

Geographical Information Systems Institute
Center for Geographic Analysis, Harvard University

LAB EXERCISE 1: Basic Mapping in ArcMap

Individual files (lab instructions, PPT, and data) can be found at:
<http://gis.harvard.edu/training/non-credit-training/gis-institute/gis-institute-Winter-2018>

A note about our data: We will use a variety of files during the week, many of them are in the zip file associated with the Basic ArcGIS Overview item on the training page. This zip file is pretty big and will need to be downloaded and unzipped (extracted), do this to a new folder on the desktop or another location you can find later. Files downloaded onto these computers might stay available for several days, but they also might disappear as the computers are routinely “refreshed.”

Introduction to the ArcGIS Interface

The ArcGIS 10.4 interface has three components that we will often use:

ArcMap:  is the main application used for all map-based tasks including cartography, map analysis, and editing.

ArcCatalog:  is an application that will help you organize and manage all of your data. It can be used as a standalone application or with ArcMap.

ArcToolbox:  is an application containing many GIS tools used for geoprocessing and can be used within ArcMap as well as ArcCatalog.

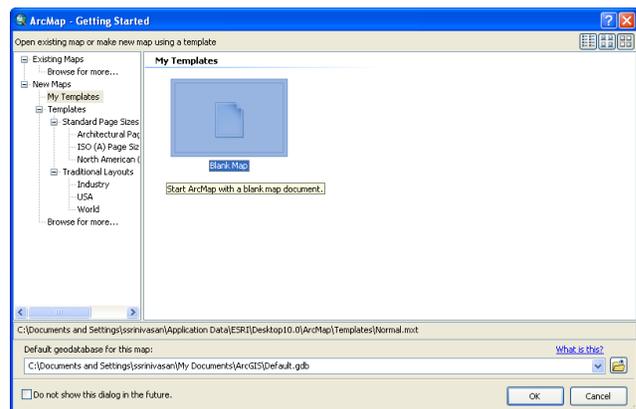
1.0 Getting Started in ArcGIS: ArcMap

1. Click **Start, All Programs, ArcGIS** to find the program **ArcMap**.

Once loaded (and this may take time), an **ArcMap** dialog box appears and offers several options for starting your ArcMap session.

2. Select “**A Blank map**” and click **OK**. A new map window will automatically open.

Now, you can see ArcMap Window in the  **Data View**.

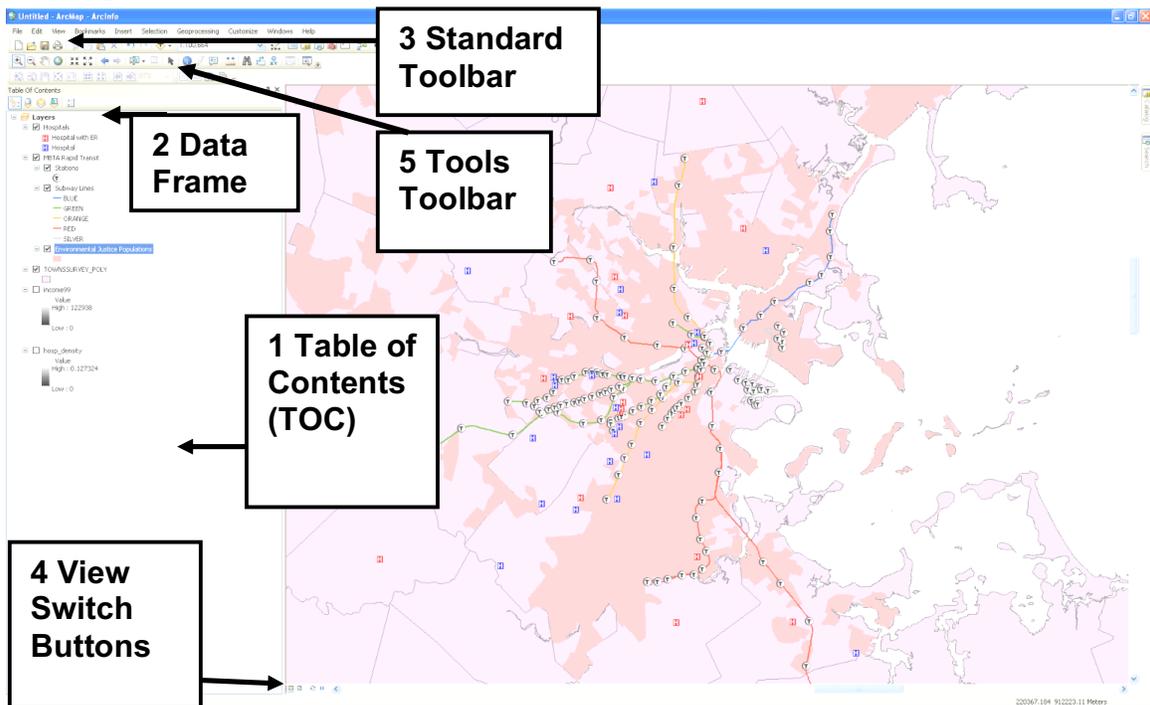


2.0 Spatial Data in ArcMap

When you first enter ArcMap, you will have a blank **View**. The data you want to add can be in various formats: points, lines and polygons make up the main geometric elements in the vector-based “**shapefiles**.” “**Geodatabases**” can include data as both vectors (discrete objects) and rasters (or grid based field data). All of these are ArcGIS compatible file formats to store geographical information together with attribute data. You can also use **ArcCatalog** to convert data from several other formats to **shapefiles** or create your own [geodatabase](#)¹.

In ArcGIS, geographic information is displayed as **layers**, where each layer represents a particular type of feature such as streams, lakes, roads, political boundaries, or geology. A layer does not store the actual geographic data; instead, it **references** the data contained in coverages, shapefiles, geodatabases, images, and so on. Referencing data in this way allows the layers on a map to automatically reflect the most current information in your GIS database.

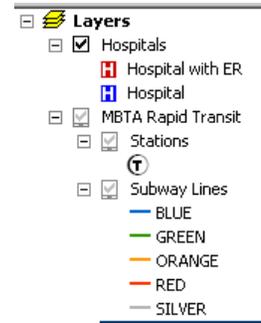
3.0 ArcMap Interface



¹ [http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An overview of the Geodatabase](http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An%20overview%20of%20the%20Geodatabase)

1 Table of Contents² (TOC)

Lists all the layers on the map and shows what the features in each layer represent. Each layer of data has both spatial and non-spatial components. The spatial components are displayed using a coordinate system, each layer as a specific coordinate system. Multiple layers can be displayed simultaneously, even if the data in each is in a different coordinate system. The check box next to each layer indicates whether it is currently turned on or off, that is, whether it is currently drawn on the map. The order of layers within the table of contents is also important as the layers at the top draw on top of those below them.



2 Data Frame³ Layers

Layers in the TOC are organized into data frames. A data frame groups the layers that you want to display together in a separate frame. By default the first data frame is called “**Layers.**” However, you can change the name to something more meaningful. Each Data Frame has its own coordinate system; this coordinate system is the one used to display the data on the screen and will be the coordinate system used for any maps created from that data frame.

3. Standard Toolbar

The standard toolbar contains buttons that provide quick access to file management operation such as opening, closing, deleting and new windows.

4. View Switch Buttons

These two (very tiny) buttons enable you to switch views between the **geographic data** view and the **layout** view. You will use the layout view later to create maps that can be published.

5. Tools Toolbar

These tools enable you to change navigate and change the look of the map in terms of zoom and visible area. It also provides access to some simple query functions.

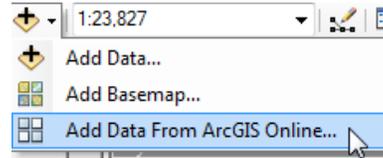
3.1 Adding Data to your Map

For this lab, you will work with GIS data of your choice.

3. Click on the **Add Data** button (see image below) and **Connect** to the folder (click on the icon ) whenever you add new data paths. Navigate to your data location. You will find several folders, each of which contains different spatial datasets. Today you can explore India, Ghana, and USA_data. The latter has a lot of data in it, go to Massgis and add the MA_tracks_2010 file.
4. Select a layer (you can also select multiple layers at a time from the add data window by holding down the “**Ctrl**” key and left mouse clicking on the layers you need).

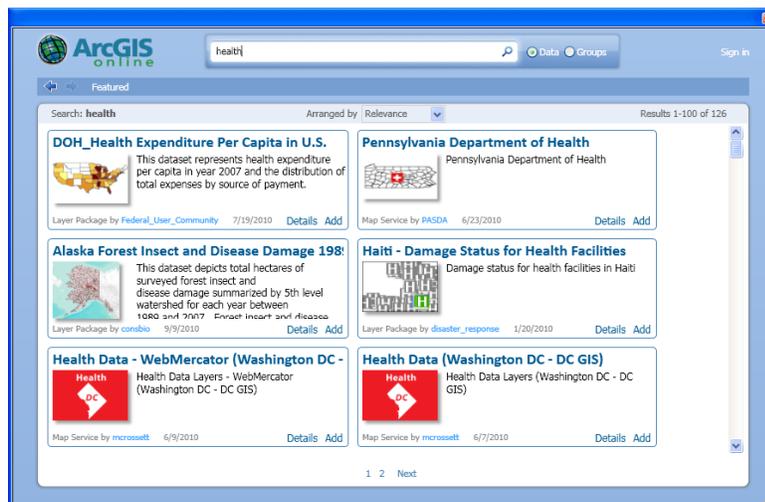
² In ArcMap, a tabbed list of data frames and layers (or tables) that shows how the data is symbolized, the source of the data, and whether or not each layer is selectable

³A map element that defines a geographic extent, a page extent, a coordinate system, and other display properties for one or more layers in ArcMap. A dataset can be represented in one or more data frames. In data view, only one data frame is displayed at a time; in layout view, all a map's data frames are displayed at the same time.



A NOTE OF CAUTION: Adding data from online sources (ArcGIS Online and Basemaps) can slow down the software dramatically. Also, adding data from these sources before adding “your own data” (like data we give you) can cause coordinate system problems as well.

5. You can also Add Data from ArcGIS Online which is an option in the drop-down menu for this button (see image above).
6. You can also add basemap data from the drop down button at ArcGIS online.



4.0 Frequently Used Tools

 **Zoom In/Out:** Increase/decreases the zoom of an image. It is important to note that using the zoom buttons does not change the scale of the image. It simply changes how it is being displayed on the screen. Hold the mouse pointer over the map display and click once to zoom around a point. Alternatively, click and drag a rectangle defining the area you want to zoom in or out on.

7. Use this tool to zoom into the data on your map.

 **Zoom to Fixed Extent:** Increases/ Decreases the zoom of an image to a fixed or pre-specified extent. This can be useful when creating maps for display.

8. Click on the Zoom to Fixed Extent button in the toolbar.



Panning: Enables you to navigate around the map to observe areas that are not displayed on the screen.

9. Move the mouse pointer (which will be in the form of a hand) over the map display, click on map and drag the pointer. Alternatively, you can pan the map by dragging the scroll bars.



Zoom to Full Extent: Zooms out so that the entire active data will be visible on the screen.

10. Click the zoom to full extent button on the Tools toolbar. If your map has more than one data frame, panning and zooming will occur in the active data frame.



Back/Forward Extent: Enables you to move back or forward one display thus enabling you to change to a previous zoom or extent.

11. Click the Back/Forward Extent button on the Tools toolbar.



Select Feature: Enables you to interactively select **features** from the selectable layers.

12. Test the different options for selection. Clear it by clicking on this button 

Select Elements tool: lets you select, resize and move **graphics** such as lines, boxes, text, labels, north arrows, scale bars, and pictures drawn on your map.

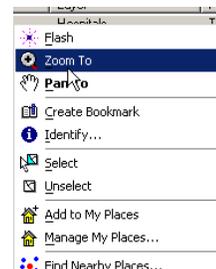


Identify Features: Provides attribute information about selected features. Click on a geographic feature to get its attributes. The features in all visible layers under the pointer will be identified. The Identify Results window will appear automatically when you use this tool. The Identify Results window contains a dropdown list that lets you control precisely which layer(s) you want to identify features from with the Identify tool. You can either choose a particular layer or one of four generic settings: top most layer, visible layers, selectable layers, and all layers.

13. Click on the Identify and then on a feature on the map.

Find: Enables you to perform basic queries on the map to find features with specific attributes. Click the find button on the toolbar. Type the string you want to find in the find text box. Click the layers drop down menu and select the layers you want to search within. Search for the string in all fields, in a specific field, or in the primary display field. The primary display field is the field that contains the name or identifying characteristics of the feature. It is set through layer properties.

14. To experiment with find tool, try entering a likely place on your map (depending on what layers you have), but you should have a file open that has place names (like one of the India files). Now by right clicking on one of the results, you can get a number of options including zoom to feature, flash feature, select and unselect feature. For



example, you can zoom to a location on the map by right clicking on the result and picking the zoom to feature option.

 **Measure:** Will help you measure distances or areas on your map. As you draw a line with this tool, the length of the line is shown in the status bar. You can draw a line with multiple segments. Click once to start a new segment. Double-click or hit ESC to finish.



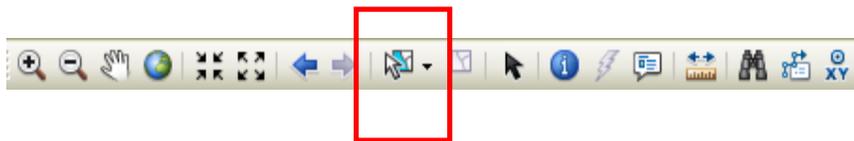
 **Go to XY:** You can use the Go To XY command on the Tools toolbar to navigate to a particular (x,y) location in your map. You can specify the location by entering coordinates in the map units of your map, decimal degrees, or Degrees Minutes Seconds. This may be useful if you are working with data from Google Earth.



Create Viewer Window: Click this and then drag over an area that you want to view in detail. You will now have a new window with the new location. This is useful if you want to see the map at different scales.

Opening Attribute Tables:

15. To open the attribute table, right click on the desired layer or spatial data file in the Table of Contents (TOC) and select **Open Attribute Table** or from the menu. Try doing this for any of the layers.
16. Once the Attribute Table is open, arrange it on the screen so that you can see both the Map screen and the attribute table. You may have to maximize the ArcMap session.
17. You will notice now that the two screens are dynamically linked. If you select an object on the ArcMap session, its attribute value is highlighted in the attribute table. To do this you can click on the select tool (see icon in red box below) and use select by rectangle. Conversely, a selection made in the table is highlighted on the map. Experiment with making selections in both the attribute table and in ArcMap.



ID	Shape	DISTRICT	NAME	STATE_UT	C_CODE91	TOT_AREA	TOT_MM_MM	TOT_POP	M_POP	F_POP	TOT_POP
12	Polygon	1614	Lahaurpur	Jammu & Kashmir	0110000000000000	4500	122462	742009	396089	343222	1
13	Polygon	907	Lahul & Spiti	Himachal Pradesh	0202000000000000	13305	7899	33204	15441	14763	1
14	Polygon	902	Chamba	Himachal Pradesh	0201000000000000	6520	87029	460897	236210	226569	1
15	Polygon	1605	Jammu	Jammu & Kashmir	0110000000000000	5097	204460	1580772	850262	730476	1
16	Polygon	1007	Kathua	Jammu & Kashmir	0114000000000000	2651	96393	555084	289391	266993	1
17	Polygon	2106	Gurdaspur	Punjab	0301000000000000	3569	386625	2104011	1113077	899034	2
18	Polygon	804	Kangra	Himachal Pradesh	0202000000000000	5739	272487	1330930	681254	671776	1
19	Polygon	906	Kulu	Himachal Pradesh	0204000000000000	5503	76902	381971	198916	183555	1
20	Polygon	905	Kinnair	Himachal Pradesh	0212000000000000	8401	18841	78334	42173	36161	1
21	Polygon	2107	Moenshar	Punjab	0305000000000000	3384	279584	1482706	785152	715064	1
22	Polygon	2101	Amritsar	Punjab	0302000000000000	5094	541339	3096977	1655859	1445488	4
23	Polygon	908	Mandi	Himachal Pradesh	0209000000000000	3950	182378	901344	447872	454272	1
24	Polygon	903	Hansi	Punjab	0309000000000000	1118	80771	412700	185693	218107	1
25	Polygon	912	Una	Himachal Pradesh	0207000000000000	1540	88181	448273	224524	222749	1
26	Polygon	909	Shimla	Himachal Pradesh	0211000000000000	5131	154693	722502	300096	341506	1
27	Polygon	2109	Kapurthala	Punjab	0303000000000000	1633	39664	784221	399623	354066	1
28	Polygon	2108	Jalandhar	Punjab	0304000000000000	2634	364030	1962700	1040177	922523	2
29	Polygon	901	Malspur	Himachal Pradesh	0208000000000000	1167	68750	340805	171263	169622	1
30	Polygon	2613	Uttaranchal	Uttaranchal	0501000000000000	8036	55550	295913	155216	142997	1
31	Polygon	2116	Rupnagar	Punjab	0307000000000000	2056	205954	1116108	586582	519528	1
32	Polygon	2109	Kapurthala	Punjab	0303000000000000	1633	39664	784221	399623	354066	1
33	Polygon	911	Solan	Himachal Pradesh	0208000000000000	1936	89317	560959	270291	230266	1
34	Polygon	2114	Hawanshahr	Punjab	0306000000000000	1266	107783	587488	306992	280586	1
35	Polygon	2105	Pinjaur	Punjab	0311000000000000	5380	301112	1746107	962224	819883	2
36	Polygon	2112	Roga	Punjab	0310000000000000	2216	153744	894864	474139	420756	1
37	Polygon	2603	Chamoli	Uttaranchal	0502000000000000	7614	78121	370359	163745	166614	1
38	Polygon	2605	Dehradun	Uttaranchal	0505000000000000	3688	228975	1282143	670563	602560	1
39	Polygon	910	Sirmur	Himachal Pradesh	0210000000000000	2825	81441	458993	241299	212794	1
40	Polygon	2110	Ludhiana	Punjab	0309000000000000	3767	558650	3052031	1662716	1370115	3
41	Polygon	913	Parbhat	Haryana	0601000000000000	888	92583	488411	258039	214272	1
42	Polygon	2104	Fatehgarh Sahb	Punjab	0308000000000000	1180	95414	530041	290137	247904	1
43	Polygon	2611	Tahrn Garhwali	Uttaranchal	0504000000000000	4080	117754	664747	295188	308979	1
44	Polygon	2613	Rudra	Punjab	0312000000000000	7169	97616	555962	292566	256266	1
45	Polygon	2610	Rudraprayag	Uttaranchal	0503000000000000	1891	47539	227439	107335	119904	1
46	Polygon	3601	Chandigarh	Chandigarh	0401000000000000	114	208465	900635	509038	393897	1
47	Polygon	2609	Rewari	Uttaranchal	0502000000000000	7169	97616	452298	229116	204874	1
48	Polygon	2115	Palias	Punjab	0317000000000000	3627	327859	1844934	987390	857544	2
49	Polygon	2117	Sangur	Punjab	0319000000000000	5021	348922	2000173	1069209	930884	2
50	Polygon	2113	Rudra	Punjab	0312000000000000	2815	135442	777493	411217	366276	1
51	Polygon	2102	Bathinda	Punjab	0314000000000000	3382	208993	1183295	632809	550486	1
52	Polygon	801	Ambed	Haryana	0602000000000000	1574	184319	1014411	542977	471434	1
53	Polygon	801	Ambed	Haryana	0602000000000000	1574	184319	1014411	542977	471434	1
54	Polygon	819	Amunagar	Haryana	0603000000000000	1768	183238	1041630	568444	482186	1
55	Polygon	2781	Saharanpur	Uttar Pradesh	0901000000000000	3809	488015	2096883	1553232	1345641	5
56	Polygon	2602	Bageshwar	Uttaranchal	0506000000000000	2303	51949	249492	118191	130652	1
57	Polygon	2607	Haridwar	Uttaranchal	0513000000000000	2360	249792	1447187	776021	671166	2
58	Polygon	2608	Gairhwar	Uttaranchal	0508000000000000	5480	149887	897970	331061	306917	1
59	Polygon	811	Runkshetra	Haryana	0604000000000000	1530	142950	825454	442323	383126	1
60	Polygon	2111	Mansa	Punjab	0310000000000000	2169	121075	680750	366446	323212	1
61	Polygon	809	Kathal	Haryana	0605000000000000	2317	142458	840131	310513	436116	1
62	Polygon	2215	Ganganagar	Rajasthan	0801000000000000	7934	303107	1789423	953739	834545	2
63	Polygon	801	Ambed	Haryana	0602000000000000	1574	184319	1014411	542977	471434	1
64	Polygon	817	Simla	Haryana	0611000000000000	4271	194839	1156468	592345	523404	1
65	Polygon	804	Ambed	Haryana	0602000000000000	1574	184319	1014411	542977	471434	1

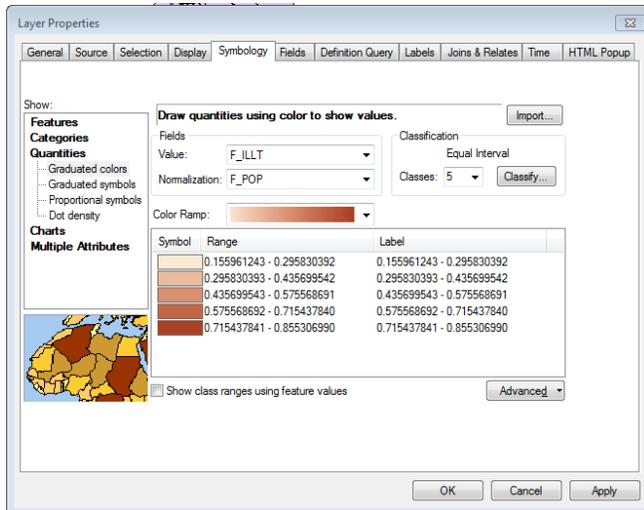
18. Make your table active and look at the main tool bar. Click on **Options** under the table to see the tools for working with the attribute tables.

4.0 Creating the Legend of a Theme

In ArcGIS, there are a wide range of options for displaying and classifying data. This section provides a brief introduction to the topic of editing the display of a layer. Currently, each layer of the map is displayed as a single color. However, we might want to observe variations within a layer. To do this, edit the display characteristics to show features from the accompanying non-spatial data. This display editing is carried out through the layer **properties** window.

19. Select the layer you want to map in the **Table of Contents** (TOC). Right click on it and in the accompanying menu, select **Properties**.

20. In the **Properties** window, click on the tab for **Symbology** to get a new window called **Layer Properties**. In the **Symbology** window, click **Quantities** and select **graduated colors**. Then change “Value” to something that is quantitative. You may experiment with the classification by clicking on the **Classify** button. Try any “Method” that appeals to you: **Equal Intervals** for example. Change the color ramp by selecting the pull down menu.



Later you add a legend to explain the classification scheme on the map, once the legend has been created you can edit the legend. You will learn more about editing legends later this week.

You have now created a basic graduated color map based on equal interval classes of minority percentages in a block group. As you can see, the layer that was previously displayed with a single color is now displayed using a graduated color ramp. The ranges used are displayed in the table of contents.

21. To remove any data files that you don't need from the map document using the **right-click** menu in TOC ("**Remove**" is one of the options).

4.1 Creating Layouts

Thus far, we have been working in the Geographic data view of ArcMap. Now as we set out to layout our data for printing, we will work in the **Layout**  view of ArcMap. The **Layout View**  provides the ability to manipulate an assortment of data frames and map elements on a page.

22. Make sure that you are in the  Layout View
23. Within the TOC you can right click on each layer to get **Properties** and then use **Symbology** to select **Categories** (nominal or ordinal variables like income categories or province names) or **Quantities** (continuous variables like population or elevation) depending on what you want to show on the map.

Now, we are going to add the legend to the layout. To do so:

24. Click on the **Insert** main menu (in the Layout view) and scroll down to **Legend**. This will open the Legend Wizard.
 - a) In step one of the **Legend Wizard**, ensure that all of the layers that you desire to display have been included in the legend. You can also shift the order that they are displayed by clicking on the up and down arrow. When done, click **Next**.
 - b) In the second part of the Legend Wizard, you can add a **Title**, change its font and justify your legend. When done, click **Next**.
 - c) In the next part, you can select the format for your legend frame. You could experiment with different border, background and drop shadow options. Then click **Next**.
 - d) At this or any other point in the creation of your legend, you can select **preview** and avoid the remaining steps of the Legend Wizard.
 - e) The remaining two screens in the Legend Wizard provide advanced formatting options. For now, click **Preview** and then **Finish**.
 - f) A legend will now appear on your screen. Drag it to the bottom of your layout. You can resize it by clicking on the legend corners. You can also resize the map by clicking on the outline and dragging it in the direction that you desire.

Now, we are going to insert a title, north arrow, and scale bar:

25. You can use the main menu **Insert** to select **Title** or **Text**. Set the text characteristics, which includes, size, font, color, bold, italics and underline. Enter a suitable title. You can now readjust the location of the title by clicking and dragging on it.
26. To add a north arrow click **Insert** on the main menu in the layout display. Scroll down and select “**North Arrow.**” Select the north arrow you want from the menu and click OK. The north arrow will be added to the map. When it is highlighted in blue, you can move it around and adjust the size of the arrow.
27. To add a scale bar to your layout click **Insert** along the main menu. Scroll down and select **Scale Bar**. In the **Scale Bar Selector**, select the style of scale bar.
28. Then change the units of the scale bar. To do this, click on **Properties** and in the dialog that emerges, set the Division Units to miles (meters is the default). Click OK. A scale bar will be added to the layout. When it is highlighted in blue, you can adjust its size and adjust its location.
29. From the main menu **File**, select **Export Map**. When the Export dialog appears, choose the file format you want to export to from the dropdown list of file types. Go to “**Options**” and set the optimum resolution value you need (more resolution means larger files).

5.0 Exporting Views and Layouts

You can export a view or a layout to a graphics file in a number of supported output formats. This is an alternative to using screenshots (which you can create by holding down **Ctrl** and **Alt** and then hitting **Print Screen**). To export a map (from the **layout view** so that you get legends, etc):

30. From the **File** menu, select **Export Map**
31. In the Export Map window choose the file format you want to export to from the dropdown list of “Save as type.” Go to “**Resolution**” and set the optimum resolution value you need (more resolution means larger files).

