TUTORIAL

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Working with Lidar in ArcGIS 10

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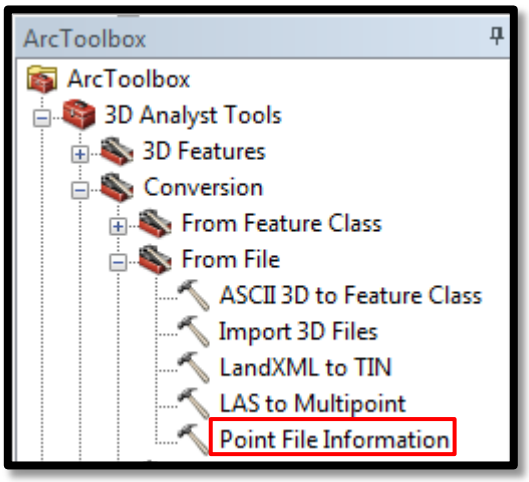
Using Lidar in ArcGIS 10

Several tools are now available for working with lidar data in ArcGIS 10. Historically, because of the large file sizes, working with lidar datasets has been a challenge for those without specialized software packages designed for lidar processing. The release of ArcGIS 10 has provided many improvements in this field and can increase lidar processing and productivity for coastal applications. Listed below are a few of the tools in ArcGIS 10 that can be helpful for coastal applications and general lidar processing functionality.

Checking Data Quality

Data quality can vary with lidar depending on collection specifications, and there is always a chance of encountering anomalies in the data. Some common examples of anomalies include irregular minimum bounding shapes, "holes" in the sampling, and extreme high/low values (i.e., outliers). If any of these anomalies might affect project scoping or requirements, a user may want to check the data before performing any analyses. The **Point File Information** tool (requires 3D Analyst license) can assist in performing data quality assurance checks on lidar datasets. This step is optional and not required for the importing process of lidar data into ArcMap.

The Point File Information tool, found in the 3D Analyst Tools (ArcToolbox > 3D Analyst Tools > Conversion > From File > Point File Information), reports important statistics about the raw lidar files.



The result from this tool is a feature class that shows the

- Minimum bounding rectangle for each file
- Number of points recorded
- Average point spacing
- Minimum/Maximum z-values

When the feature class is loaded into ArcMap, the minimum bounding rectangle of each lidar file is drawn. Lidar data files are usually uniform in size, so if any of the feature shapes appear large or irregular compared to the majority of features from the feature class, they will appear different in ArcMap, which may require the user to refer to the corresponding lidar data file for further investigation.

For more detailed information on the Point Information Tool output results and determining lidar data quality, refer to the Esri white paper: *www.esri.com/library/whitepapers/pdfs/lidar-analysis-forestry-10.pdf*.

Loading LAS Files to ArcGIS – LAS to Multipoint Tool

This tool imports one or more files in LAS format, the industry standard for lidar data, into a new multipoint feature class. The tool enables the user to read the lidar data files and load them into the geodatabase. Loading the lidar files in a geodatabase allows a seamless mosaic of the entire lidar dataset, which then can be analyzed by ArcGIS tools. Supported LAS file format versions are 1.0, 1.1, and 1.2.

LAS points can be classified into a number of categories, including bare earth or ground, water, and vegetation (low, medium, or high). The different classes are defined using numeric integer codes. Unfortunately, the LAS 1.0 specification does not have a predefined classification scheme, nor do the files summarize what, if any, class codes are used by the points. The data provider must supply this information.

If working with the LAS 1.1 or 1.2 specifications, refer to the predefined classification schemes defined by American Society for Photogrammetry and Remote Sensing (ASPRS) for the desired data category. The following table lists the LAS class codes based on LAS version 1.2 defined by ASPRS.

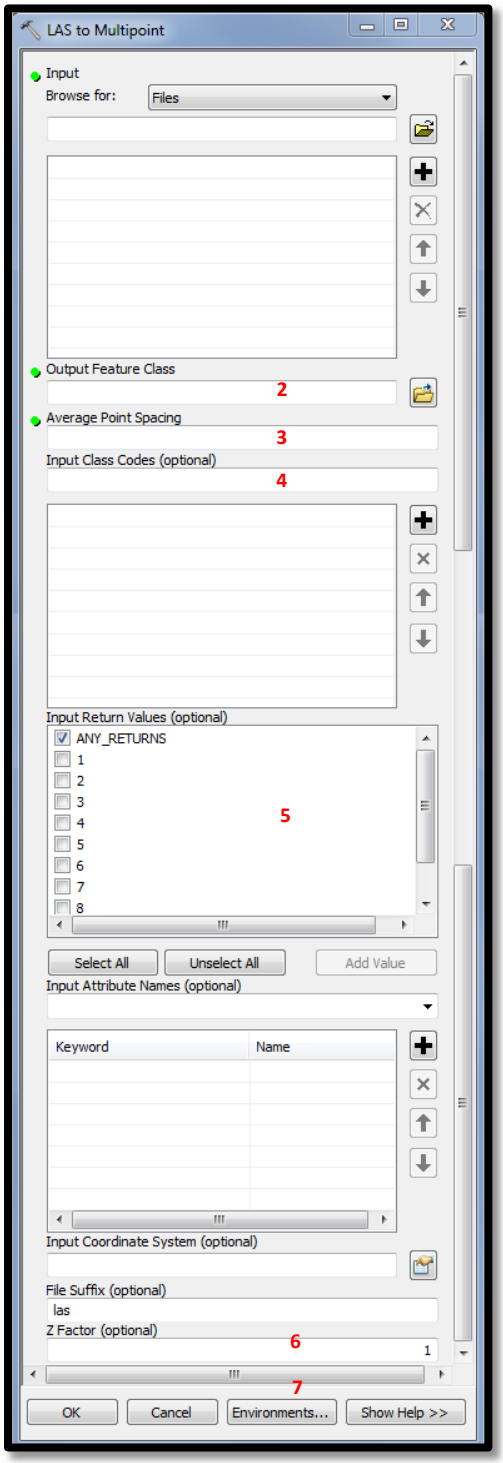
To import predefined LAS points from the LAS file or files, specify them in the **Input Class Codes** parameter.

ASPRS Standard LiDAR Point Classes

Classification Value	Meaning
0	Created, never classified
1	Unclassified
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Points (noise)
8	Model Key-Points (mass points)
9	Water
10	Reserved for ASPRS Definition
11	Reserved for ASPRS Definition
12	Overlap Points
13-31	Reserved fro ASPRS Definition

When the LAS data files are read by the **LAS to Multipoint tool**, it can accommodate these classifications and separate them into unique feature classes.

The LAS to Multipoint tool needs certain specifications depending on the project. An example for ground returns is displayed below.



1. A folder is specified for the data source. Individual files can be specified, but when large amounts of lidar data are being read, it is a best practice to specify the folder.

2. The Output Feature Class is specified in a file geodatabase. Multipoint feature classes exist in geodatabases and shapefiles, but geodatabases are preferred because of the extended capabilities of the geodatabase and the size restrictions of a shapefile.

3. The ground spacing is specified. This is acquired from the Point File Information tool or from the supplied metadata.

4. The Input Class Code to be extracted is specified. The specific code entered will vary depending on the classification being analyzed (example: enter 2 for ground returns only).

5. The Input Return Values are specified. (Example: if the goal is to produce a ground surface, then the Input Class Codes need to be specified as 2 and the Input Return Values as ANY_RETURNS.)

6. The coordinate system is specified.

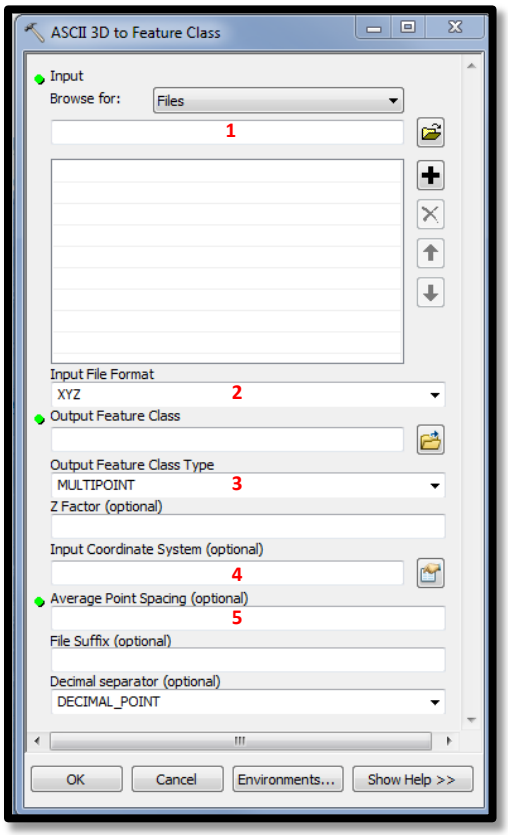
7. The LAS file extension is designated as a **.las** file.

Loading ASCII (X,Y,Z) Files to ArcGIS – Option 1 (requires 3D Analyst)

The **ASCII 3D To Feature Class** tool found in the 3D Analyst Tools (ArcToolbox > 3D Analyst Tools > Conversion > From File > ASCII 3D to Feature Class) imports 3D features from one or more ASCII files into a new output feature class.

In some cases, lidar data may be provided as an ASCII text file containing X (latitude), Y (longitude), and Z (elevation) information. The ASCII 3D to Feature Class tool will read the XYZ information and generate a new output feature class. The Input File Format may be set to XYZ, XYZI, or GENERATE. For more information on the differences in input file formats, please refer to *http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00q900000092000000*.

A preview of the tool and some of the notable required inputs is provided below.

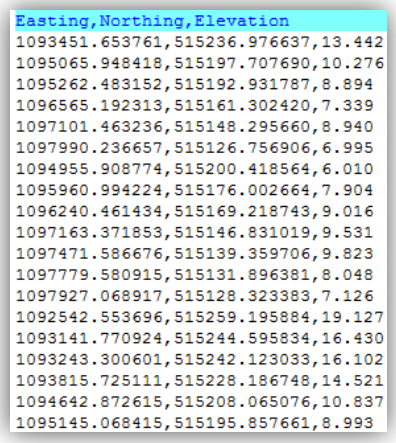


1. One or more input files or folders with data in ASCII XYZ or XYZI (with lidar intensity) or 3-D GENERATE format. If a folder is specified, all the files inside the folder named with the same extension as the file suffix parameter will be used. If multiple files are involved, they need to be in the same format.
2. The format of the input file(s). The format can be set to XYZ or XYZI or GENERATE.
3. The Output Feature Class Type. When points are input, the only valid types are POINT or MULTIPOINT. Multipoints are recommended when many thousands or millions of points are involved.
4. Input Coordinate System. (Note that if the dataset does not have a defined projection, it may need to be defined after the tool has run to show up in the right place. If the coordinate system is already defined, it is best practice to add it here.)
5. The average distance between points of the input. This parameter is only used when the Output Feature Class Type is set to MULTIPOINT.

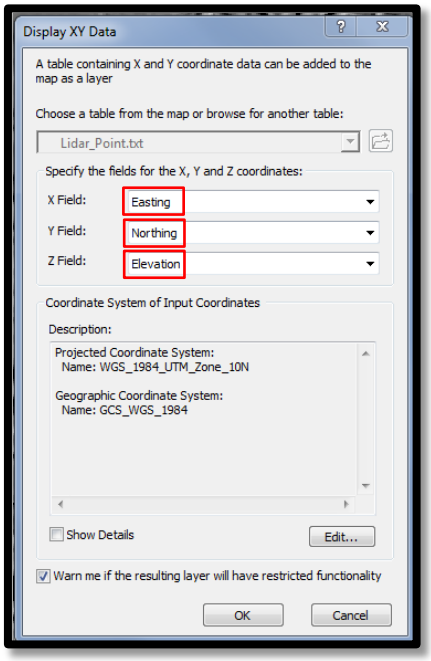
Once the tool has run, the output feature class will be added to the map project. This may take some time to load depending on the number of features in the dataset.

Loading ASCII (X,Y,Z) Files to ArcGIS – Option 2 (does NOT require 3D Analyst)

Text files containing X coordinates (longitude), Y coordinates (latitude), and Z (elevation) components can also be brought into ArcMap and converted into a shapefile or geodatabase feature class. There are several table formats that ArcMap can read to bring point data into ArcMap as an event theme. These include DBase III, DBase IV, PRN, TXT, and CSV.



```
Easting,Northing,Elevation
1093451.653761,515236.976637,13.442
1095065.948418,515197.707690,10.276
1095262.483152,515192.931787,8.894
1096565.192313,515161.302420,7.339
1097101.463236,515148.295660,8.940
1097990.236657,515126.756906,6.995
1094955.908774,515200.418564,6.010
1095960.994224,515176.002664,7.904
1096240.461434,515169.218743,9.016
1097163.371853,515146.831019,9.531
1097471.586676,515139.359706,9.823
1097779.580915,515131.896381,8.048
1097927.068917,515128.323383,7.126
1092542.553696,515259.195884,19.127
1093141.770924,515244.595834,16.430
1093243.300601,515242.123033,16.102
1093815.725111,515228.186748,14.521
1094642.872615,515208.065076,10.837
1095145.068415,515195.857661,8.993
```



1. To ensure that ArcMap can read the data in the file correctly, the user may need to format the header (text editor), or columns (Excel), containing the longitude (X), latitude (Y), and elevation (Z) values. For text-based files (PRN, TXT, CSV), an example of a header would read “longitude,latitude,elevation” or “easting,northing,elevation” with no spaces between or after the header. If using Excel, format the columns containing the longitude (X) and latitude (Y) values as NUMBER, with a minimum of 8 decimal places.
2. Add the data to the map using the Add Data button. The file will be added to the table of contents, which will switch to the List by Source view by default.
3. Right-click on the table in the table of contents and select Display XY Data.
4. Specify the fields for the X, Y, and Z coordinates. For the X Field select longitude (Easting), for the Y Field select latitude (Northing), and select the appropriate elevation variable for the Z Field. Click OK.
5. Depending on the number of points included in the table, this process could take some time.
6. The data will be added to the map as an “event” layer. This layer is temporary and must be exported to become permanent. Right-click on the event layer in the table of contents and select Data > Export Data. Choose to export all features using the same coordinate system as the layer’s source data. Select the output feature class location and the desired name of the dataset. Click OK.
7. Once exported, a dialog will ask if the user wants to add the layer to the current map. (Note: If the data does not draw in the correct location, make sure to check the projection information.)

Apply LYR File Symbology

Apply LYR File Symbology applies the symbology stored within a layer file to data layers within the active data frame that are the same type.

1. First, create a .lyr file that references geographic data stored on disk. Set the layer properties for the selected layer to the desired symbology.
2. In ArcToolbox navigate to System Toolboxes > Data Management Tools > Layers and Table Views and open the Save to Layer File tool.
3. Choose the Input Layer as the symbolized layer. Select the Output Layer to house the .lyr file. Click OK.
4. To apply the .lyr file properties to another layer, right-click the layer in the table of contents and select Properties. Click the Symbology tab and then click the Import option at the top right. Navigate to the .lyr file to apply the symbology. Click OK.

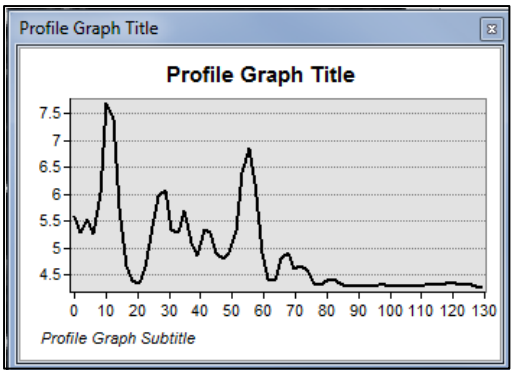
Create Grid Profiles

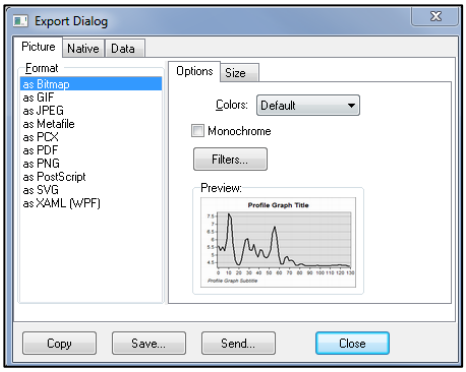
Create profiles or transects across selected grid themes (requires 3D Analyst).

1. This function can be accessed as a tool located on the 3D Analyst toolbar that is added with the Customize option on the main menu. Select Toolbars and then select the 3D Analyst toolbar option. The toolbar will be added to the display and can be docked similar to any other toolbar.

2. To activate the functions of the toolbar, a raster input layer must be selected from the Layer drop-down menu. Otherwise, the toolbar functions will be grayed out as in the image above.

3. Click on the Interpolate Line function (highlighted in the image above with the red box). Next, click the starting point on the raster layer and then double-click to finish drawing the line.
4. Once a line is completed, the Create Profile Graph option will become active (see image below). Click the Create Profile Graph drop-down menu and select Profile Graph to show the grid profile. The graph can be exported in many different formats by right-clicking the graph and choosing Export. To define parameters, choose the location in which to save the information.

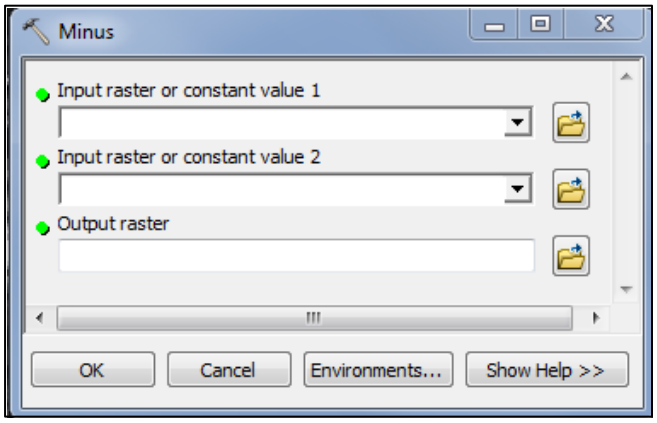




Subtract Grids

Subtract one grid from another (requires Spatial Analyst).

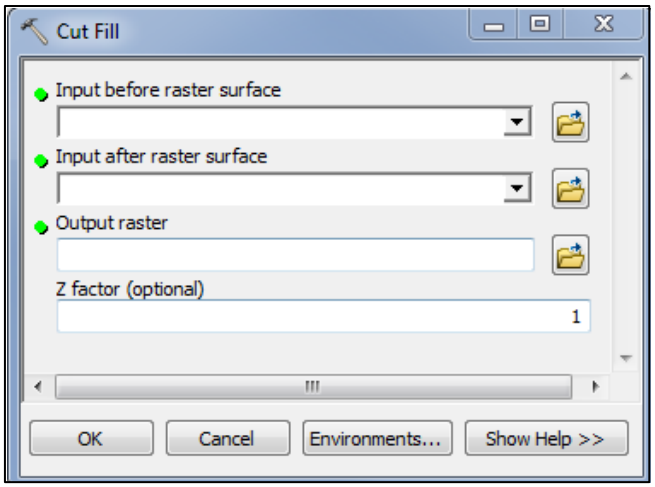
1. This function can be performed using the Minus tool found in the Spatial Analyst Tools Math toolset in ArcToolbox. (Note: the Spatial Analyst extension must be turned on to access the tool. Select Customize > Extensions and then check the box for Spatial Analyst.)
2. Open the tool by double-clicking it. Add the first raster to the Input raster or constant value 1 option. Add the second raster, or the value to be subtracted from the first raster, to the Input raster or constant value 2 option. Name and save the new raster to the desired location. (Note: if the two input rasters have different horizontal resolutions, the output resolution will need to be defined using the Environments tab at the bottom of the tool.) Click OK to run the Minus tool.



Cut and Fill

Calculate the volume change between two surfaces (requires 3D Analyst).

1. This function can be performed using the Cut Fill tool found in the 3D Analyst Tools Raster Surface toolset in ArcToolbox. (Note: the 3D Analyst extension must be turned on to access the tool. Select Customize > Extensions and then check the box for 3D Analyst.)
2. Double-click the Cut Fill tool to open the interface. Input the raster representing the surface before the cut or fill operation. Input the raster representing the surface after the cut or fill operation. Define the name and location of the output raster.



3. Apply a Z factor if necessary to adjust the units of measure for the Z units when they are different from the X,Y units of the input surface. The Z values of the input surface are multiplied by the Z factor when calculating the final output surface. Click OK to run the Cut Fill tool.

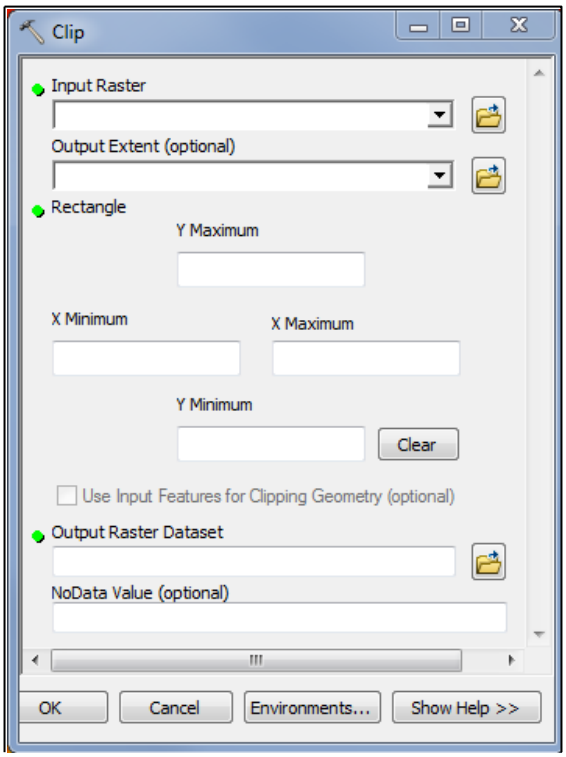
Clip Grids

Clip a grid by a selected polygon theme or graphic. This can be useful for calculating differences for a small section of a grid.

1. This function can be performed in several different ways using tools from ArcToolbox. This instruction will use the Clip Raster tool in the Data Management Tools > Raster > Raster Processing toolset that does not require any additional licenses. (Note: the Extract by Mask tool found in the Spatial Analyst Tools > Extraction toolset is an alternative method but requires a Spatial Analyst license.)
2. Double-click the Clip tool to open the user interface. Select the input raster to be clipped.
3. Select the Output Extent which can be an existing raster or vector layer to be used as

the clip extent. The clip output includes any pixels that intersect the minimum bounding rectangle. Or, input the rectangle bounding coordinates defining the minimum bounding rectangle to be clipped.

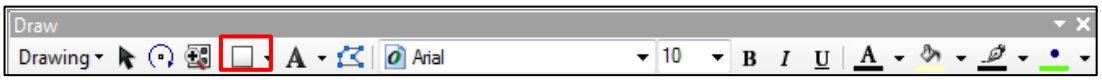
4. Define the name and location of the output raster. Click OK to run the Clip tool.



Convert Graphic to Shape

Convert a selected graphic (e.g., one used to clip a grid) to a polyline or polygon theme. This can be useful for extracting, or clipping, study areas from large lidar datasets or DEMs.

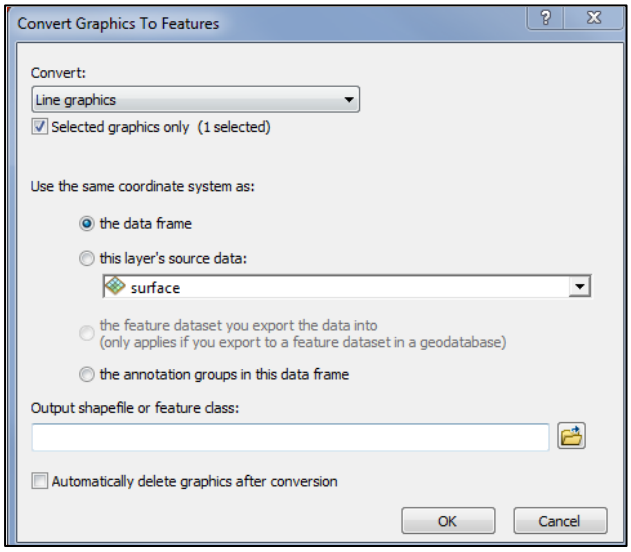
1. This function can be performed using the Drawing tools from the Draw toolbar in ArcMap and doesn't require any additional licensing. The Draw toolbar is generally in the ArcMap layout by default and is located at the bottom left area of the display. If it is not displayed it can be turned on using the Customize > Toolbars option on the main menu.



2. Select the drawing tool to be used to create the graphic for the area of interest from the drop-down menu (red box on image above). Click once to begin drawing the graphic. Click multiple vertices if needed by clicking

once for each section. Double-click to finish drawing the graphic. The graphic will remain selected in the map.

3. From the Drawing drop-down menu in the Draw toolbar, select Convert Graphics to Features.



4. Select to convert the graphic just created. Choose to apply the coordinate system from the data frame or another layer source.
5. Define the name and location of the output feature.
6. Select to delete the graphics after conversion option if applicable. Click OK.

For Additional Help

Please refer to the ESRI ArcGIS Help Library:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html