EXERCISE 4: EXTRACTING FIXED RADIUS PLOT SUBSETS FROM A LIDAR POINT DATA FILE

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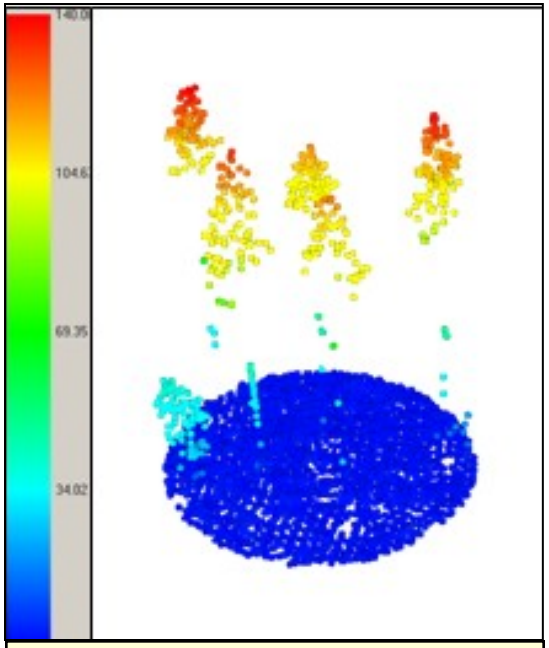


Example of a fixed radius plot subset as viewed in LDV.

Introduction

There are two parts to this exercise. Part 1 describes the manual process to extract fixed radius subsets of LIDAR data; Part 2 introduces you to using the FUSION command line executables and batch files to accomplish the same task more efficiently for a large number of subsets. In the next exercise (Exercise 5) we'll describe the process to extract useful statistics from these subsets.

Prerequisites

Successful completion of Exercises 1-3, or proficiency with the basics of FUSION.

Overview of Major Steps

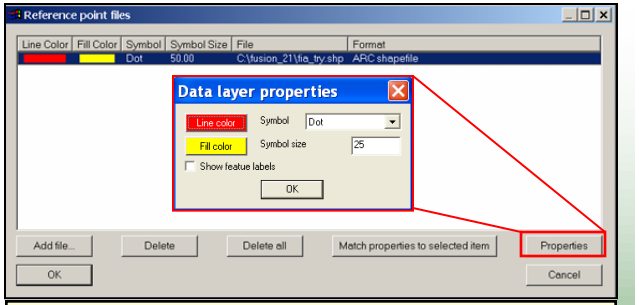
Part 1—Subsetting one to a few plots
Part 2—Subsetting many plots using Fusion command line executables and batch files.

Procedure

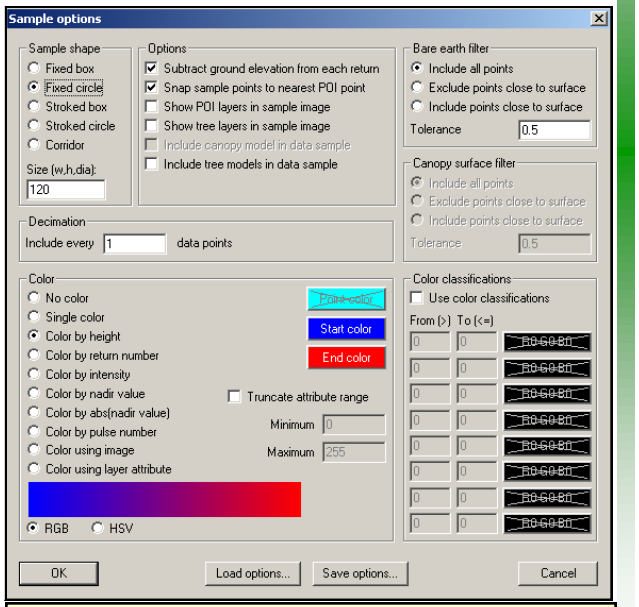
Part 1: Dealing with one to a few plots:

Background/ Initial State: You should have FUSION up and running with the **Ortho-photo_4800k.jpg** image file displayed and the **lda_4800K_data.lda** raw data file loaded (but not displayed). We have coordinates of the center points of three plots—these have been converted to a shapefile (going through an event theme in ArcGIS). This point shapefile (three_plots.shp) is not part of the original example dataset so you will have to download it from the online tutorial. Let's begin by loading this shapefile as a POI (Point of Interest) in Fusion:

1. *Click* the **POI...** Button (see sidebar)**.**
2. Navigate to the location of the **three_plots.shp** shape file.



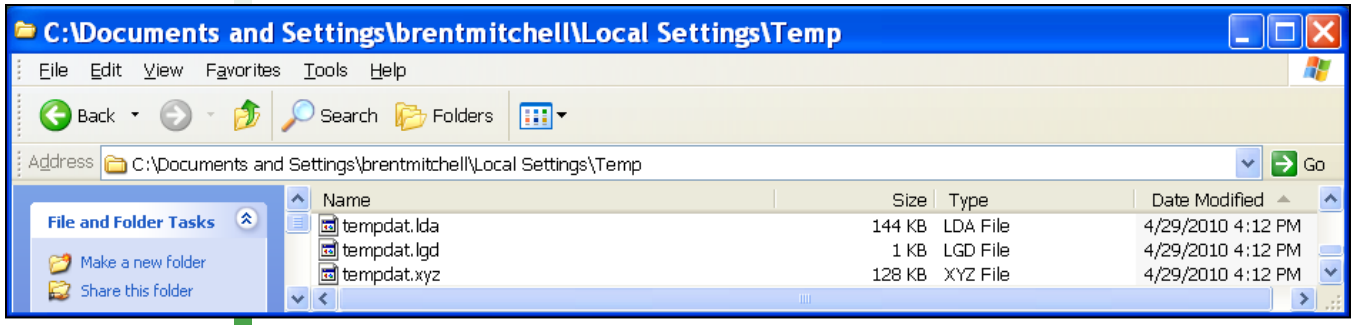
Change the attributes (color and size) of the POI if required and click OK.

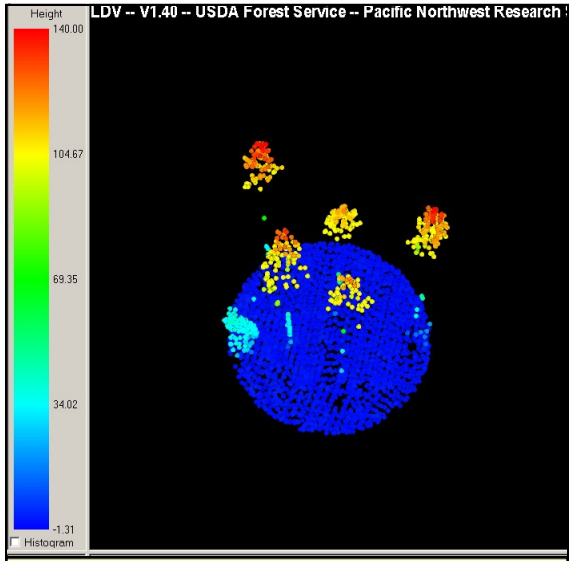


Sample options for extracting fixed radius subsets.

3. *Select* the file and *Click,* **Open.**
4. Change the attributes (color and size) of the POI if desired (see side bar) and *Click,* **OK**. The three plot locations will display over the orthophoto.
5. If you've already loaded the bare earth surface for this project area, skip to step 12, otherwise:
    6. *Click* the **Bare earth…** button
    7. *Navigate* to and *Select,* **4800K_ground_surface.dtm.**
    8. *Click,* **Open.**
    9. Accept all of the Surface model default options and *Click,* **OK.** Topo lines representing the ground surface elevations will display over the orthophoto image.
10. Now, we only want to select the lidar data within our plots rather than the entire lidar data set. *Click* the **Sample options…** button (from the menu on the left) and *Select* the following options:
    11. Sample shape: **Fixed circle**
    12. Sample Size: **120** (diameter in feet) Note: in future projects make sure the units of the data and the plot are the same, if the data are in UTM meters, convert the plot diameter to meters as well.
    13. Options: **Snap sample points to nearest POI point**
    14. Options: **Subtract ground elevation from each return**
    15. *Click,* **OK** at the bottom left to accept the sample settings.
16. Next, within the Fusion display window, ***Click*** on one of the plot locations (note which one you select). The POI changes color and an LDV window pops up showing the lidar points within the 120 meter diameter circle around the plot center.

17. These lidar data points are simultaneously written to three temporary files named **tempdat** with three different extensions (.lda, .lgd, .xyz) in the user's temporary folder (e.g. C:\documents and settings\user name\local settings\temp) as in the figure below.





Example of a fixed radius plot subset as viewed in LDV.

Potentially you could locate and rename the 3 temporary files with a corresponding plot identifier: ex **Plot1.*** and move them into a working directory. You would then have a subset (for each plot) of lidar data. It is good to be aware that FUSION writes these temp files and deletes them when FUSION closes (if you want the temp files make sure you move and rename them!) In the next section we will work through a process that will allow you to automate the subsetting of many plots and subsequently calculate statistics for each plot.

Part 2 of this exercise continues on the next page...

DOS Tip-Batch files. Most of FUSION's command line *.exe files can be batched to facilitate/automate repetitive data processing steps from the DOS prompt. **A batch file is simply a text file containing a separate line for each DOS command or each time the command should be executed.** The extension of the file has to be .bat to let DOS know is has to process every line consecutively. Running the batch file is easy--simply type the name of the batch file at the DOS command prompt.

FUSION Tip-The batch files that you will create for this exercise can be used to start your own library of Fusion batch files. We recommend creating a folder (e.g. C:\Fusion\batch) to keep your batch files in.

An example of the care you must take… If you entered shape:1 instead of **/**shape:1, the clipdata command would assume shape:1 is the input data file and lda_4800K_data.lda is the output file. Clipdata would then overwrite the data file—oops!

Part 2—Dealing with many plots:

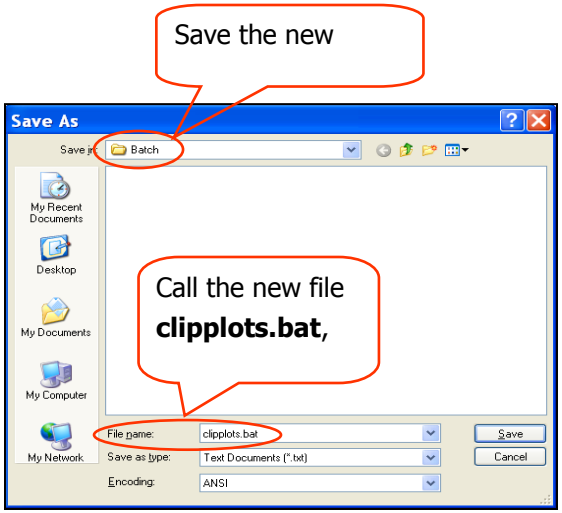
Subsetting the LIDAR points for a substantial amount of plots can best be done from the **DOS command line**, using FUSION's command line executable (**clipdata.exe**) either one plot at a time or preferably within a batch process. Batch files can be created with a text editor or any other program that can save the output as a text file. In this exercise we will manually type the commands into notepad and save it as a batch file (.bat). We chose this simplistic approach to familiarize you with creating batch files and running FUSION's command line executables in the DOS environment. Alternatively, you could use MS Excel to create large batch files. The advantage of creating such a file in a spreadsheet is the capability to generate a series of incremented field entries and to be able to concatenate several fields into a single text string (this technique can save you a lot of time if you are trying to analyze 200 plots!). Please refer to **Appendix 1** (at the end of this chapter) if you are interested in learning more about creating batch files in a spreadsheet environment. Let's start by initially exploring the **Clipdata** command.

1. *Click,* **Start | Programs | Accessories | Command Prompt,** to open a DOS command prompt window.
2. At the prompt enter:
3. **cd c:\fusion** <enter> (this will change the active directory to the Fusion folder)
4. *Type* **clipdata** <enter> , inspect the syntax quickly in the DOS command prompt.
5. Now, in Windows Explorer navigate to **C:\FUSION\doc\FUSION_manual.pdf** and open the FUSION manual. Navigate to page **37** and read the **Clipdata** section. **The more you understand the capabilities of the FUSION commands, the more efficient you will be at extracting useful information from lidar data**.

This exercise continues on the next page...

DOS Tip— Batch files. Most of FUSION's command line *.exe files can be batched to facilitate/automate repetitive data processing steps from the DOS prompt. A batch file is simply a text file containing a separate line for each DOS command or each time the command should be executed. The extension of the file has to be .bat to let DOS know is has to process every line consecutively. Running the batch file is easy--simply type the name of the batch file at the DOS command prompt.

DOS Tip-Note: there are a number of tips and tricks for creating more efficient batch files. We encourage you to explore these techniques but we won't pursue them in these exercises.



6. Now that you are familar with the **clipdata** command, let's dissect an example below:

> **clipdata /shape:1 /dtm:c:\lidar\sampledata\4800k_ground_surface.dtm /height c:\lidar\sampledata\lda_4800K_data.lda c:\lidar\sampledata\clipplot1.lda 975984 567628 976104 567748**

where:

- **clipdata** is the FUSION executable command
- **/shape:1** denotes a circular shape (see critical sidebar note!)
- **/dtm:c:\lidar\sampledata\4800k_ground_surface.dtm** denotes the bare-earth surface model used to normalize the LIDAR data (substract the bare-earth surface elevation from each lidar point elevation).
- **/height** is used in conjunction with the specified dtm to convert all elevation values to height above ground
- **c:\lidar\sampledata\lda_4800K_data.lda** specifies the input data file
- **c:\lidar\sampledata\clipplot1.lda** defines the output (sample) data file
- the last four numbers are geo-coordinates that define the bounding box of the circular shape.

The example (above) clips points from a lidar point file that fall within a fixed radius of a point (plot center). Note the syntax is complicated, cumbersome, and error prone to enter at the DOS command line—**good reasons to prepare the commands in a batch file.** We'll create our own now…

Background. The example batch file we'll create will clip circular plot data from the original LIDAR (.lda) data file. We're only extracting LIDAR subsets for three plots in order to keep this exercise relatively quick and manageable. The three plot centers (made up for the sake of this exercise) have have been used to calculate the bounding box for each fixed diameter plot (diameter is 120 feet).

6. Begin by creating your batch folder. In DOS at the C:\fusion> prompt, type **MD batch** (MD is the DOS command for Make Directory).
7. Then type **CD batch**. The DOS prompt will reflect your current location (C:\fusion\batch).
8. Start a new Notepad (.txt) document: *Click,* **Start | Programs | Accessories | Notepad**
9. Save the document as **clipplots.bat**, ensure you type in the **.bat** extension before saving (see side bar).

10. In the batch file you just created you will **type in the following string of clipdata commands** that FUSION will read in sequential order from the batch file:

clipplots.bat - Notepad

File Edit Format View Help

```
..\clipdata /shape:1 /dtm:C:\lidar\SampleData\4800K_ground_surface.dtm /height c:\lidar\sampledata\lda_4800K_data.lda c:\lidar\sampledata\clipplot1.lda 975403 568166 975523 568286

..\clipdata /shape:1 /dtm:C:\lidar\SampleData\4800K_ground_surface.dtm /height c:\lidar\sampledata\lda_4800K_data.lda c:\lidar\sampledata\clipplot2.lda 977110 566581 977230 566701

..\clipdata /shape:1 /dtm:C:\lidar\SampleData\4800K_ground_surface.dtm /height c:\lidar\sampledata\lda_4800K_data.lda c:\lidar\sampledata\clipplot3.lda 974760 566560 974880 566680
```

Fusions Command Line Executable

Switch, denoting a circular shape

Switch, denotes the bare-earth surface model used to normalize the LIDAR data (substract the bare-earth surface elevation from each lidar point elevation)

Switch, used in conjunction with the specified dtm to convert all elevation values to height above ground

Input lidar data file. Including the full path so FUSION can find

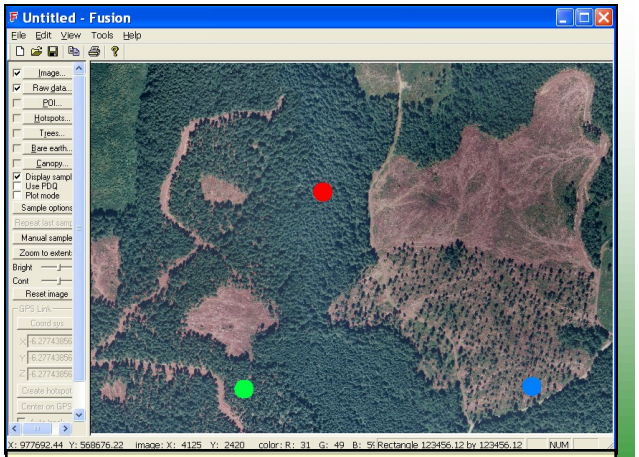
Output subset lidar data file. Including the full path so FUSION knows where to write the output file!!

- **Parameters**, denoting the dimensions of the new subset. In our case we need to enter the coordinates that define the bounding box of our circular plot shape. For efficiency and speed we have done the calculations for you, so you just have to copy them from the above example. See Appendix 1 for an explanation of the calculations.

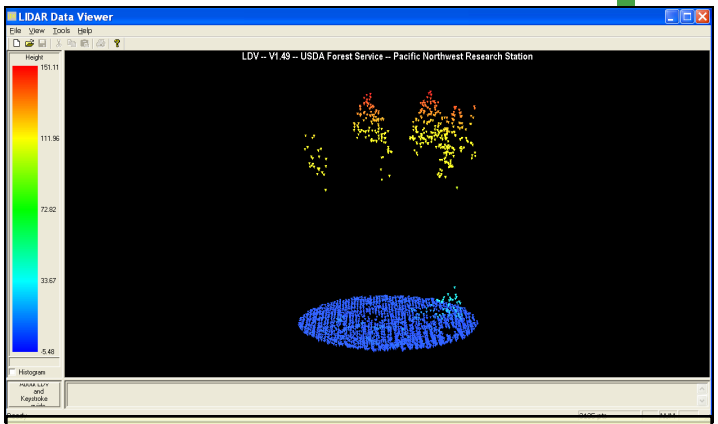
DOS Tip-Make sure you use the proper slash (**forward /** or **back **) in your syntax. **Forward Slashes before switches**, e.g., /shape:1, or **back slashes in file paths**, e.g., c:\lidar\exampledata\...

11. When you have finished entering the script, *Save* **clipplots.bat**.
12. *Close,* **clipplots.bat**
13. Navigate to your batch folder and *right click* on **clipplots.bat**, *choose* **edit**.
14. Double check your syntax.

Note: if you left click twice on the batch file it will run, even if you are not ready!!



Plot subsets clipped using the clipdata command.
Red = Plot1, Blue = Plot2, Green = Plot 3



Plot 3 displayed in the LDV.

There is only one more step: execute the batch file from the **command line prompt**:

15. *Open* your **DOS Command Line window**, if needed.
16. Change the directory to the batch folder **(>cd \fusion\batch)**, if needed.
17. *Type,* **clipplots** (you don't need to type in the .bat part) followed by the **enter** key and let it run.
18. Using Windows Explorer, navigate to the output folder directory **(c:\lidar\SampleData)** and verify that the files **clipplot1.lda, clipplot2.lda** and **clipplot3.lda** were created.

Let's look at the plot data in Fusion.

19. Ensure that the Image File (Orthophoto_4800k.jpg) and that the three POI's from Part 1 of this exercise are loaded and visible.
20. *Click* the **Raw data…** button in the Fusion window.
21. If the file **lda_4800K_data.lda** is still loaded, ***Click*** the **Delete button** to remove it.
22. *Click* the **Add File…** button.
23. *Navigate* to and *Select,* **clipplot1.lda**
24. Hold the shift key down and *select* the last file, **clipplot3.lda**, to *select* all three lidar plot subset files
25. *Click* the **Open** button.
26. Give each data file a different color and change the Symbology. *Select* one of the rows (each row is a data file) in the Data Files dialog and for each selected row:
    27. *Click* the **Properties** button (or double-click the item)
    28. *Change* the **Symbol** to **Single Pixel**
    29. *Change* the **line color** to a distinct color
    30. *Click,* **OK**
31. *Click* the check box next to the **Raw data…** button to display the three lidar subsets. Your results should be similar to the figure in the upper part of the side bar.
32. In your Sample options dialog ensure that you have *selected* a **Stroked box** sample shape and *click* **OK**.
33. Now, *drag a sample* over one of the **plots** and the lidar subset will display in the LDV, as in the side bar.

This concludes Exercise 4.

DOS Tip— Batch files. Most of FUSION's command line *.exe files can be batched to facilitate/automate repetitive data processing steps from the DOS prompt. A batch file is simply a text file containing a separate line for each DOS command or each time the command should be executed. The extension of the file has to be .bat to let DOS know is has to process every line consecutively. Running the batch file is easy--simply type the name of the batch file at the DOS command prompt.

DOS Tip— The batch files that you will create for this exercise can be used to start your own library of Fusion batch files. We recommend creating a folder (e.g. C:\Fusion\batch) to keep your batch files in.

Alternate Part 2—Using MS Excel to create batch files:

Subsetting the lidar points for a substantial amount of plots can best be done from the DOS command line, using Fusion's command line executable (**clipdata.exe**) either one plot at a time or preferably within a batch process. Batch files can be created with a text editor or any other program that can save the output as a text file. For example, we will use Excel to create the batch file for this exercise. The advantage of creating such a file in a spreadsheet is the facility to generate series of incremented field entries and to be able to concatenate several fields into a single text string.

1. Explore the Clipdata command. Begin by opening a DOS Command prompt window and exploring the syntax of the clipdata command.
2. Start | Programs | Accessories | Command Prompt
3. At the prompt enter:
4. **cd c:\fusion** <enter> (see sidebar re: the syntax for fusion_#)
   - (this will change the active directory to the Fusion folder)
5. **clipdata** <enter>
   - (this will display the syntax of the clipdata command)

An example command line use of the clipdata executable might be:

> **clipdata /shape:1 c:\lidar\sampledata\lda_4800K_data.lda c:\lidar\sampledata\clipplot1.lda 975984 567628 976104 567748**

where:

- clipdata is the executable command
- /shape:1 denotes a circular shape (see critical sidebar note!)
- c:\lidar\sampledata\lda_4800K_data.lda specifies the input data file
- c:\lidar\sampledata\clipplot1.lda defines the output (sample) data file
- the last four numbers are geo-coordinates that define the bounding box of the circular shape.

The example (above) clips points from a lidar point file that fall within a fixed radius of a point (plot center). Note the above syntax is complicated, cumbersome, and error prone to enter at the command line—good reasons to prepare the commands in a batch file. We'll create our own now…

APPENDIX 1: ALTERNATE PART 2
USING MS EXCEL TO CREATE BATCH FILES

Note: there are a number of tips and tricks for creating more efficient batch files. We encourage you to explore these techniques but we won't pursue them in these exercises.

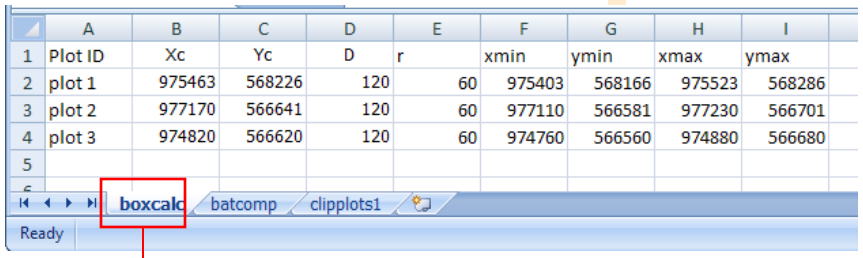
Background. The example batch file we'll create will clip circular plot data from the original LIDAR (.lda) data file. We're only extracting LIDAR subsets for three plots in order to keep this exercise relatively quick and manageable. However, the real value of this batching process will only become obvious when you want to extract a large number of LIDAR subsets. The three plot centers (made up for the sake of this exercise) have the following locations (Xc, Yc in the same units and coordinate system as the lidar data) and they have a diameter (D) of 120 meters shown below in the table:

Xc	Yc	D
975463	568226	120
977170	566641	120
974820	566620	120

6. Begin by creating your batch folder. At the C:\fusion> prompt, type **MD batch** (MD is the DOS command for Make Directory).
7. Then type **CD batch**. The DOS prompt will reflect your current location (C:\fusion\batch).
8. Start a new Excel spreadsheet.
9. Name the first Worksheet tab boxcalc (see adjacent graphic).
10. Create column headings labeled: PlotID (see sidebar), Xc, Yc, D, r, xmin, ymin, xmax, and ymax.
11. PlotID Column: Enter a plot identifier (e.g. plot1, plot2…plotn) for each plot,
12. Xc and Yc Columns: Enter the three plot center locations (from the above table),
13. D Column: Enter the plot diameter,
14. R column: calculate r = D/2,
15. Calculate the x-min, y-min, x-max and y-max by either subtracting or adding the radius to the x,y of the plot center:

    Xmin = Xc – r
    Ymin = Yc – r
    Xmax = Xc + r
    Ymax = Yc + r

Do Not use "ID" as the first column heading—If you save the spreadsheet as a CSV file, Excel sees the label "ID" and assumes a specific format (SYLK file) and will tell you it can't load the file. Using something like "PlotID" works better.



Worksheet name

After calculating these numbers the spreadsheet will resemble the adjacent graphic. These numbers create the bounding box of the subset of

The Command column path to the clipdata command is two dots (..). Two dots is the batch symbol for the higher or parent folder. So, if your batch file will be residing in the C:\fusion\batch folder, then specifying the .. path will put you in the parent (C:\fusion) folder (which is where the clipdata command is).

IMPORTANT: make sure that you use the proper slash (**/**) for the **/shape:1** switch. Bad things can happen if you use the \ slash!!!

the data. For this small number of plots, it would likely be most convenient to continue working within this worksheet, however, for large datasets you should generate the full syntax on the next worksheet—let's do that for this exercise.

16. Name the second worksheet **batcomp**.
17. Create column headings labeled: **Command**, **Input File**, and **Output File**.
    18. **Command Column**: this contains the path to and name of the fusion command line executable—in this case **..\clipdata**.
    19. **Input File Column**: contains the path and name of the lidar data set. This example contains only one file from which data will be subset (lda_4800K_data.lda) but more can be used as required.
    20. **Output File Column**: contains the path and filename of the output file (the plot subsets). They were built by concatenating the path, the plot-id listed in the boxcalc worksheet and the extension of the file:
        21. =CONCATENATE("c:\lidar\SampleData\clip",boxcalc!A2,".lda")
            22. thus the output files will be named clipplot1.lda, clipplot2.lda and clipplot3.lda.
23. The values in the next four columns are the column headings and min and max values for the bounding box copied from the boxcalc worksheet:
    24. referencing a cell from another worksheet in the same spreadsheet is done by adding the name of the worksheet followed by an exclamation mark: ex: =boxcalc!F2
25. The final column will be labeled **Full Syntax** which will be a concatenation of all of the previous columns and the insertion of the /shape:1 switch
26. =CONCATENATE(A2," /shape:1 ",B2," ",C2," ",D2," ",E2," ",F2," ",G2)

Thus the results for the first row of the Full Syntax Column should look like:

..\clipdata /shape:1 c:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot1.lda 975403 568166 975523 5682868

And the batcomp worksheet should look like:

H2 =CONCATENATE(A2," /shape:1 ",B2," ",C2," ",D2," ",E2," ",F2," ",G2)

	A	B	C	D	E	F	G	H
1	Command	Input File	Output File	xmin	ymin	xmax	ymax	Full Syntax
2	..\clipdata	C:\lidar\SampleData\lda_4800K_data.lda	c:\lidar\SampleData\clipplot 1.lda	975403	568166	975523	568286	..\clipdata /shape:1 C:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot 1.lda 975403 568166 975523 568286
3	..\clipdata	C:\lidar\SampleData\lda_4800K_data.lda	c:\lidar\SampleData\clipplot 2.lda	977110	566581	977230	566701	..\clipdata /shape:1 C:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot 2.lda 977110 566581 977230 566701
4	..\clipdata	C:\lidar\SampleData\lda_4800K_data.lda	c:\lidar\SampleData\clipplot 3.lda	974760	566560	974880	566680	..\clipdata /shape:1 C:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot 3.lda 974760 566560 974880 566680
5								

Note: The spreadsheets shown in this document have different path names than the ones we recommend.

Next, copy Column H (the Full Syntax Column) and paste its values (Paste Special | Values) in yet another worksheet named bat:

clipplots1.bat - Notepad

File Edit Format View Help

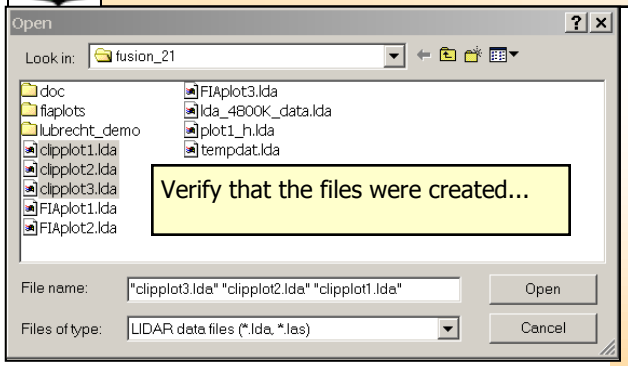
```
..\clipdata /shape:1 C:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot 1.lda 975403 568166 975523 568286
..\clipdata /shape:1 C:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot 2.lda 977110 566581 977230 566701
..\clipdata /shape:1 C:\lidar\SampleData\lda_4800K_data.lda c:\lidar\SampleData\clipplot 3.lda 974760 566560 974880 566680
```

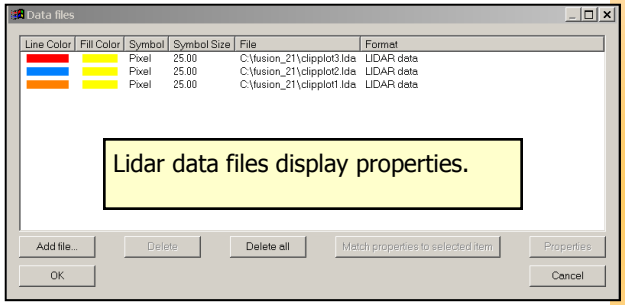
The bat worksheet has one column with data and it contains all the required elements to run the clipdata command 3 times (once for each of the plot locations) from a single command line entry.

Don't forget to add the **..** in front of each command line.

27. Save your Excel spreadsheet (any name and location that makes sense to you) but don't close the spreadsheet.
28. Save the bat worksheet as a text file named **clipplots.bat** in your batch file directory:
    29. Ensure that the bat worksheet is the active worksheet.
    30. **File | Save As...** and choose **Save as Type: Tab delimited** or **Unicode Text (*.txt).**

Before executing the batch command, check the clipplot.bat file by opening it in Wordpad or Notepad to make sure the contents are OK.
There is only one more step: execute the batch file from the command line prompt:
31. Change directory to the batch folder (>cd \fusion\batch) if needed.





31. Type **clipplots** (you don't need to type in the .bat part) followed by the **enter** key and let it run.
32. Using Windows Explorer, navigate to the output folder directory (c:\lidar\SampleData) and verify that the files clipplot1.lda, clipplot2.lda and clipplot3.lda were created.

Let's look at the plot data in Fusion.

34. Ensure that the Image File (Orthophoto_4800k.jpg) and that the three POI's from Part 1 of this exercise are loaded and visible.
35. Click the Raw data… button
36. If the file lda_4800K_data.lda is still loaded, click the Delete button to remove it.
37. Select clipplot1.lda
38. Hold the shift key down and select the last file (clipplot3.lda) to select all three lidar plot subset files
39. Click the Open button.
40. Give each data file a different color and change the Symbology. Select one of the rows (each row is a data file) in the Data Files dialog and for each selected row:
    41. Click the **Properties** button (or double-click the item)
    42. Change the **Symbol** to **Single Pixel**
    43. Change the **line color** to a distinct color
    44. Click **OK**
45. Click the check box next to the **Raw data…** button to display the three lidar subsets. Your results should be similar to: