Spatial Analysis Using ESRI ArcGIS 9.3

Background

Definition: Buffer analysis is used for identifying areas surrounding geographic features. The process involves generating a buffer around existing geographic features and then identifying or selecting features based on whether they fall inside or outside the boundary of the buffer. Buffers are commonly be used to assess and closely analyze environmental impacts, as you will see in this tutorial.

Briefing: In this tutorial you are going to use the data provided to highlight areas where earthquakes had the most profound impact on Canadians in 2002. You are going to use various **selection** and **buffering** techniques to establish areas where large earthquakes were located within a close proximity to populated places. First, you are going to use the **Select by Attribute** function to select places that had populations larger than 10,000 people, and all the earthquakes with magnitude greater than or equal to 5. Then you are going to use the **Select by Location** function to select the populated places that are within 100 km of a large earthquake. You are then going to use this information to create a series of buffers to assist you in some distance and population analysis.

By the end of the tutorial you will have a clear map that demonstrates which earthquake had a significant impact on Canadians in 2002.

Overview

In this tutorial you will learn how to:

- Change the projection
- Select features by definition query or their attributes
- Create a new shapefile
- Select features based on their location
- Use buffer tool to create single or multiple ring buffers
- Perform a field calculation
- Label features

Getting Started

The data used in this tutorial include three shapefiles and a mxd file:

- Quakes2002.shp - Information of earthquakes occurred in 2002
- Places_dd.shp - population of each geographical location
- province_dd.shp - provincial and territorial boundaries
- Buffering.mdx - ESRI ArcMap document

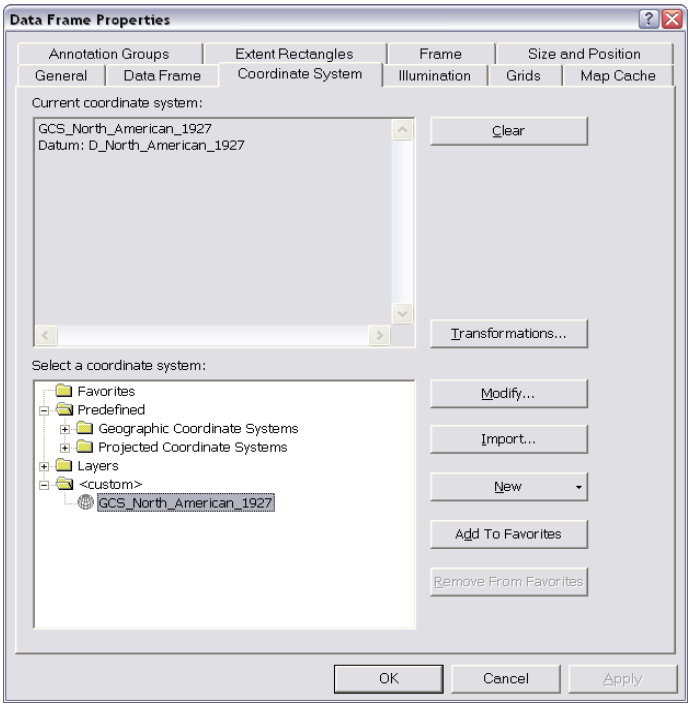
1. Start **ArcMap**. In the welcome window select “Start using ArcMap with:” **An Existing Map** and click **OK**.

2. Browse to the **E:\Buffering** and select **buffering.mxd** and click **Open**.

Change the Projection

The original projection is in a geographic coordinate system (latitude and longitude) which we will change to *Canada Lambert Conformal Conic*.

1. To change the coordinate to a different projection, double click on **Layers** (the Data Frame) in the table of contents. This will bring up the Data Frame **Properties** dialog box.



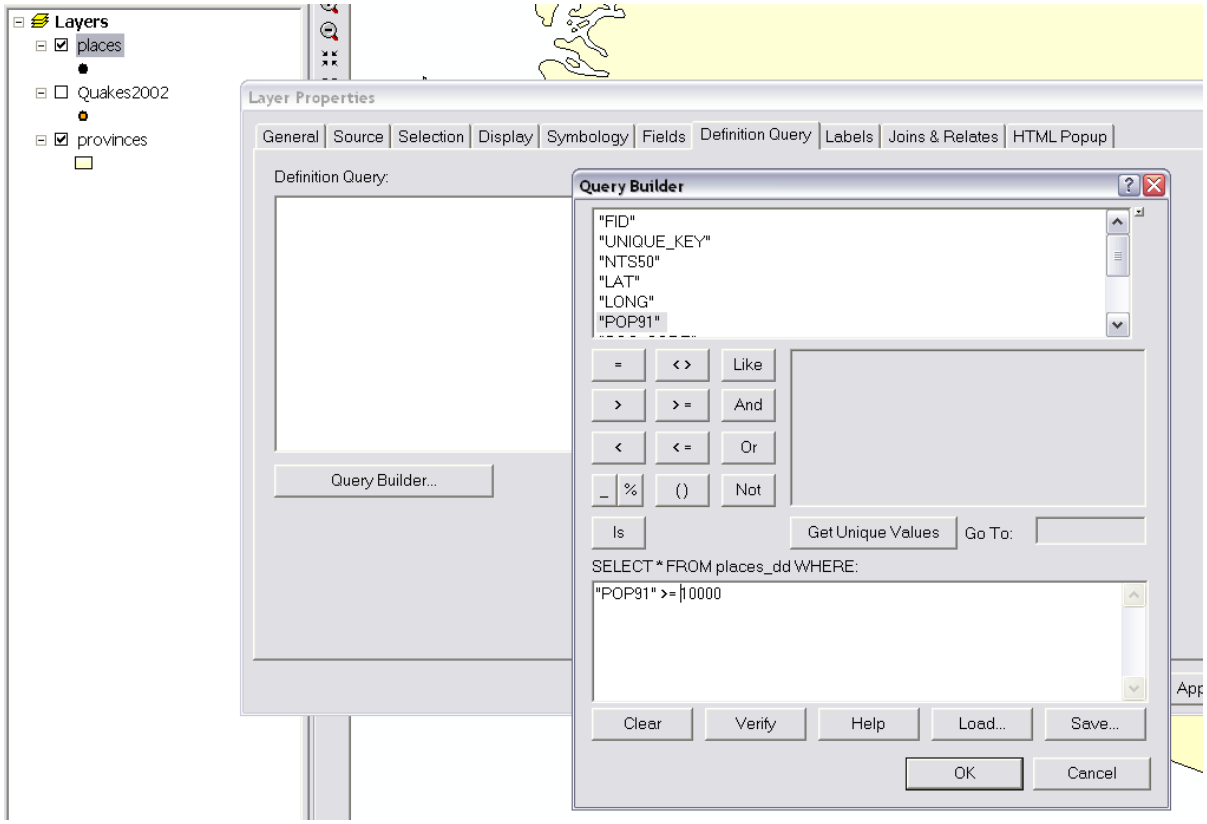
2. Select the **Coordinate System** tab and choose **Predefined** -> **Projected Coordinate Systems** -> **Continental** -> **North America** -> ***Canada Lambert Conformal Conic***.

3. Choose the **General** tab and change the display units to **Kilometers**. Click **OK** and click **Yes** to the coordinate system warning.

Select features by definition query

Next you are going to create a SQL query to select the features that you are interested in buffering. You are going to start by selecting places with populations greater than 10,000 people.

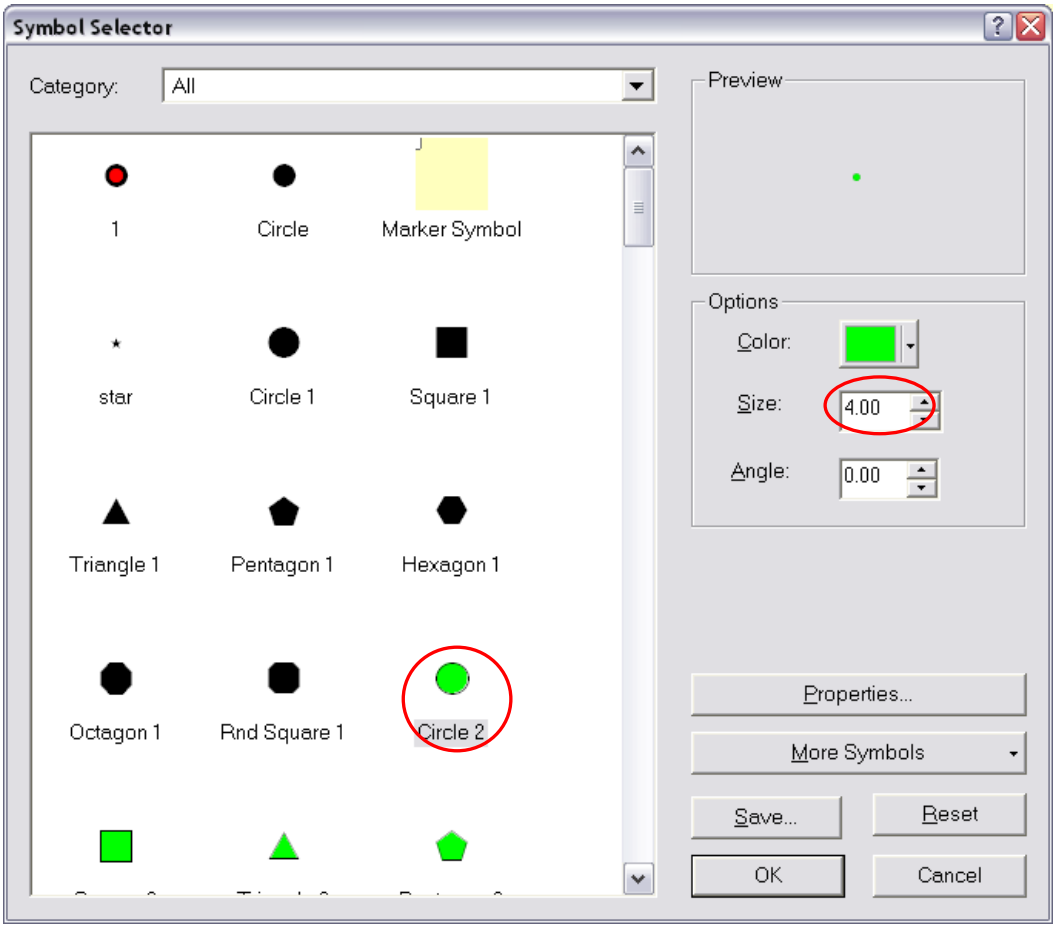
1. Double click "**Places**", this will bring up **Layer Properties**, choose **Definition Query.**



2. Click **Query Builder**. This will bring up a dialog box. Then, double click on the **POP91** (Total Population in 1991) field, single click on the "**>=**" sign, and type **10000.** (This will select all the places in Canada with a population of 10,000 or more.) Click **OK** to close the dialog box.

3. Now we are going to label the cities. Click on the **Labels** tab. Make sure that the Label Field is **NAME_ENG (City Name)**. Click on the Predefined **Label Styles** and choose **City.** Then click **OK.** Click **OK** again to close the **Layer Properties.**

4. Now you are going to assign a symbol to the selected places. Double click on the "**places**" symbol (the point). This will bring up the "**Symbol Selector**" and change the symbol to Circle 2, size 4 to emphasize these points. Click OK to apply the change.

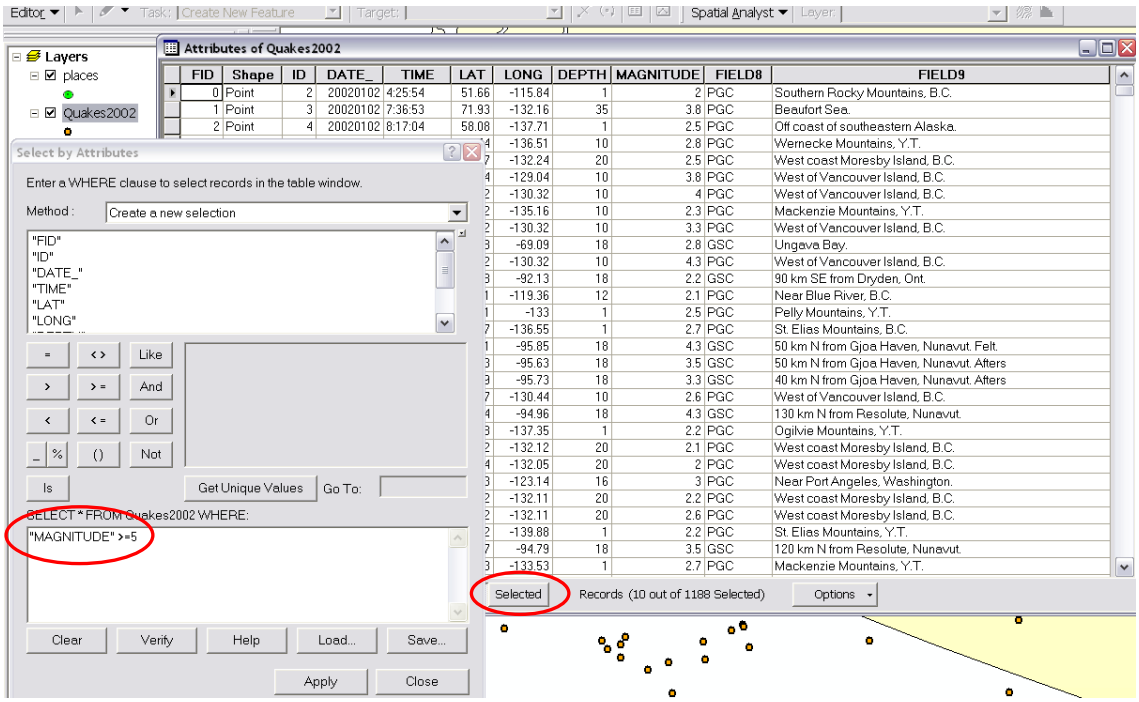


Select by Attributes

You are now going to use a different technique to select and display the earthquakes with a magnitude of 5.0 or greater. The isolated big earthquakes will be used to create a new shapefile to use in the next section.

1. Right click on **Quakes2002** in the table of contents and click **Open Attribute Table**. Have a look at the attributes in the table.

2. You are going to select the earthquakes with a magnitude of 5.0 or greater in the **Attributes of Quakes2002** table. Click **Options** -> **Select by Attribute**.



3. In the **Select by Attributes** dialog box, ensure that the method is **Create a new selection**.

4. Double click **MAGNITUDE** in the query builder, click "**>=**" and the type **5**.

5. Click **Apply** to execute the query and **Close** to close the **Select by Attributes** dialog box.

6. Click the "**Selected**" button at the bottom of the table to display the query. Examine the selected **Attributes of Quakes2002** table. There should be 10 of 1188 records selected.

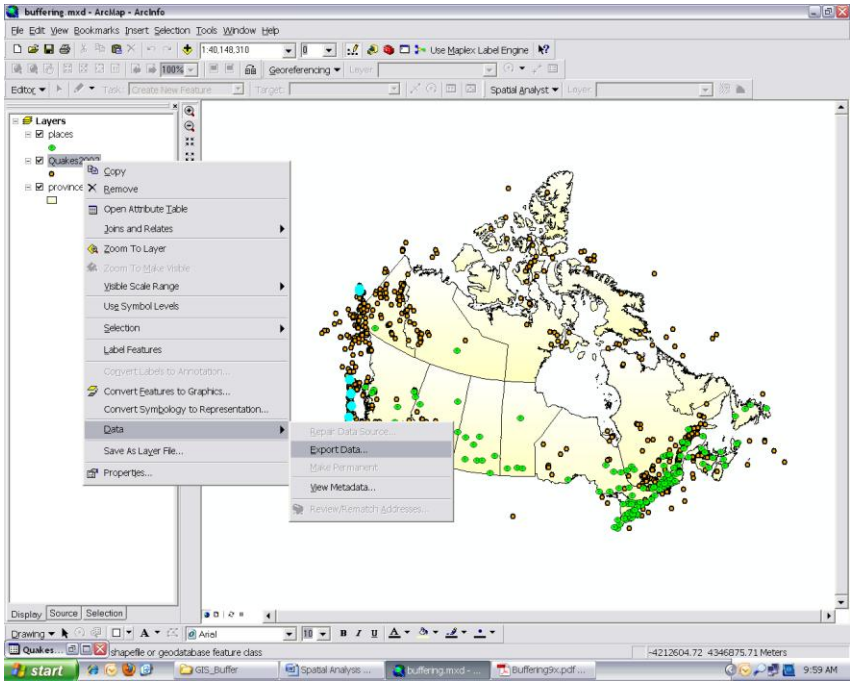
Is there a pattern of where the big earthquakes are located?

7. Close the **Attributes of Quakes2002** table.

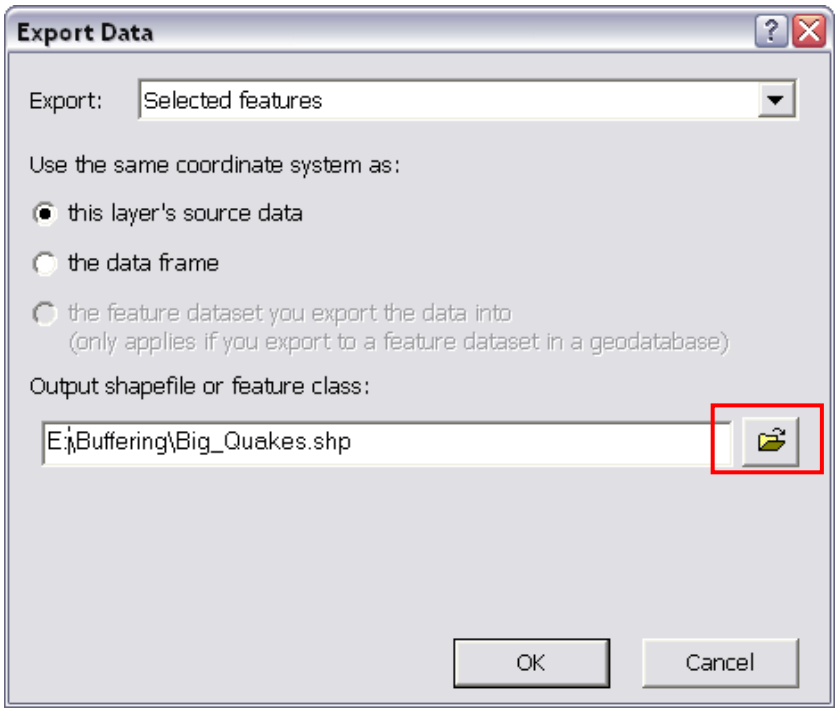
Create a New Shapefile

In order to simplify your map, you are going to create a new shapefile of the Magnitude of earthquakes greater than 5.0. The new shapefile can be created from selected records using the function called *Export*.

1. Right click on the **Quakes2002** layer in the table of contents and choose **Data -> Export Data.**

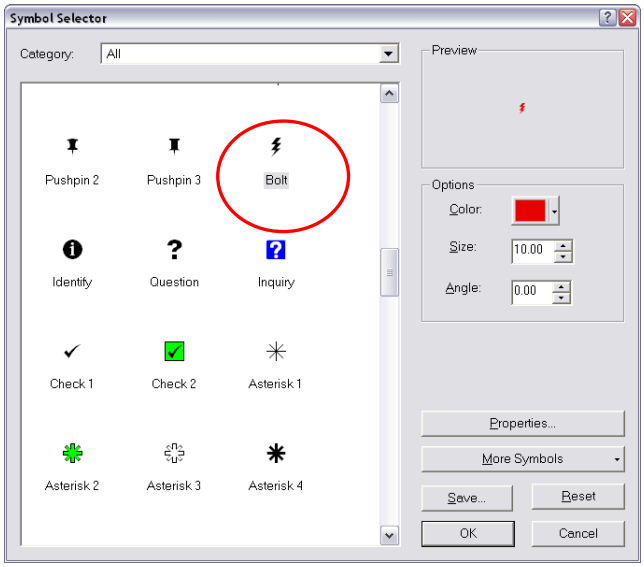


2. In the **Export Data** window, click the **Browse** button to navigate to your **Buffering** folder and name your new shapefile as **Big_Quakes.shp.** Add the exported data to your map.



3. Right click on the **Quakes2002** layer in the table of contents and choose Remove. This will remove the **Quakes2002** layer.

4. Change the symbol of the **Big_Quakes** layer to a red Bolt, size 10.

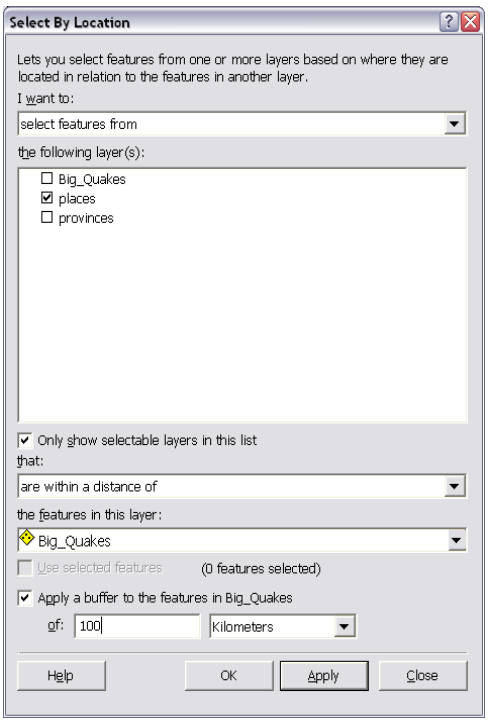


Select by Location

You are now going to use the **Select by Location** function to find out if there are any **places** with 10,000 people or more that are within 100 km of an earthquake with magnitude 5.0 or greater in 2002.

1. From the **Selection** drop down menu, choose **Select by Location.**

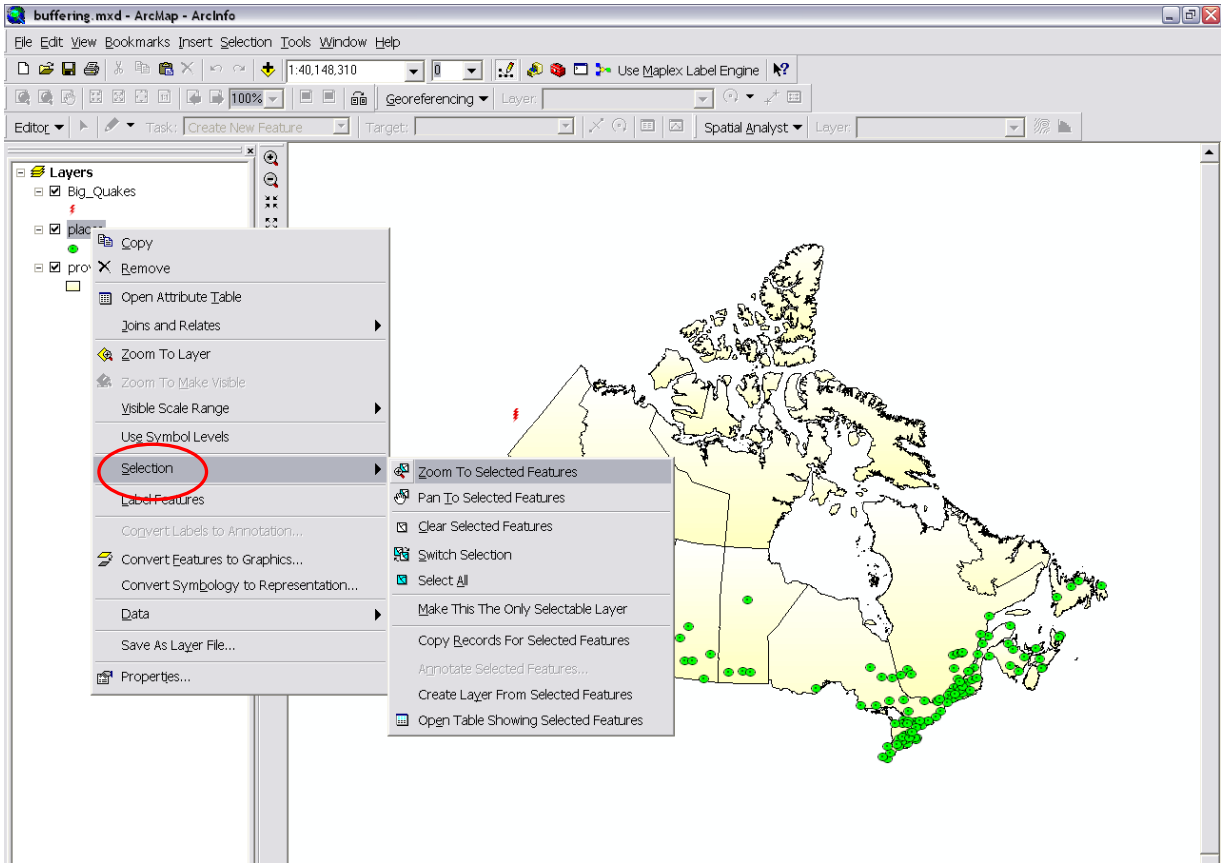
2. In the **Select by Location** dialog box, choose "I want to:" **select features from** "the following layers:" **places** that "**are within a distance of"** the features in this layer: "**Big_Quakes.** Put a check in the **Apply a buffer to the features in Big_Quakes** and set the buffer to **100 Kilometres.** Click **Apply** and then **Close.**



3. Right click on the **places** layer in the table of contents and **Open Attribute Table.** Click on the **Selected** button to see how many places fit the criteria.

Note: There should be 4 places selected out 141 meaning that there are 4 places with more than10,000 people that are within 100 km of an earthquake with a magnitude of 5.0 or greater.

4. Close the table and right click on the **places** layer in the table of contents and choose **Selection** -> **Zoom to Selected Features**.



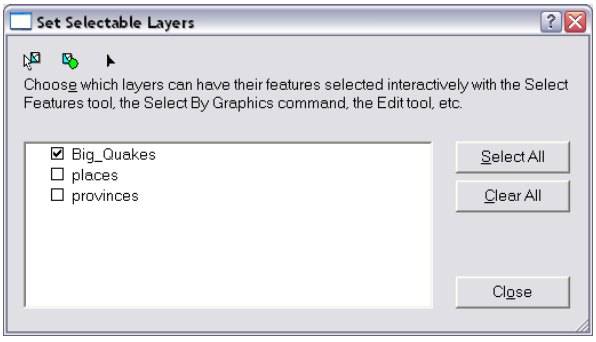
Note: Notice that all four of the places that meet the criteria are very close to the same earthquake. This earthquake occurred in the **Haro Strait**.

5. From the **Selection** drop down menu, choose **Clear Selected Features.**

Select Location using Selected Features Tool

You are going to select out the earthquake occurred in the **Haro Strait** around which you are going to create a multiple ring buffer.

1. You will need to set the selectable layers to avoid selecting features in other layers. Go to the **Selection** drop down menu, choose **Set Selectable Layers.**

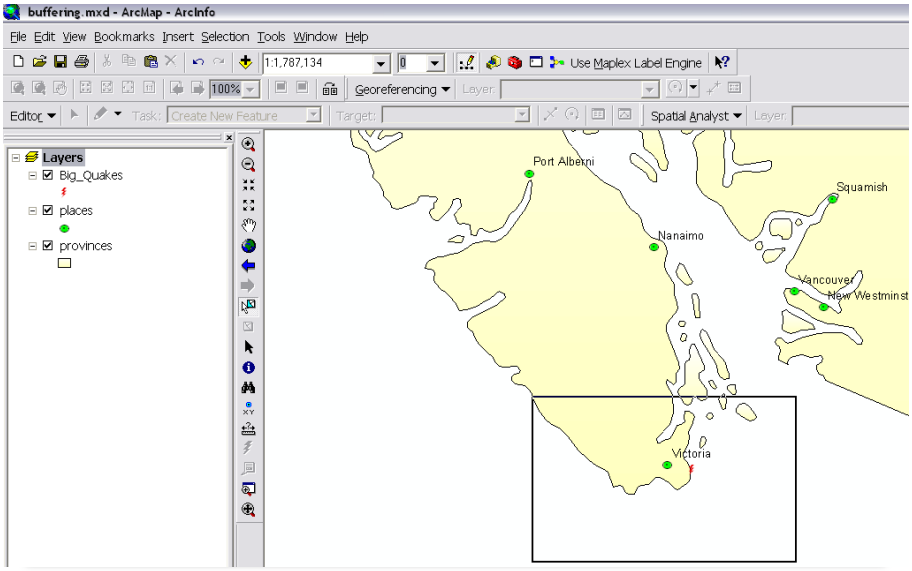


2. Click the **Clear All** button to unselect all the layers and then click to put a check mark in the box next to **Big_Quakes.**

3. Click **Selected Features**  tool to and draw a box around the big earthquake (red Bolt) that occurred in **Haro Strait** near Victoria.

The selected earthquake will be used to create a multiple ring buffer.

(Notice that all four of the places that meet the criteria are very close to the same earthquake. This earthquake occurred in the **Haro Strait** and we are going to use the earthquake epicentre to build a buffer)



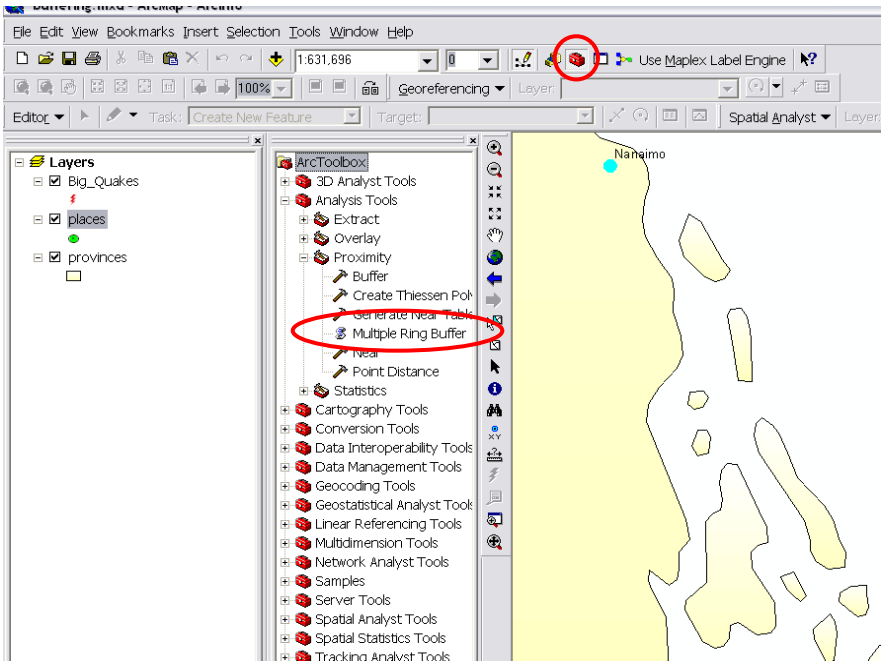
Create multiple ring buffers using the Multiple Buffer Tool

You are going to create a multiple ring buffer using the **Multiple Buffer Tool.** The buffer will have four concentric rings spaced out at 25 km helping illustrate the proximity of each place to the earthquake. The places located closest to the earthquake are susceptible to the greatest amount of damage.

In ArcView 9.3, the **Buffer Tool** is located inside ArcToolbox; it is not automatically present.

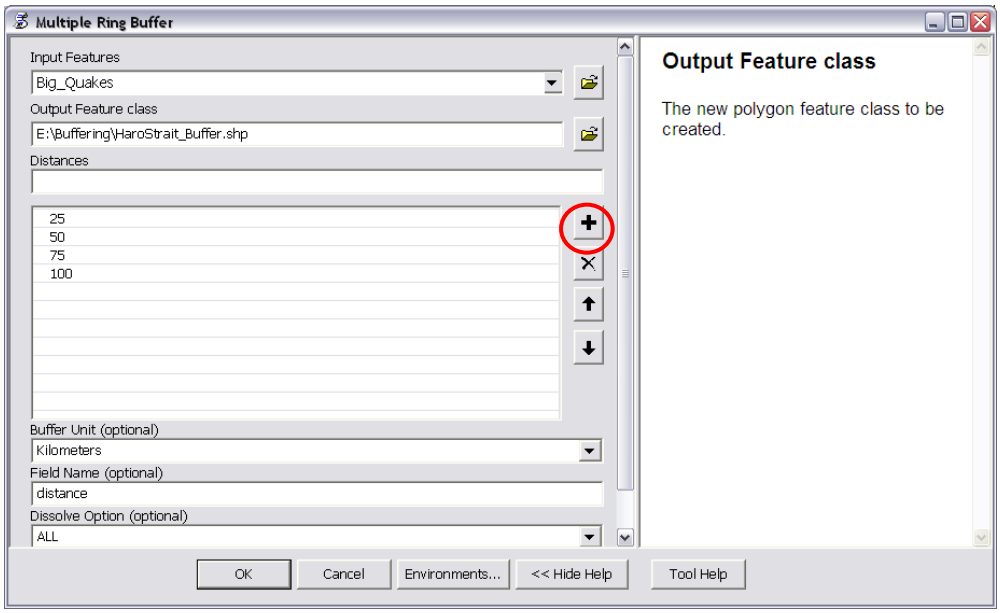
1. Click the Show/Hide ArcToolBox Windows  .

2. Click on the **Analysis Tools -> Proximity** and scroll through and find the **Multiple Ring Buffer Tool.**



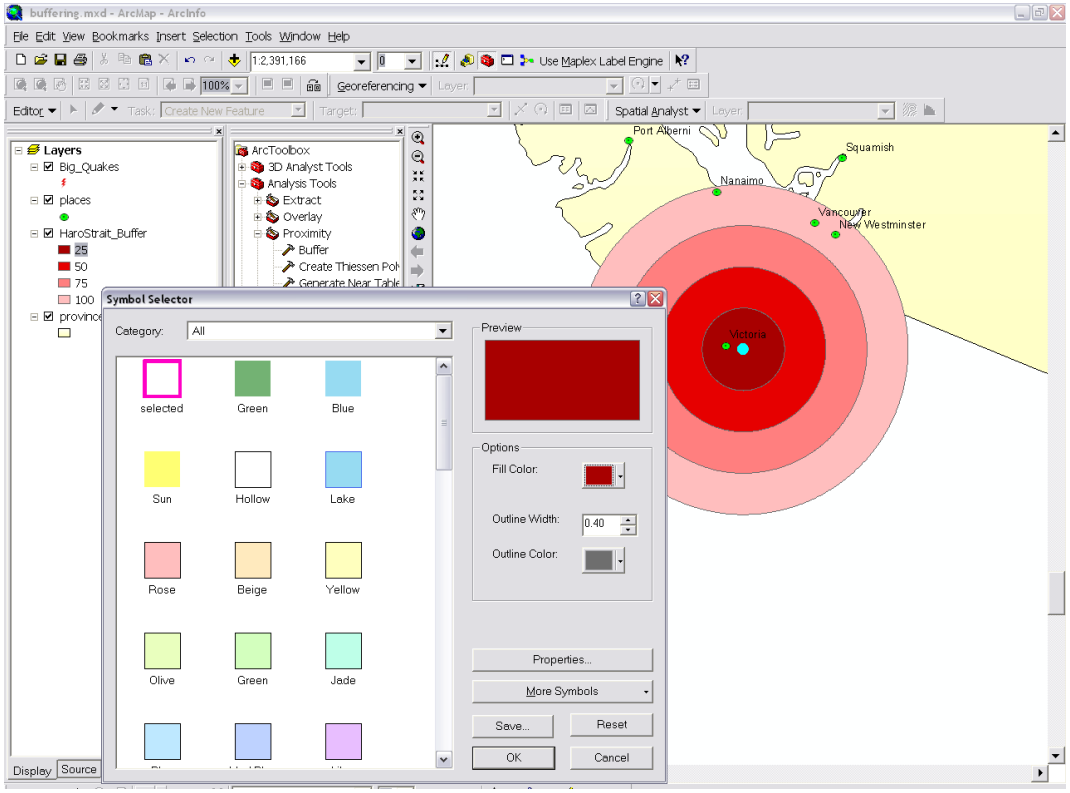
3. Double click the **Multiple Ring Buffer Tool.** This will bring up the dialog box. Choose the **Big_Quakes** as input feature and output feature class as **HaroStrait_buffer.shp.** Output feature class is a new shapefile created as a result of buffer analysis.

4. You are going to create 4 rings at intervals 25, 50, 75, 100 km. In the distances field, type in **25** and click **Add**  . Continue to type and add **50**, **75** and **100**. In the optional Buffer Unit, select **Kilometers.** Click **OK** and in a couple of minutes, your buffers will be created.



5. Double click on the "**HaroStrait_buffer**" 25 km ring symbol. This will bring up the "**Symbol Selector**" and change the fill color to a dark red color. Click **OK** to apply the

change. Continue to apply the fill color change for the 50, 75 and 100 km rings. The rule of thumb is that the darker shading correlates with an increased susceptibility to earthquake.

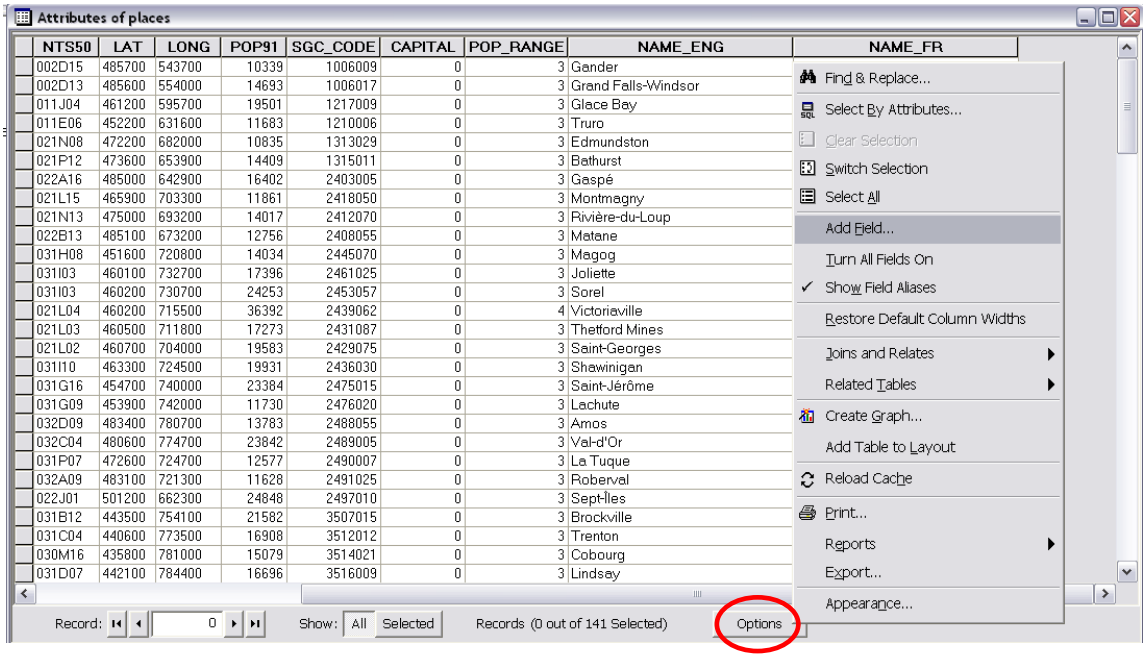


6. Go to the **Selection** drop down menu, click **Clear Selected Features**. Choose **Set Selectable Layers** and Click **Select All** and then **close.**

Perform a field calculation

The other major factor that determines the impact of an earthquake is the size of the populated places nearest to it. The point of this exercise is to create a faked distance field which is the physical representation of each populated place weighted by population. The attribute you are going to use, Pop91 field (Total Population in 1991), is not a measurement of length. It is important to remember that the faked field value **do not** represent the real distance each populated place extends outward.

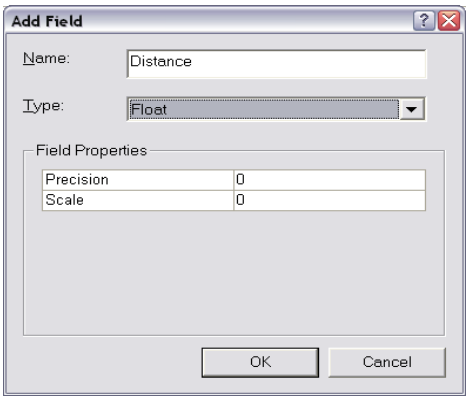
1. To create a new field, right click on the **places** layer and select **"Open Attribute Table".** Click "**Options**" and select "**Add Field**".

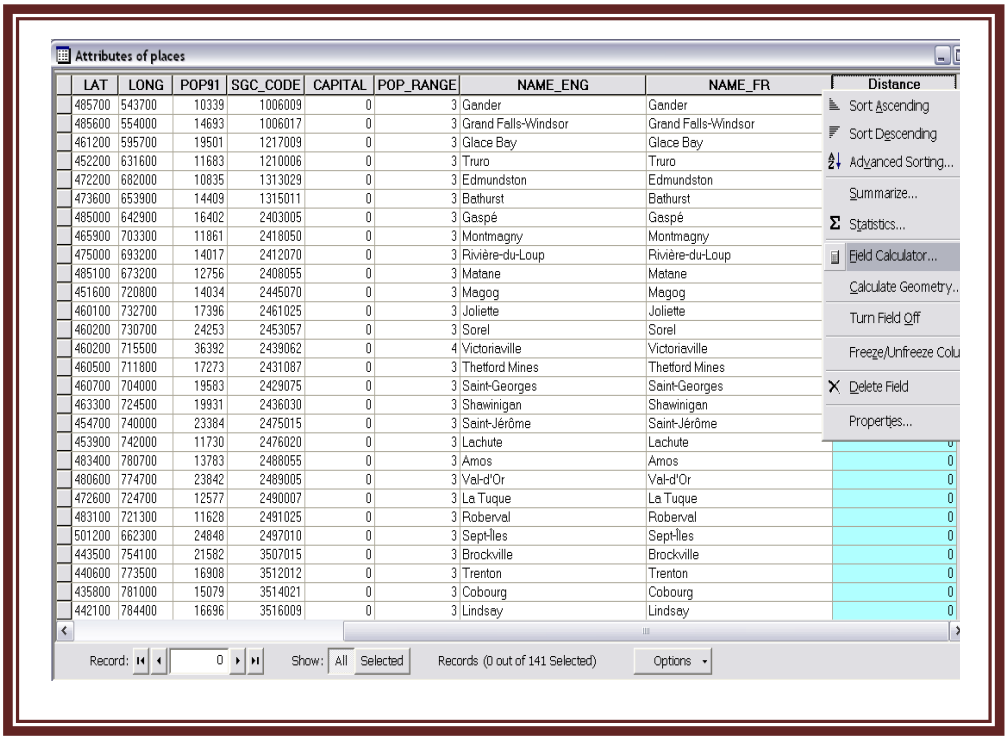


2. Create a new field, name it as “Distance” and set the Type as “Float”. Click “**OK**”.

When you add a field to a table in shapefile, the field is created as a specific data type. In this example, you are going to add a single-precision floating point number column to the existing table, often referred to as ***float***.

2. Scroll down to the **Distance** field (far right), right click under the **Distance** and select **Field Calculator.**





3. In the Field Calculator, enter Distance = **[POP91]/40** (total population is divided by 40) and click "**OK**" This value 40 was chosen through trial and error based on how well the distance value was able to display the relative size of the population at each place.

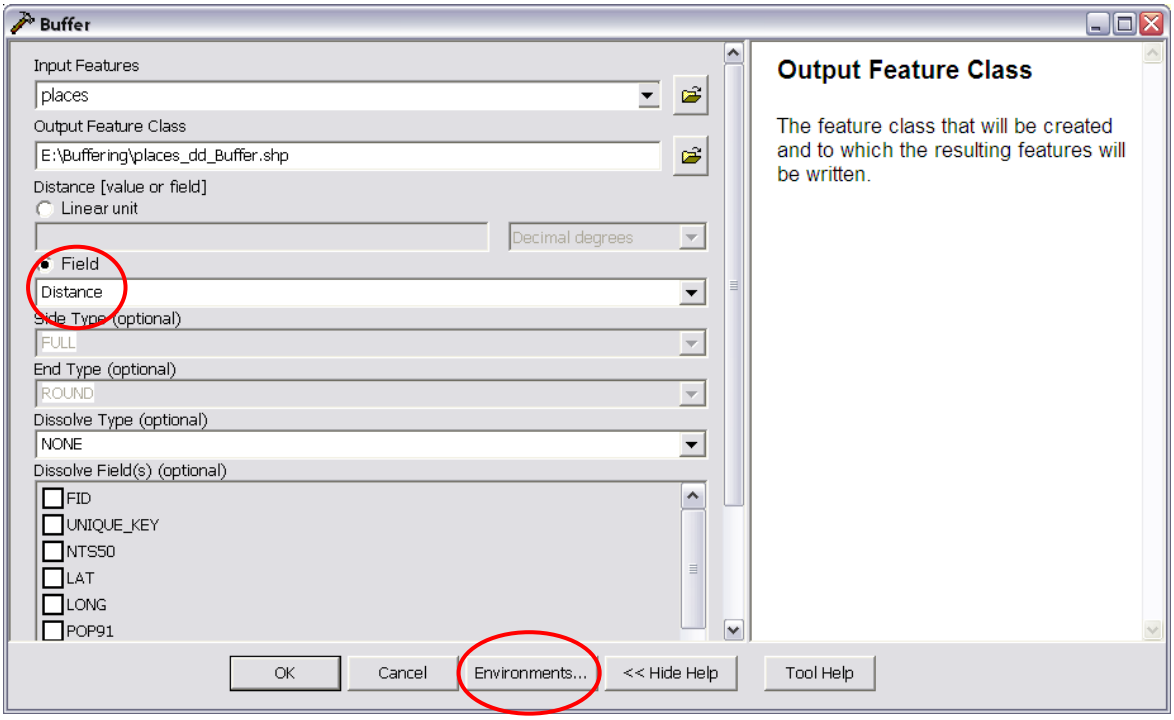
Creating a buffer based on a distance from a table attribute

The next step is to create single ring buffers based on the faked distance.

1. Select the four populated places within 100 km of the **Haro Strait** earthquake again. To do this, go back to the **Selection** menu and click on **Select by Location**. In the dialog box, choose "I want to:" **select features from** "the following layers:" **places** that "**are within a distance of"** the features in this layer: "**Big_Quakes.** Put a check in the **Apply a buffer to the features in Big_Quakes** and set the buffer to **100** Kilometres**.** Click **Apply** and then **Close.**

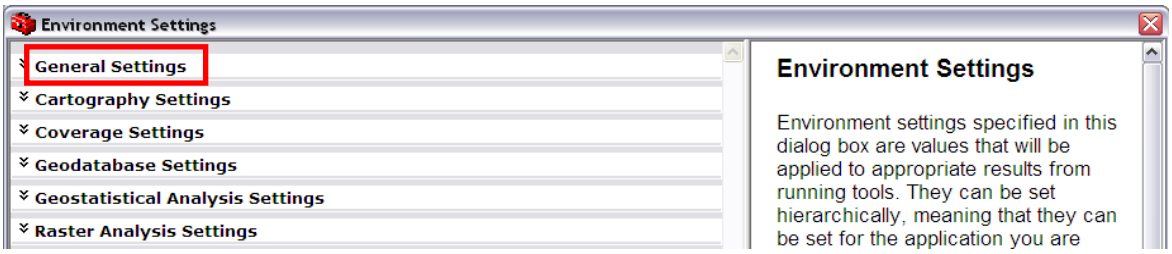
2. Click on the **Analysis Tools -> Proximity** and scroll through and find and double click the **Buffer** Tool. This will bring up the dialog box.

3. In the dialog box, set Input Features as "**Places**", Output Feature Class as E:\Buffering\places_dd_Buffer.shp. Next choose Field as "Distance". The numeric values in the field will be the buffer distances



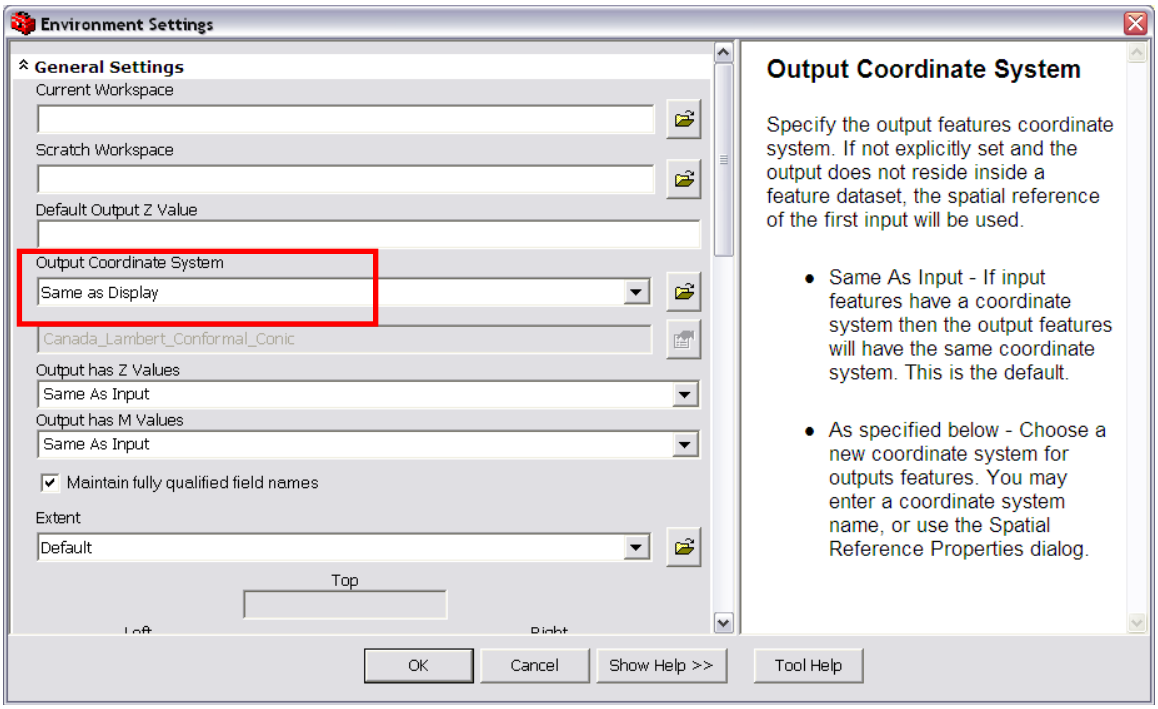
4. Click **Environments** to make some changes to the Buffer Tool Environment Settings

5. In the Environment Settings dialog box, click on the General Settings.



6. In the General Settings, make a change on the Output Coordinate System to **Same as Display.** The default is “Same as Input”. Click OK.

The input feature’s **(Places)** coordinate system is in a geographical coordinate (Latitude and Longitude) which cannot be used to create a valid buffer. Therefore the display coordinate system is ***Canada Lambert Conformal Conic (in the unit of kilometre)*** *is used.*



7. Back to the buffer tool dialog box, click OK to perform the buffer operation.

8. Double click on the “places_dd_Buffer1” symbol. This will bring up the “**Symbol Selector**” and change the fill color to **Grey 30 %**. Click OK to apply the change.

9. Go to the **Selection** menu and click **Clear Selected Features.**

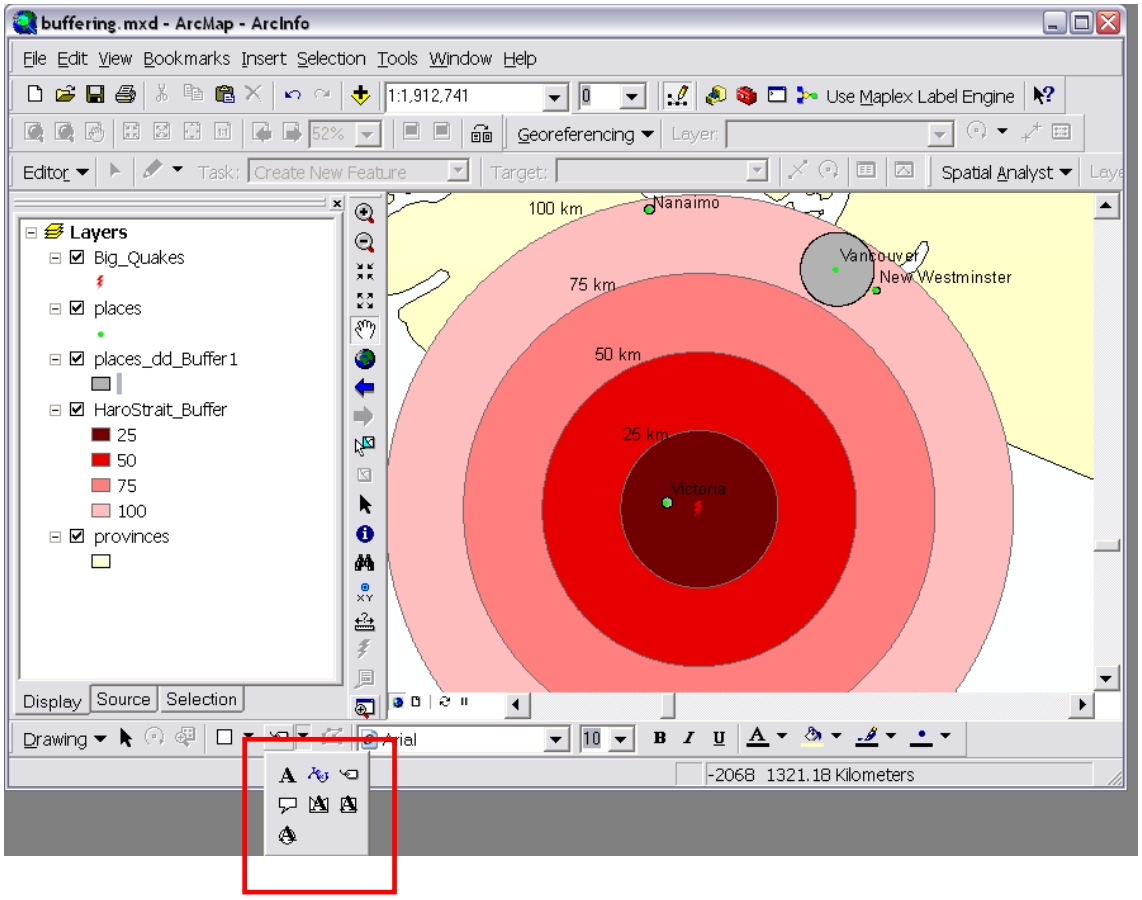
After selecting all 4 places within 100 km of the **Haro Strait** earthquake, you have used a distance representing the relative size of population to create buffers. Then you have assigned a grey color to the buffer rings.

Labelling the Buffer

Next, you are going to label the buffer distances. The easiest way to do this is using the **New Text** tool (Drawing toolbar at the bottom), although you could use the **Label Features** function as well. The **New Text** function allows you to have more control over the exact placement of the text.

1. Click on the **New Text** tool and click just above the inner buffer line to create a text box there. Type in 25 km and click outside the text box when you are finished typing. Adjust the box using the Pointer tool (Tools bar) into the desired position.

2. Repeat the same procedure to label the 50 km through 100 km lines.



Note. The darker shading correlates with an increased susceptibility. Therefore, because Victoria falls within the inner darkest ring, it was the most vulnerable to damage from the earthquake occurred in the **Haro Strait**. The size of the grey buffers around the 4 cities correlates to the size of population. Therefore they symbolise the potential extent of earthquake impact.

Congratulations! You have now successfully created buffers using a variety of selection methods.

Reference:

This tutorial was modified from the ESRI Canada K12 buffering tutorial.