

# Introduction to ArcGIS 10.2

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## Overview

Making maps in ArcMap is very easy: **Browse geospatial data** in ArcMap and **choose an appropriate presentation**. The table below outlines the steps that this workshop will guide you through.

No.	Steps	Sections to check	Difficulties
1	Load Geospatial Data into ArcMap	1.1	Data formats and folder connection
2	Identify the features and attributes to present	1.2	Layer order, feature selection, and (briefly) frequent-used projections
3	Define how to show the data	2.2	Transparency (raster and vector), data classification, and layer file
4	Add maps components	2.3	Geospatial data references
5	Export maps	2.4	Resolution and file formats

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## 1.1 Load Data

# 1. Browse Geospatial Data

## 1.1. Load data

To launch ArcMap, click: **Start -> All Programs -> ArcGIS -> ArcMap 10**. By default, a start-up splash window will appear once ArcMap has loaded (Figure 1).

Click **OK** to proceed. You can ignore all other options. They are redundant.

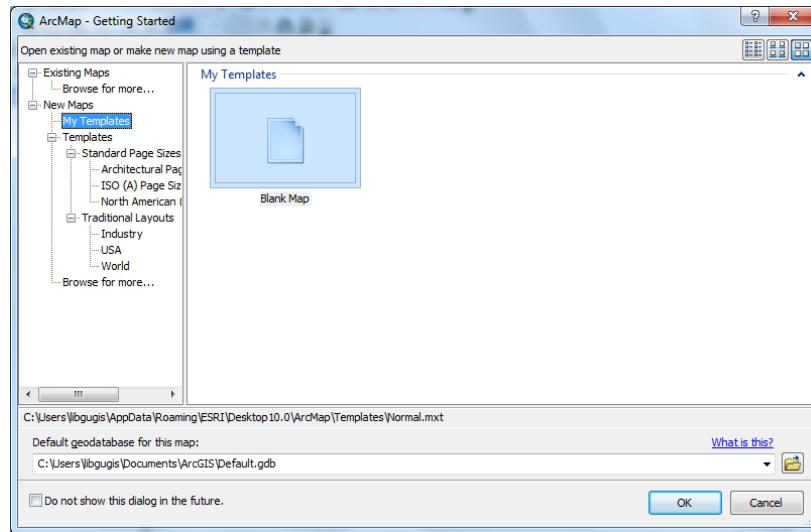


Figure 1. The start-up splash window of ArcMap

There are two ways to add data: Click the **Add Data** button (Figure 2), which opens a window similar to Figure 1.

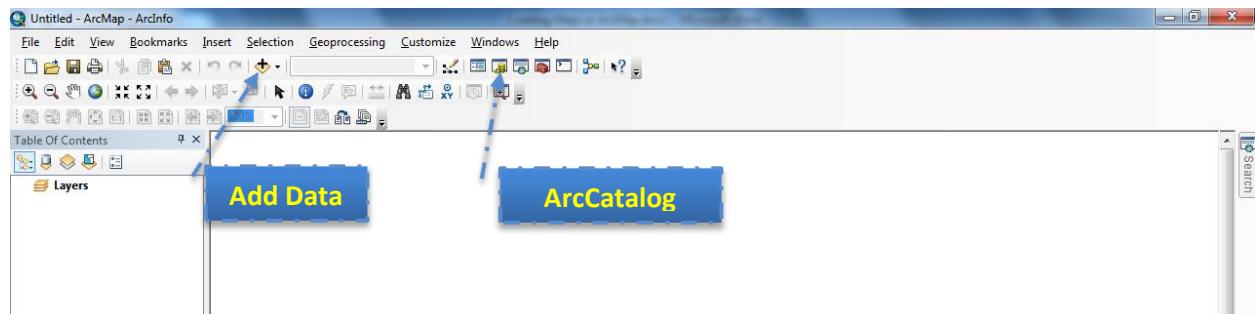


Figure 2. Main Windows with Marks on Add Data and ArcCatalog

## 1.1 Load Data

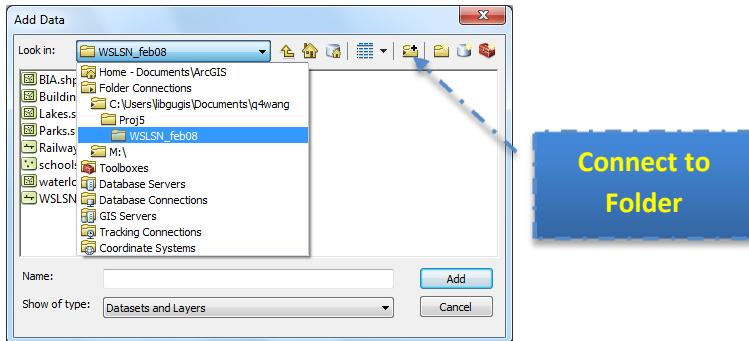


Figure 3. The Pop-up Window of "Add Data"

To browse to the file you want to work with, you can link to the folder containing all these files by clicking the **Connect to Folder** | button shown in Figure 3, then browse to add the folder that contains your files and click **OK**. After that, you can locate the files listed below and add them all at once by holding the **Ctrl** or **Shift** button while clicking on each selection. Please click the **Add** button just like any other file explorer dialogs in Windows to close the dialog.

- **Public\_schools.shp:** All public schools in the City of Waterloo
- **waterloo\_city.shp:** The administrative boundary of the City of Waterloo
- **waterloo\_streets.shp:** Street network in the City of Waterloo

When the data is loaded, all files will be listed in the left pane, called the Table of Contents (Figure 4). The geographic features (contents) are displayed in the main window, called the Data Frame. The toolbars can be found on the periphery of the other two windows.

## 1.1 Load Data



### Frequently-used File Formats in ArcGIS:

- **Feature Data:** Feature data are usually organized as points, lines, and polygons in vector format.
  - **Shapefile:** The most commonly used geospatial data format. Although it appears to be one file in ArcMap, a shapefile includes **multiple files** with the same file name, but different extensions. \*.shp, \*.dbf, and \*.shx are necessary components of the shapefile.
  - **Personal Geodatabase:** These files are based on Microsoft Access (\*.mdb). From a user perspective, the personal geodatabase is essentially a database structure but contains geospatial information as well as rows and columns.
  - **File Geodatabase:** A file geodatabase is much like a personal geodatabase except that it has more capacity and greater processing capabilities than a personal geodatabase. File geodatabases enable users to create datasets, which are like subfolders within the geodatabase. These can be used to organize datasets that participate in various kinds of spatial networks.
  - **Further Reading:**
    - [http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Types of geodatabases/003n00000007000000/](http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Types_of_geodatabases/003n00000007000000/)
    - [http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/About geographic data formats/00r90000006r000000/](http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/About_geographic_data_formats/00r90000006r000000/)
- **Raster Data:** Raster data uses grid to represent a region with values as a "field". Images explicitly have the parameter of resolution. Typical raster data is:
  - **GeoTIFF:** They have the file extension of \*.tif. The key difference between normal TIFF file and GeoTIFF is that GeoTIFF has projection information. Hence, normal TIFF files cannot be correctly added to the desired location.
  - **GeoJPEG:** Similar to GeoTIFF, but they have \*.jpg extension.
  - **Usage:** Raster data can be air photos, satellite images, elevation data (DEM). But raster data tends to be huge and slow to load.
- **External Data:** ESRI also supports some file formats produced by other vendors due to their popularity. Typical ones are:
  - **AutoCAD:** \*.dwg files can be added, imported and converted into ArcMap.
  - **Google Earth:** \*.kml files are supported by ArcGIS as well. However, conversion from KML into Shapefile is required, which can be done using ArcToolbox or some online services.
  - **Further Reading:** Wikipedia on GIS File Formats  
[http://en.wikipedia.org/wiki/GIS\\_file\\_formats](http://en.wikipedia.org/wiki/GIS_file_formats)

## 1.1 Load Data

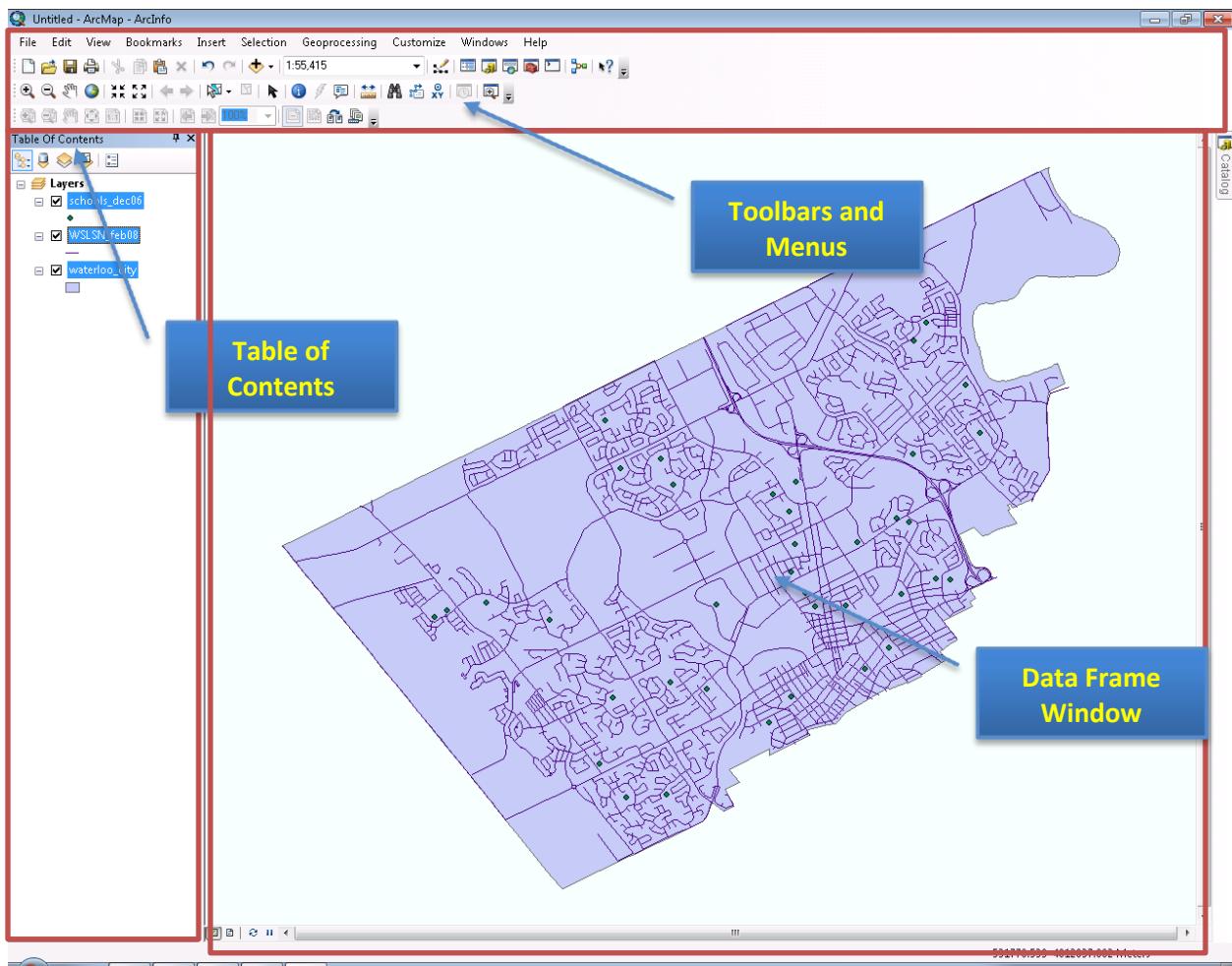


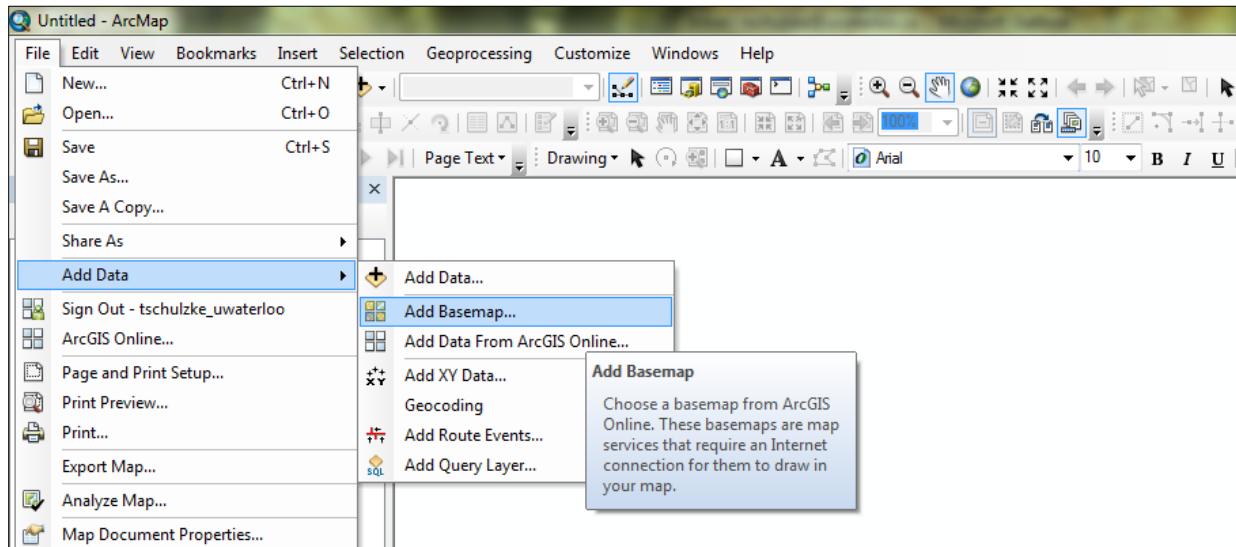
Figure 4. Structure of the Main Window

## 1.2 Add an Esri Basemap

### 1.2. Add an Esri Basemap

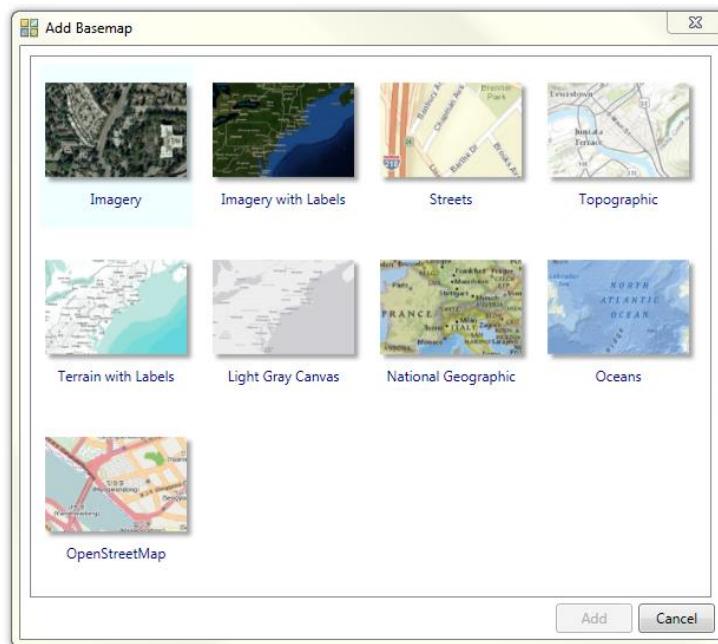
When users want to overlay a basemap and city boundary (`waterloo_city.shp`) together to produce a map like [one you might see on Google Maps](#), they can add a basemap directly from ArcMap.

To add a basemap, go to **File -> Add data -> Add Basemap Layer** (Figure 5)



**Figure 5. Adding a basemap from the File menu**

When the Add Basemap dialog box appears, you will see that there are several types to choose from. For this tutorial, choose either “Streets” or “Topographic” as your basemap (Figure 6).



**Figure 6. Esri Basemaps**

## 1.3 Browse Geographic Features

### 1.3. Browse Geographic Features

Most of the basic controls for working with data are found in the Tools toolbar (Figure 7). If you cannot find this toolbar, please go to **Customize -> Toolbars** and check the **Tools** on.

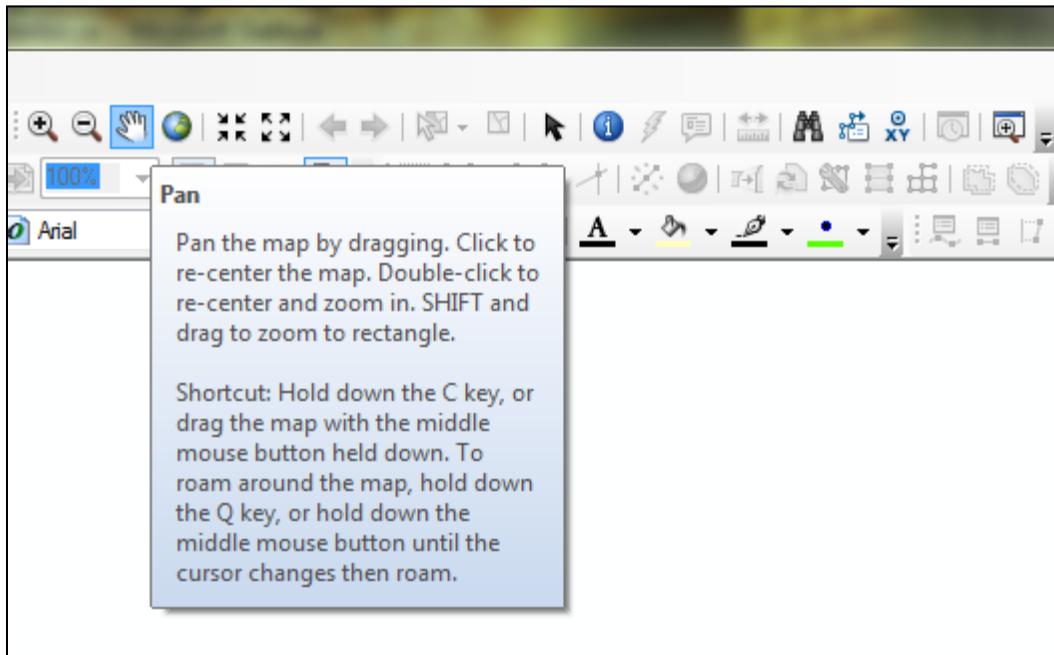


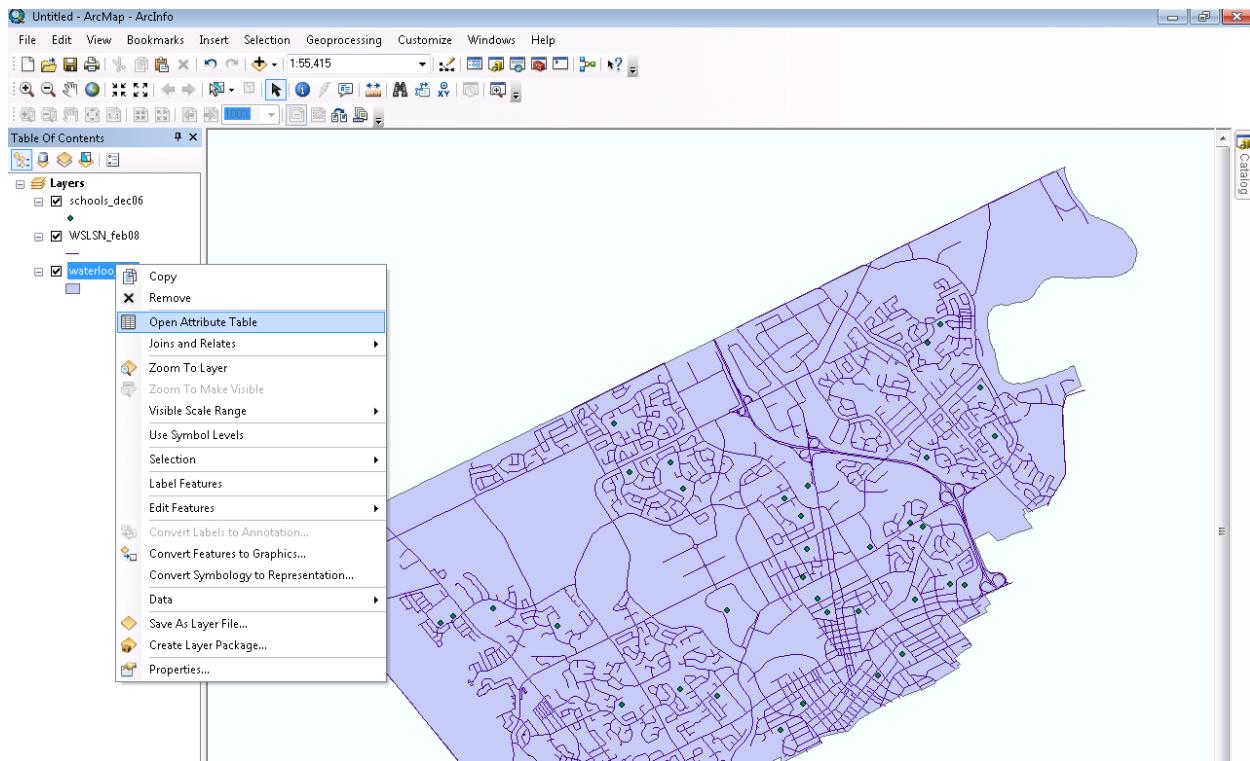
Figure 7. The Tools toolbar with Data Controls

Most icons are intuitive and self-explained. If you are not sure what function it has, you can hover your mouse over that icon. A pop-up text will show and further explanation. In Figure 7, you can see the

description for the Pan tool when the mouse is hovering over the icon.

In addition to the toolbar, some functions on attribute data are put in the pop-up window when you right click on one layer (a geospatial data file or a feature class) in the table of contents (Figure 8). When you click on “Open Attribute Table”, a table with all information on features will be shown (Figure 9).

### 1.3 Browse Geographic Features



**Figure 8.** Pop-up Window with Options on a Layer

FID	Shape *	NAME	TYPE
0	Point	Bluevale Collegiate	PUBLIC
1	Point	Brighton Public	PUBLIC
2	Point	Cedarbrae Public	
3	Point	Centennial Public	
4	Point	Elizabeth Ziegler Public	
5	Point	Empire Public	
6	Point	Harold Wagner Public	PUBLIC
7	Point	Holy Rosary Separate	SEPARAT

**Figure 9.** Attribute Data Window

These controls can be classified and summarized into the following table:

	Geographic Operations	Attribute Operations
<b>Browse</b>		Right-click on the layer (Figure 8 and 9)
<b>Search/Identify</b>		
<b>Select</b>		(Figure 9)

## 2.1 Distinction between Geospatial Data and Map Components

# 2. Mapping

## 2.1. Distinction between Geospatial Data and Map Components

This section is more concept oriented. To simplify the mapping process, ArcMap offers two ways of viewing the map contents: Data View, which focuses on data manipulation and representation; and Layout View, which shows you how the map will look on the page, including map elements such as the legend, scale bar, north arrow, etc.

- **All data representations should be set in data view.** Key operations include the change of layer order, symbology customization, layer transparency, labeling, and annotations. Most of data representations can be saved in a layer file (\*.lyr), because they are more data associated.
- **Layout view shows the virtual map you will get.** Layout view works in a What You See Is What You Got (WYSIWYG) fashion. The output will be the same as what you see in the layout view, where you can add map elements and change the paper and output settings. Map settings will be save in an \*.mxd file.

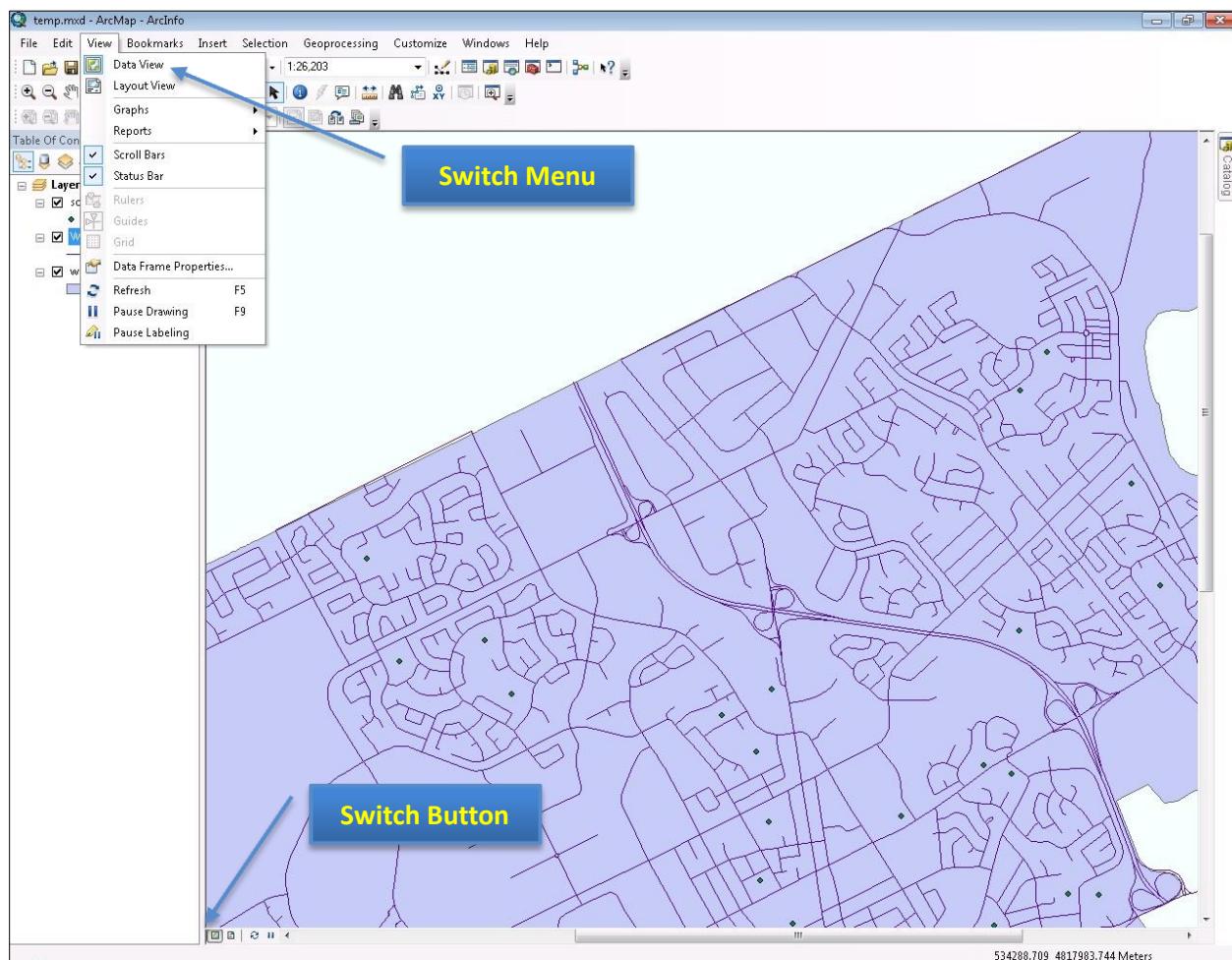


Figure 10. Switch between Data View and Layout View

## 2.2. Key Operations of Geospatial Data Representations

### 2.2. Key Operations of Geospatial Data Representations

The main operations of changing geospatial data representations are layer order, layer transparency, symbology, label, and annotation. Apart from the first one (layer order) and last one (annotations), these operations can be found in the pop-up window shown below (Figure 11) by right-clicking the layer you want to modify and selecting **Properties**. The Layer Properties dialog box appears (Figure 12) and you can select from the different tabs such as **Symbology** or **Labels** as shown below.

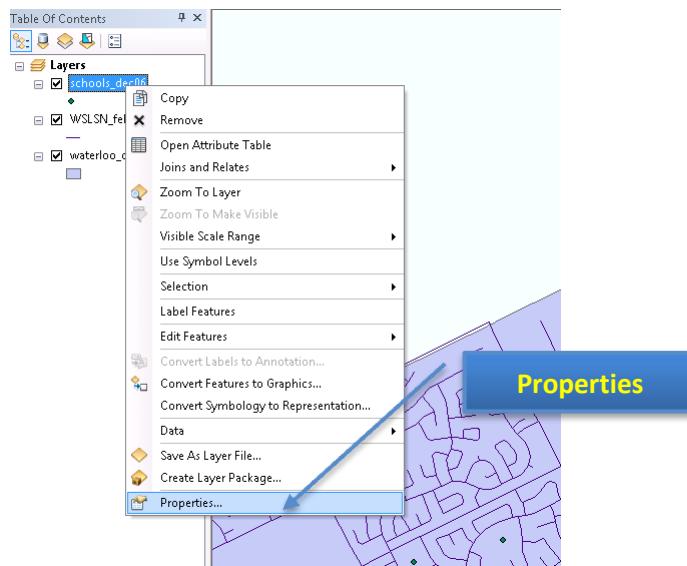


Figure 11. Pop-up Window of a Layer's Property

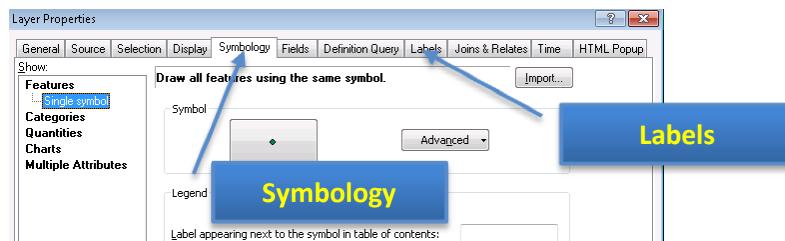


Figure 52. The Property Window

The following subsections discuss the operations in detail.

#### 2.2.1. Layer Order and Transparency

The boundary layer ('waterloo\_city.shp') can be made to outline the city (i.e. no fill color), which allows us to see the underlying basemap. The detailed steps will be introduced after the concept of layer order.

#### Layer Order

ArcMap displays geospatial data according to the order in the table of contents: the bottom layer will be drawn on the screen first, the next one up will be drawn on top, and so forth until the uppermost layer. Hence, the layer on the top will be drawn last and may cover up other layers. **By default, ArcMap orders points, lines, polygons, and raster data (images, DEMs, etc) from top to bottom respectively** so that

## 2.2. Key Operations of Geospatial Data Representations

the visibility is maximized. If two layers belong to the same feature class, i.e., point features, the newly added one will be on top of the older one.

When there are multiple raster files, layer visibility and order are important. You can change layer visibility by switching the checkboxes to the left of the layer name in the table of contents (Figure 13). And the display order can be changed by simply dragging the layer toward or away from the top.

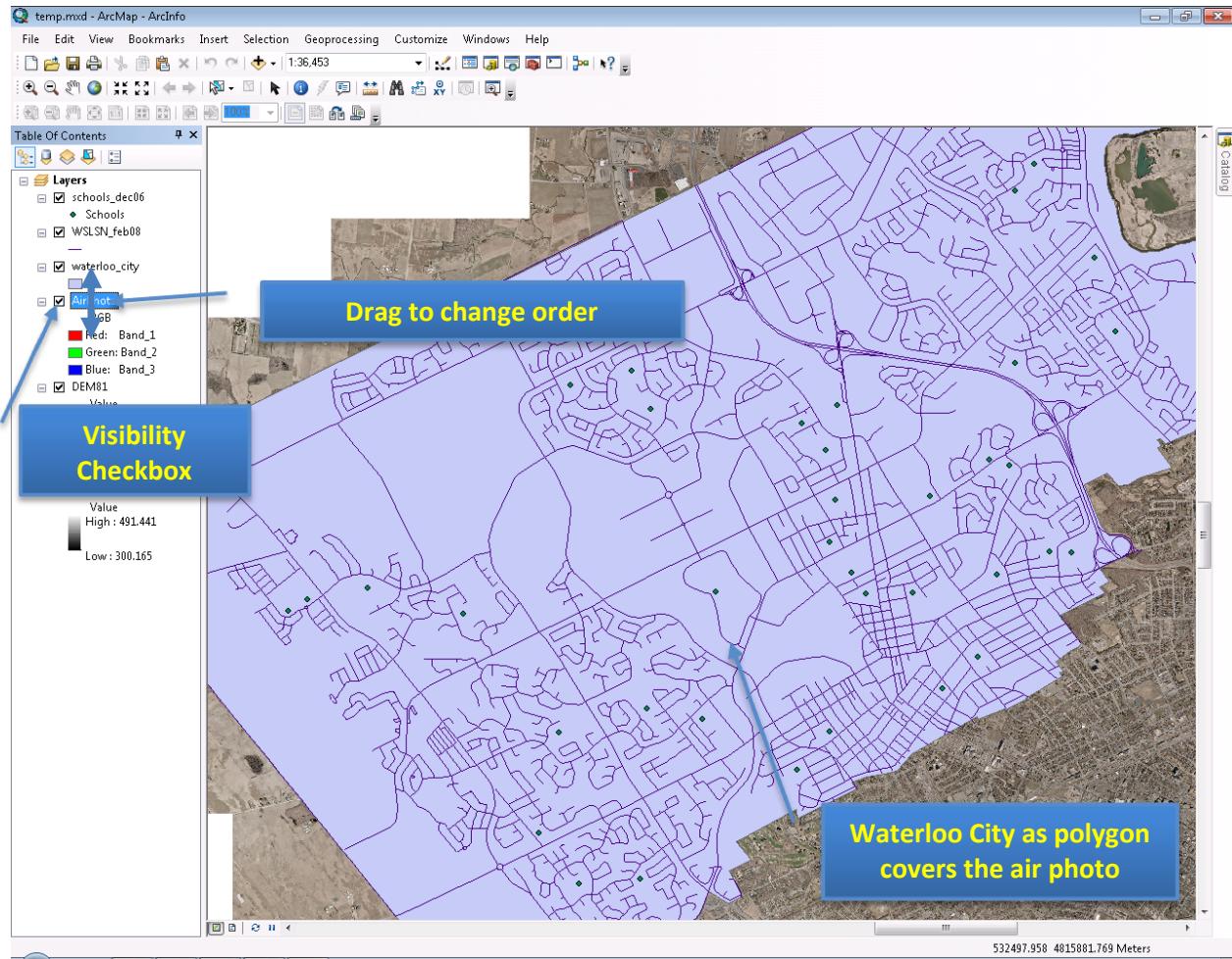


Figure 63. Layer Visibility and Order Control

### Layer Visibility

When a polygon layer, such as **waterloo\_city**, is added over an image (**basemap**), the image under the polygon is not visible, as in Figure 13. But users often like to only show the polygon's boundary so that the basemap imagery is also visible. In this case, layer transparency and hollow symbology can help.

To do so, **right-click on the polygon layer** (**waterloo\_city**) and select **Properties** (Figure 11). Then under the **Symbology** tab, click on the symbol itself (Figure 14).

## 2.2. Key Operations of Geospatial Data Representations

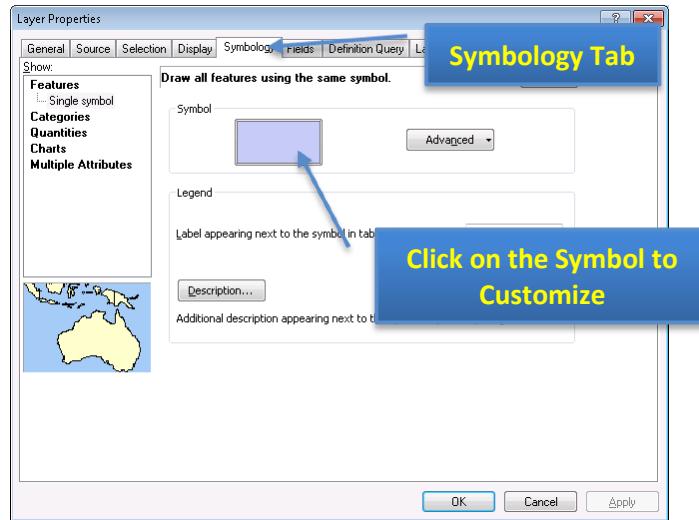


Figure 74. Properties of Symbology

When the Symbol Selector opens, (Figure 15), you can change the **Fill Color** to **No Color** and increase the **Outline Width** from 0.4 to 1.0.

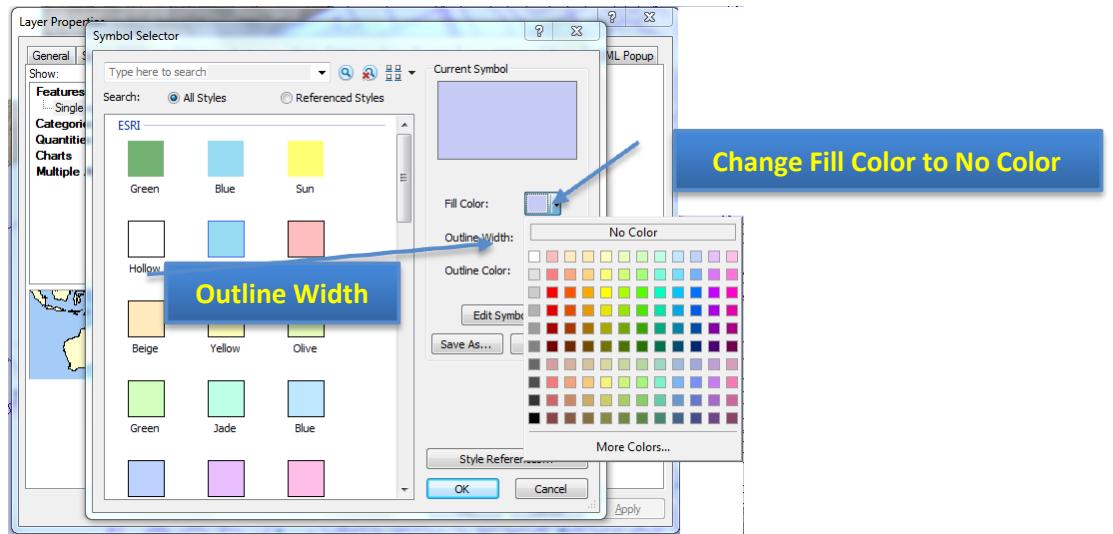


Figure 85. Make Hollow Polygons



### Layer Transparency:

An alternative (actually more generic) way of preventing overlaying is to right-click the layer and select **Properties** (Figure 11), then go to the **Display** tab. You can freely change the transparency as the parameter (percentage) of "**Transparent**" (or "**Transparency**" for raster layers).

## 2.2. Key Operations of Geospatial Data Representations

### 2.2.2. Symbology and Label

#### Symbology

Symbology is critical in making maps, which are classified into four categories in ArcMap. Due to its complexity, these four categories and their normal usages will be briefly introduced in the note region with further reading. We will only focus on symbol customization and classification symbols, which are mostly used.

Please right-click the **public\_schools** layer and select **Properties**. Then switch to the **Symbology** tab and click on the **Symbol**. The Symbol Selector dialog (Figure 16) contains four main parts. In most cases, you will simply choose a symbol from the symbol library (other than making hollow polygons mentioned in 2.2.1.). Depending on the type of feature (point, line, or polygon), the options change accordingly.

You can type in **school** and click the search icon (magnifier) to search all symbols related to school representations.

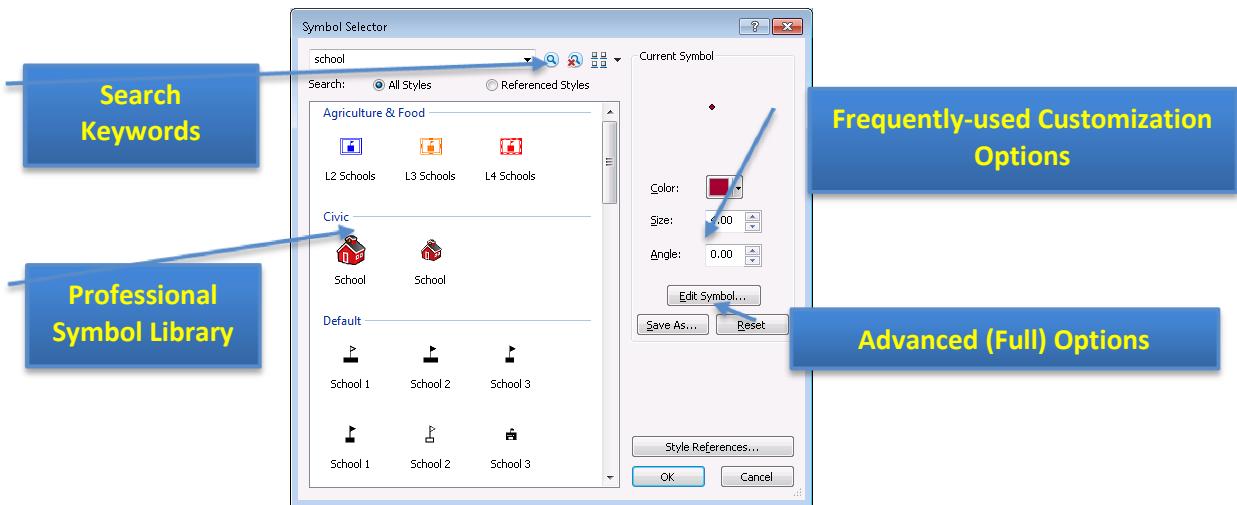


Figure 96. Symbology Customization Window with Explanations

There are cases when you want to differentiate features in a layer based on some attribute. For instance, I want to know the type of public school (elementary or secondary), which is the top layer in Figure 13. Different types will be symbolized using different colors. To do so, we should **right-click** on the school layer, select **Properties**, and go to the **Symbology** tab, which is the same as shown in Figure 14. But instead of the default **Features** option, click the **Categories** option (Figure 17).

1. Click on the **Categories** first and make sure the “**Unique Value**” is chosen;
2. Draw down the dropdown of **Value Field**, and select TYPE as the classification attribute;
3. Click on the **Add All Values** button to add all distinct values under the TYPE attribute into consideration;
4. (**Optional**) Click on the **Color Ramp** dropdown and select your favourite color schema.

## 2.2. Key Operations of Geospatial Data Representations

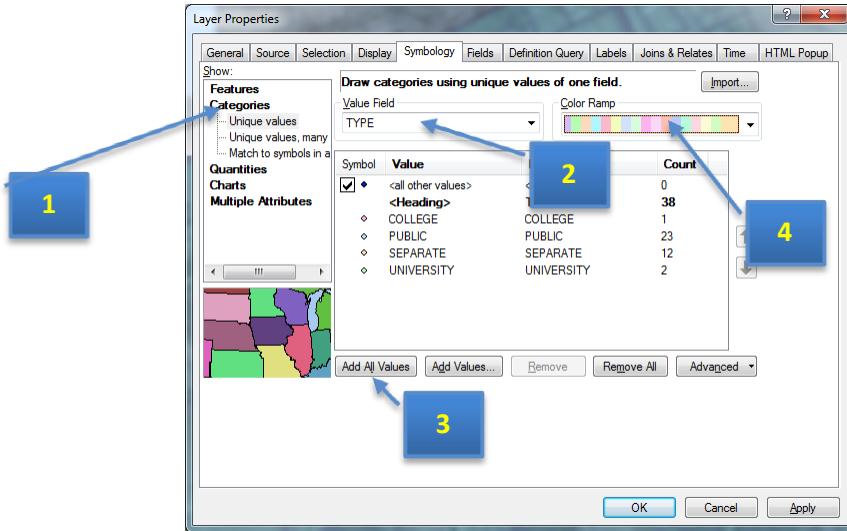


Figure 107. Classifying Features using Colors

The result is shown in Figure 18. Please note that you can still customize individual symbol for each category (size, shape, etc.) by double-clicking corresponding classes on either the left pane or the line in the symbology window. The pop-up window is very similar to the window in Figure 14. Please choose



School 1 for each class. And no need to worry about the color: ArcMap manages this automatically.

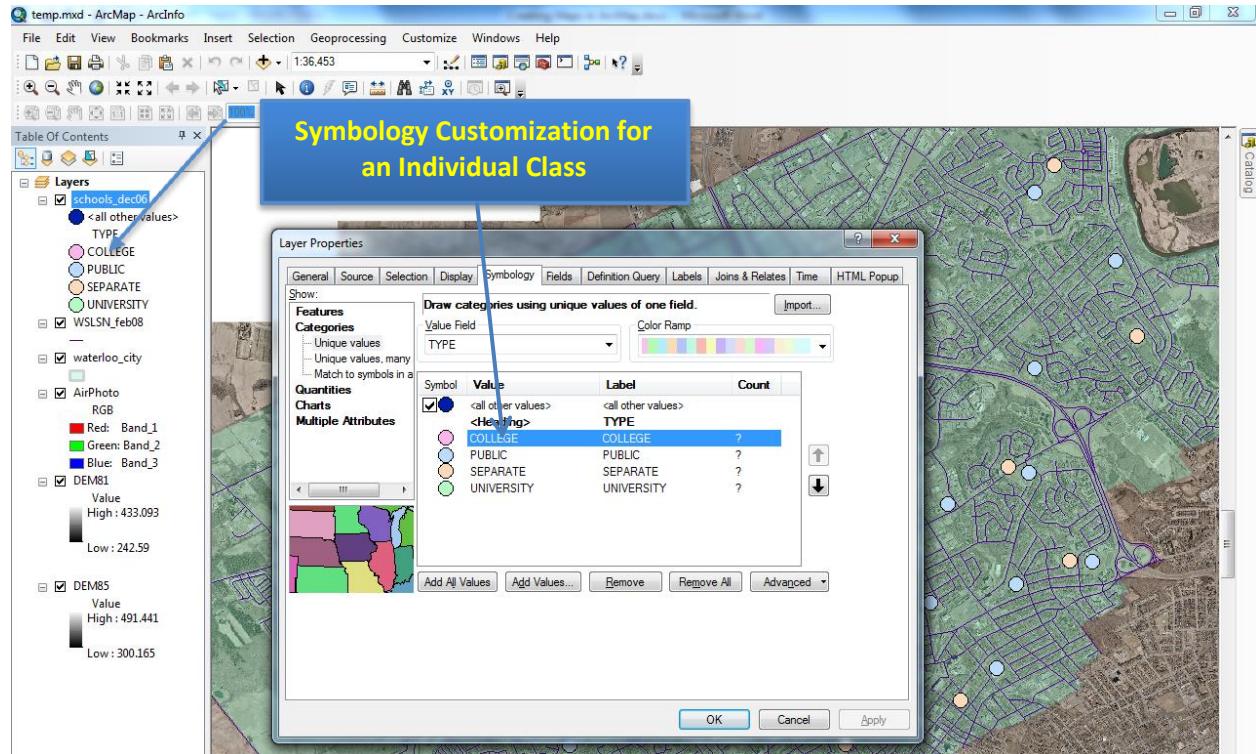


Figure 118. Classified Symbols and Further Customization

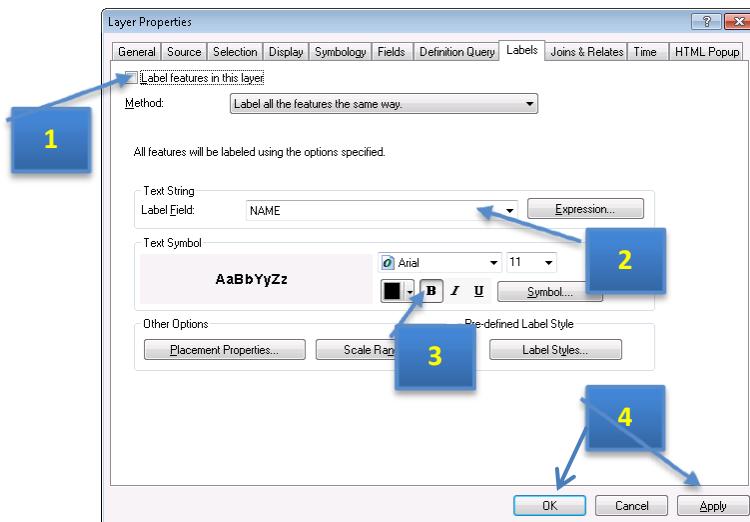
## 2.2. Key Operations of Geospatial Data Representations

### Label

The labels are an important feature of a map. In order for people to recognize unique attributes of a feature, you need to label the features. Labels help make your map more useful, informative, and visually appealing.

To add labels to your map, **right-click** on the layer that you want to add marks on (**public\_school**) and select **Properties** (Figure 12). Then follow the steps below:

1. Under the **Labels** tab, check the box to “Label features in this layer”.
2. Choose the attribute you want to label from the dropdown menu next to **Label Field** (Figure 19).
3. Change Font (**10 pt size and Bold**), so that it is clearly shown on the map.
4. You can click on the **Apply** button to see the effect until it is satisfactory. Then click **OK** to save your setting and exit.



**Figure 129. Label Setting Window**

To ensure a clear label, you can add a halo around the lettering. Click on **Symbol** located in the **Text Symbol** section of the window (Figure 20). Then click the **Edit Symbol** button, navigate to the **Mask** tab shown in Figure 18 below. Change the **Style** from **None** to **Halo**.

## 2.2. Key Operations of Geospatial Data Representations

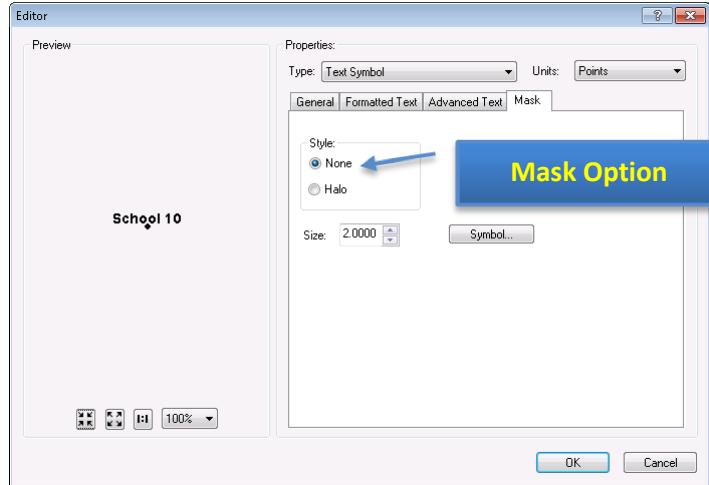


Figure 20. Change Mask Option for Clearer Labels



### Symbology Types and Their Normal Usage:

- *Features: Mainly used when you just want to mark geographic features on a map.*
- *Categories: Suit for the case when feature classification is needed.*
- *Quantities: Appropriate when numbers involve, i.e., population, income, depth, etc.*
- *Charts: Employed when not only quantity but also the relative importance is important as well. For instance, incomes from different types of consumers.*
- *Multiple Attributes: Utilized when multiple criteria are involved, which may not be quantitative. It can be regarded as a generalized case of Charts.*

### 2.2.3. Annotations

Annotations are a method of labeling your features that offer more control over the placement of each label. Annotation can also be used for additional data that may not be part of your layers. For instance, we can add a point showing the location of the University of Waterloo, which is not part of the current data (***Please note that annotations can only be edited under the data view***):

1. Turn on the **Draw** toolbar by choosing **Customize -> Toolbars -> Draw** (Figure 21).

## 2.2. Key Operations of Geospatial Data Representations

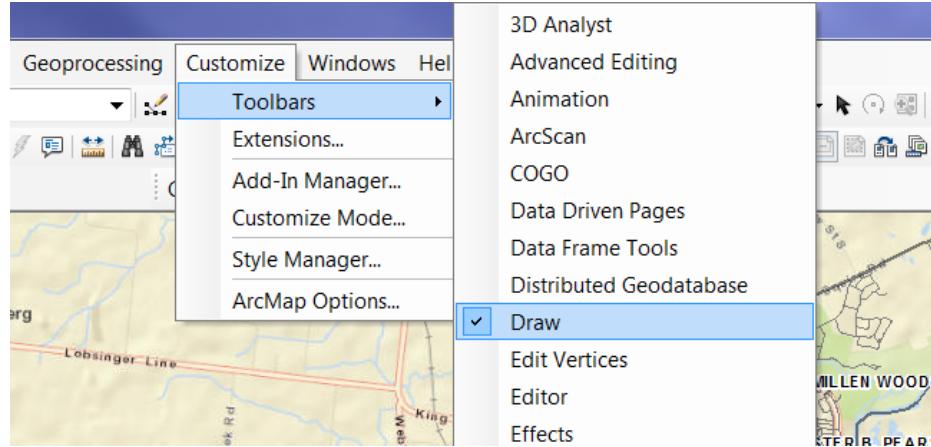


Figure 21. The Way of Turning on the Draw Toolbar

2. Add Marker. Click on and select **Marker**. Then browse and point to the location you want to add the marker (South Campus Hall in this case) and click. A marker will be added to the location.



Figure 132. The Draw Toolbar

3. Add Text. Click and choose **New Text**. Click on the map, somewhere close to the marker you just made and type "University of Waterloo" (result is shown in Figure 23).

## 2.2. Key Operations of Geospatial Data Representations

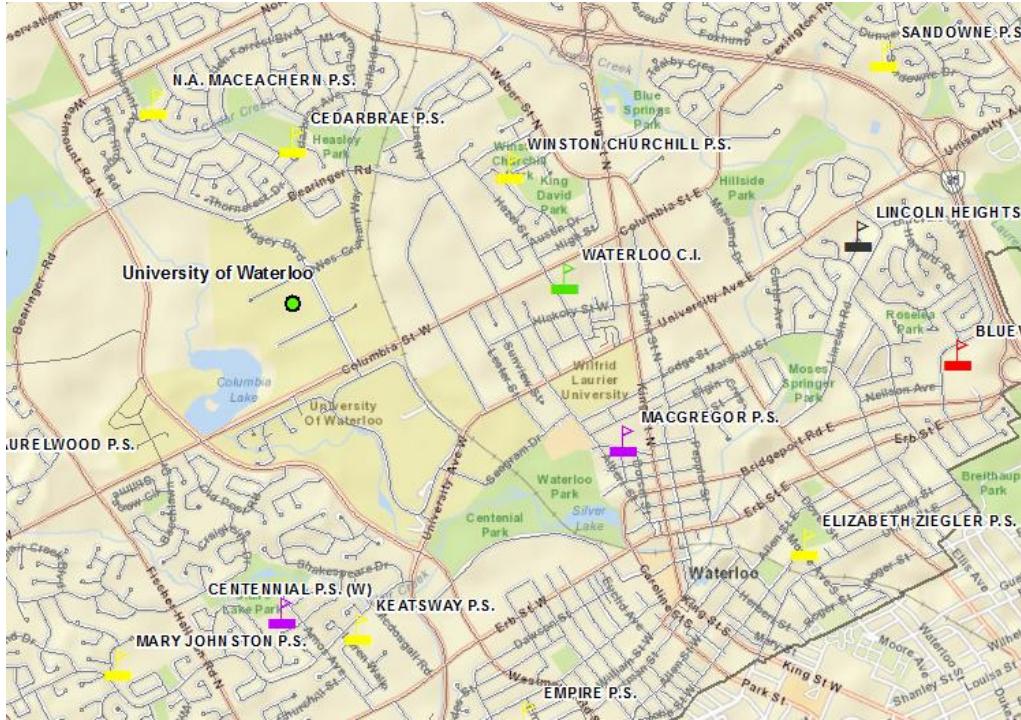


Figure 143. Map after Adding Labels (with Mask) and Annotations



### Some Other Types of Annotations:

- Annotate a polygon: Sometimes you may want to annotate a polygon. The easiest way to do so is to choose **Polygon Text**. Please modify the text style (color, size, etc) and the filled color accordingly, which locates at the right part of the Draw Toolbar (Figure 19).
- Annotate along the road: ArcMap also allows to you to put your annotations warp along the road, which looks nicer. To do so, please choose **Splined Text**. Then make single clicks along the road, which defines the display route. Type in the texts and enter. The text will be shown along the route you made.

## 2.3. Map Components

### 2.3. Map Components

Switch to **Layout View** to start adding map components, which can be accessed from the **Insert** menu (Figure 24). The key ones are:

- The title of the map (Purpose/Content)
- The scale of the map (Measurement)
- The North Arrow (Orientation)
- The Legend (how to interpret the map)
- (Optional) The reference (where you obtain the data)

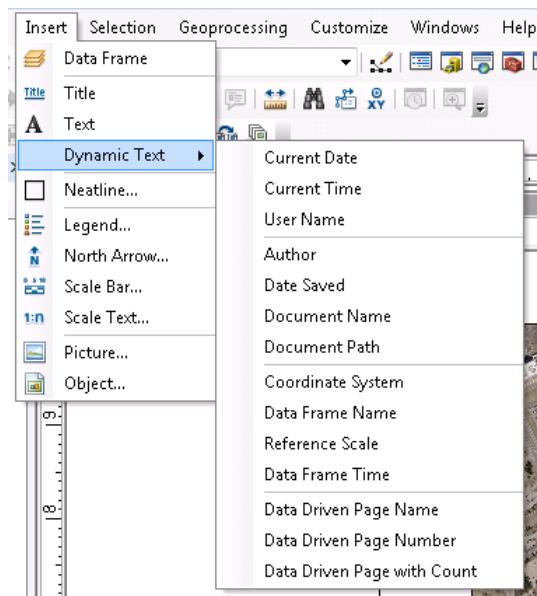


Figure 24. All Map Components Available

Map titles are just a specific kind of text box with some pre-defined fonts. Hence, the usage of title and text are identical and intuitive: type in the content and customize the text properties.

Add scale bar or scale text is also intuitive. The only thing that should be noted is the display unit, such as meters, degrees, miles, etc. You can change it by clicking the **Properties** button in the **Scale Bar (or Text) Selector**, which is the pop-up window when you choose **Insert -> Scale Bar (or Scale Text)**. In the **Scale and Units** tab, you can choose an appropriate unit in the **Division Units** dropdown (Figure 25). In addition, you can change the font style under the **Format** tab as well.

In this example, use Scale Text with meters for the units, shown as **1 cm = 75 meters**.

Adding a North Arrow is an easy but often overlooked task. It is similar to adding a scale bar in that you simply choose a pre-defined north arrow from the library shown in the left pane. If your North Arrow is difficult to be distinguished from the background, you can add some background color, which has a similar effect as “mask” for labels. This option is normally located in the **Frame** tab (Figure 26). Legend, scales, and texts all have similar options.

## 2.3. Map Components

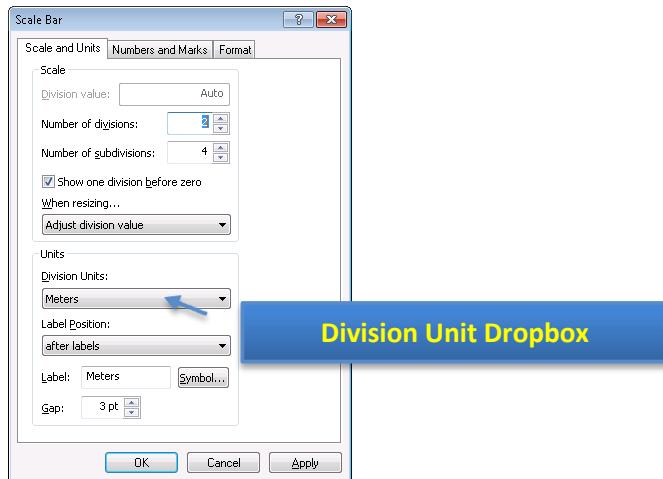


Figure 155. The Scale Bar (or Text) Property Window

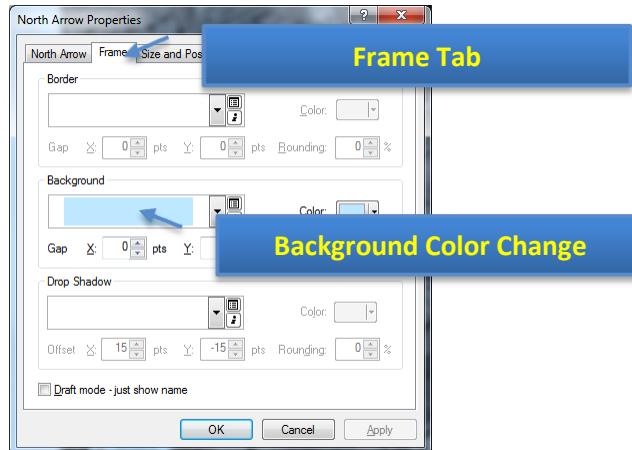


Figure 166. Change Background Color in Frame Tab

Adding a Legend is somewhat complex and deserves some explanation. When **Insert -> Legend** is selected, ArcMap will use a wizard guiding you through various options of making a legend.

At the first step, you will be asked about which layers you'd like to include in the legend and the order of those layers (Figure 27). The left pane **Map Layers** displays all layers (geospatial data) available for the map. The right pane **Legend Items** shows the layers that will be added to the legend and their order.

- **Add/Remove Layers:** You add layers to the legend by clicking and remove them by clicking . Note: Although you can add the basemap to your legend, it will not have any symbol next to it because it is a tiled map service; however, the basemap information is automatically included at the bottom of the map when in Layout View. Similarly, if you add a raster to your legend, it will only show the RGB or other relevant values.

## 2.3. Map Components

- Change the Display Orders: The legend items will be added strictly in the order shown in the **Legend Items** pane. You can change the order by clicking a layer first (displayed in the blue bar) and move it up  or move it down .

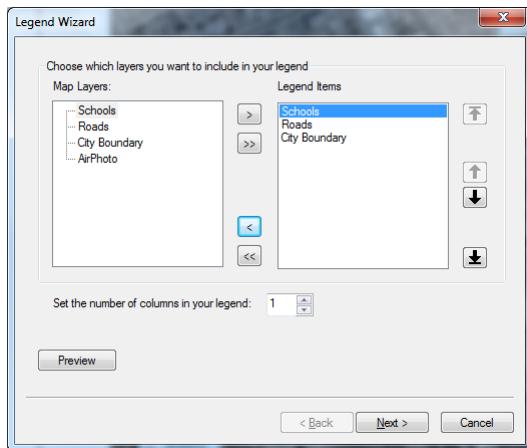


Figure 177. The First Step of Adding Legend

In the following three steps (four steps in total), ArcMap will ask you about some options to display the legend. None of them is critical or requires customization (especially for normal users). You can just accept all the defaults and click **Next** until you get to the end. Your legend should look something like Figure 28 below.

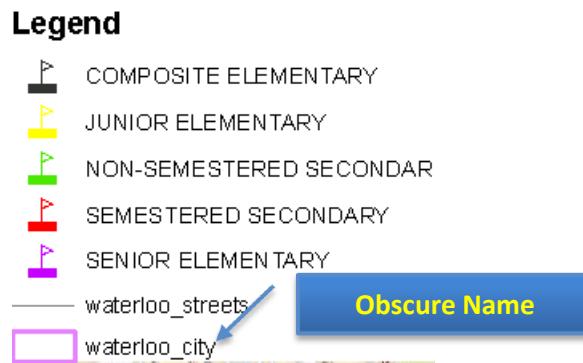


Figure 188. An Example of Generated Legend

It is easy to find that the name displayed in the legend is either difficult to understand or looks strange because of how the file was named. For instance, users can understand what “waterloo\_city” means, but it doesn’t look good in all lowercase letters and with the underscore. In this case, you can modify the name in the **table of contents** pane (Figure 4). To do so, you can **right-click** on the “waterloo\_city” layer and select **Properties**. Under the **General** tab, you can type the more meaningful name in the **Layer Name**: Waterloo City Limits (Figure 29). Use the same method to change any other obscure names.

## 2.3. Map Components

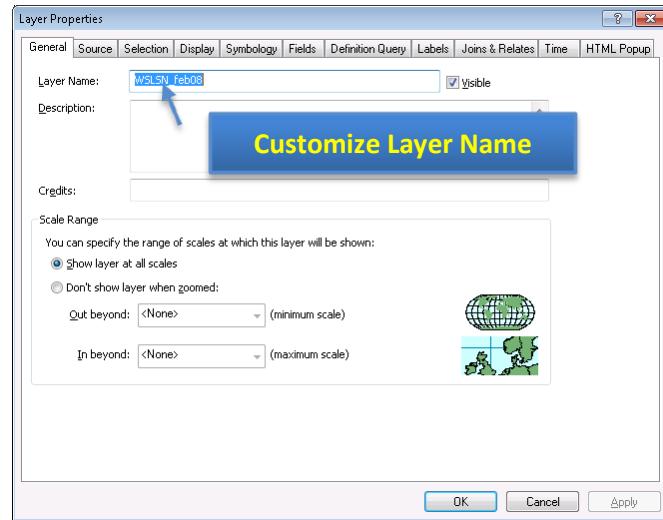


Figure 199. The General Tab to Change Layer Name

Lastly, we're going to add a citation to the map. Click on **Insert -> Text** under the layout view and type in your citation.

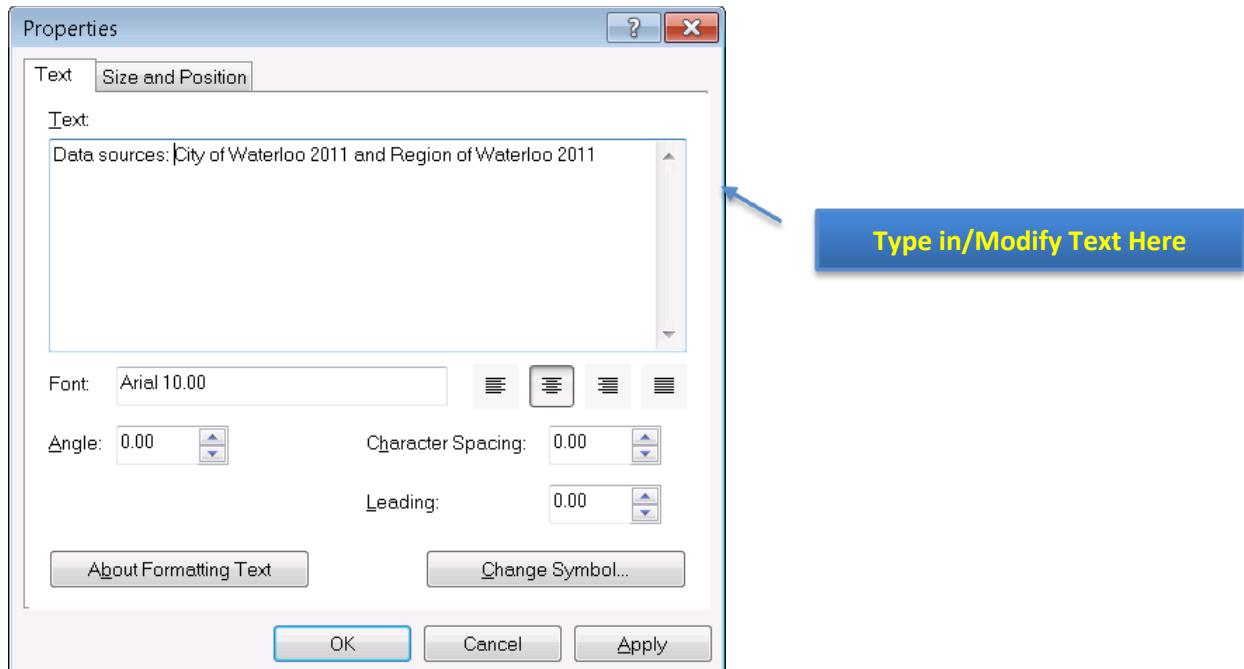


Figure 30. Property Window of Text in Layout View

### 2.3. Map Components



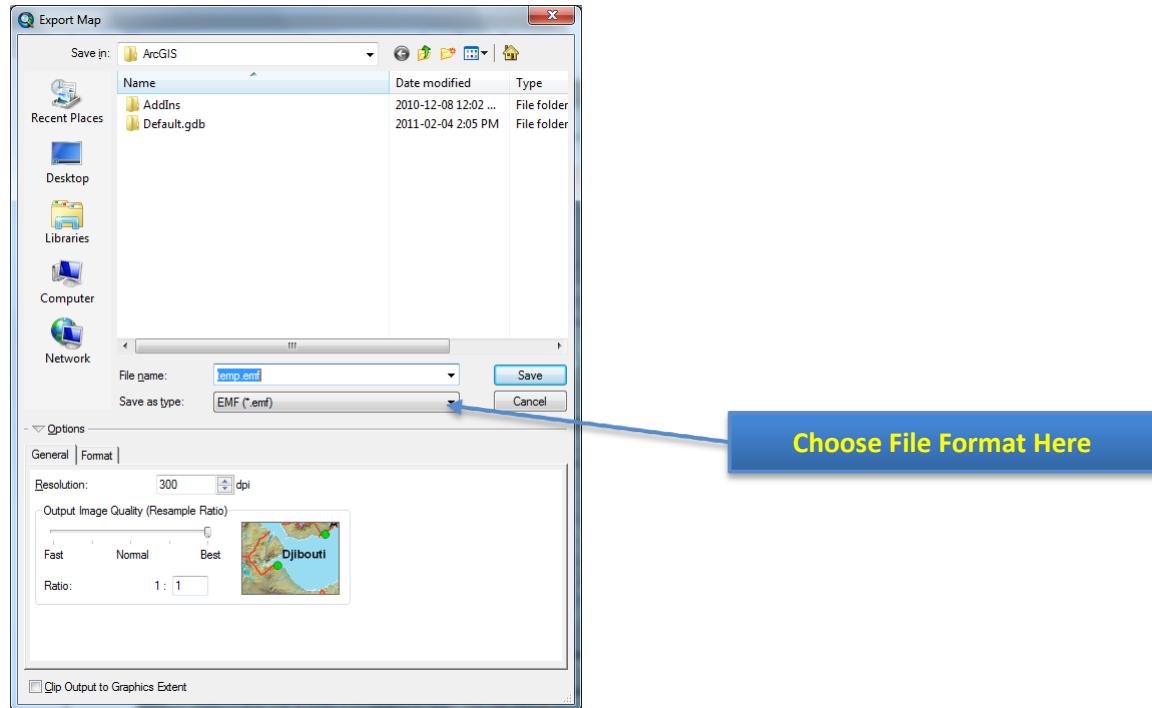
*Some Components that are also frequently added:*

- Author of the Map: Users may want to know who creates the map;
- Date Saved (Created/Modified): The more frequent a region changes, the more important it is for users to know when the map is created;
- Coordinate System: The globe is not flat, but a map is. Any kind of projection used to make the map distorts the reality in some way. Hence, it is critical for users to know how reliable their measurements on the map are, especially for pilots and navigators.

## 2.4. Export Maps

### 2.4. Export Maps

When you are satisfied with everything in the map and are ready to deliver, you can export your map by the menu of **File -> Export Map**, which will pop-up a dialog (Figure 31).



**Figure 31. Export Map Dialog**

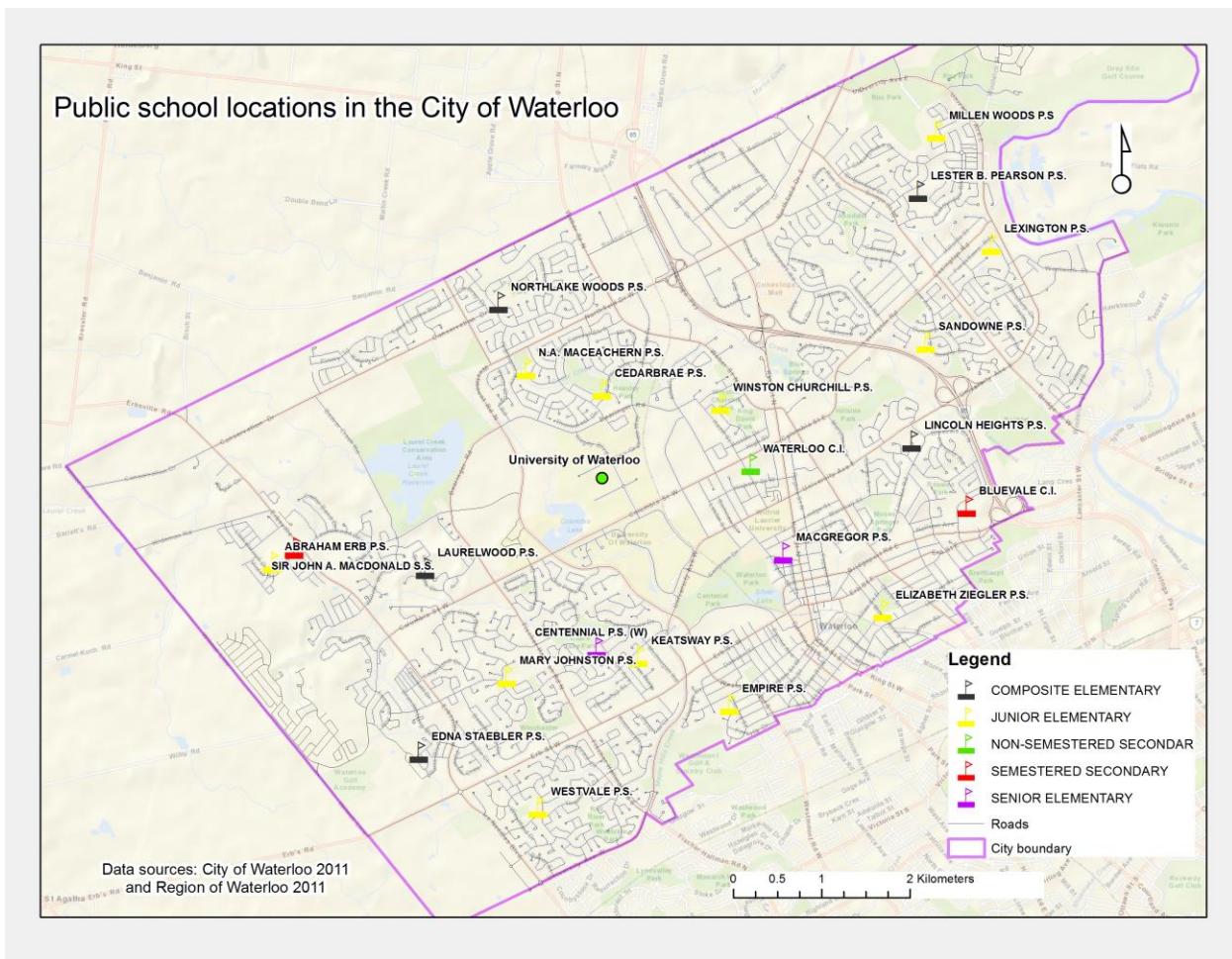
You can specify the directory and file name of the map in this dialog. But, most importantly, you need to choose an appropriate file format by click on the **Save as type** dropdown. The most frequent-used formats are JPEG and PDF. JPEG is a popular graphic file format, which is easy to be inserted into word as a graph, while PDF is best used for sharing. The printed copy of PDF will be identical regardless of your computer (and printer) environment.

Please note that if the purpose of your map is to be shown on screen, **96 dpi** resolution is good enough. It is especially true when you want to publish your map online, given that lower resolution maps are much smaller, and therefore, easier to transfer via Internet. If you need hard copies of your map, please make sure that the resolution is set to **300 dpi** or **600 dpi**. Otherwise the output map might be obscure.

Other than export map to other file formats, you can directly print out hardcopies of your map by **File -> Print**. You can preview the result via **File -> Print Preview** to ensure satisfactory result. And, of course, you can customize page and printer setup via **File -> Page and Print Setup**, such as page orientation (portrait and landscape), page size, printer configuration (color or grey), and so on. All these operations are intuitive and very similar to other applications, such as Microsoft Word.

## 2.4. Export Maps

The final map will look similar to the one below.



## 2.4. Export Maps



Brief Explanation of Graphic File Formats:

- EMF file: Enhanced Metafile, specified for Windows, which can be regarded as an alternative of TIFF file. EMF is an not recommended option;
- EPS file: Enhanced PostScript file, specified by Adobe for printer drivers. It is popular in open-source editors, for instance, LaTeX and TeX. But it seems to be a buggy option. Try to avoid it;
- AI file: Adobe Illustrator file. A major vector graphic file format. A good choice if you work with Adobe products, such as Illustrator, Flash, and Macromedia ones;
- SVG file: Scalable Vector Graphics, an open-source vector graphic standard. It is becoming more and more popular and can be accepted by many vendors;
- BMP file: BitMap file, which is a mature loss-less uncompressed raster format. The quality is great. But its file size tends to be huge. It can be used if you need both high-quality output and compatibility ;
- PNG file: Portable Network Graphics, which is an open-source standard designed to replace BMP and GIF. It is a true-color loss-less raster file format. PNG file is slightly larger than JPEG (compressed with quality loss). And some old browsers and operating systems do not support PNG files;
- TIFF file: Tagged Image File Format. A major raster graphic file format provided by Adobe (AI for vector). Best to be used for raster file editing on Adobe Products, such as Photoshop;
- GIF file: Graphics Interchange Format. An uncompressed raster file format with 256-color limitation. Hence, if your map contains only a few colors (vector-based data), GIF is a good candidate.

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