

Creating Maps in ArcMap: A Quick Guide

Overview

Making maps in ArcMap is very easy: **Browse geospatial data** in ArcMap and **choose an appropriate presentation**. This workshop will guide you through all necessary steps in the following table.

No.	Steps	Sections to check	Difficulties
1	Load geospatial data and basemap into ArcMap	1.1	Data formats and folder connection
2	Identify the features and attributes to present	1.3	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, please 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.

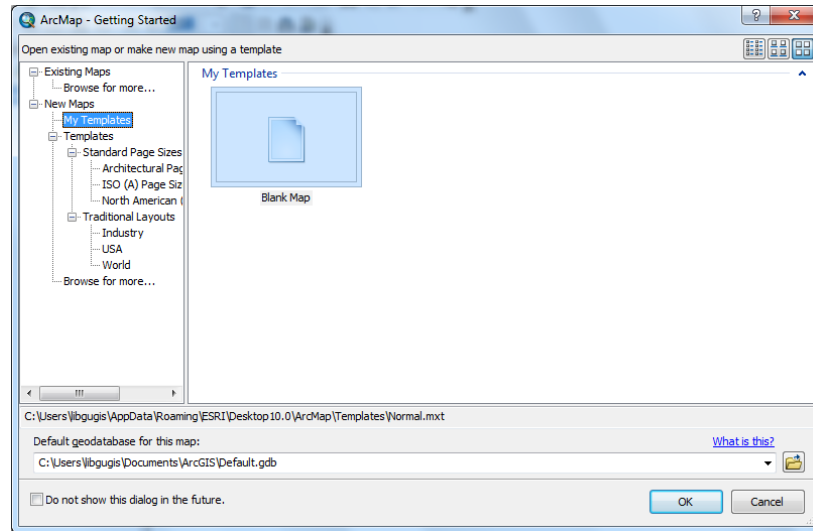


Figure 1. The start-up splash window of ArcMap

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

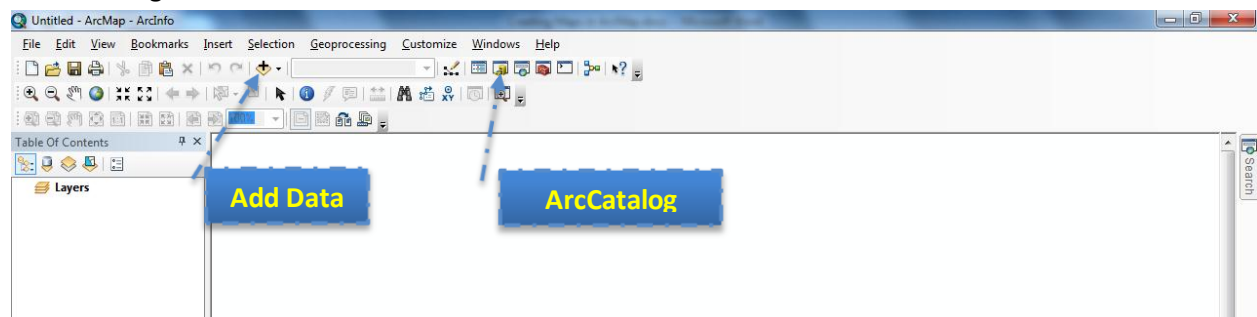


Figure 2. Main Windows with Marks on Add Data and ArcCatalog

1.1 Load data

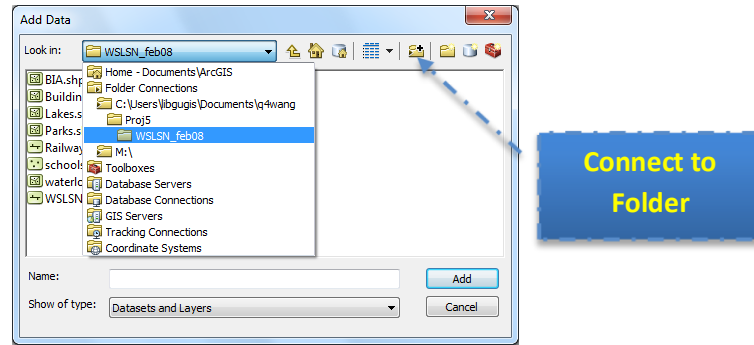



Figure 3. The Pop-up Window of "Add Data"

To browse to the file you want to play with, you can link to the folder containing all these files by clicking the **Connect to Folder**  button 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 in at one time by holding the **Ctrl** or **Shift** button when you are clicking mouse button to make selections. Please click the **Add** button just like any other file explorer dialogs in Windows to close the dialog.

- **Public_schools.shp**: All public school locations 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 data is loaded, all files will be listed in the left pane (table of contents) in Figure 4. The geographic features (contents) are displayed in the right pane. And most controls can be found on the top pane (or by right-clicking on the object you are working at and checking the pop-up window).

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, shapefile includes **multiple files** with the same file name, but different extensions. *.shp, *.dbf, and *.shx are must-have.
 - **Personal Geodatabase:** These files are based on Microsoft Access (*.mdb). From user perspective, all kinds of geodatabase are the same, which include multiple layers (different geospatial data) in one geodatabase.
 - **File Geodatabase:** File geodatabase is a folder that contains geospatial data, which is newly introduced to ArcGIS. In ArcMap, file geodatabase is shown as a file rather than a folder. This might be the reason why ESRI adds “connect to folder” in ArcMap 10. Hence, when you navigate to the file you want to open but are unable to do so, ALWAYS check if you should go one level upper to link to the folder first. You can open the file in the next step.
 - **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#/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

1.1 Load data

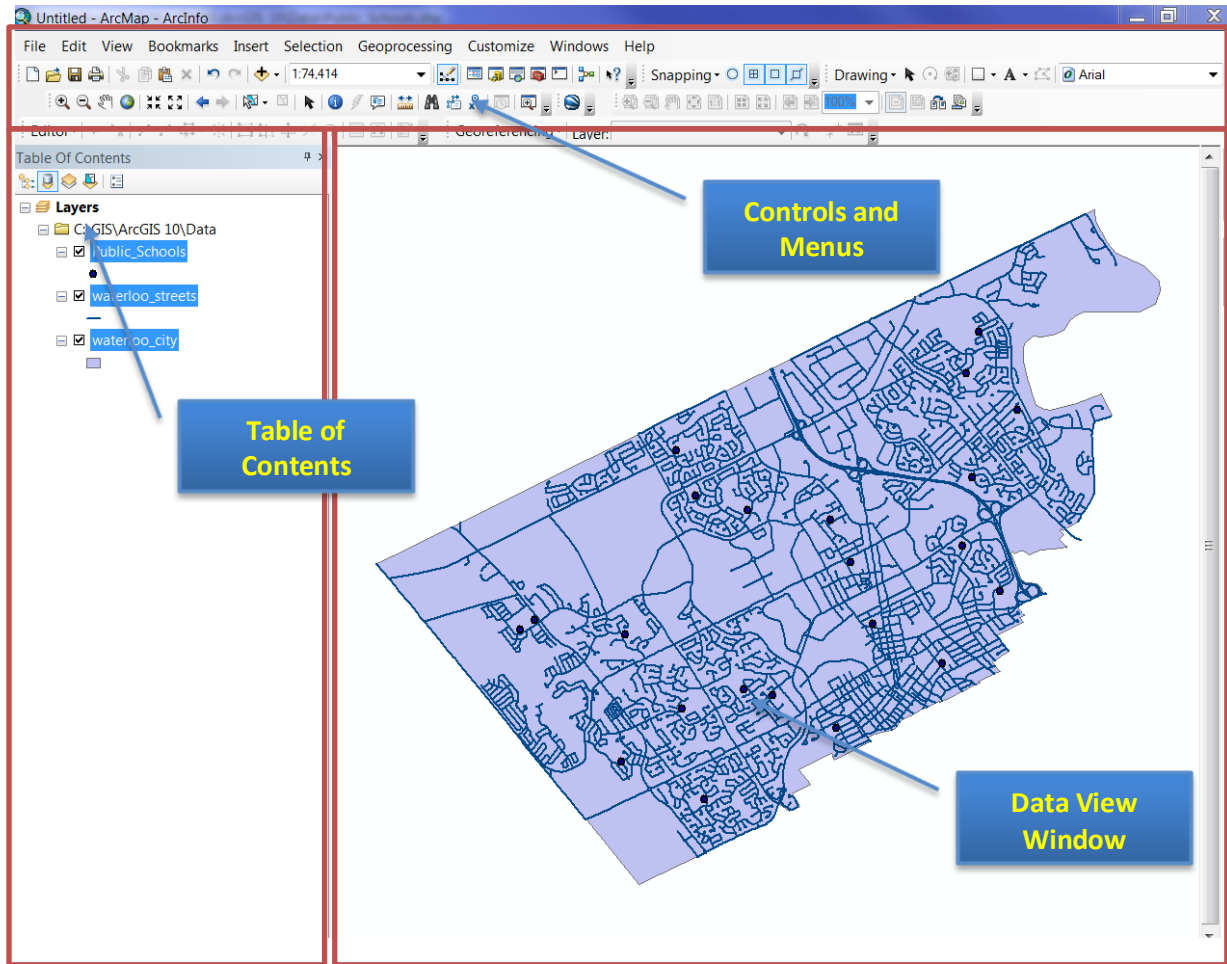


Figure 4. Structure of the Main Window

1.2 Add a ESRI Basemap

When users want to overlay a basemap and city boundary (**waterloo_city.shp**) together to produce a map like Google map View (i.e. <http://maps.google.ca/maps?q=waterloo,+ontario&hl=en&ll=43.48257,-80.533905&spn=0.134519,0.219727&sll=43.470394,-80.538411&sspn=0.016818,0.027466&hnear=Waterloo,+Waterloo+Regional+Municipality,+Ontario&t=m&z=12>), they can add a basemap directly from Esri Basemap (Internet).

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

1.1 Load data

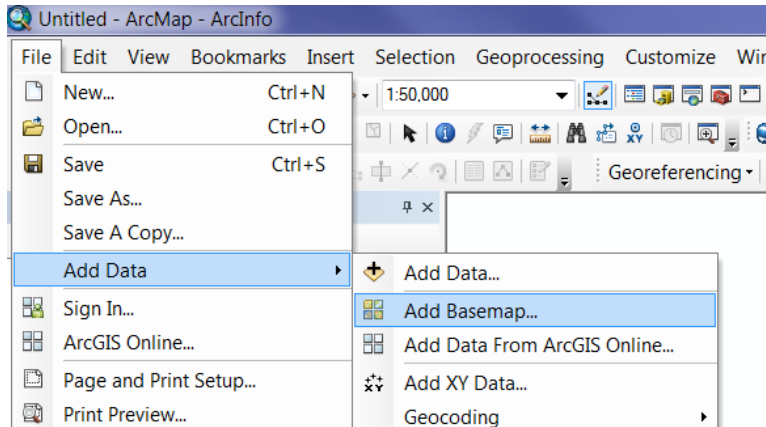


Figure 5 Steps to add a basemap layer

Currently 12 different basemaps are available. You can select either 'Street' or 'Topographic' as the basemap (Figure 6).

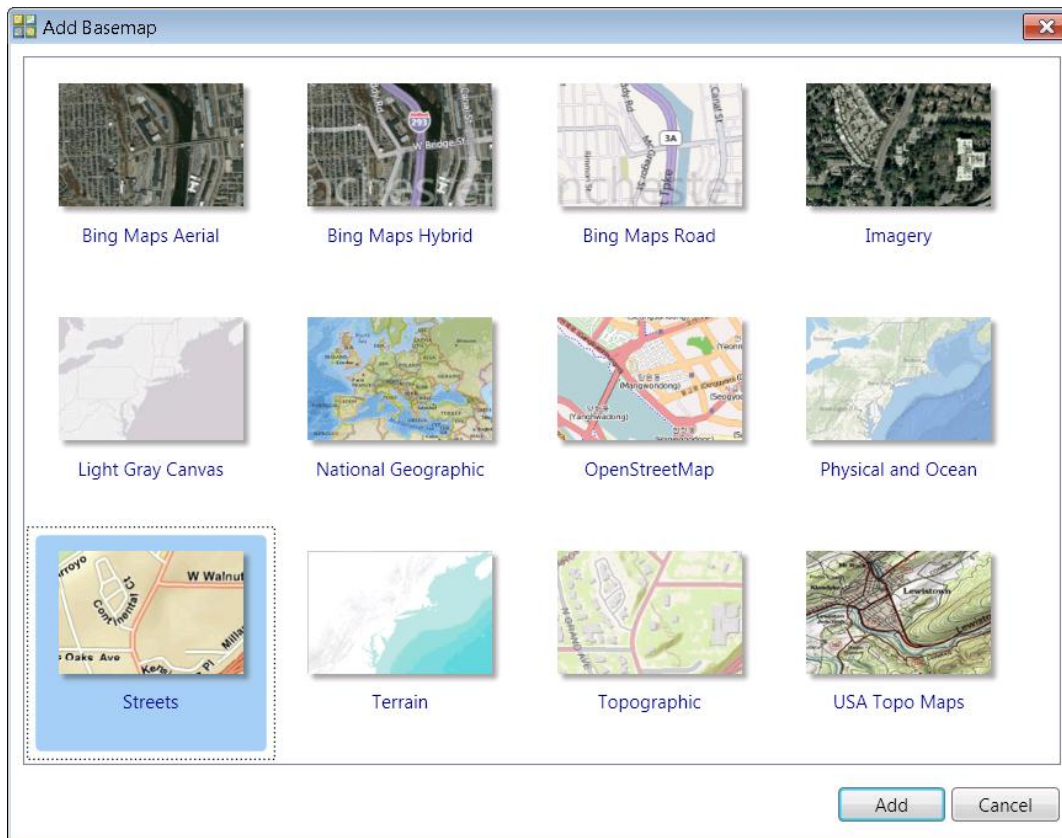


Figure 6. ESRI basemap layers


1.3 Browse Geographic Features

1.3 Browse Geographic Features

In ArcMap 10, ESRI starts to put most controls to browse data into one tool bar (Figure 7). If you cannot find this toolbar, please go to **Customize -> Toolbars** and check the **Tools** on.



Figure 7. The Toolbar with Data Browsing Controls

Most icons are intuitive and self-explained. If you are not sure what function it has, please put your mouse on that icon. A pop-up text will show and further explanation. In Figure 7, an example is shown when the mouse is hovering over the icon . The pop-up window explains its functionality: “Select Features by Rectangle”, which means that you can draw a rectangle over some area, and all features within (or have parts within) this rectangle will be selected for further operations.

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).

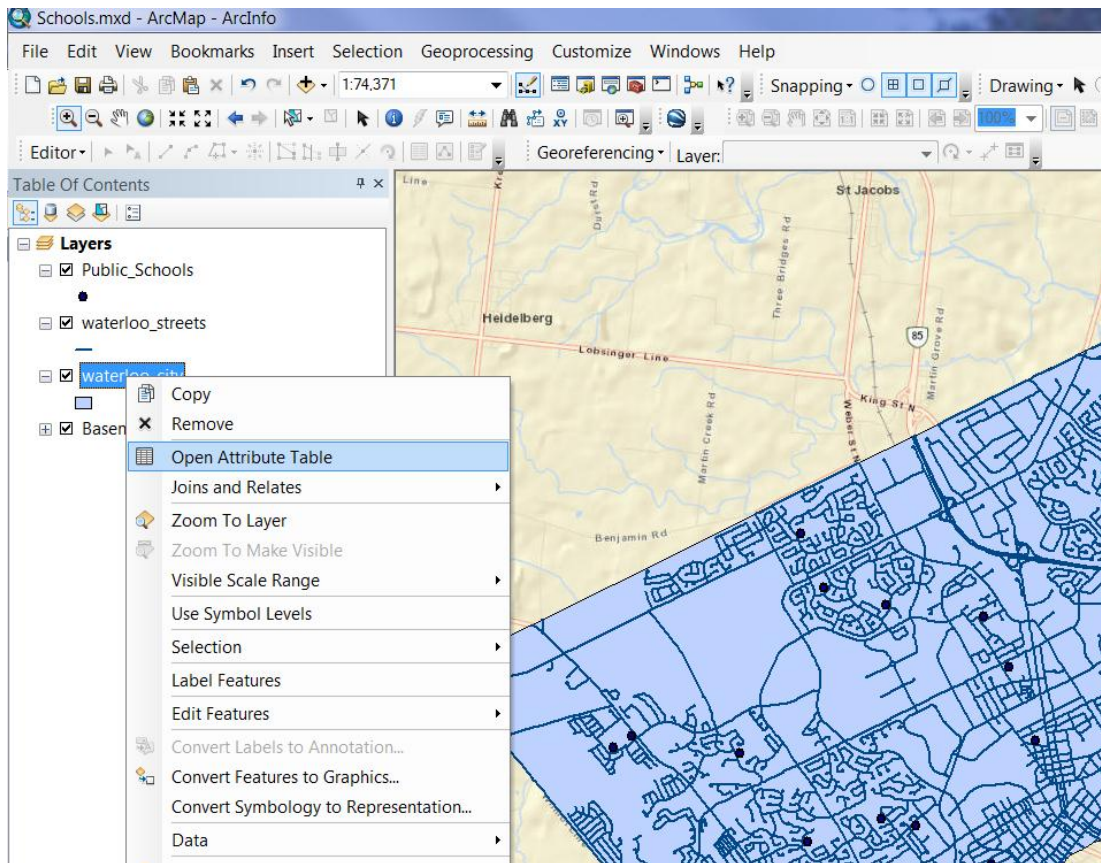


Figure 8. Pop-up Window with Options on a Layer

1.3 Browse Geographic Features

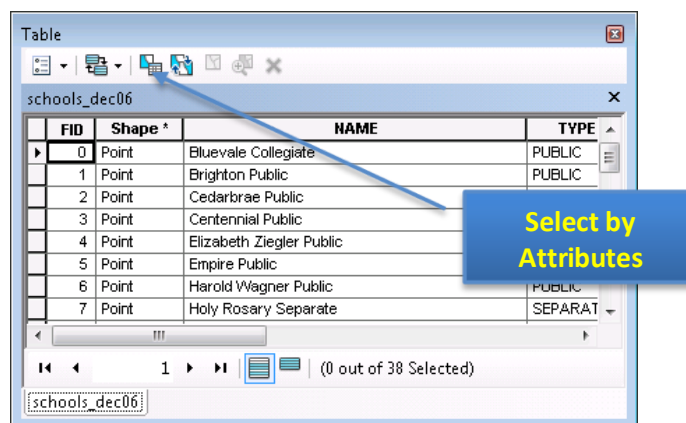







Figure 9. Attribute Data Window

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

	Geographic Operations	Attribute Operations
Browse		Right-click on the layer (Figure 8 and 9)
Search/Identify		
Select		 (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 mapping process, ArcGIS divides mapping into two categories: data view, which focuses on data manipulation and representation (symbolology), and layout view, which provides functionality of adding 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 setting will be save in a *.mxd file.

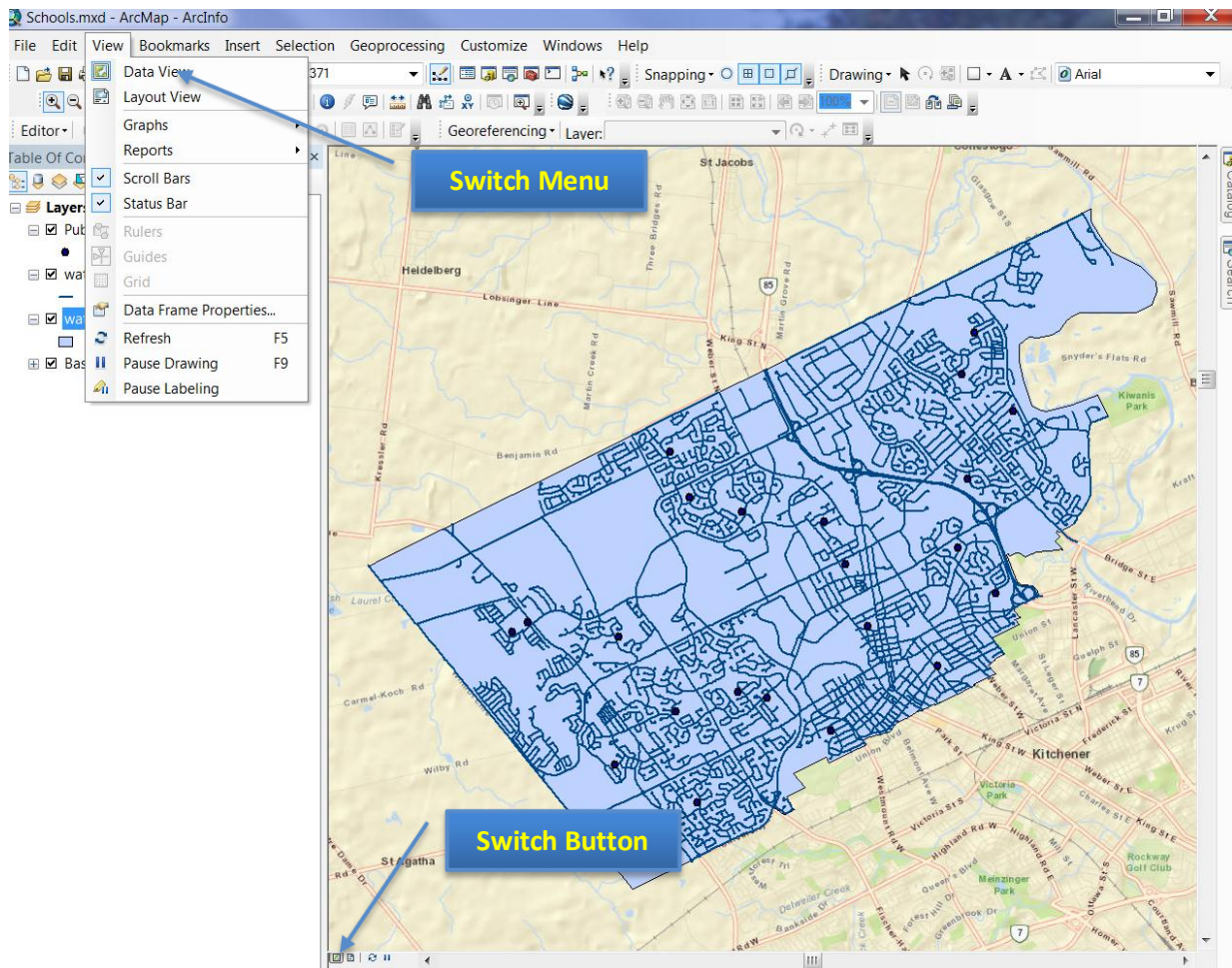


Figure 10. Switch between Data View and Layout View

2.2. Key Options of Geospatial Data Representations

2.2. Key Options of Geospatial Data Representations

Main options of changing geospatial data representations are *layer order*, *layer transparency*, *symbolology*, *label*, and *annotation*. Apart from the first one (layer order) and last one (annotations), all the rest locate in the pop-up window (Figure 11) when you right-click the layer you want to modify and select '**Properties**' (Figure 12). They are under either the **symbolology** or **labels** tab.

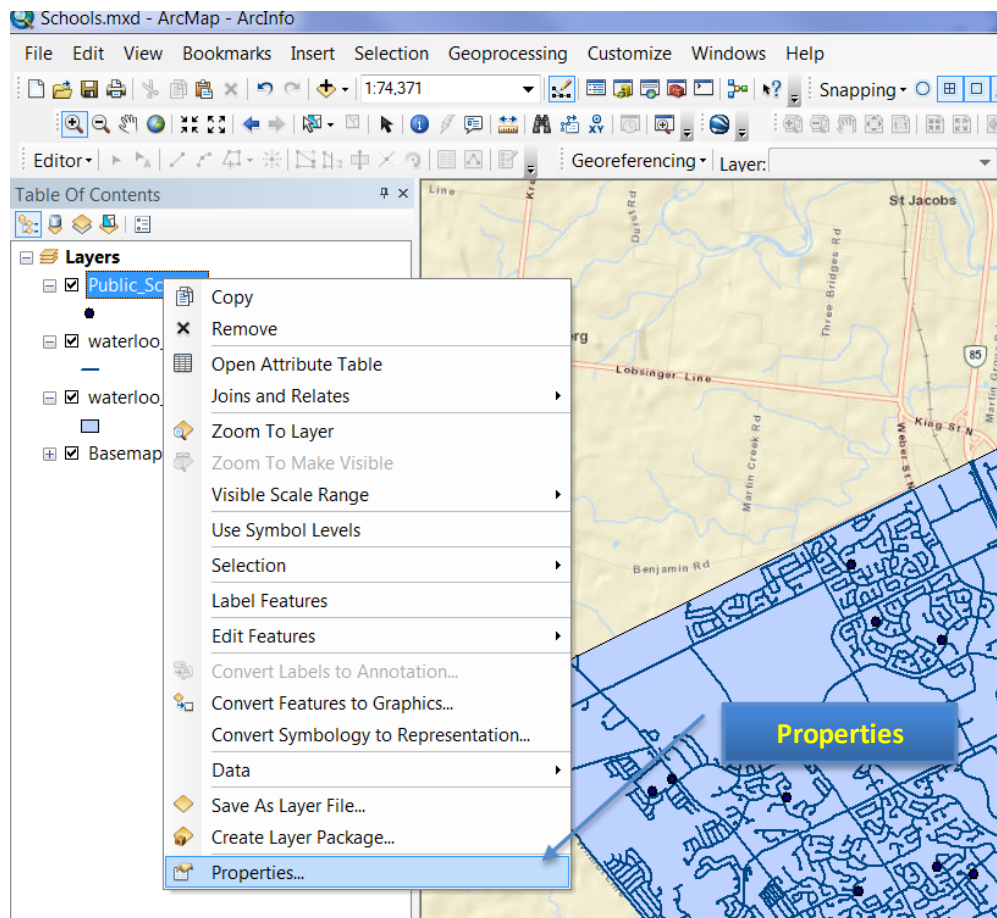


Figure 11. Pop-up Window of a Layer's Property

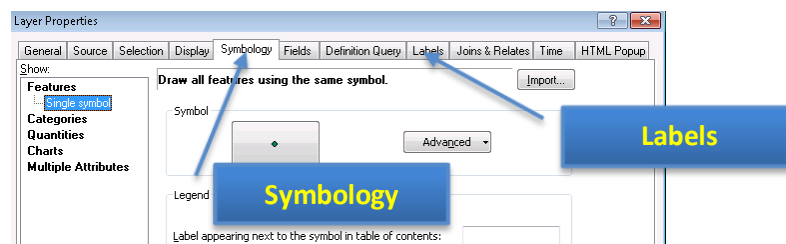


Figure 12. The **Properties** Window

All options will be introduced as subsections in the following.

2.2. Key Options of Geospatial Data Representations

2.2.1. Layer Order and Transparency

The boundary layer (waterloo_city.shp) can be made as “halo” (no fill color) polygons allowing the overlaying basemap to be visible. 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 and covered by upper layer. Hence, the layer on the top in the table of content will be displayed as the top layer in the map. **By default, ArcMap shows points, lines, polygons, and raster data (images, DEMs, etc) from the top to the bottom respectively** so that 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 left to the layer name in table of contents (Figure 13). And the display order can be changed by simply dragging the layer toward or away from the top.

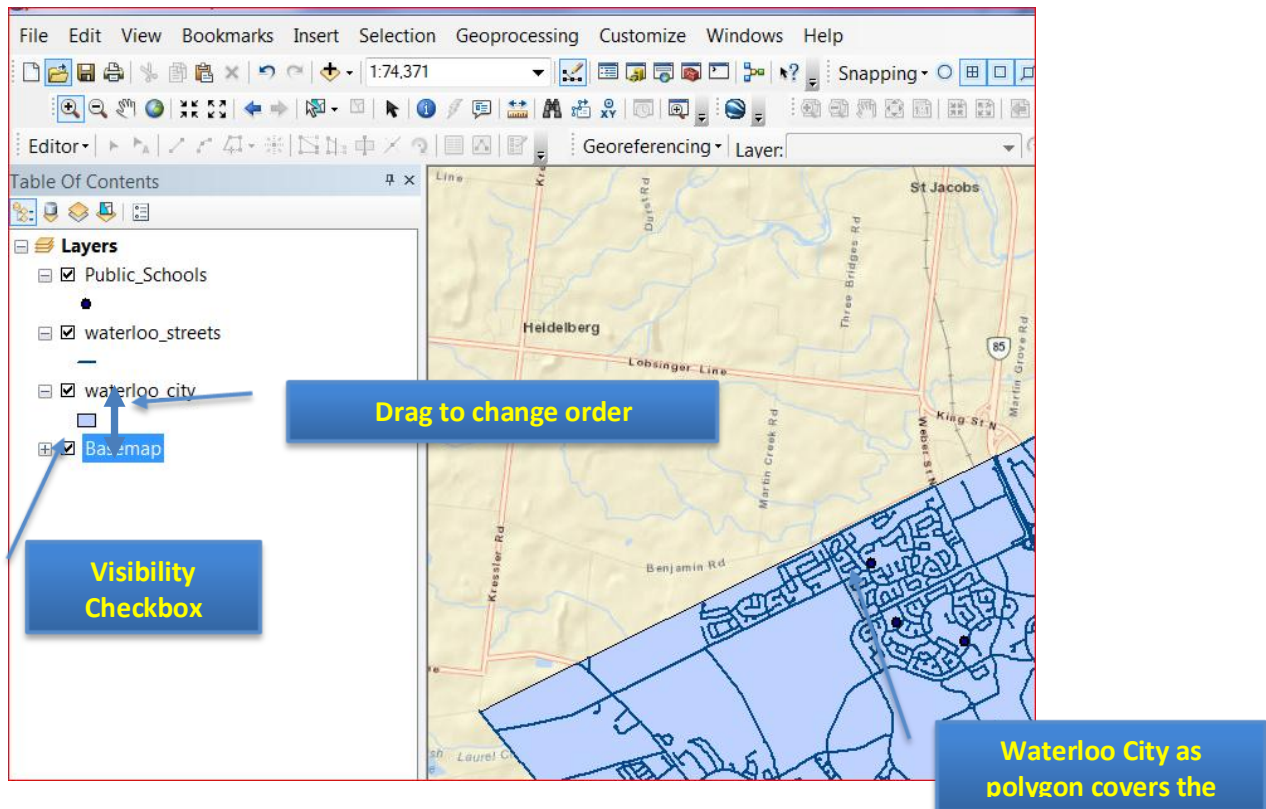


Figure 13. Layer Visibility and Order Control

2.2. Key Options of Geospatial Data Representations

Layer Visibility

When a polygon layer, such as **waterloo_city**, is added over an image (**basemap**), the image under the polygon is invisible (Figure 13). But users often like to only show the city boundary as long as the image. In this case, you can either set layer transparency or polygon fill color as 'none'.

To do so, please **right-click on the polygon layer** (waterloo_city) and select **Properties** first (Figure 9). Then please switch to the tab **Symbology** and click on the symbol itself (Figure 14).

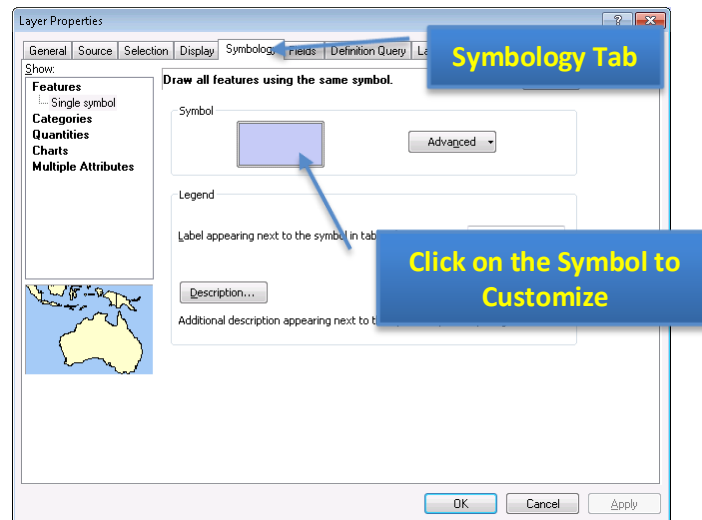


Figure 14. Properties of Symbology

When the pop-up window shows (Figure 15), you can change the **Fill Color** to **No Color** and increase the **Outline Width** (0.4 point is somewhat narrow).

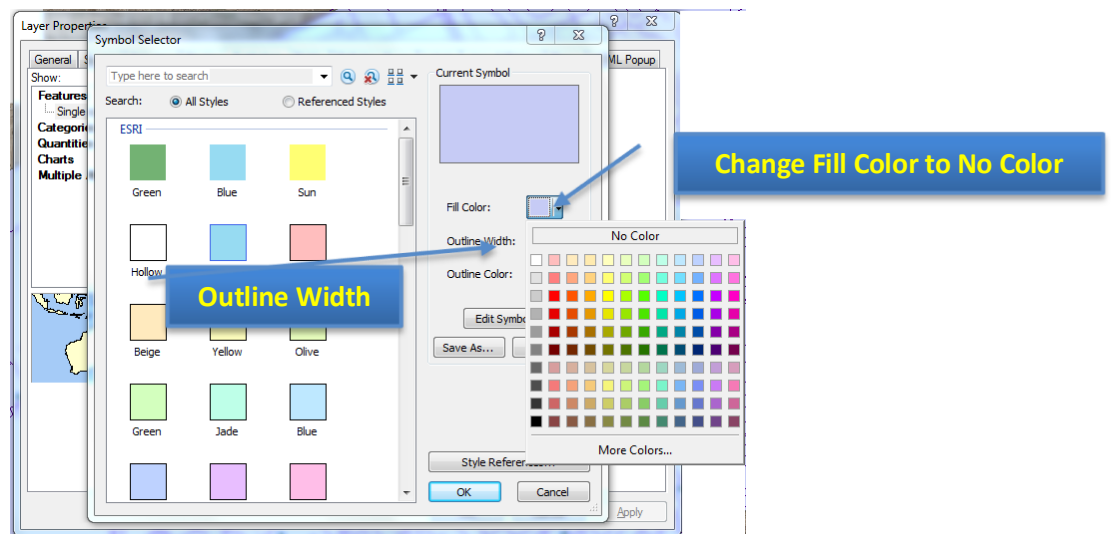


Figure 15. Make Hallow Polygons

2.2. Key Options of Geospatial Data Representations

Layer Transparency:

An alternative (actually more generic) way of preventing overlaying is right-click the layer and select properties (Figure 9) first, and go to the **Display** tab. You can freely change the transparency as the parameter (percentage) of “**Transparent**” (or “**Transparency**” for raster layers).

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** (Figure 14). The pop-up window (Figure 16) contains three 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 the 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.

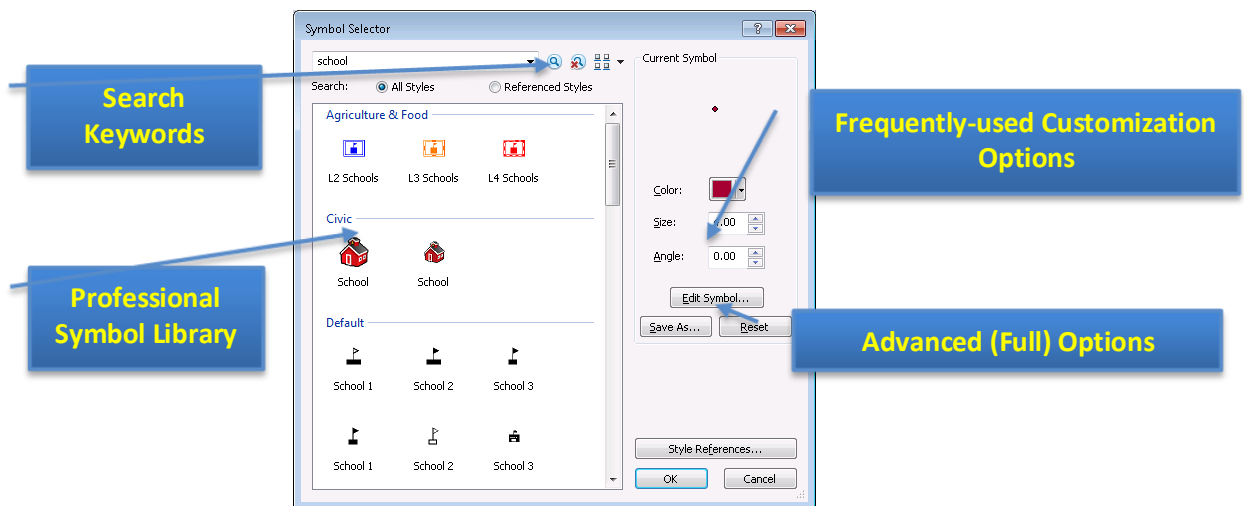


Figure 16. Symbology Customization Window with Explanations

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 11. Different types will be marked in colors. To do so, we should **right-click** on the school layer,

2.2. Key Options of Geospatial Data Representations

select **properties**, and go to the **symbology** tab, which is the same as shown in Figure 12. But, instead of by-default **Features** option, we should click and select the **categories** option (Figure 15). The steps to follow are also shown in 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.

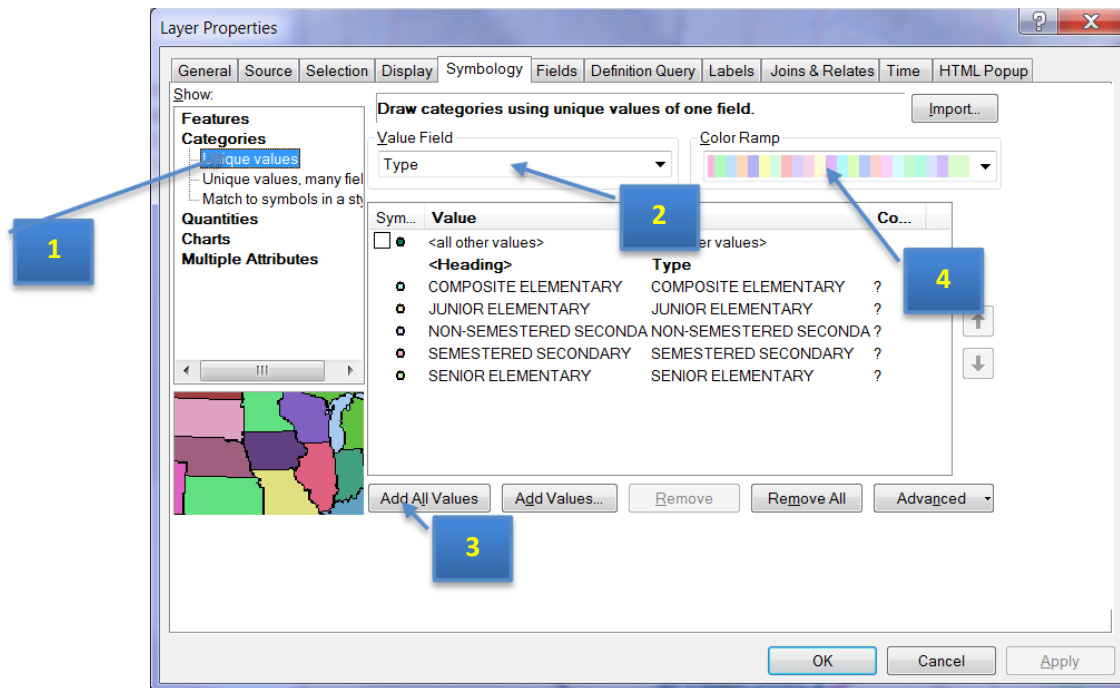



Figure 17. Classifying Features using Colors

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 class on either the left pane or the line in symbology window (Figure 18). The pop-up window is very similar to the window in Figure 16. Please

choose **School 1**  and assign a color for each school type.

2.2. Key Options of Geospatial Data Representations

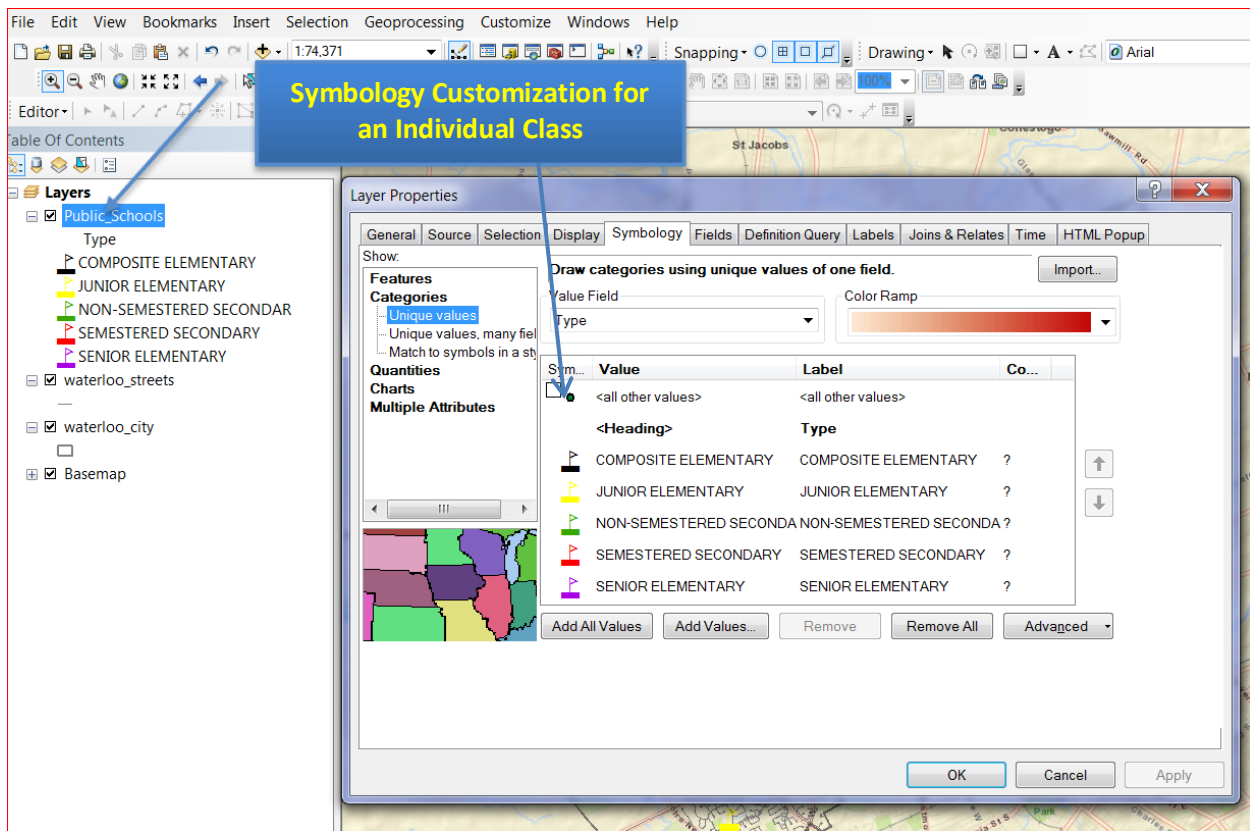


Figure 18. Classified Symbols and Further Customization

Label

The labels are an important feature of a map. By marking some property up on the map, for stance, the name of the marked location, labels can make your map more useful, informative, and visually appealing.

To add labels to your map, please **right-click** on the layer that you want to add marks on (public-school) and select **Properties** (Figure 14). Then follow the steps below:

1. Select the **Labels** tab and check on (off by default) "Label features in this layer".
2. Choose the attribute you want to display (**SchoolName**) on the map in the dropdown of **Label Field** (Figure 19).
3. Change Font (**7 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.

2.2. Key Options of Geospatial Data Representations

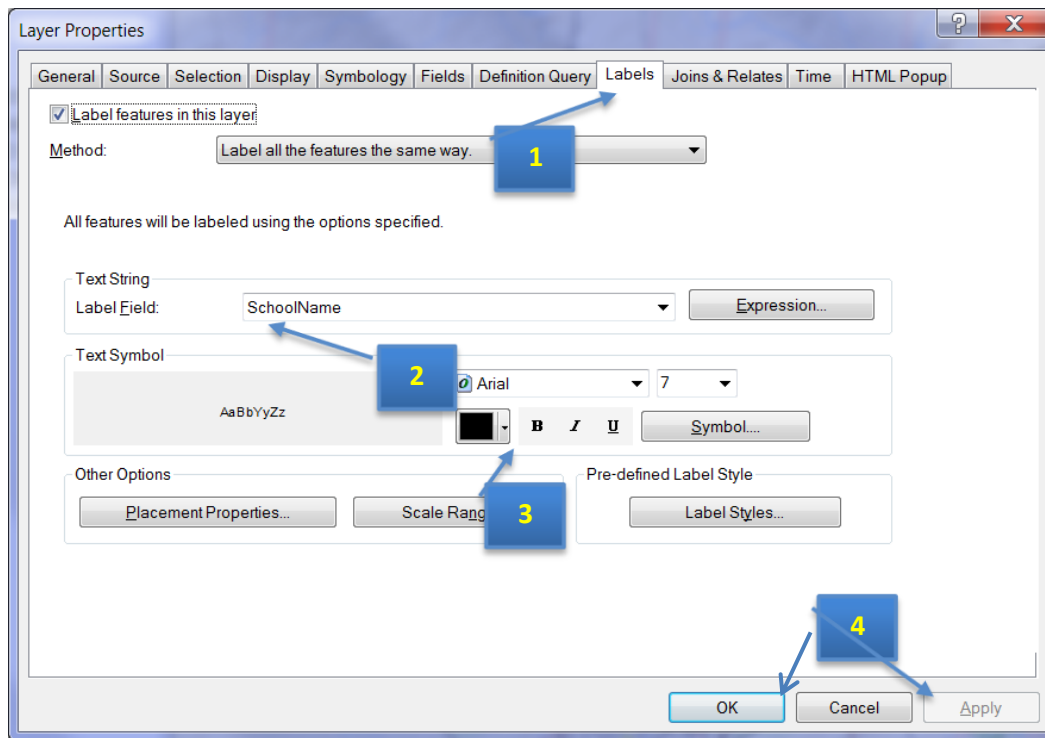


Figure 19. Label Setting Window

To ensure a clear label, the option of mask can be used **Symbol**, which locates to the right of Font options as a **Symbol** button (Figure 19). Please click it and then click the **Edit Symbol** button, since label is a kind of symbol (text symbol) too. Navigate to the **Mask** tab shown in the figure below. Change the option of **Style** to **Halo** and **size as '1'** (Figure 20).

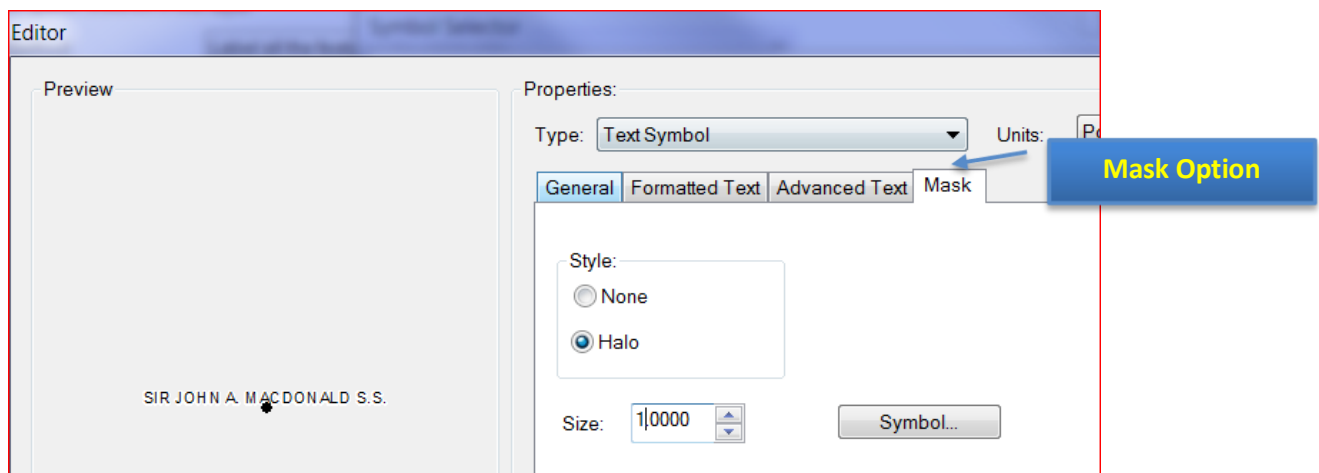


Figure 20. Change Mask Option for Clearer Labels

2.2. Key Options of Geospatial Data Representations

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 main not be quantitative. It can be regarded as a generalized case of Charts.

2.2.3. Annotations

Annotations look like labels. The key difference is that annotation can be any text you want to add on the map, regardless to whether the information has been included in the geospatial data.

For instance, if you want to add a point showing the location of the University of Waterloo, please follow the steps below (***Please note that annotations can only be edited under the data view***):

1. Turn on the **Draw** toolbar. To do so, please click on the menu of **Customize -> Toolbars -> Draw** (Figure 21).

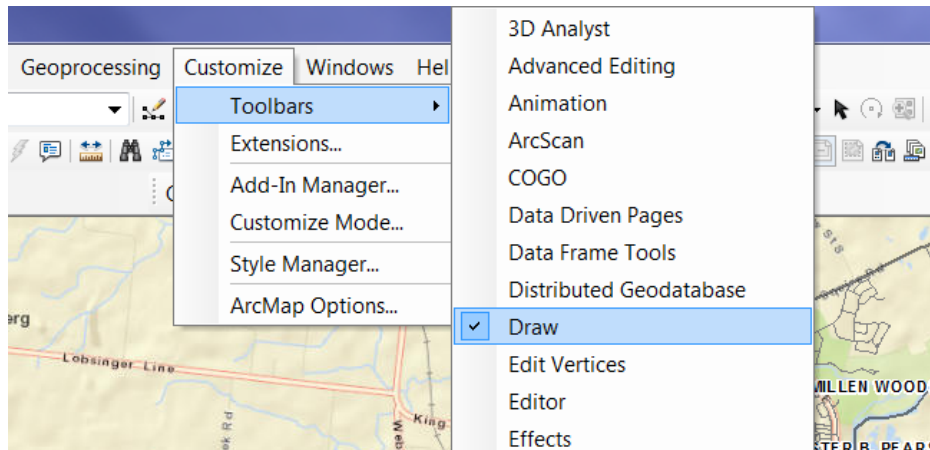


Figure 21. The Way of Turning on the Draw Toolbar


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 22. The Draw Toolbar

2.2. Key Options of Geospatial Data Representations

3. Add Text. Click **A** and choose **New Text**. Click on the map, somewhere close to the marker you just made and type in accordingly (i.e. “University of Waterloo”).

Result is shown in Figure 23.

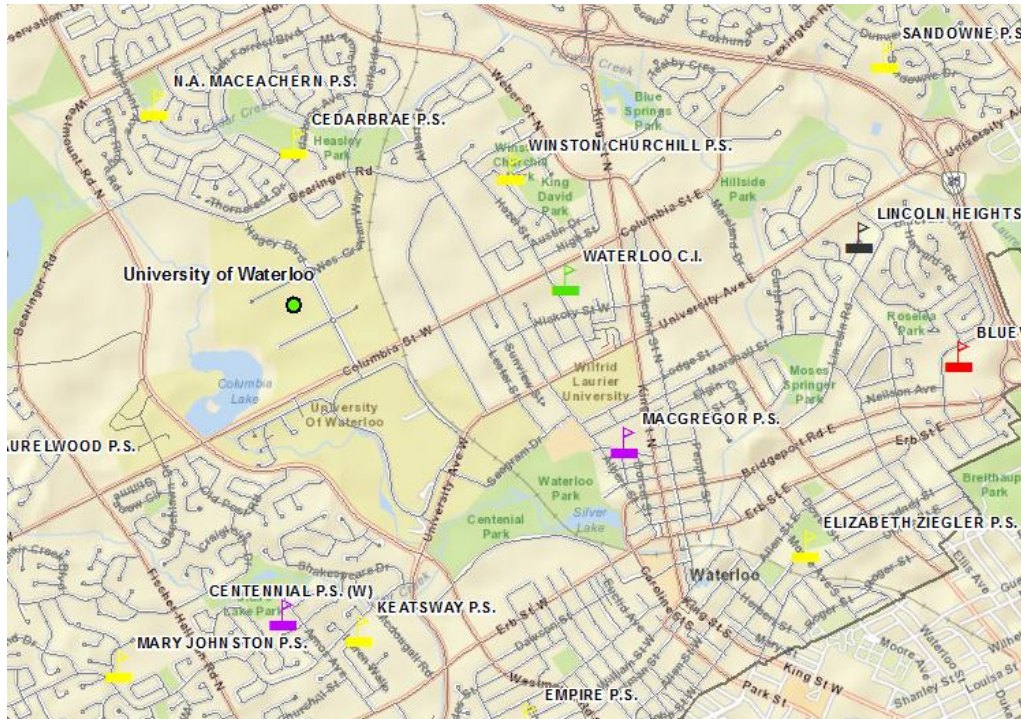


Figure 23. Map after Adding Labels (with Mask) and Annotations

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.

2.4. Export Maps

2.3. May Layout Map Components

Switch to **Layout View** to start adding map components, all components are gathered in the menu of **Insert** (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).

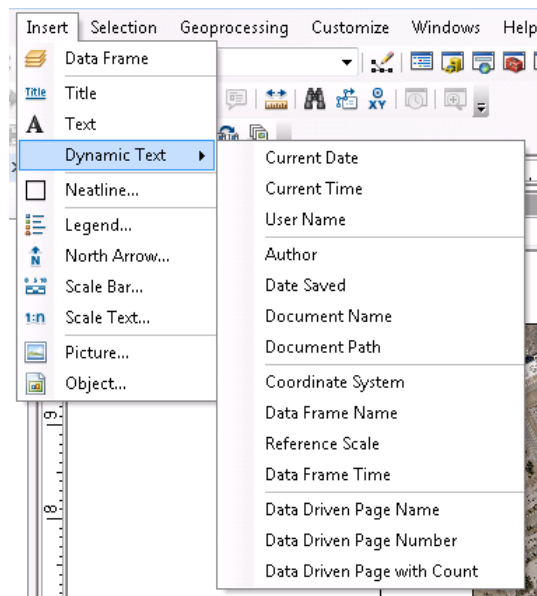


Figure 24. All Map Components Available

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 as the display unit, such as meters, degrees, miles, etc. You can customize 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, please use Scale Text with meters as unites, shown like: 1 cm = 75 meters.

Add North Arrow is the easiest task, which is very similar to add a scale bar. Just choose a pre-defined north arrow from the library shown in the left pane is ok. If your North Arrow is difficult to be distinguished from the background, you can add some background color, which has similar effect of “mask” for labels. This option normally locates in the **Frame** tab (Figure 26). Legend, scales, and texts all have similar options.

2.4. Export Maps

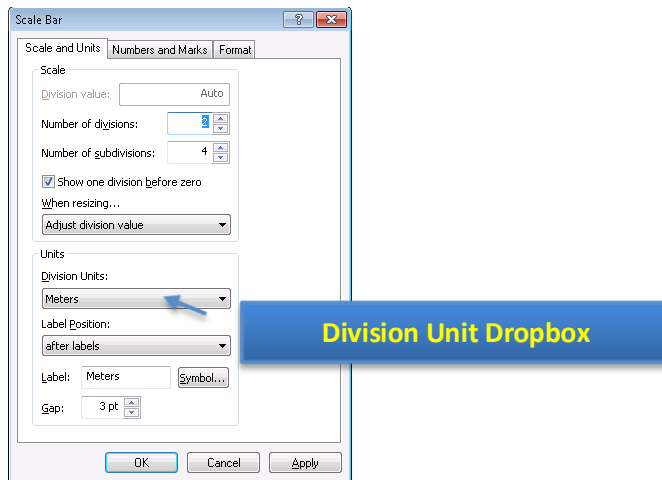


Figure 25. The Scale Bar (or Text) Property Window

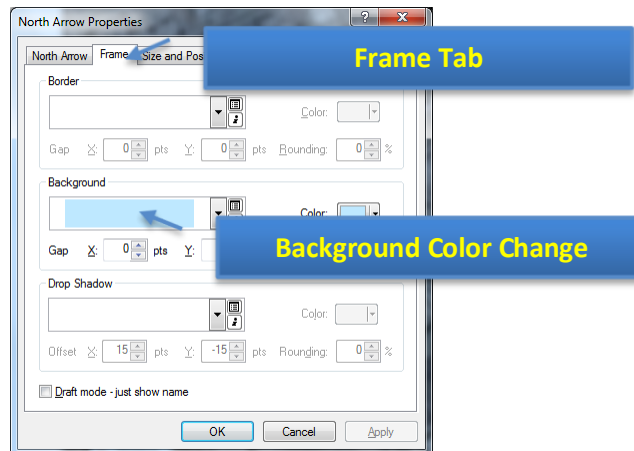






Figure 26. Change Background Color in Frame Tab

Adding 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 need legend and the order of adding legend (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 in order.

- Add/Remove Layers: You can decide the layers to be added to the legend by clicking  to add or  to remove. Please **remove the airphoto layer**, since the band information for raster images is not useful (Figure 24).

2.4. Export Maps

- 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 .

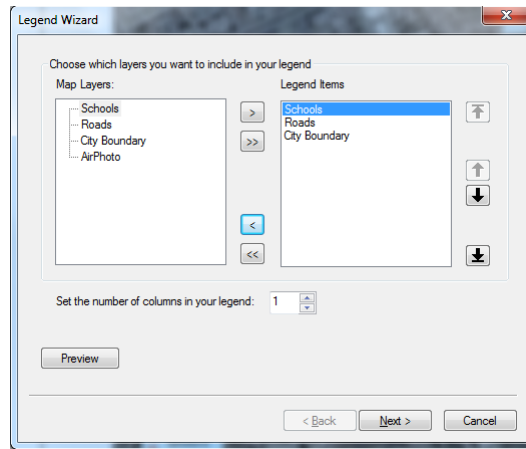


Figure 5. The First Step of Adding Legend

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 and requires customization (especially for normal users). You can just accept all default configuration and click **next** until **Finish** it. You will get the legend that looks like in Figure 28.

Legend

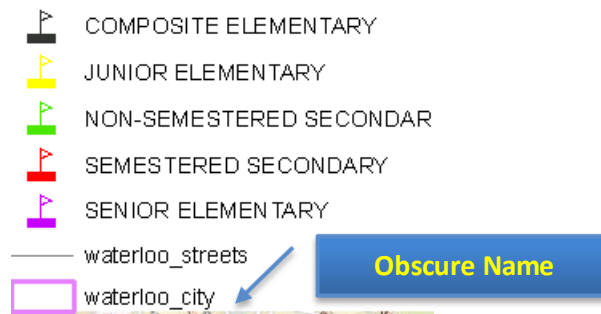


Figure 28. An Example of Generated Legend

It is easy to find that the name displayed in the legend is difficult to understand. For instance, users won't know what "waterloo_city" means. In this case, you can modify the name in the **table of content** pane (Figure 4). To do so, you can **right-click** on the "waterloo-city" layer and select **Properties** (Figure 14). At this time, please switch to the **General** tab. Then you can type the more meaningful name in the **Layer Name**: City boundary (Figure 29). You can use the same method to change "waterloo_streets" to "Roads".

2.4. Export Maps

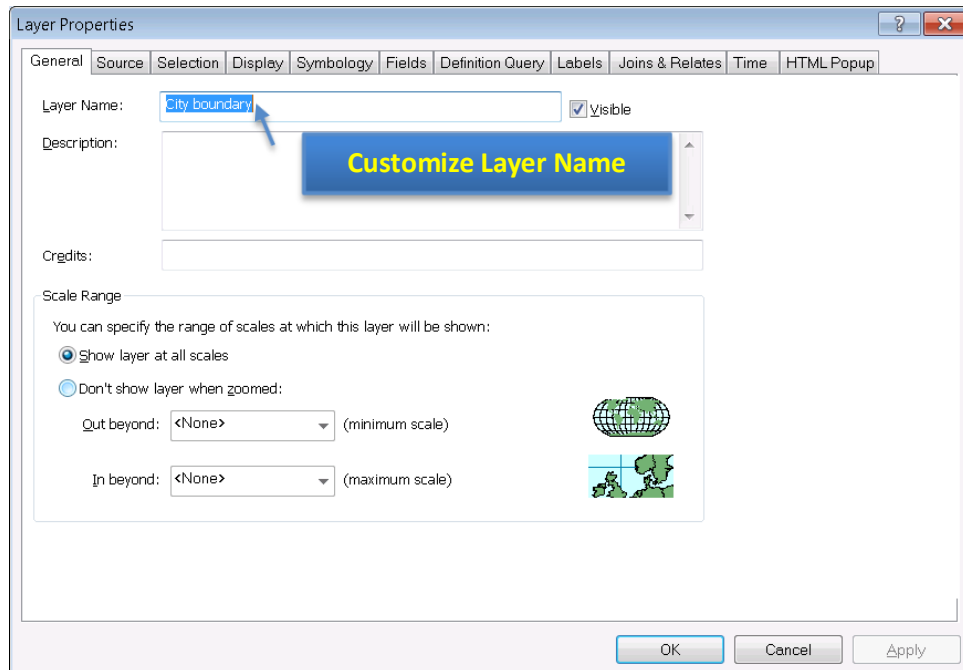


Figure 29. The General Tab to Change Layer Name

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

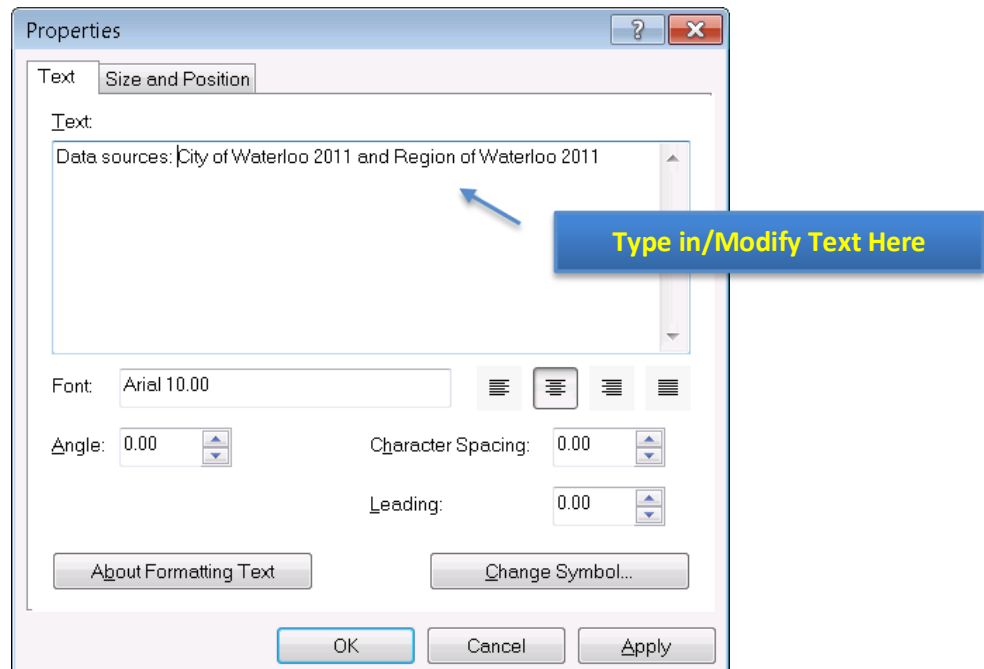



Figure 30. Property Window of Text in Layout View

2.4. Export Maps

 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.

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).

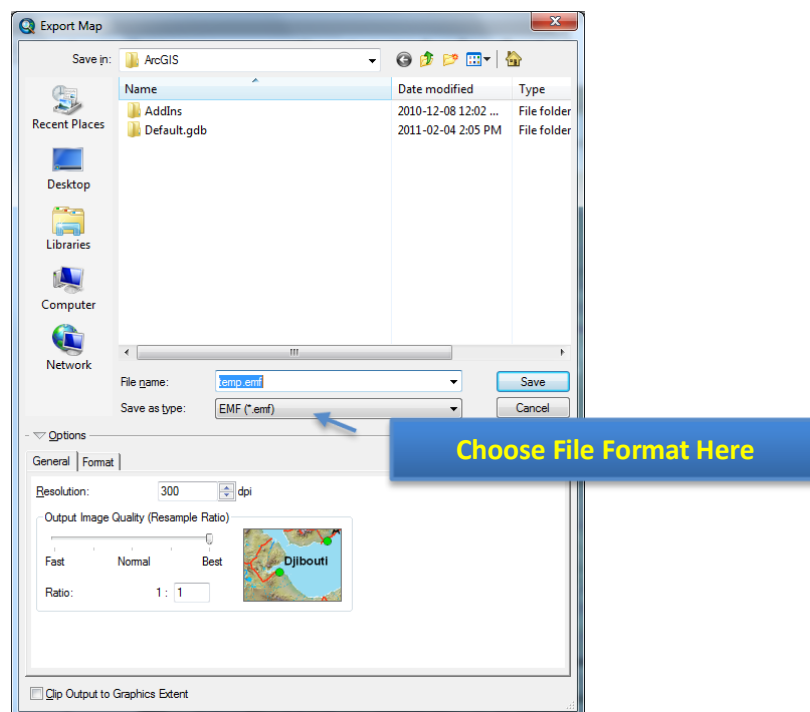


Figure 6. Export Map Dialog

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** dropbox. 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.

2.4. Export Maps

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.

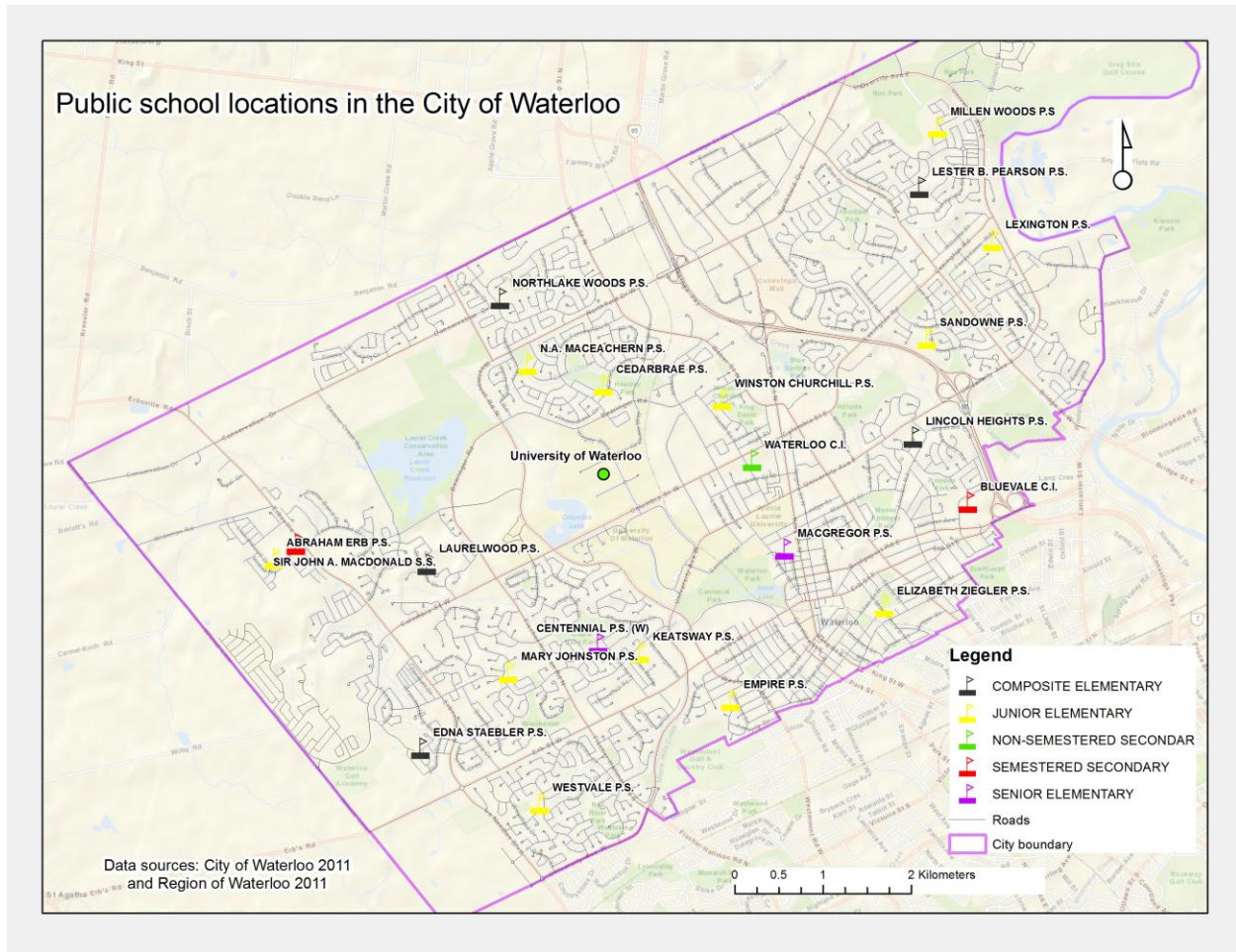


Brief Explanation of Graphic File Formats:

- 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.

2.4. Export Maps

The final map may look as one below.



Created by Qian Wang in 2011 and modified by Steve Xu in 2012