

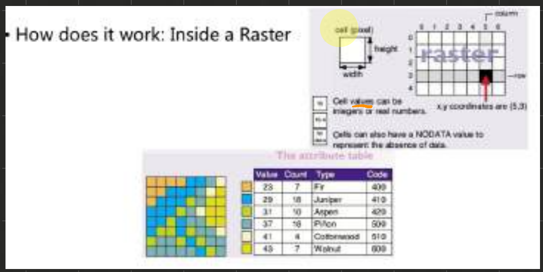
△ Raster representations divide the world into arrays of cells and assign attributes to the cells

· Typical examples include remote sensing imagery and digital elevation models (DEM), land cover maps

Forms:
- Satellite imagery
- Aerial (航拍) imagery
- Pictures (失真)
- Scanned maps
- Converted data

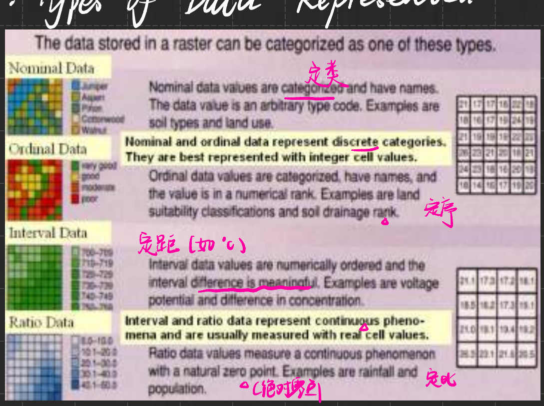
· Use of Rooster Data



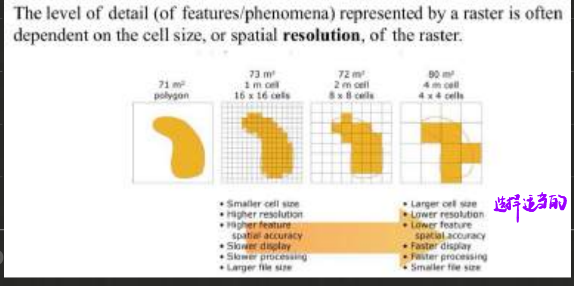


Value	Count	Type	Code
23	7	Fir	400
29	18	Juniper	410
31	10	Aspen	420
37	18	Piñon	500
41	4	Cottonwood	510
43	7	Walnut	600

· Types of Data Represented in Cells

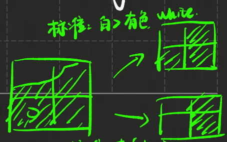


· Cell Size (Resolution)



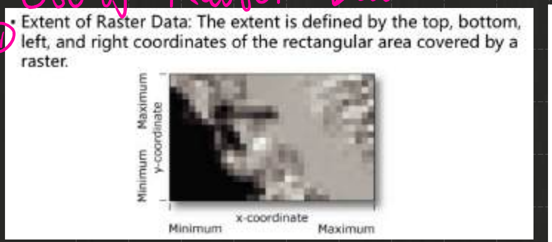
· When information is represented in raster form, all detail about variation within cells is lost, and instead the cell is given a single value.

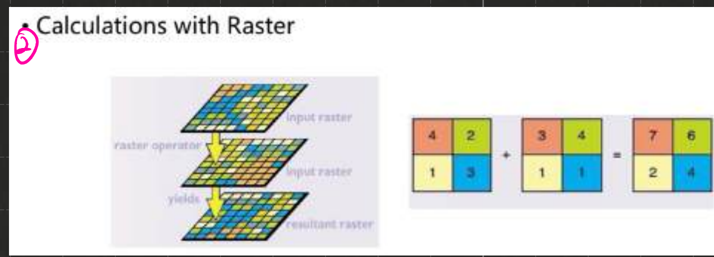
e.g.

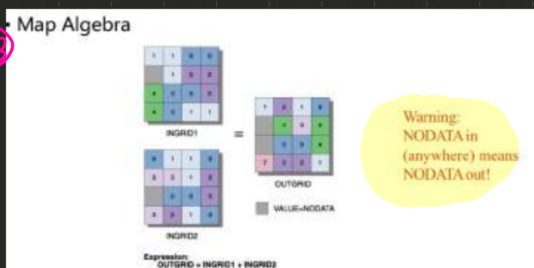


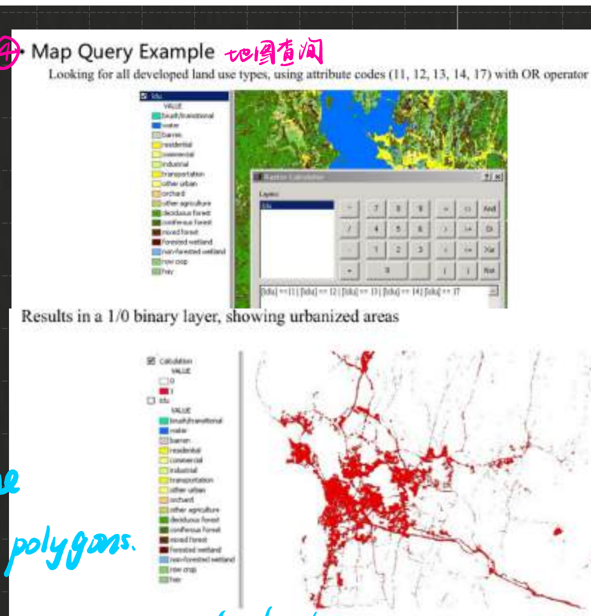
2000-2001 male + female → total
(时间变化，类别)

Use of Raster Data:

① 

② 

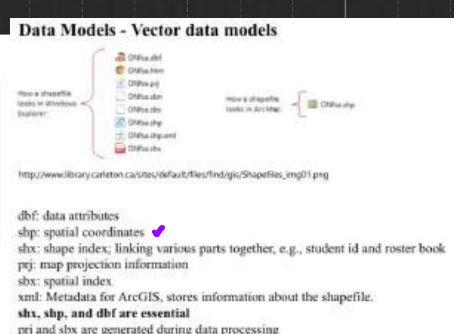
③ 

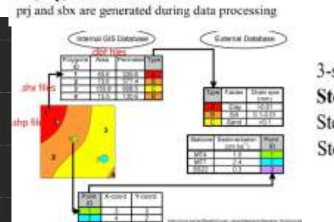
④ 

Vector

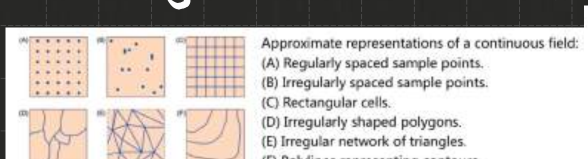
- Vector data represent the world as points, lines and polygons.
- Lines are captured as points connected by precisely straight lines, while an area is captured by straight lines

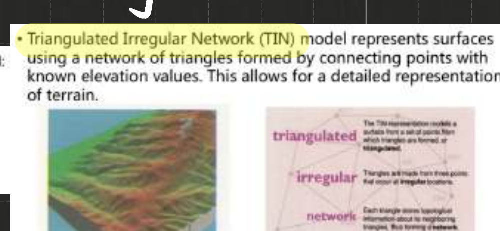
选择尺度 - 一种权衡

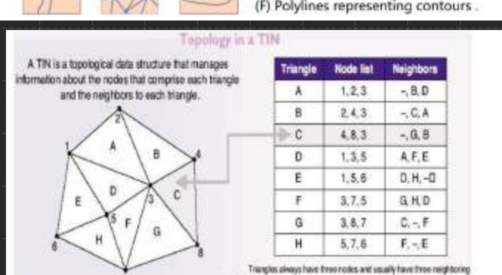




- The continuous variation of a field can also be expressed in a vector representation.
  - The objects used to represent a field are not real, but simply artifacts of the representation of something that is actually conceived as spatially continuous.







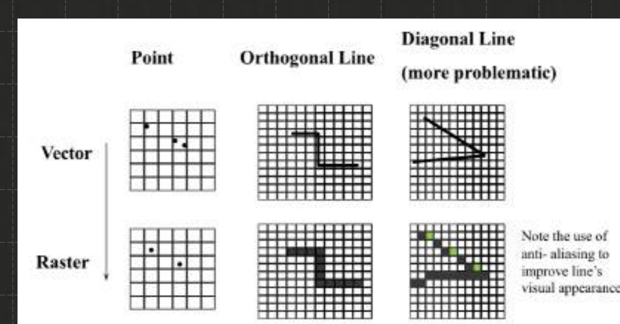
Use: Terrain Analysis

Vector vs Raster

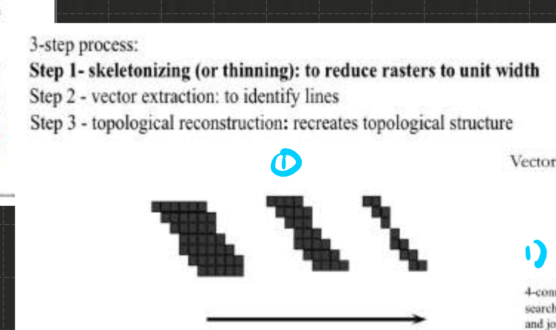
- How to choose?

Issue	Raster	Vector
Volume of data	Depends on cell size	Depends on density of vertices
Sources of data	Remote sensing, imagery	Social and environmental data
Applications	Resources, environmental	Social, economic, administrative
Software	Raster GI systems, image processing	Vector GI systems, automated cartography
Resolution	Fixed	Variable

- Vector to Raster Conversion

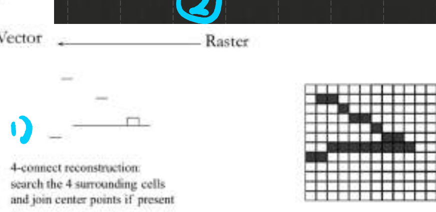


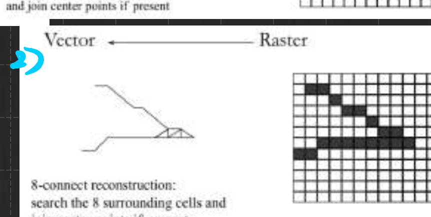
- Raster to Vector Conversion

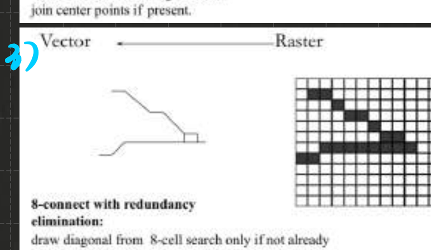


①

②

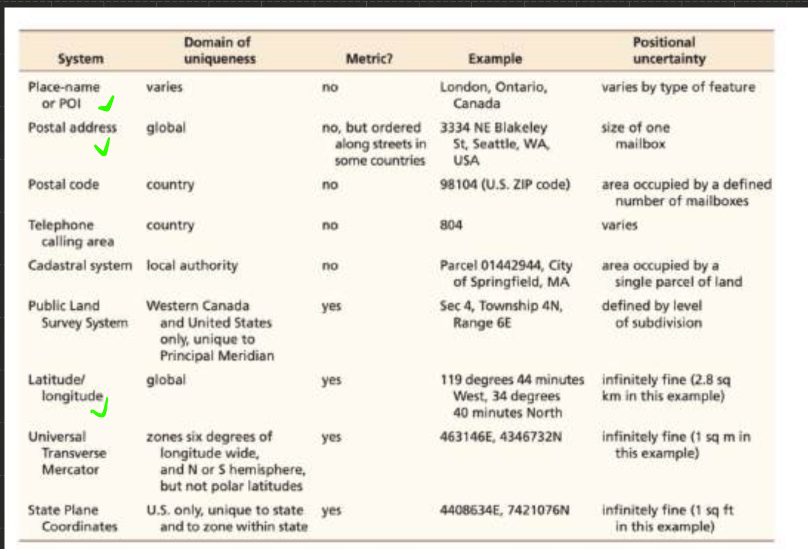
1) 

2) 

3) 

Georeferencing 地理配准.

1. Systems



System	Domain of uniqueness	Metric?	Example	Positional uncertainty
Place-name or POI	varies	no	London, Ontario, Canada	varies by type of feature
Postal address	global	no, but ordered along streets in some countries	3334 NE Blakeley St, Seattle, WA, USA	size of one mailbox
Postal code	country	no	98104 (U.S. ZIP code)	area occupied by a defined number of mailboxes
Telephone calling area	country	no	804	varies
Cadastral system	local authority	no	Parcel 01442944, City of Springfield, MA	area occupied by a single parcel of land
Public Land Survey System	Western Canada and United States only, unique to Principal Meridian	yes	Sec 4, Township 4N, Range 6E	defined by level of subdivision
Latitude/ longitude	global	yes	119 degrees 44 minutes West, 34 degrees 40 minutes North	infinitely fine (2.8 sq km in this example)
Universal Transverse Mercator	zones six degrees of longitude wide, and N or S hemisphere, but not polar latitudes	yes	463146E, 4346732N	infinitely fine (1 sq m in this example)
State Plane Coordinates	U.S. only, unique to state and to zone within state	yes	4408634E, 7421076N	infinitely fine (1 sq ft in this example)

2. Coordinate Systems

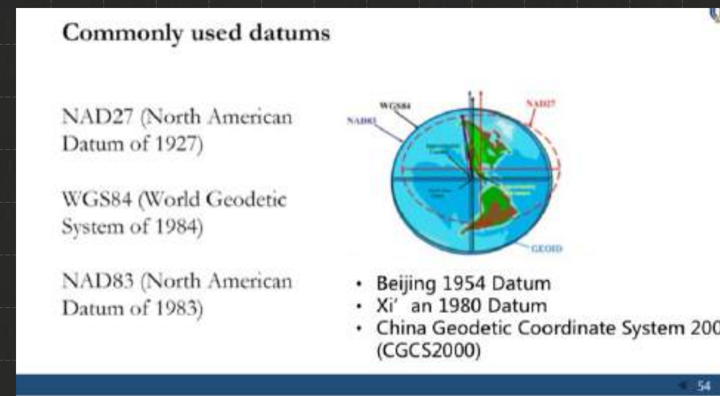
- A coordinate system is a system that uses one or more numbers, or coordinates, to uniquely determine the position of the points or the geometric elements on a manifold such as Euclidean space.
- A Euclidean coordinate system specifies: 1) the origin point; 2) the orientation of reference axes; 3) the units of measure

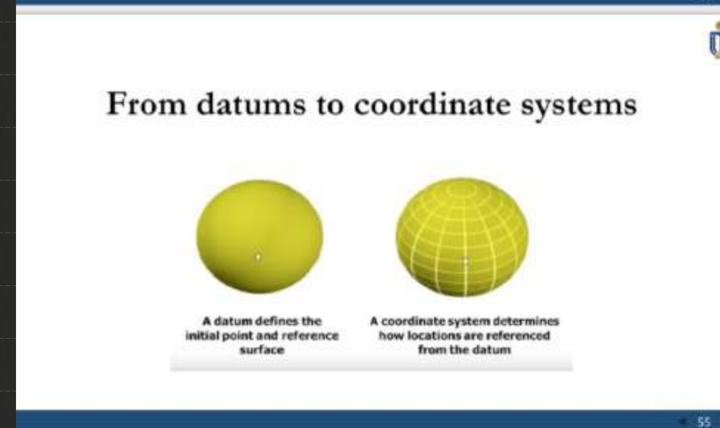
3. Geographic Coordinate Systems (GCS)

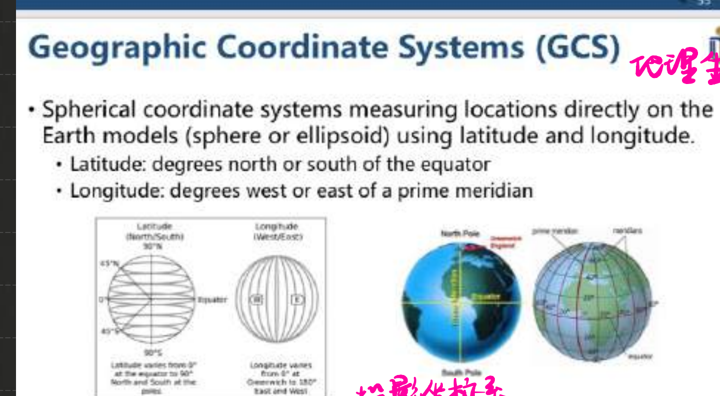
- A geographic coordinate systems (GCS) is a spherical or ellipsoidal coordinate system for measuring and communicating positions directly on the Earth as latitude and longitude.

球 椭圆

- The Earth is an irregularly shaped ellipsoid!

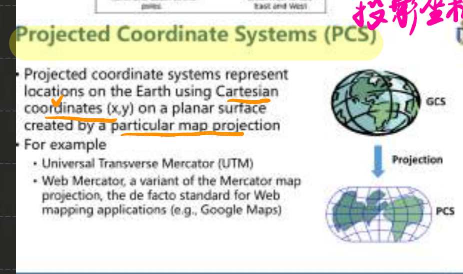






地理坐标系.

投影坐标系



- Map Projection:

1) Flatten a globe's surface into a plane in order to make a map

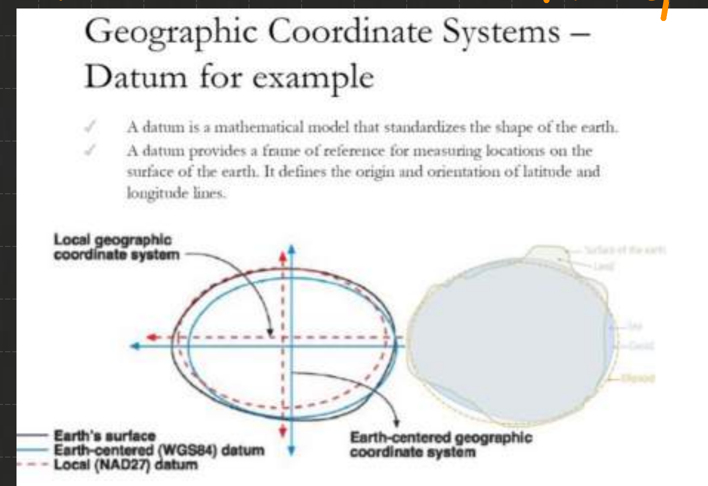
2) All map projections will cause distortions

3) Select the appropriate projection by application needs

- Spatial Reference Identifier (SRID)
  - a unique identifier associated with a specific coordinate system, tolerance, and resolution.
- EPSG Code

↓

between 1024 and 32767 along with a standard machine-readable well-known text (WKT) representation.



Lab 3: Creating Vector Data

OVERVIEW

Images of the earth surface such as aerial photos and remote sensing images usually contain rich information about the ground and are useful in many urban planning applications. For example, geographic features such as buildings, lakes, and roads can often be easily identified with human eyes from these images. In this lab, you will create vector data layers to represent features shown in aerial imagery to enable vector-based GIS analysis. This process is called 'digitization.' Similar to aerial imageries, XY coordinates are another type of data that are not stored in proper vector-based GIS-compatible format but nonetheless contain spatial information. This lab provides instructions for the following two basic GIS functions:

1. Adding XY coordinate data as a point layer in ArcGIS;
2. Digitizing information based on a spatially-referenced aerial photo.

Task 1: Adding XY coordinate data as a point layer in ArcGIS

In this exercise, you will add traffic fatality data from New York City in 2022 to a map using Adding XY Data. In this exercise, the raw data to be imported into ArcGIS contains descriptions, latitudes, and longitudes for individual fatal car crashes.

Step 1.1: Use your web browser to access the Fatality Analysis Reporting System (http://www.nhtsa.gov/FARS) to download traffic fatality data for New York City in 2022.

First click the link labeled *Download Raw Data from FTP Site* (Figure 1.1).

You will first open the directory for *2022*, and then open the directory labeled *National*.

In this directory, there are three zip files that contain data in different formats: two SAS format files (*FARS2022NationalSAS.zip and FARS2022NationalAuxiliarySAS.zip*) and a CSV format file (*FARS2022NationalCSV.zip*).

Figure 1.1

Download the file with the CSV format, unzip all files, and then open *accident.csv* with Microsoft Excel. In the CITY column, filter and select records with the ID 4170; this identification number represents New York City. Copy these selected records, paste them into a new CSV file, and name this new file *NYC_Accidents_2022.csv*.

Launch **ArcGIS Pro** and create a **Blank Map.** Click **Add Data - Data**, and then use the **Connect to Folder** icon to navigate to *NYC_Accidents_2022.csv*. Click **OK,** and you will see the file in the **Contents**.

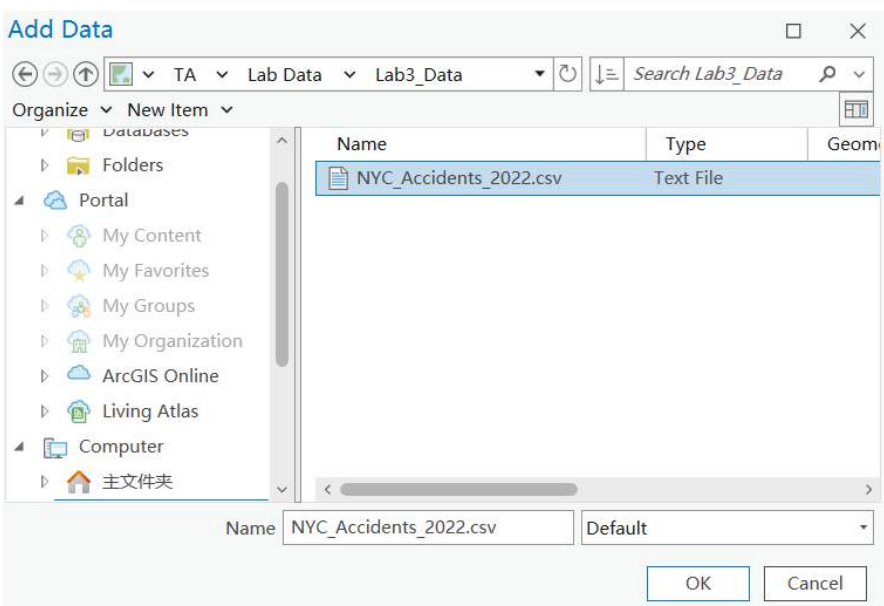
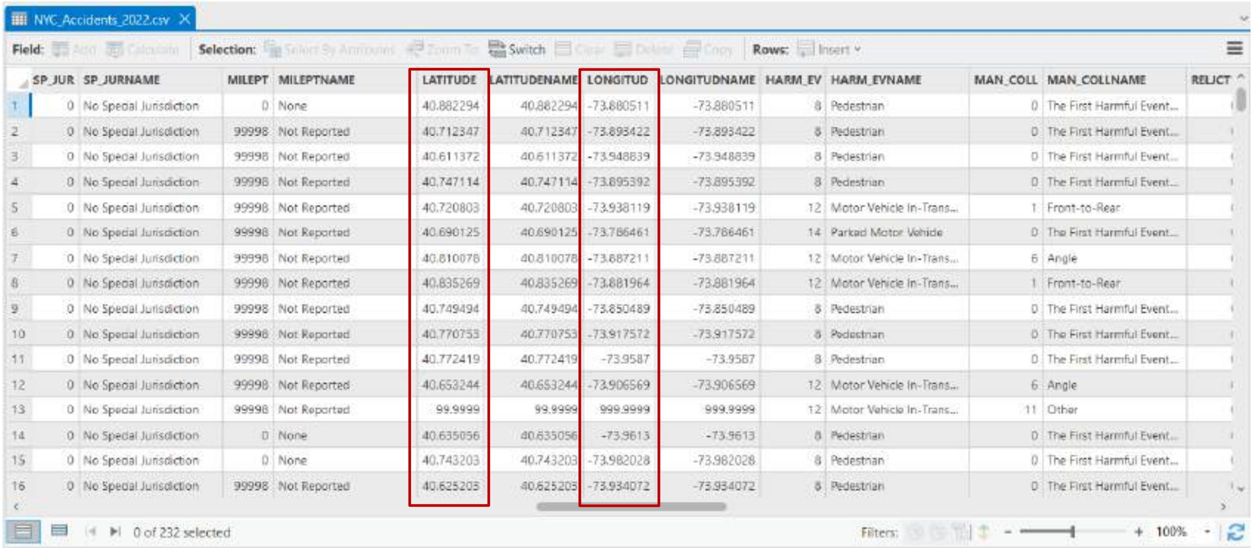


Figure 1.2

Right-click the layer *NYC_Accidents_2022.csv* in the **Contents** and click **Open.** You will then be able to see all the information included in the CSV file. You will want to note that coordinate information is stored in the columns entitled *LATITUDE* and *LONGITUDE*. After reviewing the data, close the table.


NYC_Accidents_2022.csv

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy Rows: Insert

	SP_JUR	SP_JURNAME	MILEPT	MILEPTNAME	LATITUDE	LATITUDENAME	LONGITUD	LONGITUDNAME	HARM_EV	HARM_EVNAME	MAN_COLL	MAN_COLLNAME	RELICT
1	0	No Special Jurisdiction	0	None	40.882294	40.882294	-73.880511	-73.880511	8	Pedestrian	0	The First Harmful Event...	
2	0	No Special Jurisdiction	99998	Not Reported	40.712347	40.712347	-73.893422	-73.893422	8	Pedestrian	0	The First Harmful Event...	
3	0	No Special Jurisdiction	99998	Not Reported	40.611372	40.611372	-73.948839	-73.948839	8	Pedestrian	0	The First Harmful Event...	
4	0	No Special Jurisdiction	99998	Not Reported	40.747114	40.747114	-73.895392	-73.895392	8	Pedestrian	0	The First Harmful Event...	
5	0	No Special Jurisdiction	99998	Not Reported	40.720803	40.720803	-73.938119	-73.938119	12	Motor Vehicle In-Trans...	1	Front-to-Rear	
6	0	No Special Jurisdiction	99998	Not Reported	40.690125	40.690125	-73.786461	-73.786461	14	Parked Motor Vehicle	0	The First Harmful Event...	
7	0	No Special Jurisdiction	99998	Not Reported	40.810078	40.810078	-73.887211	-73.887211	12	Motor Vehicle In-Trans...	6	Angle	
8	0	No Special Jurisdiction	99998	Not Reported	40.835269	40.835269	-73.881964	-73.881964	12	Motor Vehicle In-Trans...	1	Front-to-Rear	
9	0	No Special Jurisdiction	99998	Not Reported	40.749494	40.749494	-73.850489	-73.850489	8	Pedestrian	0	The First Harmful Event...	
10	0	No Special Jurisdiction	99998	Not Reported	40.770753	40.770753	-73.917572	-73.917572	8	Pedestrian	0	The First Harmful Event...	
11	0	No Special Jurisdiction	99998	Not Reported	40.772419	40.772419	-73.9587	-73.9587	8	Pedestrian	0	The First Harmful Event...	
12	0	No Special Jurisdiction	99998	Not Reported	40.653244	40.653244	-73.906569	-73.906569	12	Motor Vehicle In-Trans...	6	Angle	
13	0	No Special Jurisdiction	99998	Not Reported	99.9999	99.9999	999.9999	999.9999	12	Motor Vehicle In-Trans...	11	Other	
14	0	No Special Jurisdiction	0	None	40.635056	40.635056	-73.9613	-73.9613	8	Pedestrian	0	The First Harmful Event...	
15	0	No Special Jurisdiction	0	None	40.743203	40.743203	-73.982028	-73.982028	8	Pedestrian	0	The First Harmful Event...	
16	0	No Special Jurisdiction	99998	Not Reported	40.625203	40.625203	-73.934072	-73.934072	8	Pedestrian	0	The First Harmful Event...	

0 of 232 selected Filters: 100%

Figure 1.3

Step 1.2: Before loading the XY coordinate data, add *nycb2020.shp.* The *nycb2020.shp* layer contains information about census blocks in New York and can be downloaded from New York City's Department of City Planning at the following web address:

https://www1.nyc.gov/site/planning/data-maps/open-data/districts-download-metadata.page.

Please download **2020 Census Blocks (Clipped to Shoreline)** under **Census** section. (As shown in Figure1.4-1.6)

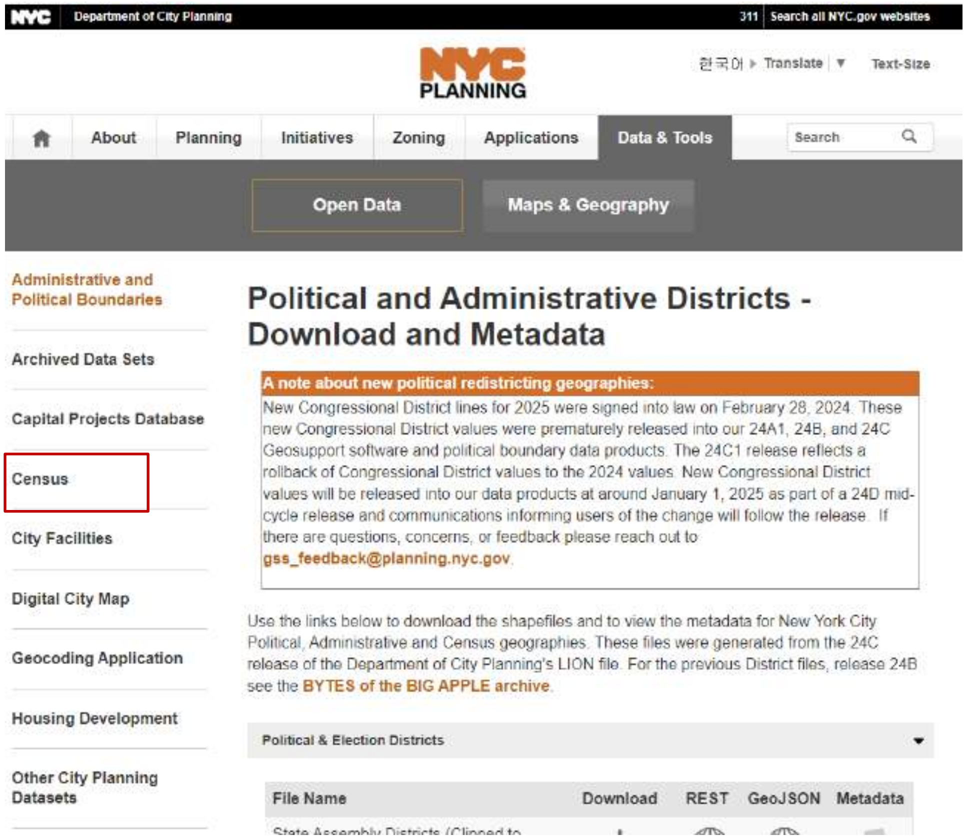


Figure 1.4

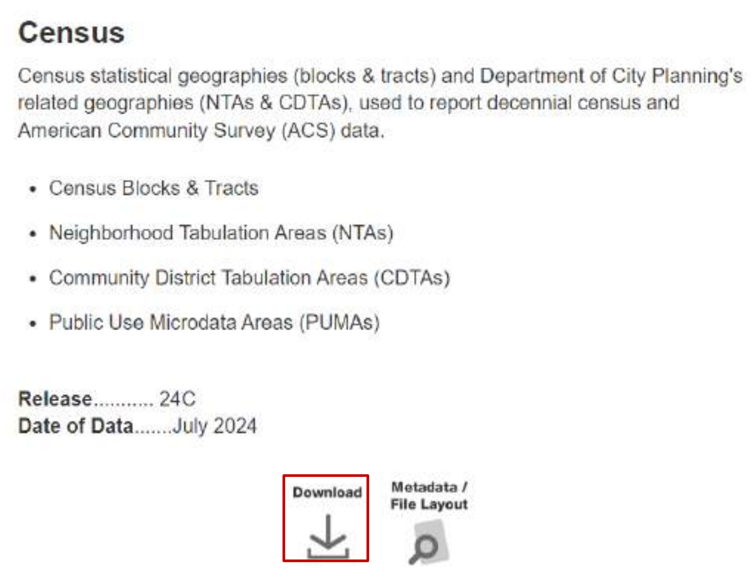
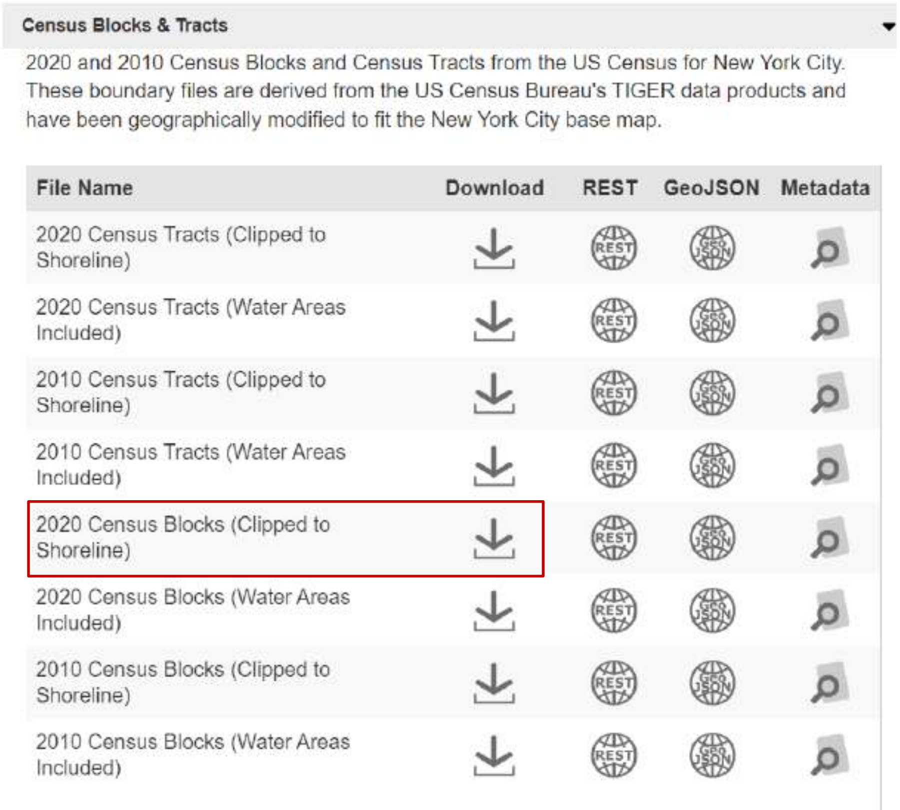


Figure 1.5


Census Blocks & Tracts

2020 and 2010 Census Blocks and Census Tracts from the US Census for New York City. These boundary files are derived from the US Census Bureau's TIGER data products and have been geographically modified to fit the New York City base map.

File Name	Download	REST	GeoJSON	Metadata
2020 Census Tracts (Clipped to Shoreline)				
2020 Census Tracts (Water Areas Included)				
2010 Census Tracts (Clipped to Shoreline)				
2010 Census Tracts (Water Areas Included)				
2020 Census Blocks (Clipped to Shoreline)				
2020 Census Blocks (Water Areas Included)				
2010 Census Blocks (Clipped to Shoreline)				
2010 Census Blocks (Water Areas Included)				

Figure 1.6

In the **Contents**, right-click *NYC_Accidents_2022.csv* and choose **XY Table to point** from **Create Points From Tabl**e option (Figure1.7).

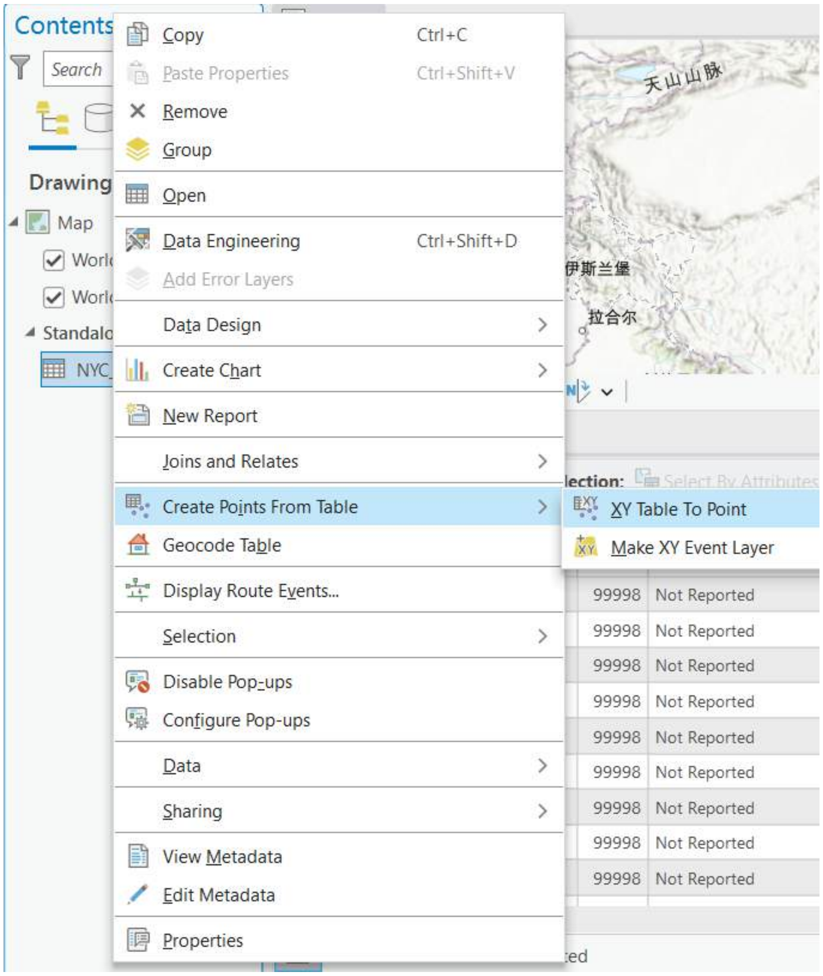


Figure 1.7

In the **XY Table to Point** window, select *LONGITUDE* for the X Field and *LATITUDE* for the Y Field. Next, change the output feature class name to *NYC_Accidents_2022.shp*, and make sure it is saved in the folder you store the data for this exercise.

Click the **Earth** icon besides **Coordinate System**, in the **Coordinate System** window, choose **Geographic Coordinate Systems** followed by **North America**, then choose **USA and Territories,** then scroll down to **NAD 1983** in the list. Highlight it with your cursor and click the OK button. Click the **OK** button in the **XY Table to Point** to map out all the accidents. (Figure1.8-1.9)

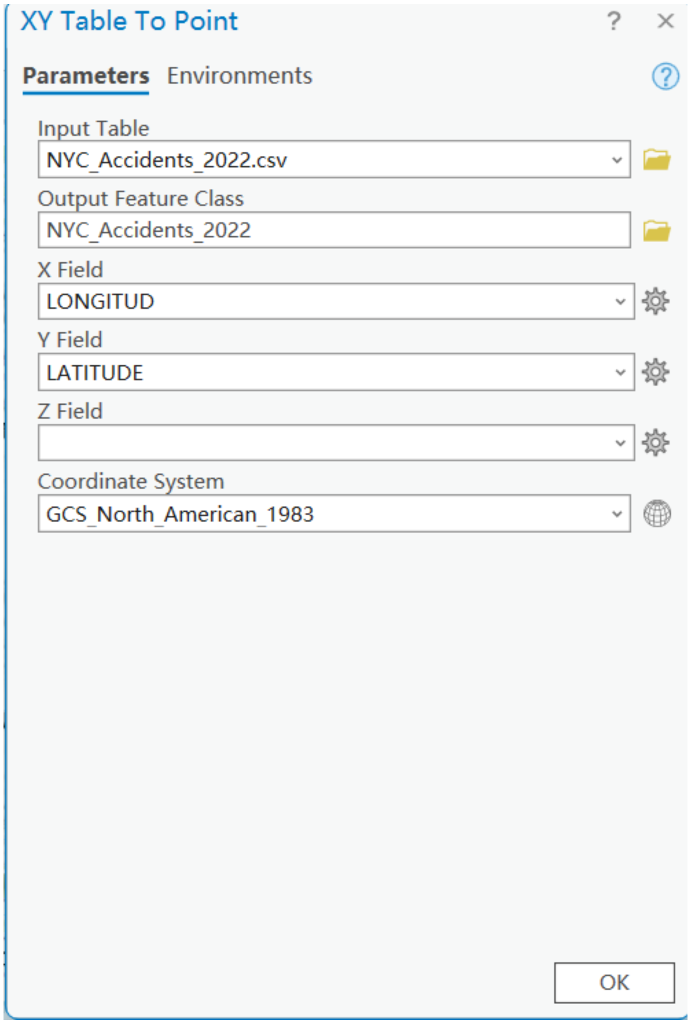

XY Table To Point
Parameters
Environments
Input Table
NYC_Accidents_2022.csv
Output Feature Class
NYC_Accidents_2022
X Field
LONGITUD
Y Field
LATITUDE
Z Field
Coordinate System
GCS_North_American_1983
OK

Figure 1.8

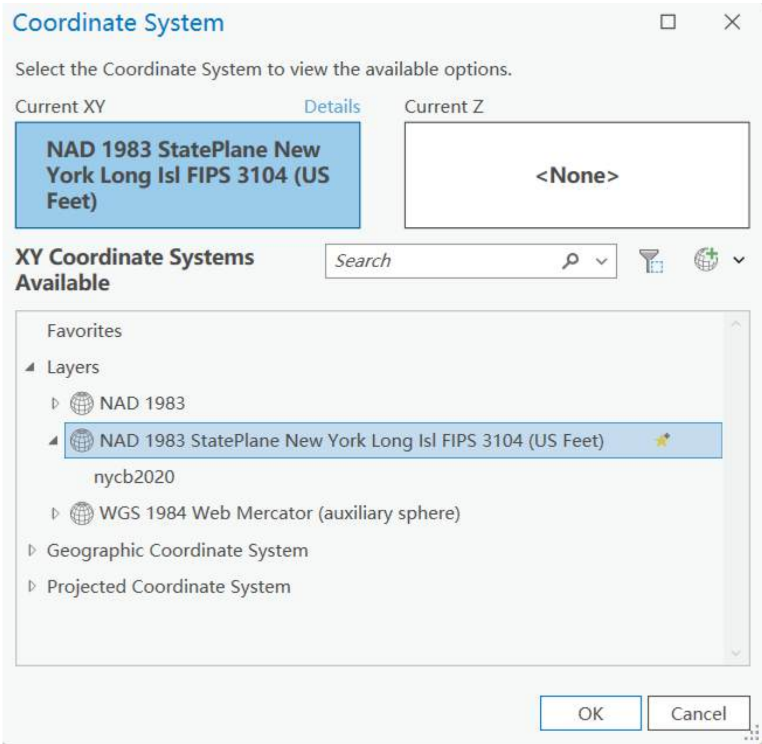


Figure 1.9

Note that some features that have invalid geometry will be removed automatically, as shown in Figure 1.10.

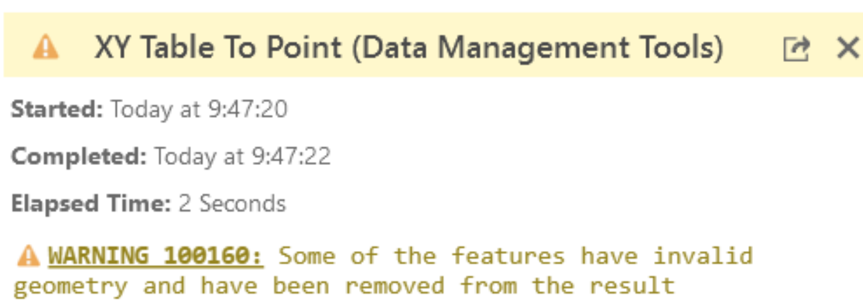


Figure 1.10

Next, you need to project the accident shapefile to have the same projected coordinated system with the NYC Census Block group shapefile.

In **Tools** window, expand **Data Management Tool – Projections and Transformations**, click **Project** to launch the tool. Specify *NYC_Accident_2022.shp* as the Input Dataset or Feature Class, and change the Output Dataset or Feature Class to *NYC_Accident_2022_Projected.shp*. Click the earth icon beside Coordinate System, then **Import Coordinate System** from the *nycb2020.shp*.

The imported shapefile name should be *NAD 1983 StatePlane New York Long Island FIPS 3104 Feet*. Hit **Run** button to execute the tool.

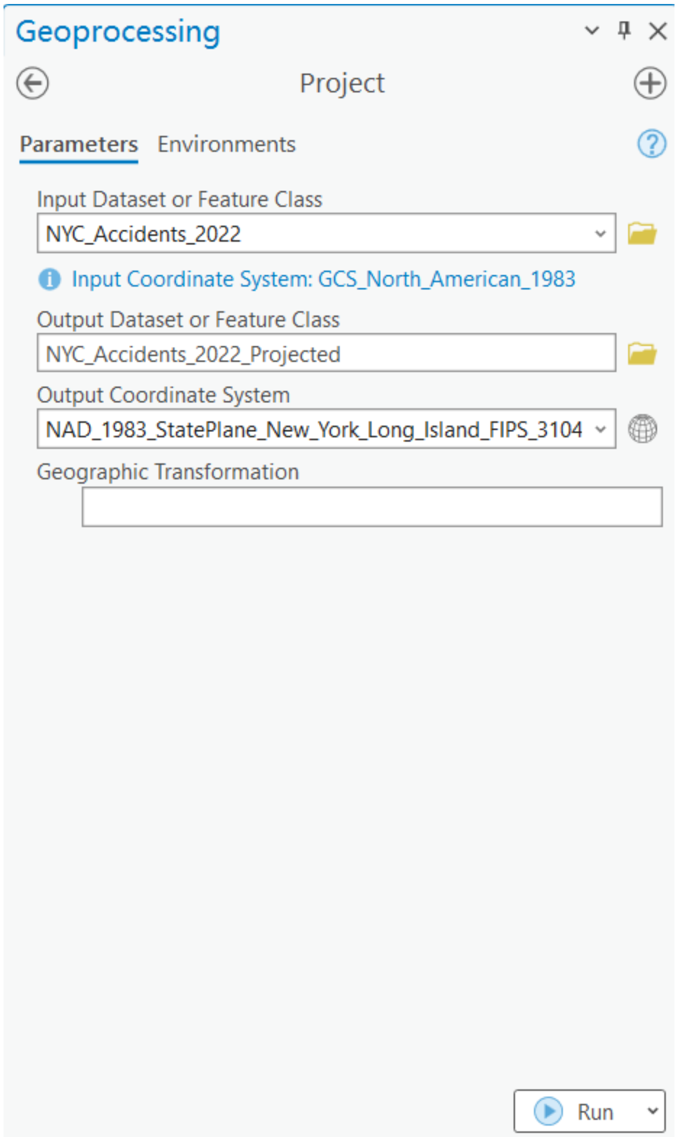


Figure 1.10

After completing these actions, right click NYC_Accidents_2022 and remove it from the contents (Make sure you remove the shapefile but not the CSV).

Import the NYC Census Block shapefile by clicking **Add Data** button on the **Map** ribbon and then navigate to the folder you stored the data for this exercise and select *nycb2020.shp* to import.

You should see a map as Figure 1.11, if not, you may want to change the coordinate system in your map setting. Right click the map icon in the **Contents**, open **Properties** window, switch to

Coordinates System, then expand **Layers** and select *NAD 1983 StatePlane New York Long Island FIPS 3104 Feet,* hit OK to confirm the settings.

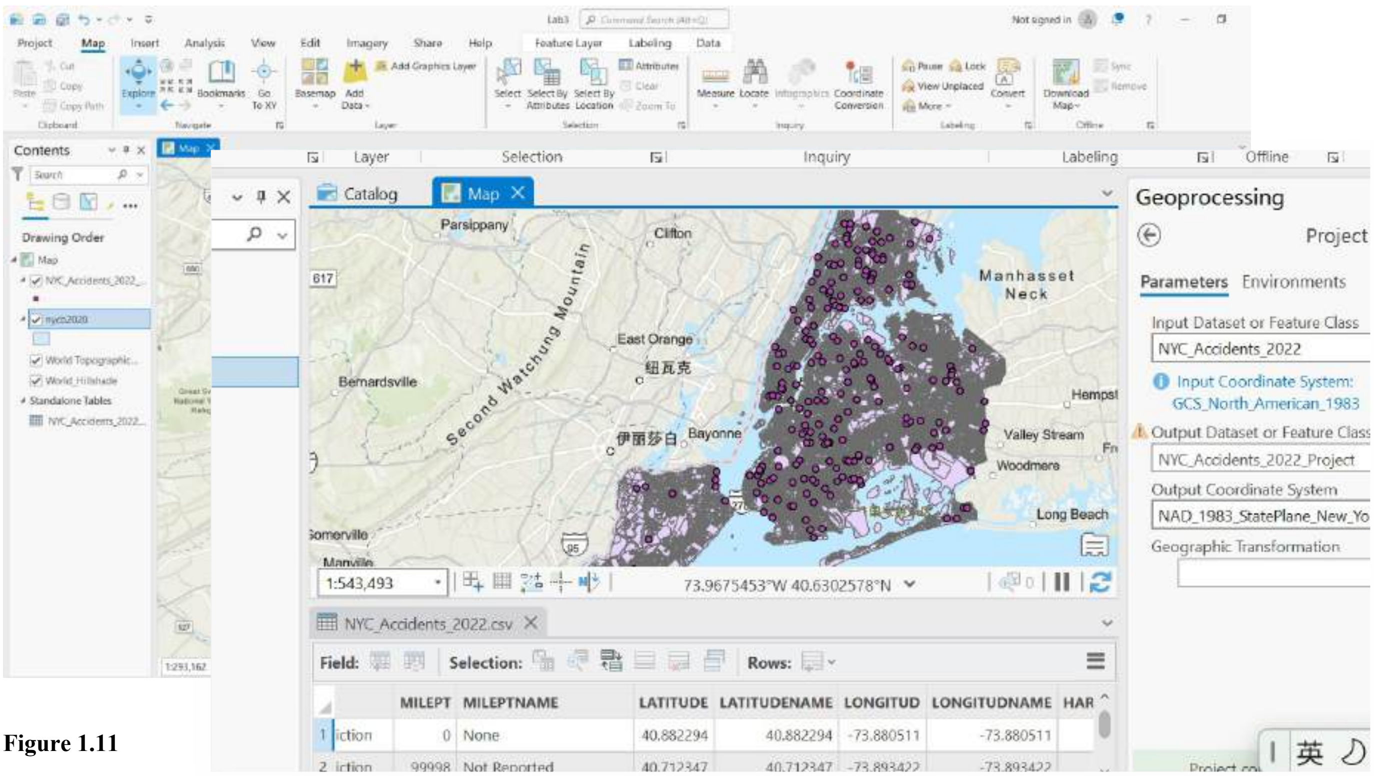


Figure 1.11

Note: You can also avoid importing the CSV file into **Map** by directly **Add XY Data**. Expand **Add Data** drop down list from the Map ribbon, click **XY Point Data**, then you can use **XY Table to Poin**t tool to read your external table files.

Task 2: Digitizing an aerial photo

Step 2.1: Launch **Map** and create a **Blank Map** from the startup screen.

From the **Map** ribbon, click **Basemap** and select *Imagery (In our licensed version of ArcGIS Pro, the basemap is named '世界影像图')*. You will use the satellite imagery in ArcGIS Pro as the reference image for this exercise, but other high resolution remote sensing images may be sufficient for digitization.

Zoom in to the HKUST(GZ) (22.889916, 113.476523) by using the **Go to XY** tool under the **Map** ribbon to pinpoint the location that we are going to digitize. (Figure 2.1)

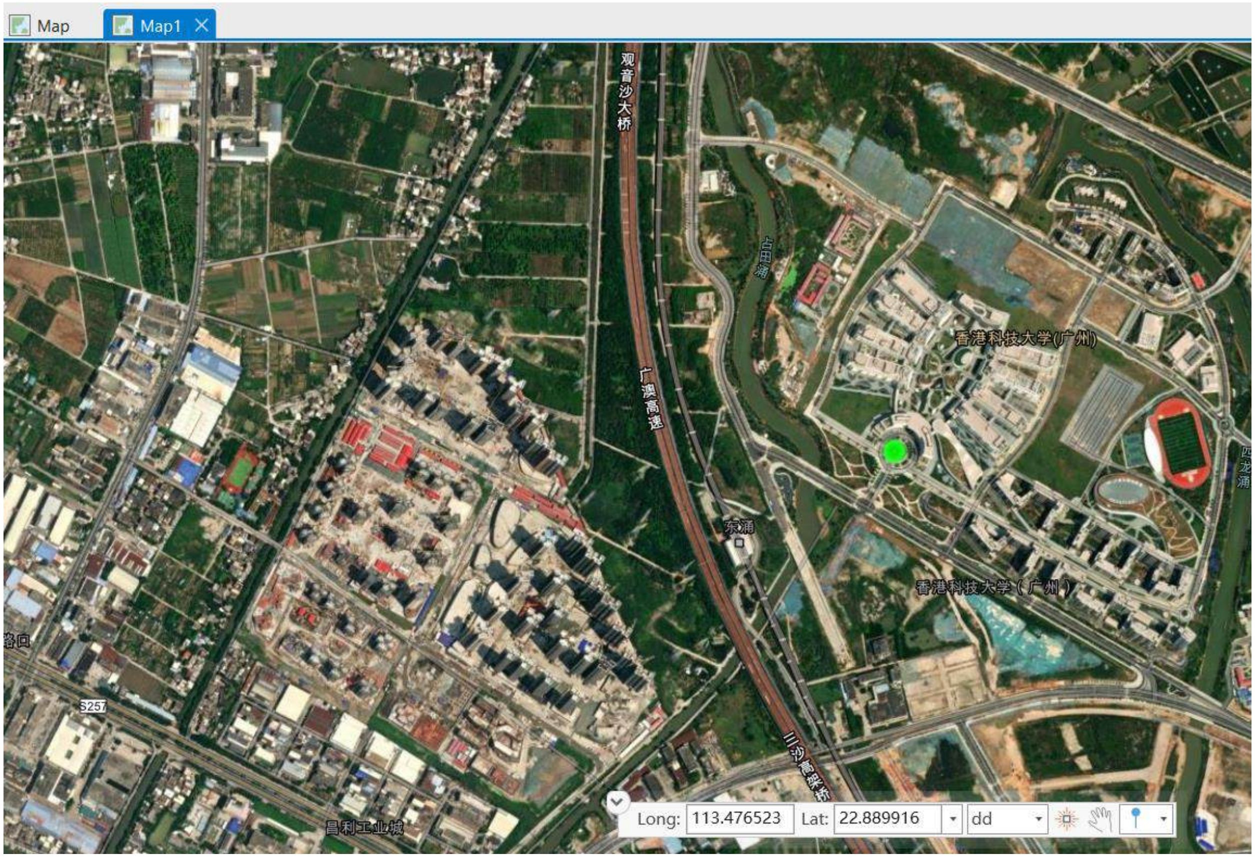


Figure 2.1

Step 2.2: Right-click the map name in the **Contents** and open property window to check the coordinate system information for the **World Imagery**. The new layer that you will create to store the digitized features should have the same coordinate system as the **World Imagery**.

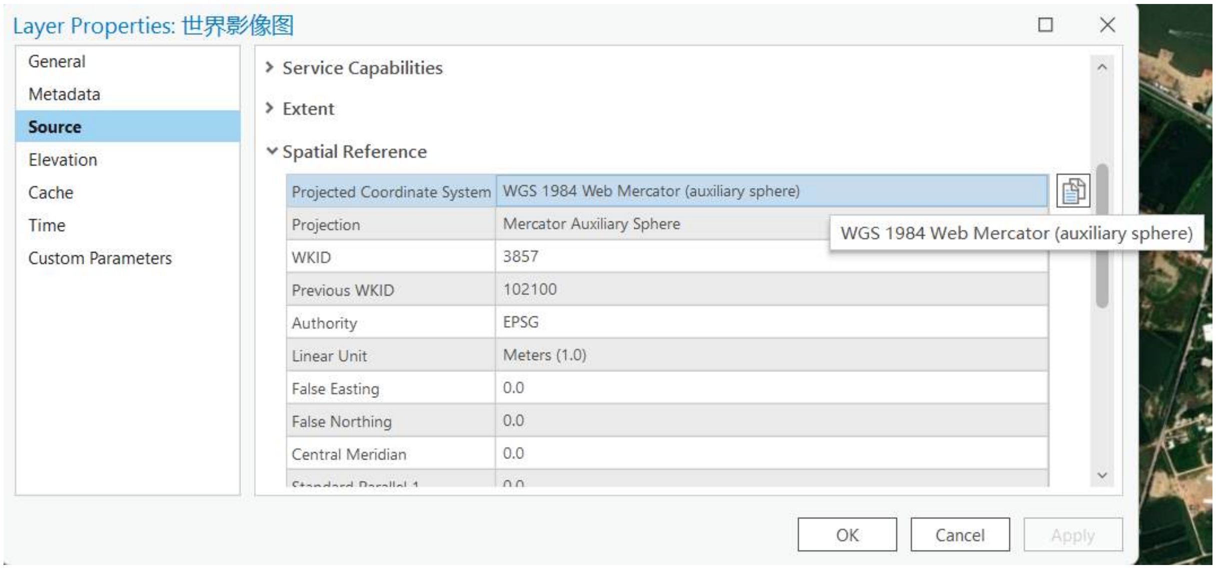


Figure 2.2

In the **View** ribbon, open **Catalog Pane** and navigate to the data folder for this exercise. Right-click this folder and select **New** to create a new **Shapefile**.

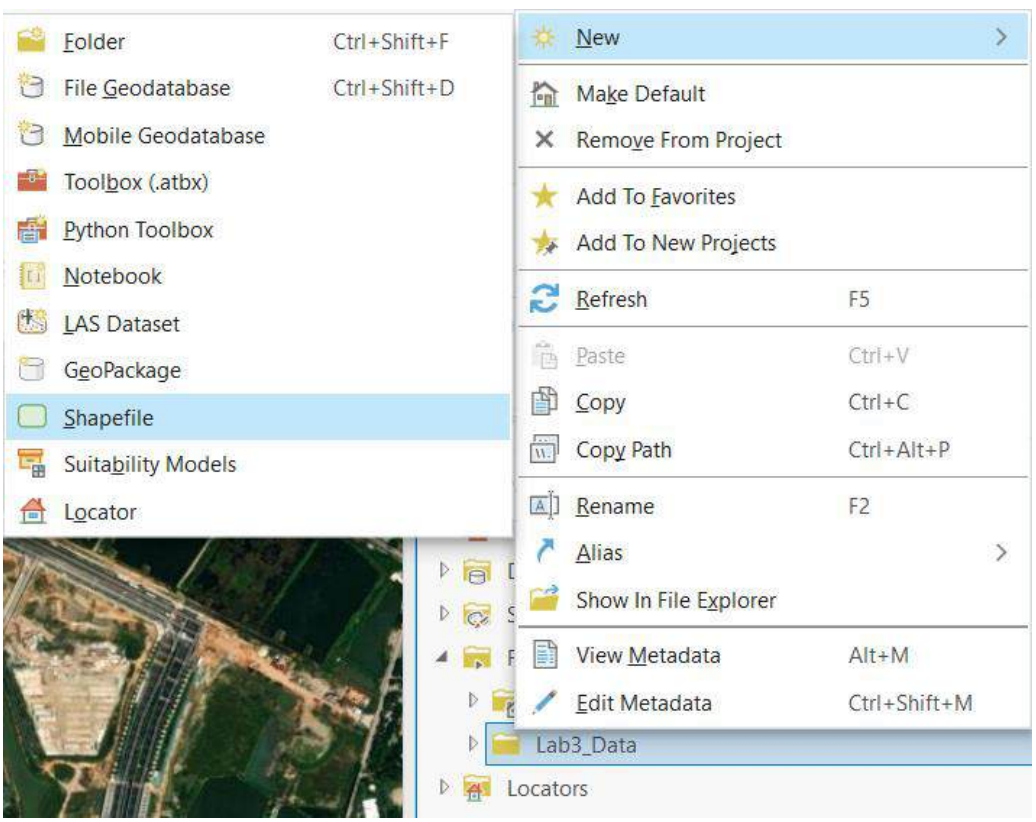


Figure 2.3

You can digitize new features as points, lines, and polygons.

If you want to digitize buildings in our campus, you will want to use polygon features to digitize data. In the **Create New Shapefile** window, set the **Feature Class Name** to 'building' and **Geometry Type** to 'polygon.'

Change the coordinate system by clicking the earth icon. Search and select 'WGS_1984_Web_Mercator_Auxiliary_Sphere' so that the newly created layer will have the same coordinate system as the **World Imagery**.

Note that you can also use the **Import** function within the **Coordinate System** window to import the projection system from another dataset with a specific coordinate system.

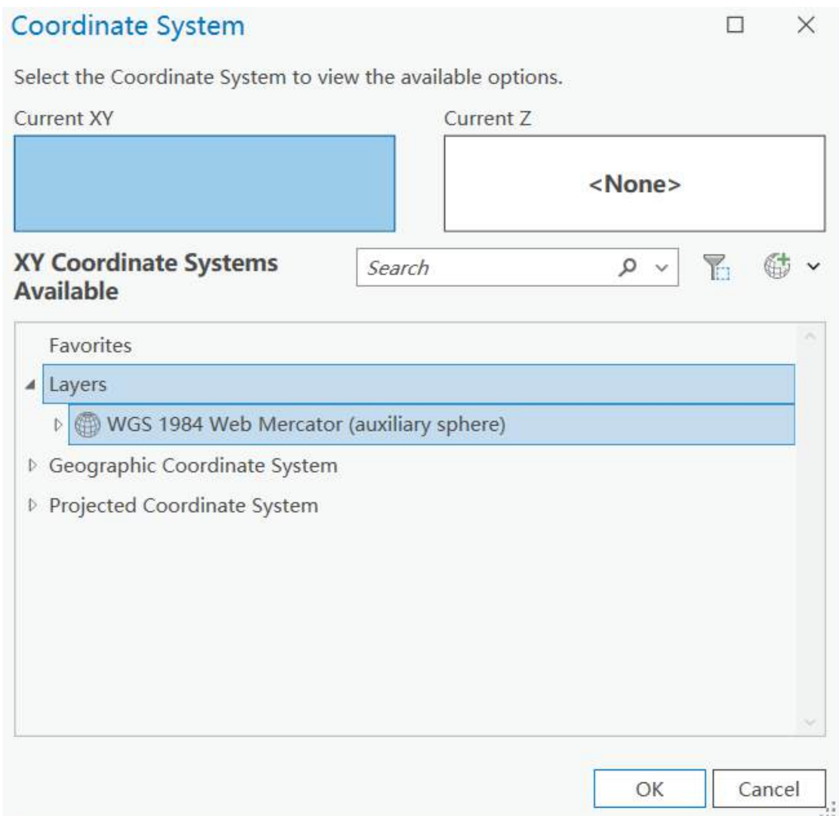


Figure 2.4

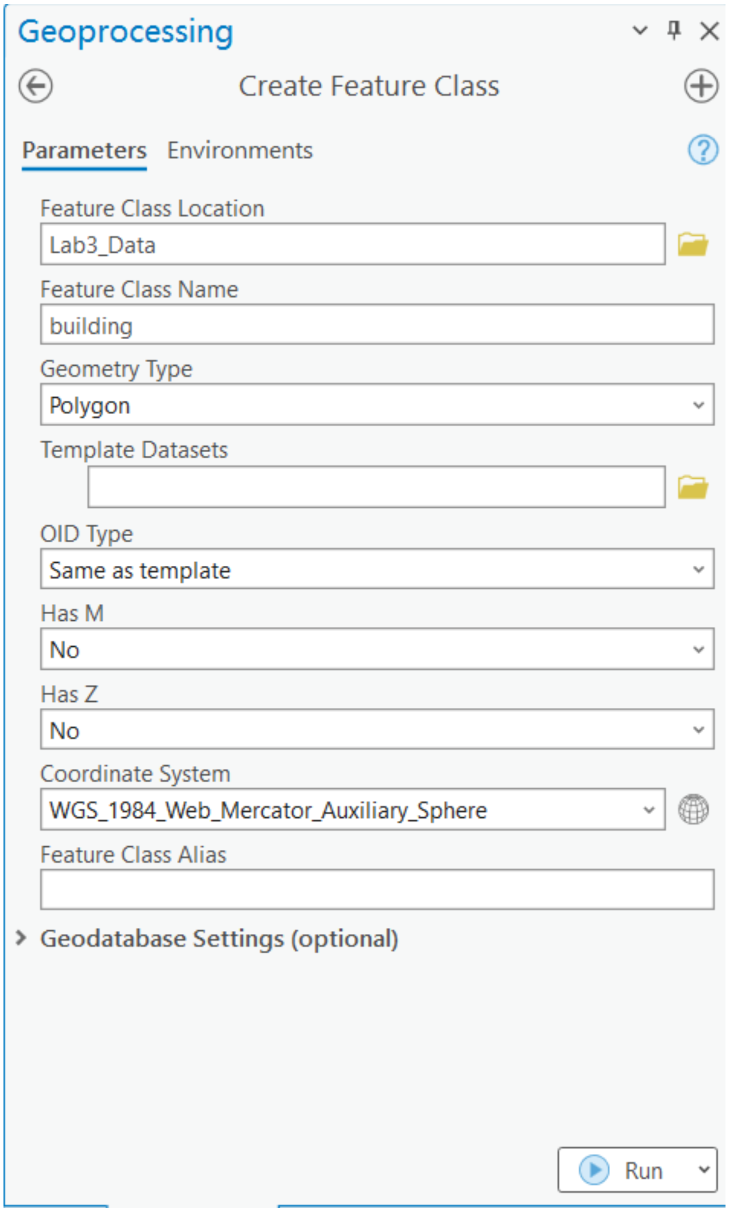


Figure 2.5

Step 2.3: Next, you will create new vector features using the **Edit** tool. Switch to **Edit** ribbon then you can see all available editing tools.

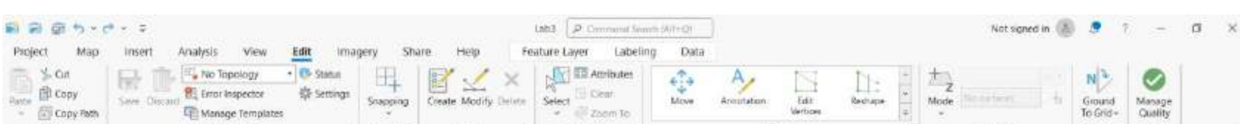


Figure 2.6

Click **Create** on the **Edit** ribbon to launch a **Create Features** window. In the Template tab, there is a list of all editable layers, click on *buildings* to see supported shape types.

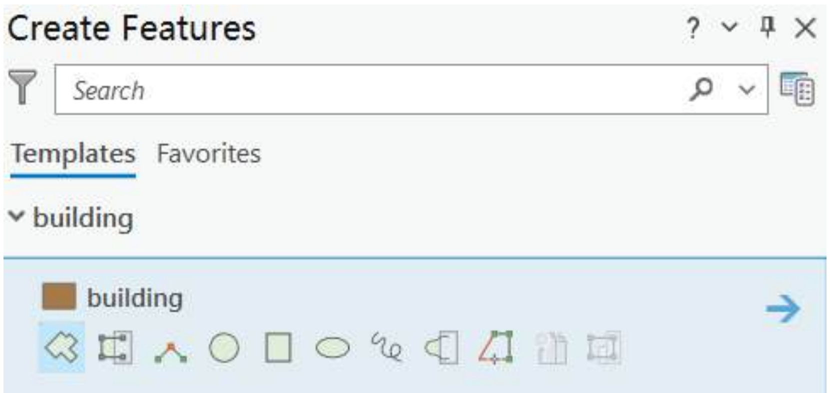


Figure 2.7

Step 2.4: Choose the default **Polygon** tool to draw polygon features.

Left-click on a point on the building outline to begin creating the polygon. Move your cursor and click where you want to add the next point on the building polygon. Once you have clicked on all points of a building, finish digitizing the building by double-clicking. The **Autocomplete Polygon** tool in the **Create Features** window will ensure that the newly digitized polygon will snap to the nearest existing digitized feature (e.g., two buildings that share one wall).

Figure 2.8

Step 2.5: To make changes to digitized features, first select the features, then click the **Modify** tool on the **Edit** ribbon. **Modify Features** window provides a lot of tools to edit your feature.

For example, you can add additional vertices or move existing vertices to more accurately represent the building outline by clicking **Edit Vertices** under **Reshape** section.(Figure 2.9-2.10)

If you have defined attribute fields for individual buildings (e.g., building names) when the shapefile is created, you can also edit these attributes via the **Attribute** tool on the **Edit** ribbon.

If you want to combine two or more polygons representing the same building, select these polygon segments by pressing shift at the same time. Choose **Merge** under the **Construct** section, and then click **Merge.** The two selected polygons will then be merged into one. More advanced tools such as **Cut Polygons** and **Reshape Feature** can also be applied. (Figure 2.11-2.12)

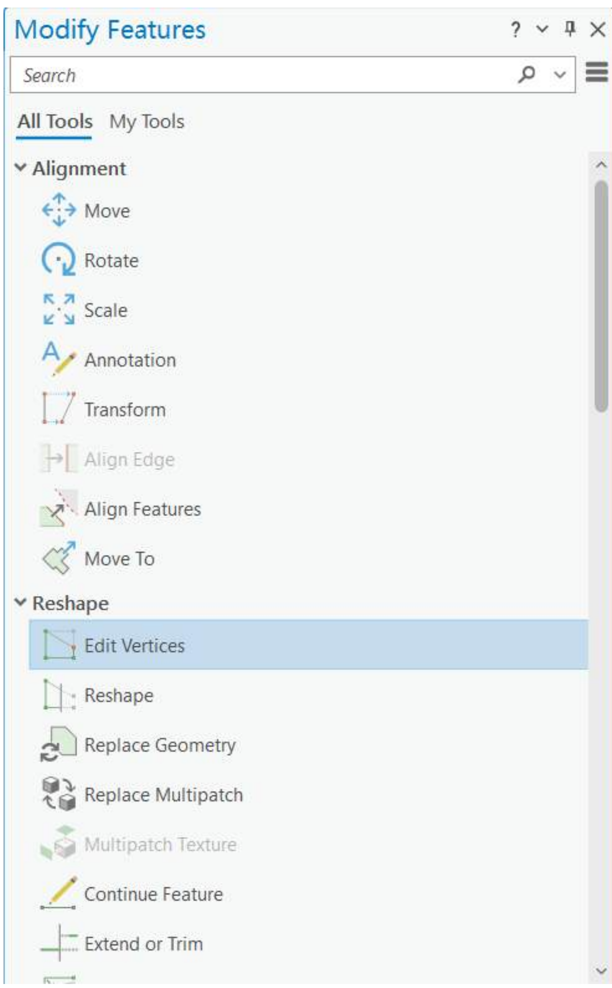


Figure 2.9

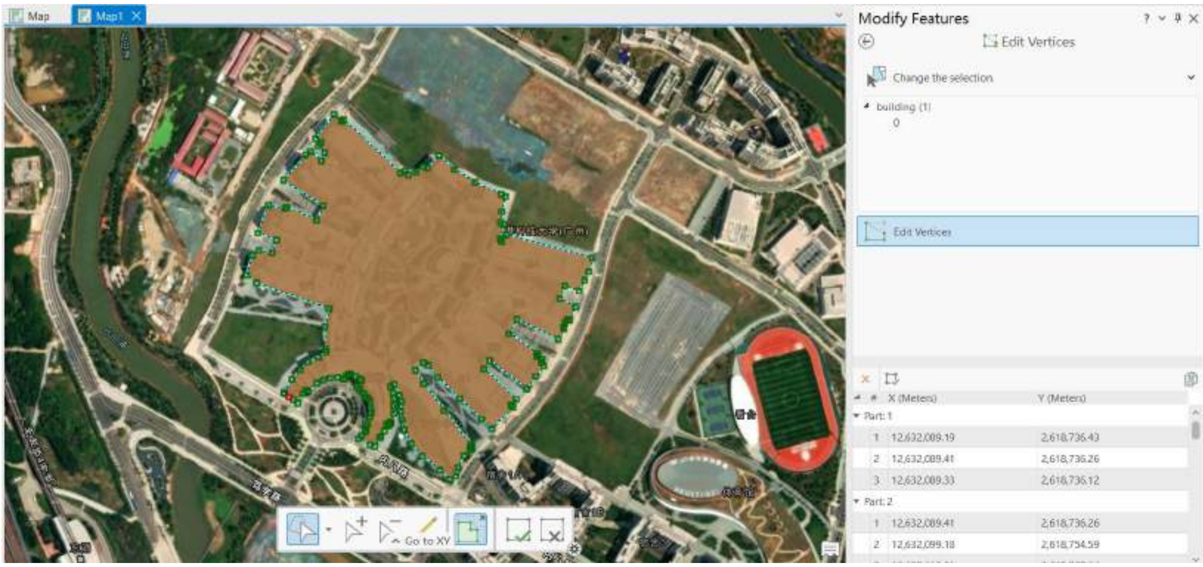


Figure 2.10

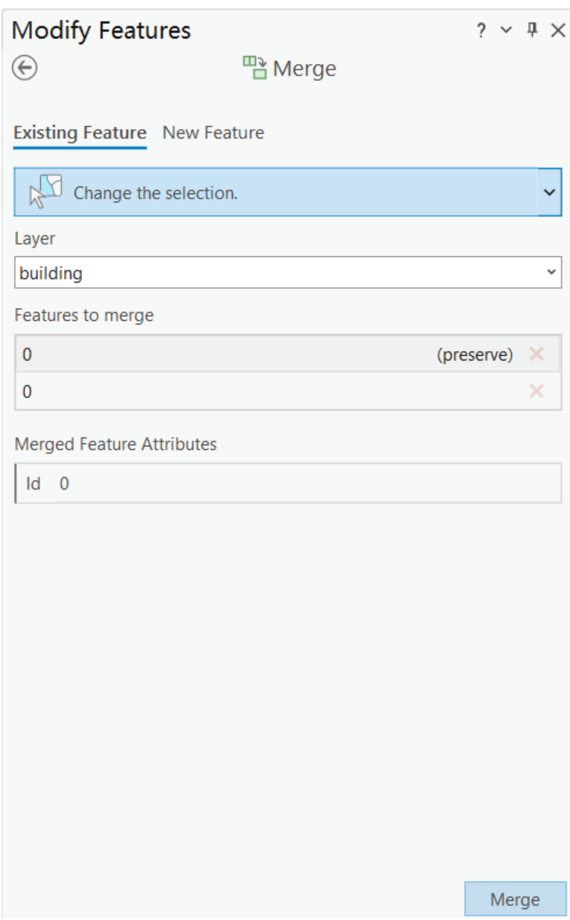


Figure 2.11

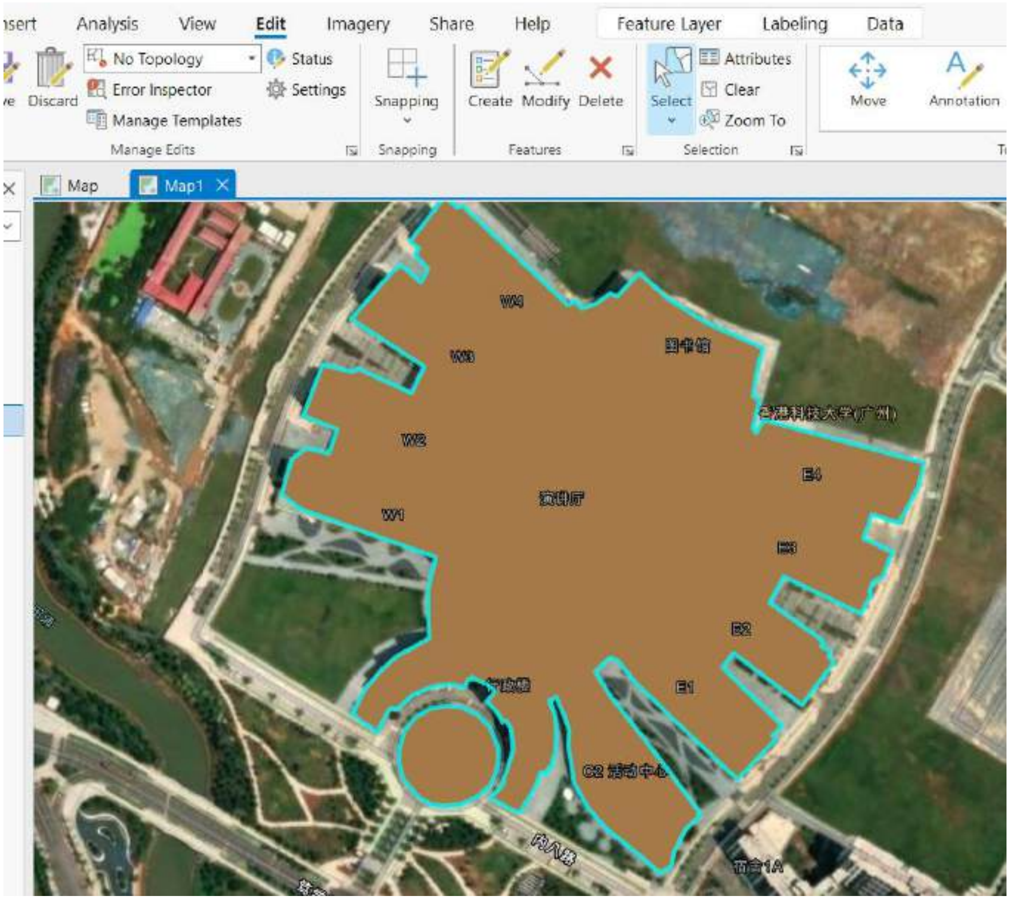


Figure 2.12

Step 2.6: After finished editing, you can save edits by clicking **Save** on the **Editor** ribbon.

SUMMARY

This exercise mainly introduces basic concepts and techniques for digitizing aerial photos. Four main steps are involved in a typical digitization process, including setting the spatial reference framework, creating spatial features, editing spatial features, and saving the edits. Two ways of transforming XY coorindates into Point shapefiles are also introduced.

ASSIGNMENT

Utilize the digitization method in this lab to create a vector dataset of the buildings on our campus. Please submit a file documenting your experiment process and results with screenshots. Name the document ***studentID_name_lab3.docx***, and then submit it through the **Canvas** platfrom in the '*Lab3 Assignment*' task before the deadline.

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Chapter 82

Keywords / 关键词

Important and difficult points / 重点难点

Date / 复习日期	Total Time / 复习时长	Efficiency / 学习效率	Note / 备注
		优秀 ◯ 良好 ◯ 一般 ◯ 差 ◯	
		优秀 ◯ 良好 ◯ 一般 ◯ 差 ◯	
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		优秀 ◯ 良好 ◯ 一般 ◯ 差 ◯	
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Chapter 83

Keywords / 关键词

Important and difficult points / 重点难点

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		优秀 ◯ 良好 ◯ 一般 ◯ 差 ◯	

Chapter 100

Keywords / 关键词

Important and difficult points / 重点难点

Date / 复习日期	Total Time / 复习时长	Efficiency / 学习效率	Note / 备注
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