ERDAS IMAGINE 2015

Understanding LiDAR and Point Clouds

TIPS AND TRICKS

USFWS WORKSHOP

Point Clouds and Terrain

Section Objective

Students will use the ERDAS IMAGINE© tools and Viewers to understand the different types of information stored in point cloud data and visualizing it. Students will apply IMAGINE's tools for extracting information from this data.

Tools Used

2D View	Used to visualize data layers, zooming, inquiries, setting scales, and measuring
Color Slice	*Visually represent elevation values as different colors along a gradient*
Profile Views	*Tools used to view the points from Side and Front views, as opposed to viewing that at nadir (from above)*
Measurement Tools	*Tools Used to measure length, height, distance, slope, and azimuth in the profile views*
3D View	*Used to provide free-rotating and roaming 3D visualization of the point cloud*
Classify	*Tools for labeling points according to the features that they represent on the ground, e.g. Building, Ground, High Vegetation, etc.*
Filter	*Create a new file and remove unwanted points from the dataset. You can filter by Class, Return, or Both*
Terrain Prep Tool	*Used to create vector contours and to create raster surfaces of the data*
Shaded Relief	*Displays the surface as a topographic relief for better visualization of the terrain. Allows you to set the angle of the sun for optimal viewing*
Viewshed	*Graphically demarcates areas that are visible or hidden from a specified observation point*

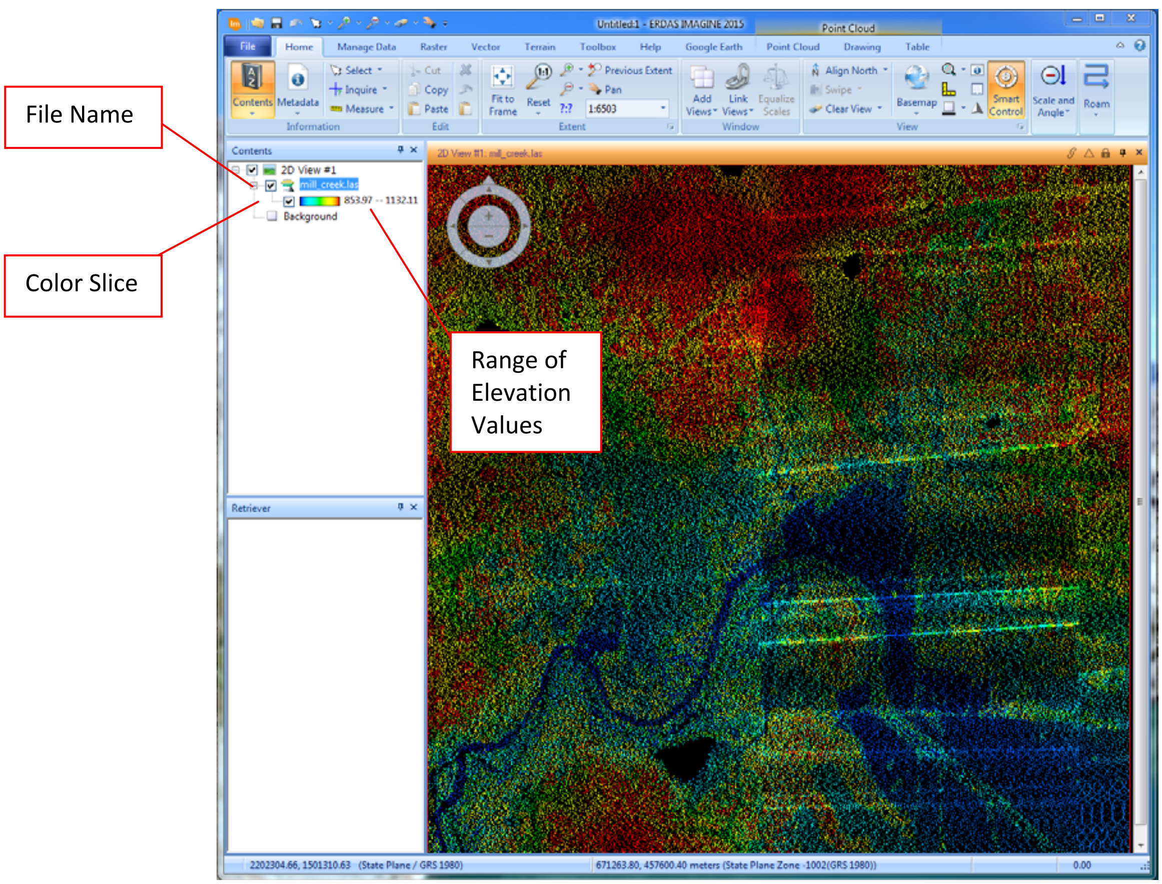
Exercise 1: Viewing Point Cloud Data in 2D

Objective:

Students will gain an understanding of point cloud data through the use of the eWorkspace. Students will use the 2D View in order to visualize point cloud data and to change the color scheme used to represent elevation in the data.

Task 1.1: Display Data in a Viewer

1. From the eWorkspace, click the **File** Menu. From the menu, select **Open** > **Point Cloud Layer**.
2. Ensure that **Files of type** is set to the default **LAS as Point Cloud (*.las)**.
3. Navigate to the course data directory (e.g., ***C:\training\Funamentals2\PointCloud***) and click the button on the upper-right hand corner of the dialog to save the current directory as the default input directory. This path is saved in your Preferences.
4. Locate and *single-click* on the point cloud layer ***mill_creek.las*** to highlight it in the File Chooser.
5. Click **OK** and the point cloud displays in the Viewer.

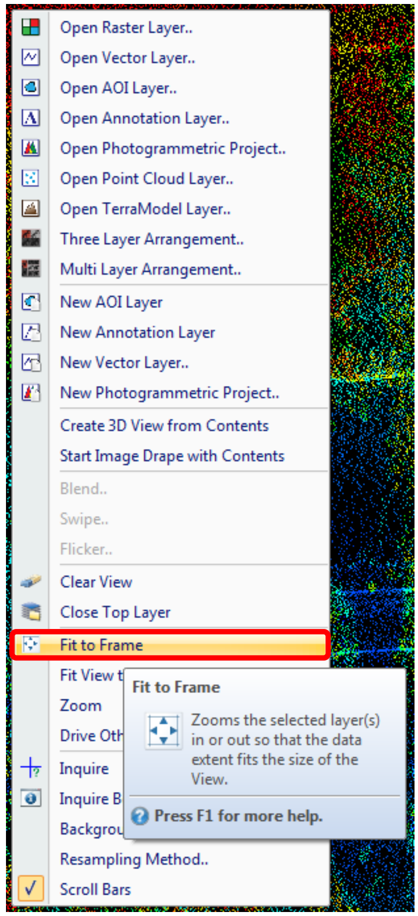


The point cloud is shown with a blue-to-red maximal color slice. The lower elevations are displayed in blue shades and the higher elevations are displayed in shades of red.

Maximal color slices provide the largest number of hues. This is like taking the longest route from one color to another around the color wheel.

Minimal color slices provide the smallest number of hues. This is like taking the shortest route from one color to another around the color wheel.

6. To quickly display the Viewer options, right-click in Viewer #1 and select **Fit to Frame.**



You can also select **Fit to Frame** in the **Extent** group on the **Home** tab.

7. To zoom in, position the cursor over the area you want to zoom in on, and scroll the mouse wheel up.
8. To zoom out, scroll the mouse wheel down.
9. Use the **Interactive Zoom In** and **Interactive Zoom Out** tools to draw a box around the areas you want to view.

Additional options for zooming are available in the **Extent** group on the **Home** tab. To zoom to a specific extent by entering coordinates, click the menu arrow to open the View Extent menu. Enter the coordinates of the extent in File or Map coordinates.

10. Click the  **Previous Extent** button. This icon will step you back to the last zoom level.
11. From the **Scale and Angle** group, use the **thumbwheel** to zoom out and back in to the image.

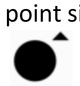
12. In the Viewer, click on the pull-down arrow from the icon panel and select a scale of **1:10000**.

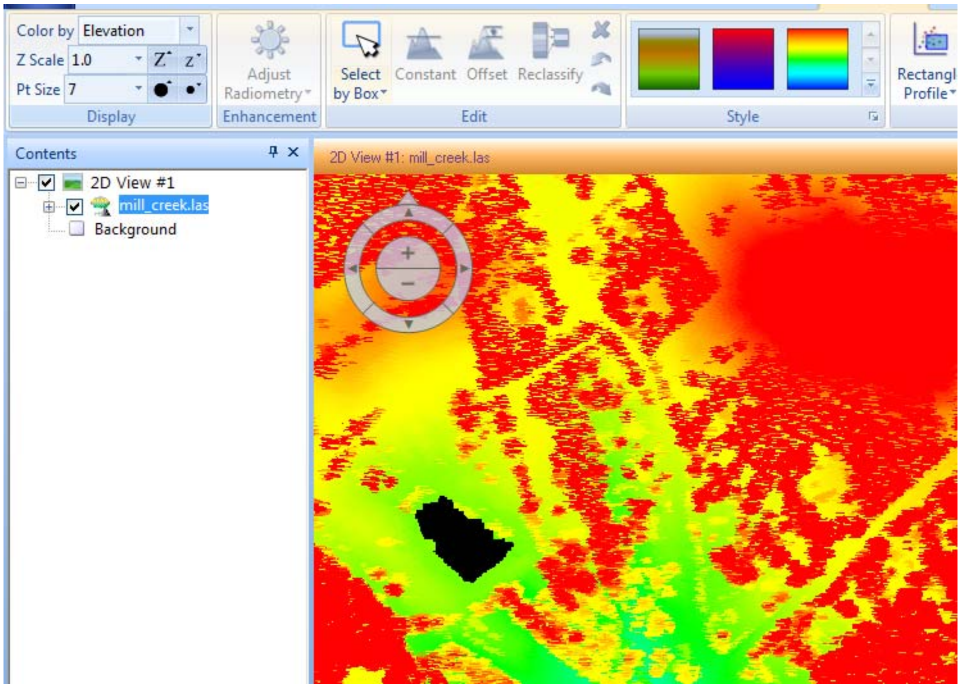
In addition to using the variety of pre-selected scales and percentages, users can type in a specific scale.

13. Type **1:2500** in the window. Press Enter.
14. In the Viewer, hold the middle mouse button down and pan through the image.
15. From the Viewer tool bar, click the  **Pan**. Notice the pointer changes to a hand when in the Viewer.
16. Click in the Viewer while in **Pan** mode. This will change the icon to 4 arrows. 
17. Using the Virtual Roam capabilities of ERDAS IMAGINE, roam across the image to the State of Washington (in the northwest corner) by moving the mouse in that direction.
18. Click in the Viewer again to turn off the **Pan** mode.

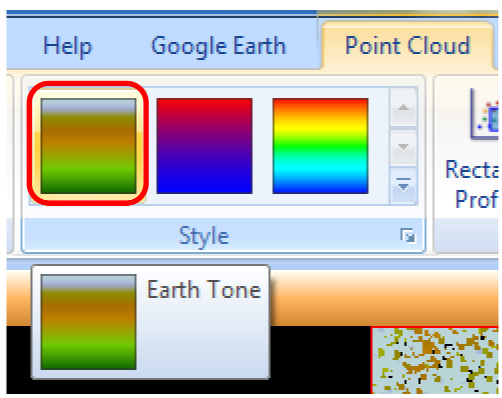
Task 1.2: Change Color Slice

Now we want to look at some different ways of visualizing of the point clouds. First, as you zoomed in on the data, you noticed that for this dataset, at about 1:1000 the data became hard to interpret. The points were spaced too far apart to be viewed effectively.

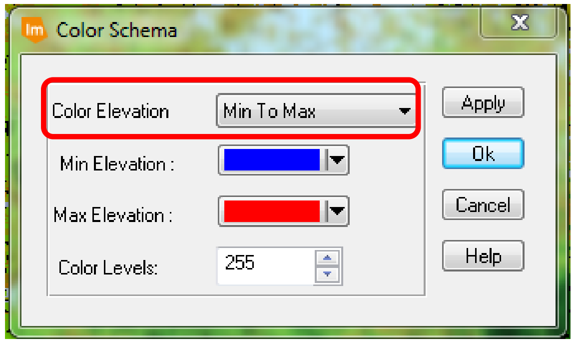
1. In the Scale portion of the **Home** tab, type ***1:1000*** and press Enter. The data is still interpretable, but it is becoming difficult to see the points. We can increase the point size to make it easier to interpret the data.
2. Select the **Point Cloud** tab. In the **Display** group, click the  button to increase the size of points.
3. In the **Point Size** menu, select **7**.



4. Zoom in and out of the data and see how the changed point size affects the display of the data. Change the point size to **3**.
5. Zoom out so that you can see a large portion of the image.
6. Click the **Fit to Frame** button  on the **Home** tab to zoom out to the data extent.
7. On the **Point Cloud** tab, click the **Earth Tones Style** button to use a different color slice. The elevation values are colored ranging from dark green for the lowest values through browns to grays for the highest values.



8. Now click the **Properties**  button at the bottom right corner of the **Style** group. The **Color Schema** dialog is opened.

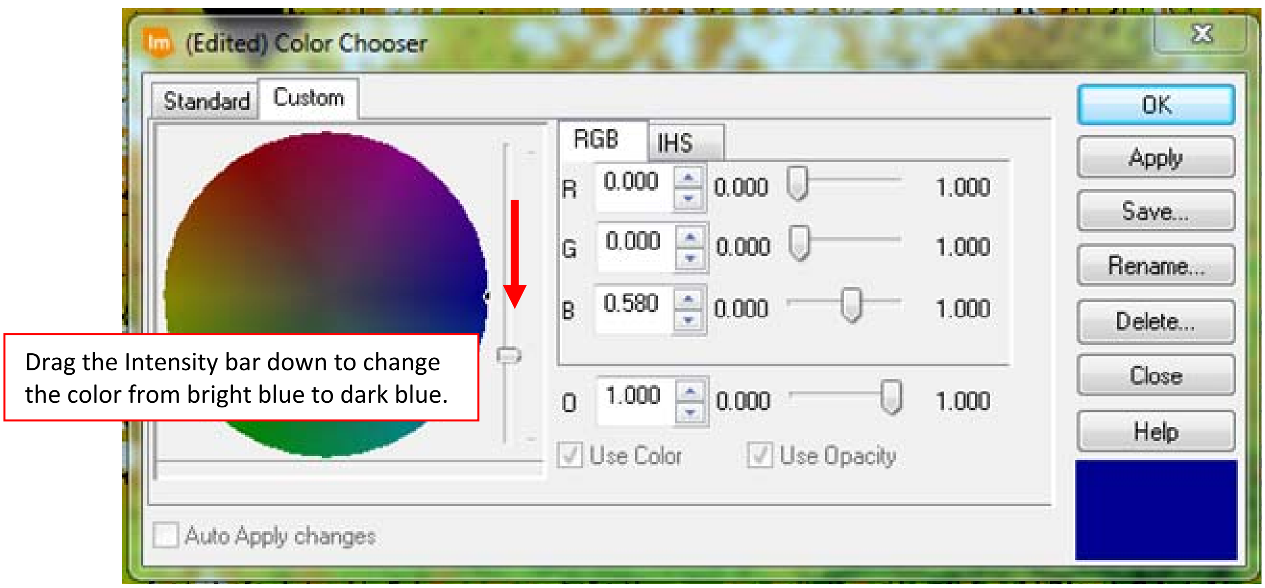


9. Select **Min To Max** from the **Color Elevation** pull-down list.

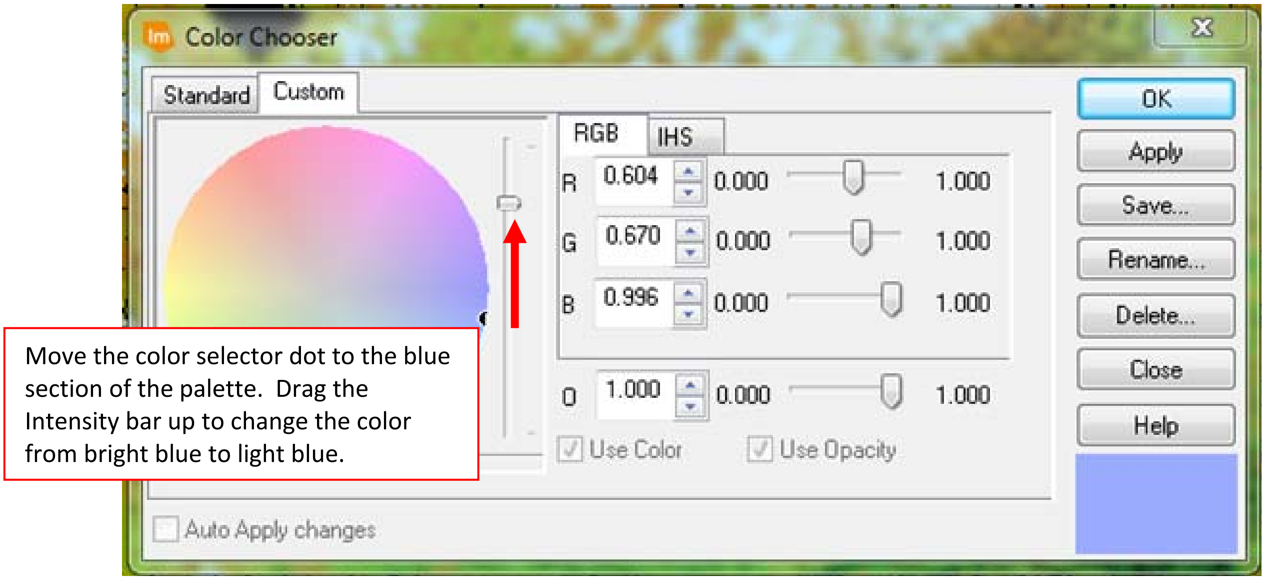
The Min To Max option is the only scheme that allows for customization.

Now we will apply a blue monochromatic color slice to this point cloud, as if it were bathymetric data.

10. Click on the **Min Elevation** color block. The Color Chooser dialog is displayed.

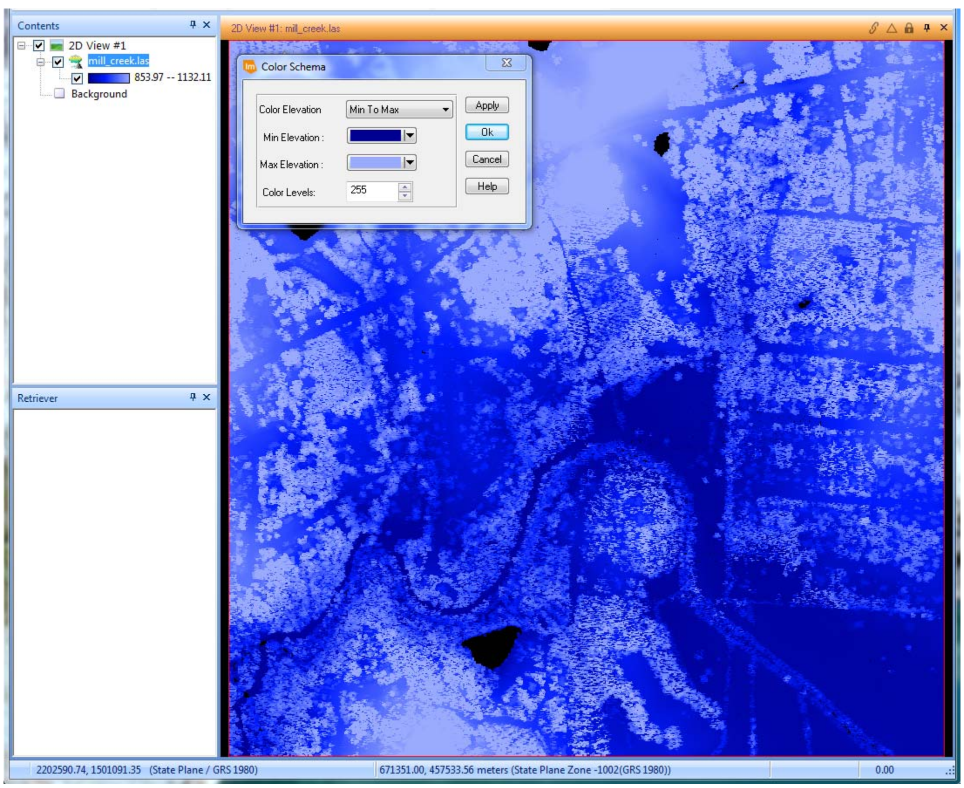


11. The color is already blue, and we want the starting color to be a dark blue, so drag the **Intensity bar** down to darken the blue. Click **OK**.
12. Click on the Color Block next to **Max Elevation**.
13. Drag the color dot back around to a blue hue. Drag the Intensity slider up to lighten the color.



It is important to note that when the color slice applies it moves around the color wheel in a clockwise direction. If the ending color is not exactly on, or a little clockwise from, your starting color, you will get a maximal color slice and not a monochromatic blue color slice.

14. Click **OK** on the Color Chooser dialog.
15. Click **Apply** on the Color Schema dialog to apply your custom color slice.



16. Click to return to the Earth Tone style.

Task 1.3: Display Imagery and Sync the Views

To enhance or improve our recognition of the geography represented by this point cloud, we can display an orthorectified image of the same location and link the Views.

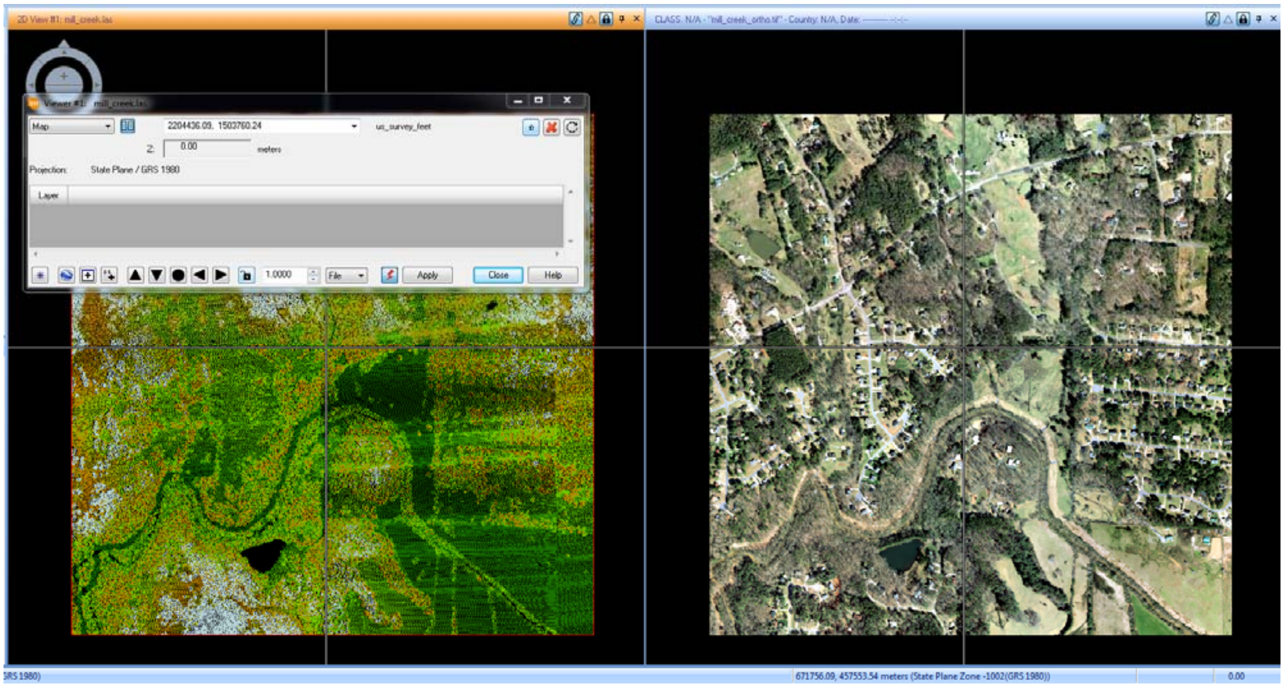
1. In the **Window** group on the **Home** tab, click the **Add Views** button. Select **Display Two Views** from the Add Views menu. This will open a second View within the eWorkspace.
2. In the View containing the point cloud, click **Fit to Frame** to zoom out to the extent of the data.
3. Select **View #2** by clicking inside the View, or by clicking on 2D View #2 in the Contents panel. Click the **Open Layer** icon on the Quick Access menu.
4. In the File Chooser, change the Files of Type to **TIFF**. Navigate to your Input Data Directory and select ***mill_creek_ortho.tif***. Click OK on the File Chooser dialog.

The ortho image is displayed in the new 2D View.

5. Click on the **Sync** icon on the title bar of the ***inactive*** View.
6. Now roam and zoom in and out of the data. Note how the Views are locked together.

Begin looking at the data and seeing how the elevation data corresponds to the imagery. As you begin to interpret the point cloud data, it can be difficult to find the same objects. A linked cursor can help with that.

7. Open the Inquire Cursor by clicking **Inquire** in the **Information** group on the **Home** tab. The cursor appears in the active View.
8. Click on the **Link** icon at the top of the inactive View. The cursor should appear in both views.



9. To move the Inquire Cursor, click and drag the intersection of the two lines around the image.
10. You can center the cursor in the current view by clicking the  button on the **Inquire Cursor** dialog.
11. After examining the data, clear all data and close the second View.

Exercise 2: Viewing and Editing LiDAR Point Clouds

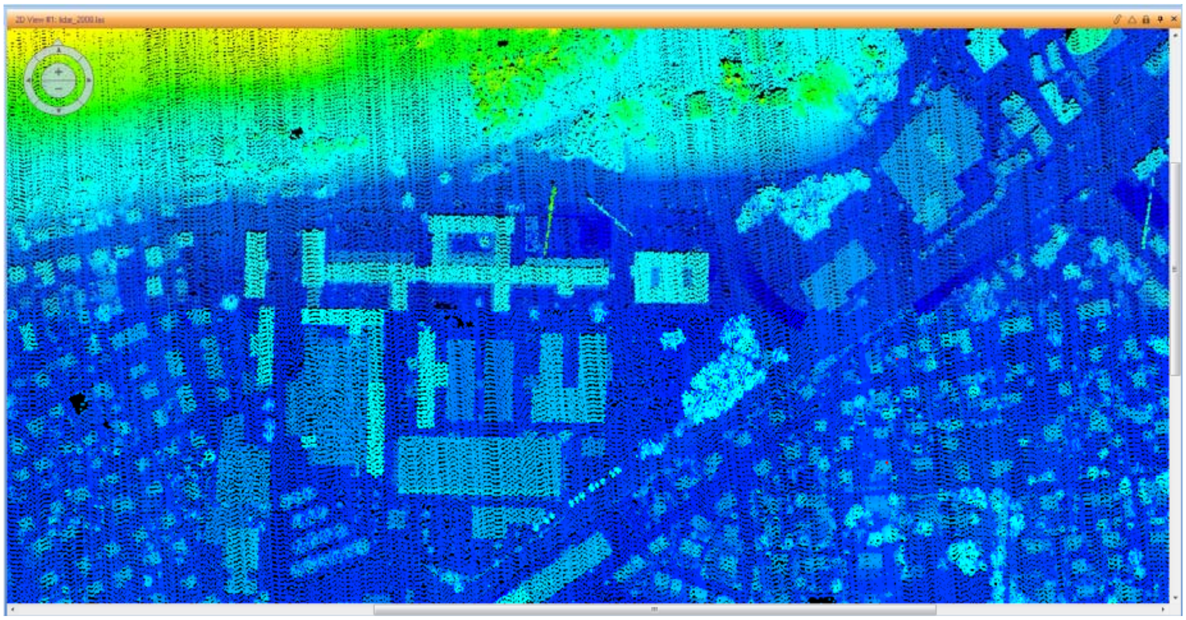
Objective:

Students will learn different ways of visualizing LiDAR point clouds, including coloring them by classification and by return number. They will also utilize a rectangular profile of the data to select and edit points.

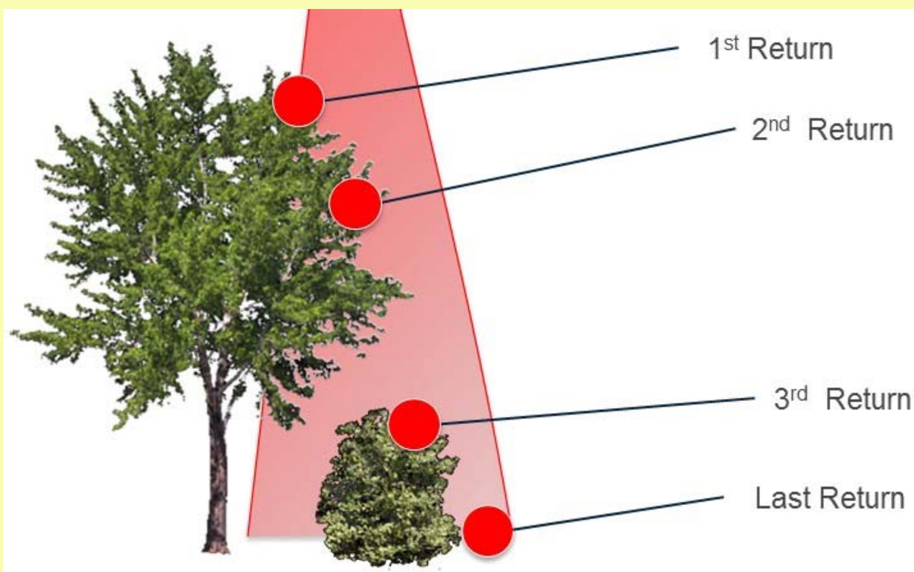
Task 2.1: Viewing by Returns

The nature of LiDAR data means that there are several different ways of looking at the data. In addition to elevation (or possible RGB encoding), LiDAR data can Many LiDAR systems also record the intensity of the light reflected back to the system, providing you with an additional way to understand the study area.

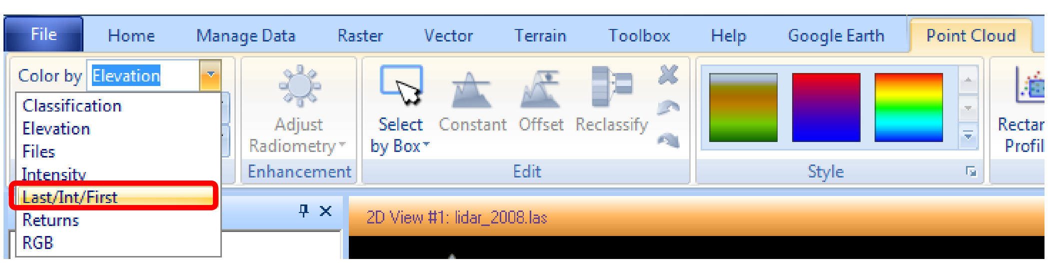
1. In a new View, open ***lidar_2008.las***. You may want to increase the point size to **3**, to improve visibility of the data.
2. Zoom in on the portion of the data highlighted in the image below.

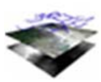


The nature of LiDAR data means that it can have more than one return per pulse. For instance, a single pulse of light can be partially reflected by the top of a tree, a branch on the tree, a bush under the tree, and the ground.



3. On the **Point Cloud** tab, select **Last/Int/First** from the **Color by** pull-down menu.





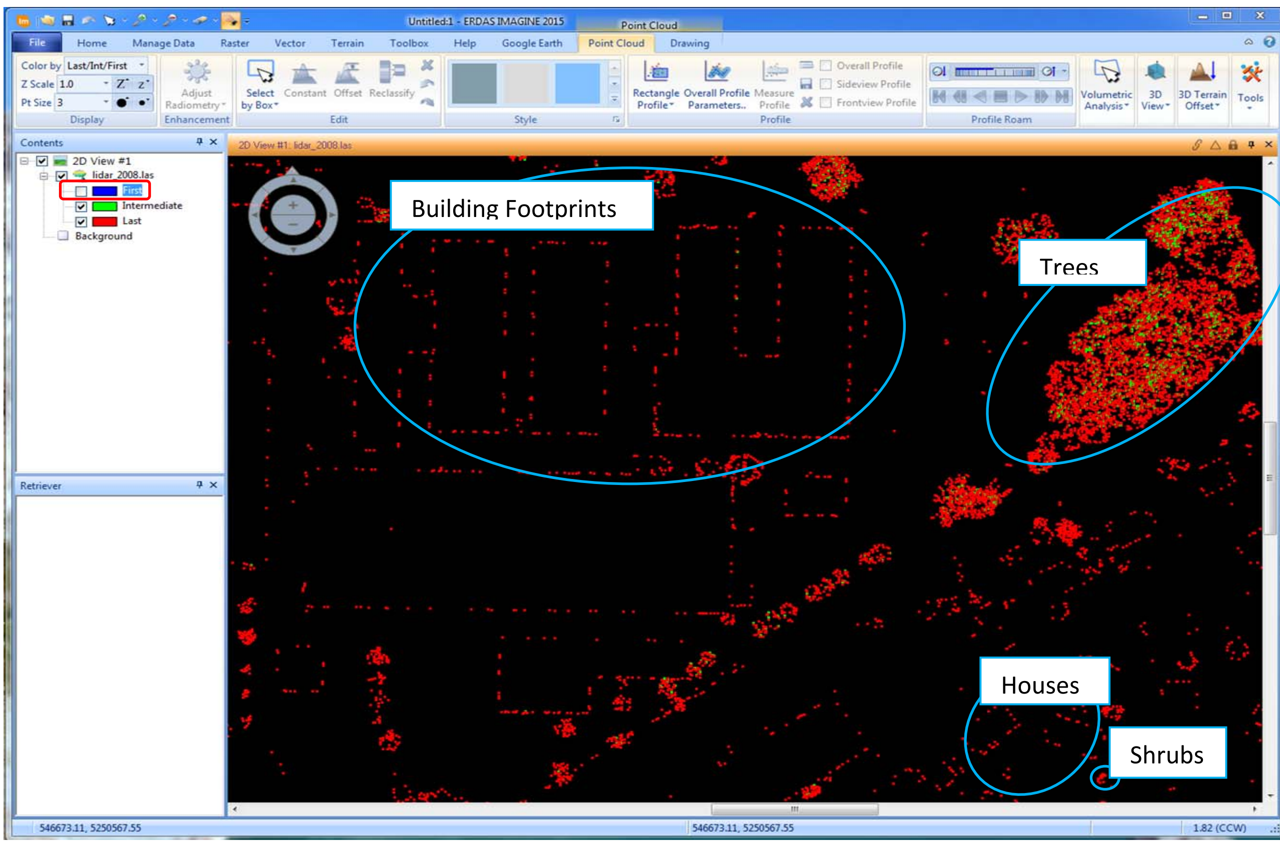
This colors the points by their return, grouping them as first, intermediate, and last returns. Single returns are considered First returns.

First/Single returns indicate the tops of things: the roofs of building, tree canopies, power lines, or just bare earth.

Last returns indicate the bottoms of things: Bare earth under a tree, the ground beside a building, etc.

Intermediate returns occur when the pulse is reflected multiple times in the way down: branches of trees, understory in forests, beams in a power transmission tower, or girders in a building under construction.

4. Turn off the **First returns** by clicking the checkbox next to **First** in the Contents pane.



Q: *Why do the edges of buildings show up?*

Q: *How can you identify trees using the Last/Int/First coloring scheme?*

5. For more information on the returns, change the **Color by** option to **Returns**.
6. Hide the returns one by one by unchecking them in the Contents pane until only **Return 4** is displayed.

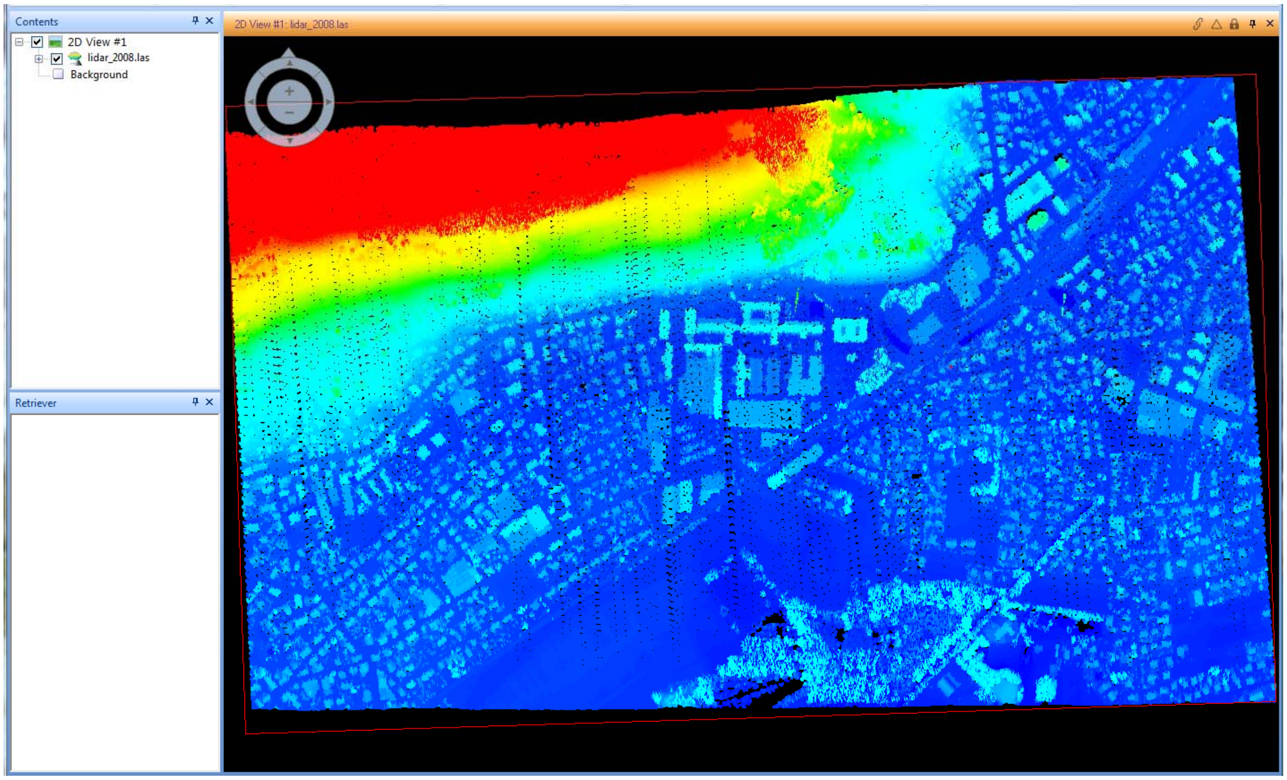
Q: ***What does Return 4 represent?***

7. Toggle back and forth between the **Color by** options we have used so far and see how different features are represented in LiDAR data.
8. Leave the data open in the View for the next task.

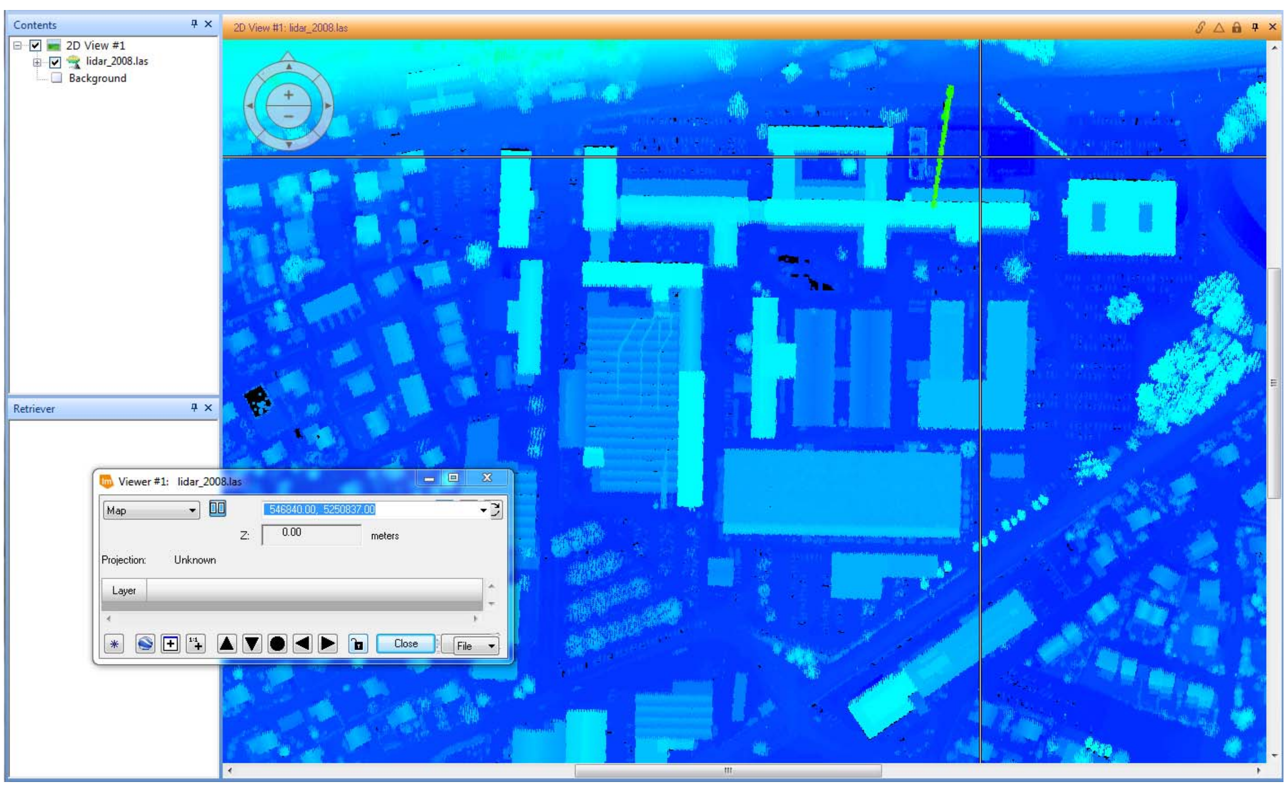
Task 2.2: Rectangular Profiles and Editing Points

LiDAR data is three-dimensional data; each point contains X, Y, and Z information. Therefore, we are not limited to only viewing the data in 2D, planimetric Views. ERDAS IMAGINE provides utilities that allow us to look at the data from several different angles at the same time.

1. In the View containing the ***lidar_2008.las*** file, change the **Color by** scheme to **Elevation** and select the color scheme that show the most variation in this area.



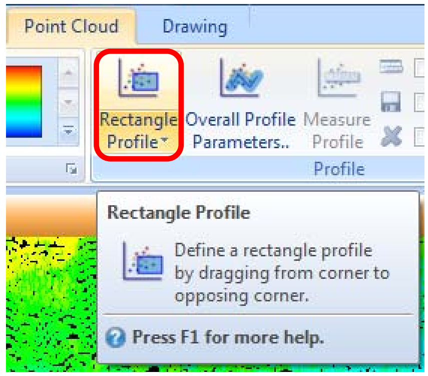
2. Open the Inquire Cursor (**Home** tab > **Information** group > **Inquire**), and enter the following coordinates: **546840, 5250837**.



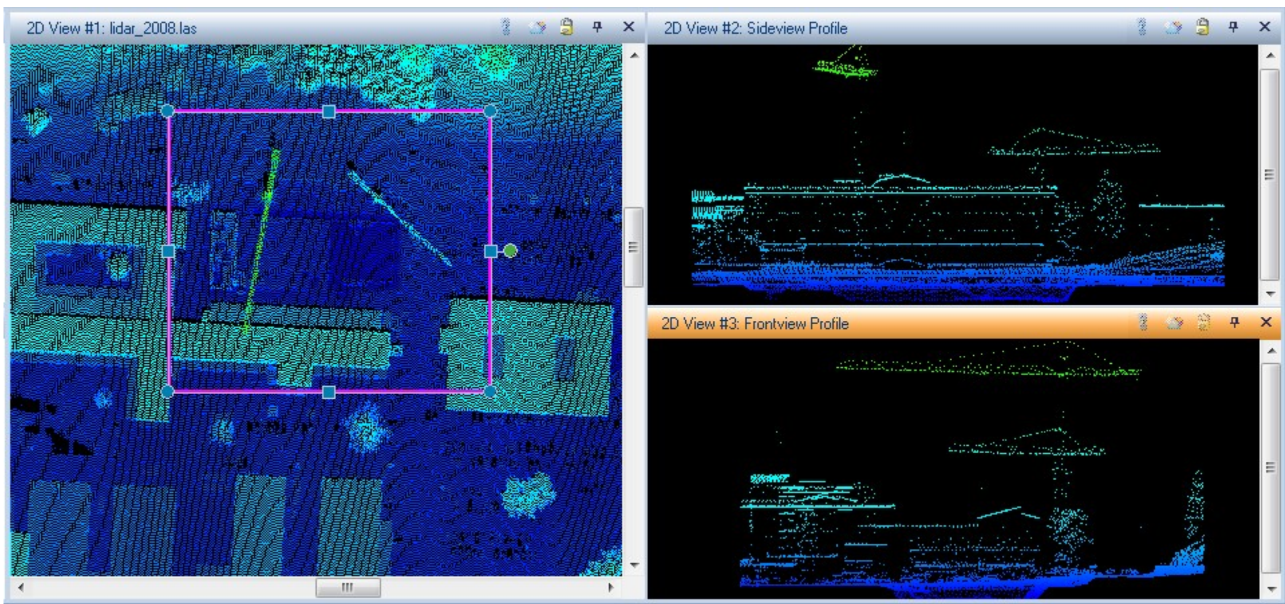
This point is in the middle of a construction zone. You should be able to see two tall, linear features.

3. Close the **Inquire Cursor**.

4. On the Point Cloud tab, click the  Rectangular Profile button.

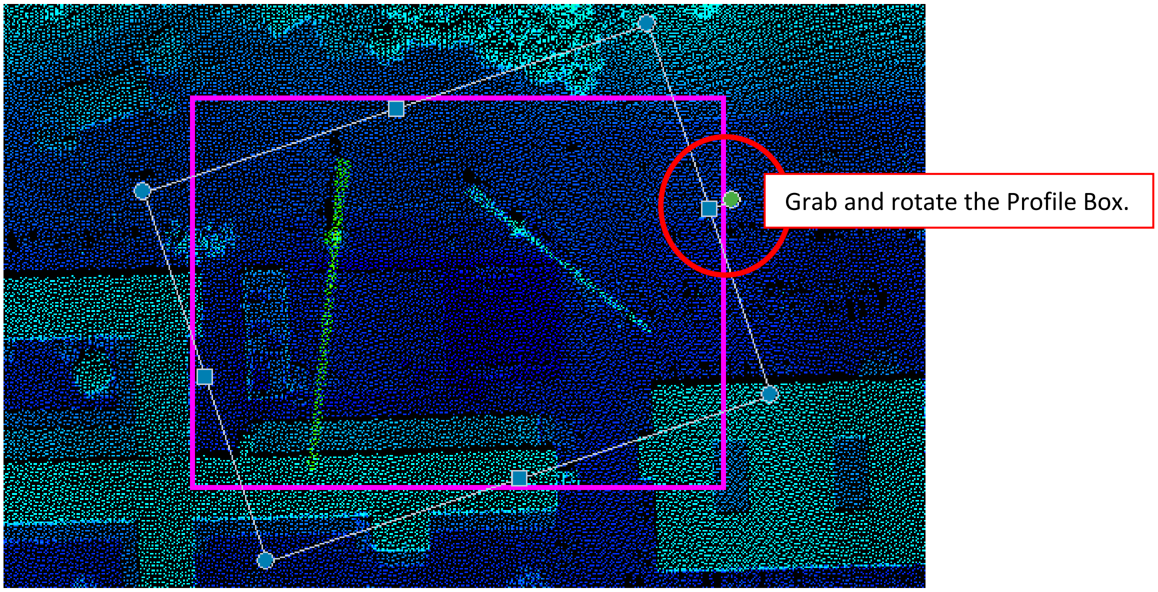


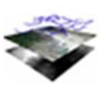
5. In the 2D View, draw a box around the construction area, as seen below.



From the Profile Views, we can identify the two Linear features as construction cranes.

6. In the 2D View, grab the **green handle** on the **Profile Box** and rotate the box to change the Profile Views.



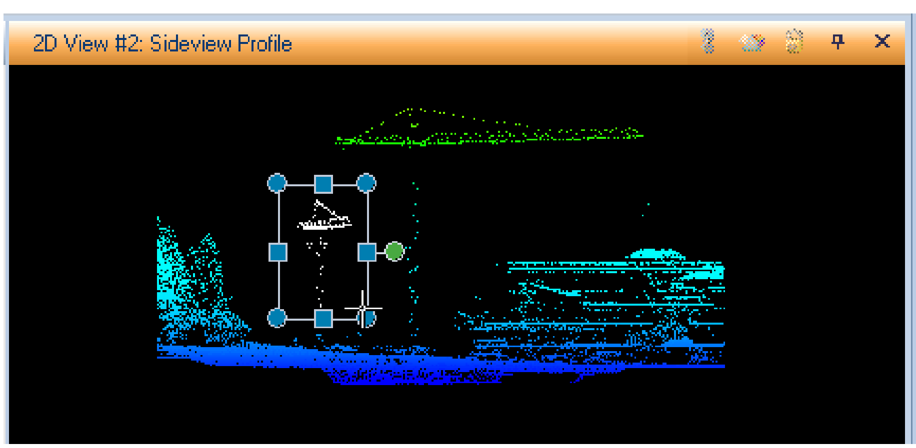


Each time you release the handle the profiles will update, showing the view from a new angle. The side of the box with the green handle defines as the “front” of the profile.

7. Drag the **blue** handles to resize the area currently in the profile. Make sure that at least one profile view allows an unobstructed view of both the boom and the tower of the eastern most (shorter) crane in the construction zone.
8. You can move the Profile Box by dragging one of the sides (not on a blue handle).

Now we will remove the crane from the data by deleting the points associated with it. It would be very difficult to only select the crane points in the 2D planimetric View, but the profiles allow you a better view from which to select the points.

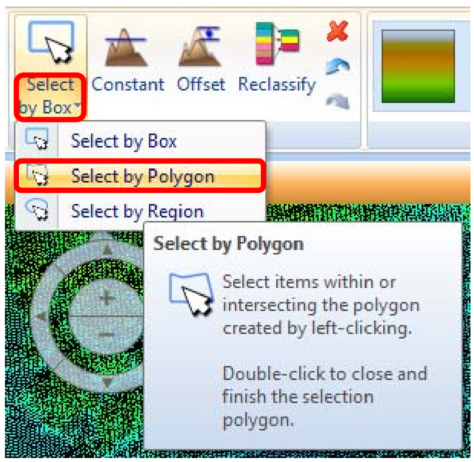
9. Click the  **Select by Box** tool in the **Edit** group of the **Point Cloud** tab.
10. In the profile view with the unobstructed view of the cranes, draw a box around the shorter of the two cranes. The points inside the box turn white to indicate that they have been selected.



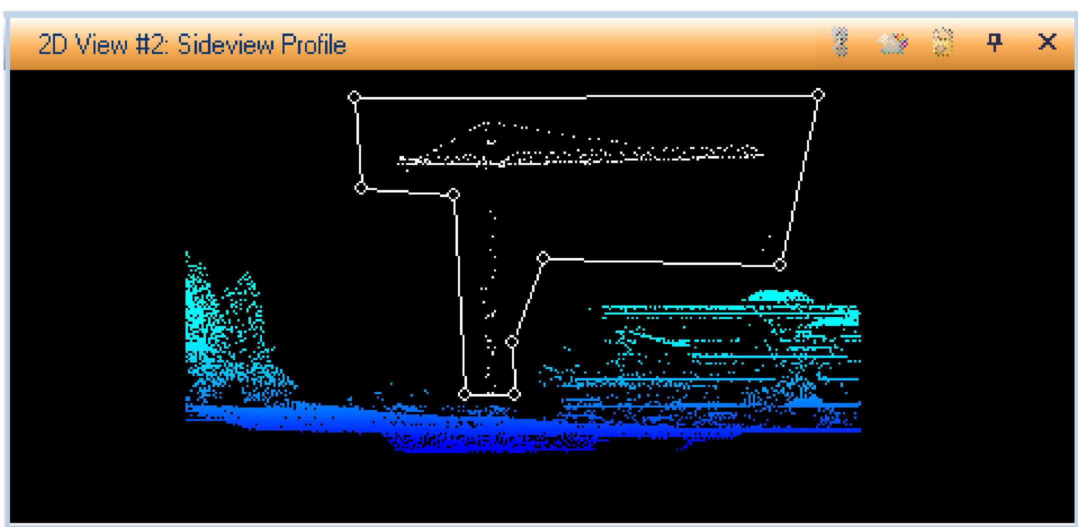
11. In the **Edit** group on the Point Cloud tab, click the  **Delete** button.
12. Click **Undo**  to bring the points back.
13. Click **Redo**  to reverse the Undo action.

Note that the taller crane (now, the only crane) overlaps a portion of the building. To remove this crane we will need a different strategy for point selection.

14. Resize and move the Profile Box to give an unobstructed view of the second crane.
15. In the **Edit** group of the **Point Cloud** tab, click on the bottom half of the **Select by Box** button and choose **Select by Polygon**.



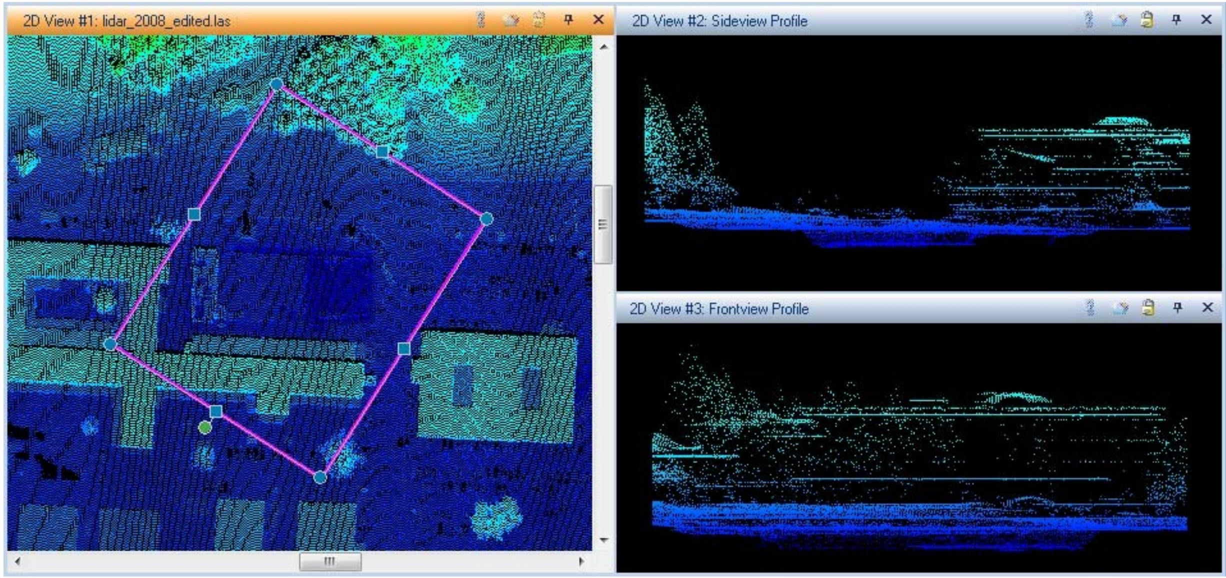
16. In the Profile view, digitize a polygon around the points representing the crane. Click to add vertices, and double-click to finish the polygon.



Again, the points turn white indicating that they have been selected.

17. After you double-click to close the polygon, you can drag the polygon nodes around to reshape the selection and get all of the points.

18. Click the **Delete** button  to remove these points.



19. Click in the 2D View to make this the active window. Select **File** > **Save As** > **Top Layer As...** and save the file as ***lidar_2008_edited.las***.
20. **Clear** the View. If prompted, you do not need to save your changes.

Exercise 3: Linear Profile Views and Mensuration

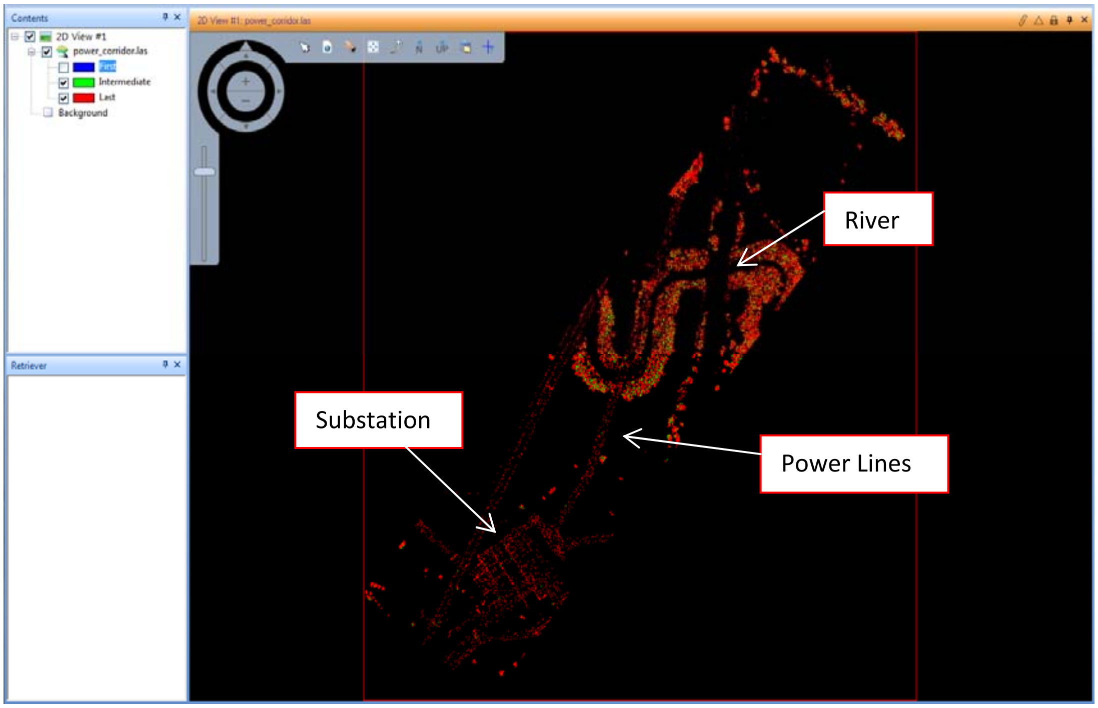
Objective:

Students will view a LiDAR dataset of a powerline corridor and learn to use a linear profile tool to roam down the corridor and identify locations where vegetation is beginning to obstruct the power corridor. They will also use the mensuration tools to measure the height and location of these obstructions.

Task 3.1: Linear Roaming and Measurements

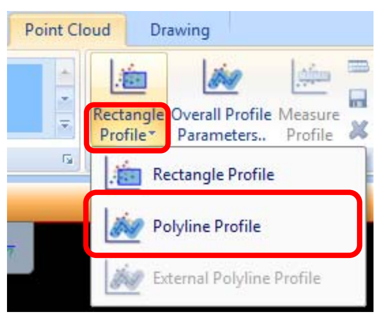
One common use of LiDAR data is to locate places where vegetation is encroaching on power lines. In this task we will load a LAS file of a power line corridor and view a linear profile along the power line.

1. In a View, display ***power_corridor.las***.
2. To most easily identify where the power lines are, change the **Color by** option to **Last/Int/First** and deselect the **First** return.

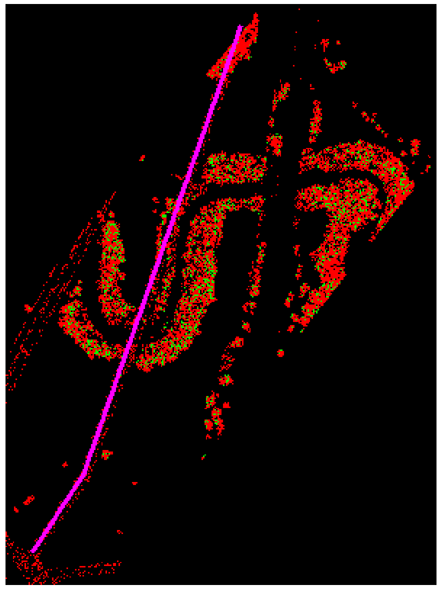


3. On the **Quick Access toolbar**, click **Fit to Frame**  to zoom to the extent of the data.

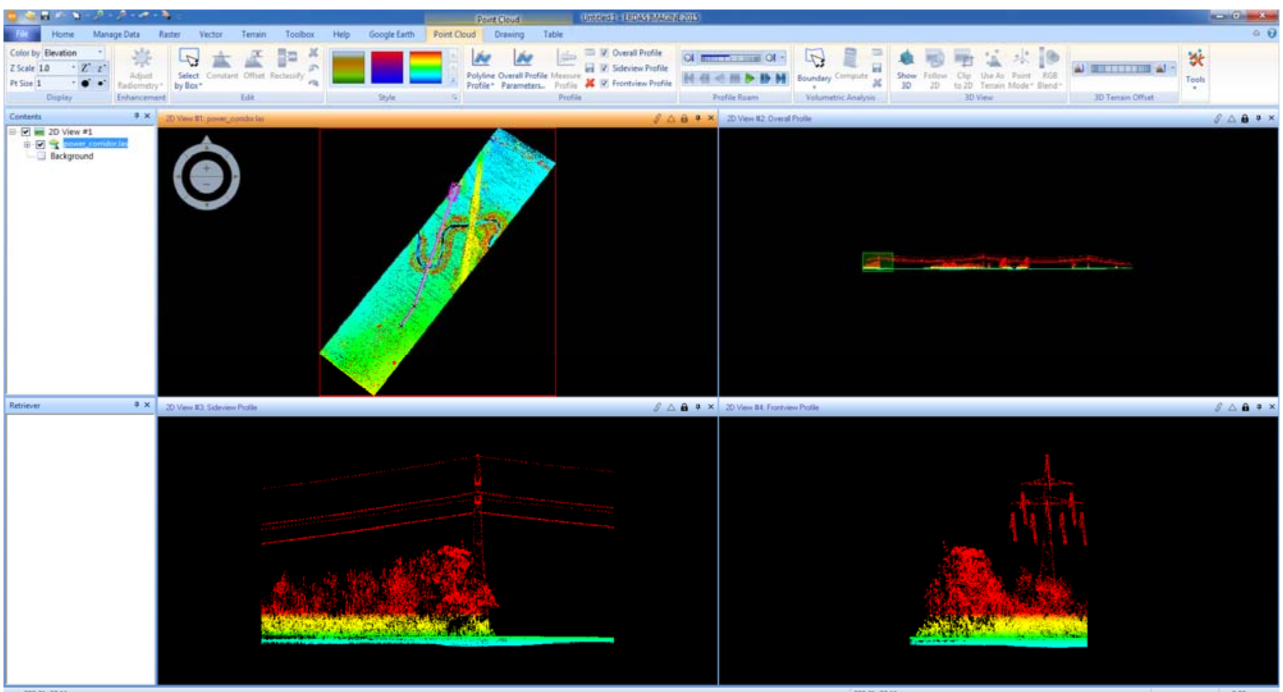
4. In the **Profile** group on the **Point Cloud** toolbar, expand the menu under **Rectangle Profile** and select  **Polyline Profile**.



5. In the 2D View, **digitize** a polyline along the powerline. **Click** to add vertices, and **double-click** to finish digitizing. Do not worry too much about getting the line perfect right now.

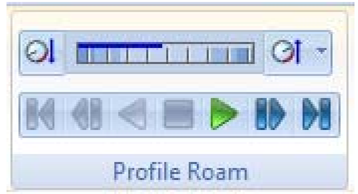


6. Once you have digitized the line, change the **Color by** back to **Elevation** and select the **Blue to Red** color scheme.

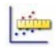


After digitizing the polyline, you can edit it. Drag a vertex to move it. Middle-click to add a vertex. Shift-middle click on a vertex to delete it.

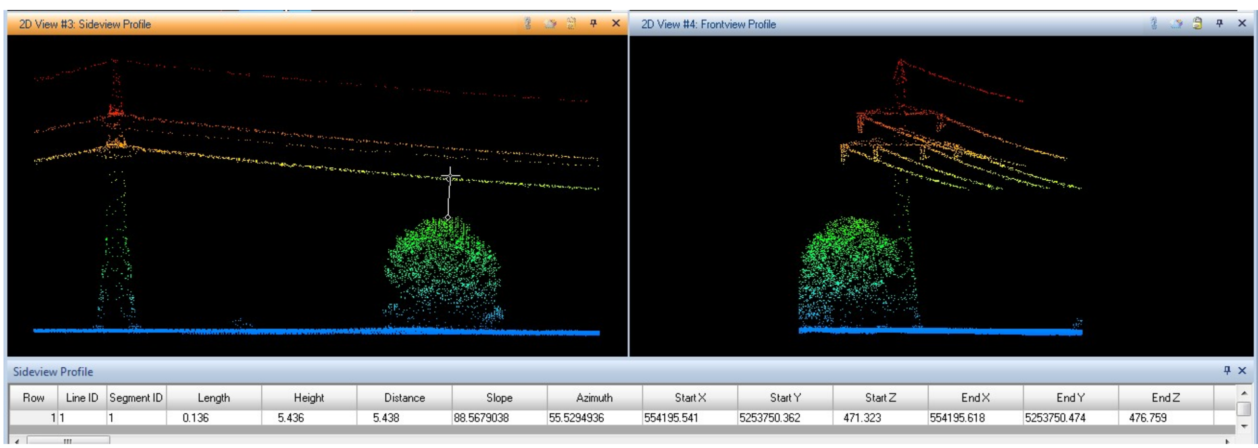
7. In the Profile Roam group, click **Play**  to begin roaming down the polyline.



As you roam along the polyline, note that the green box in the Overall Profile indicates where the current viewing location is.

8. Use the thumbwheel to increase and decrease the roam speed.
9. Watch the Frontview and Sideview profiles. When a tree enters the View, click **Pause** .
10. **Select** the Sideview profile by clicking on its title bar.
11. Activate the **Measure Profile** tool by clicking the  button in the **Profile** group on the **Point Cloud** tab.

Note that in the image below it is easier to clearly distinguish where the tree is in relation to the powerline in the Sideview profile. Therefore we will measure in the Sideview profile. Your view may differ; take the measurements in the view that provides the clearest view of the tree and powerline.

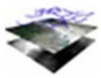


12. In the Profile that gives the best view of the tree and powerline, measure the distance between the tree and the powerline by **clicking** on the edge of the tree and then **double-clicking** on the powerline.

The measure tool records the Length (in X direction) and Height (in Y direction) as well as the Distance (the actual length of the digitized line). In addition, it records the X, Y, and Z coordinates of the start and end of the measurement line.

13. Get rid of the digitized line (while keeping its measurements) by clicking the  button in the **Profile** group.
14. Continue roaming down the polyline, pausing the roam to measure a few more trees that are encroaching on the power corridor. Use the Profile that provides the best view of the data.

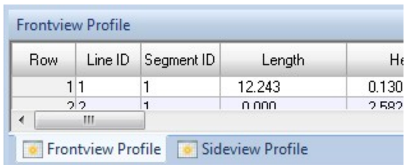
It is important to note that sometimes the vegetation can encroach from the side of the powerline. In those cases, measure in a horizontal direction.



The **Measure Profile** tool saves the measurements into two separate tables. All measurements taken in the Frontview profile are saved in the Frontview Profile table. All measurements taken in the Sideview are stored in its corresponding table.

Now we want to save the measurements to text files that can be used to pass on to the field teams for possible trimming.

15. When you have collected a few measurements, select the **Frontview Profile** table at the bottom of the eWorkspace.



16. In the Profile group, click the **Save Measurement** button. Name the file ***frontview_meas.txt***.
17. Select the **Sideview Profile** table. Click the **Save Measurement** button. Name the file ***sideview_meas.txt***.
18. This file can be viewed in a text editor, like the one included with ERDAS IMAGINE. Select **File** > **View** > **View Text file** and click on the **Recent** button.
19. Select ***frontview_meas.txt*** from the list of recent files and click **OK**.
20. Clear all views and close all open dialogs.

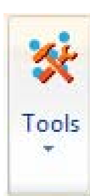
Challenge 1: RGB Encoding a LAS File

Objective:

The student will take a point cloud saved as a LAS file and encode the points with RGB values associated with an orthorectified image of the same area.

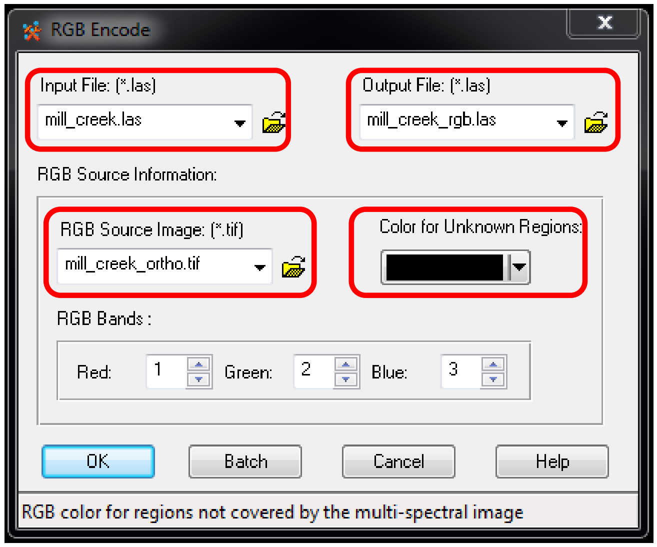
Task 1.1: Create an RGB Encoded LAS File

In a LAS file, you can include an RGB value for each point in the cloud. This means that if you have a corresponding image for your point cloud data, you can encode transfer the RGB value from the image to each point in the point cloud.

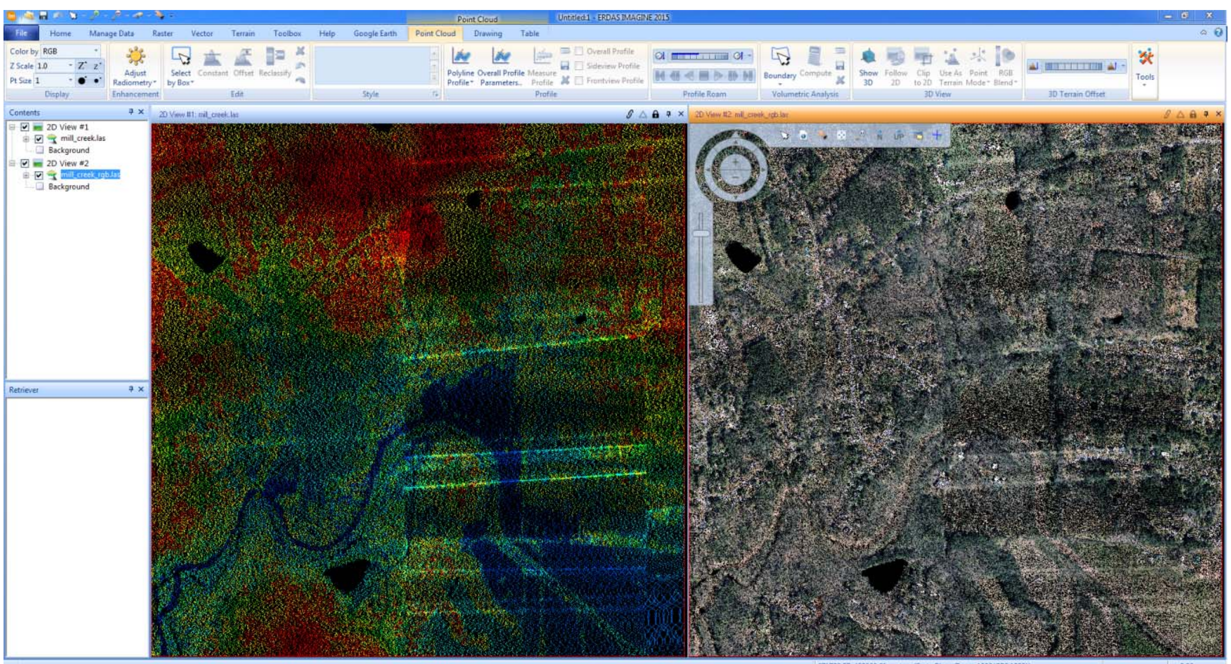
1. Display ***mill_creek.las*** in a 2D View.
2. On the **Point Cloud** tab, expand the 

Tools group. Click on the 

RGB Encode button.



3. Ensure that ***mill_creek.las*** is entered as the **Input** File.
4. Enter ***mill_creek_rgb.las*** as the **Output** file.
5. Select ***mill_creek_ortho.tif*** as the **RGB Source** image.
6. Change the **Color for Unknown Regions** to **Black**.
7. Click **OK** to run the RGB Encode process.
8. When the process finishes, display ***mill_creek_rgb.las*** in a new 2D View.
9. Ensure that **RGB** has been selected from the **Color by** list.



10. **Sync**  the Views and examine the new RGB encoded point cloud.
11. Clear Views.

Exercise 4: True Ortho Point Clouds in 3D

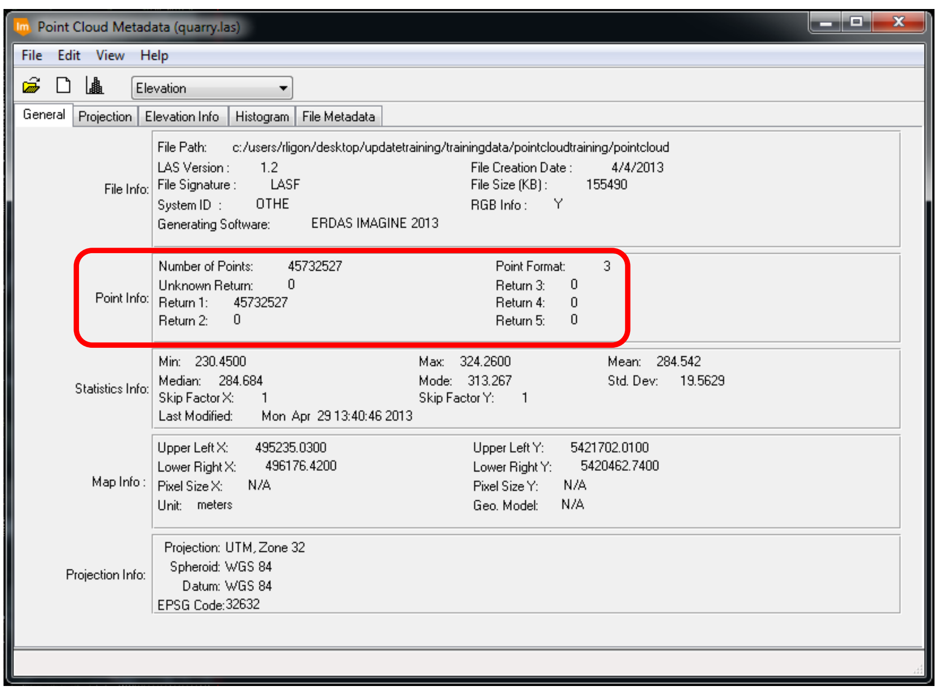
Objective:

Students will use a photogrammetrically-derived point cloud to view in 3D.

Task 4.1: View Photogrammetric Point Cloud in RGB

Now we will look at a photogrammetrically-derived point cloud. This method of creating a point cloud used four airphotos of a quarry with 10 cm pixels. The imagery was triangulated in LPS. We used the Semi-Global Matching (SGM) algorithm in ImageStation to create the point cloud from the triangulated imagery. This results in a point cloud with 10 cm post spacings, the same resolution as the input imagery.

1. Select **File** > **Open** > **Point Cloud Layer...** Browse to your input directory and select ***quarry.las***. Click **OK**.
2. On the Home tab, click **Metadata**.



The Metadata dialog shows us information about the point cloud. Note that the data has only "First" returns.

Q: ***Why does the point cloud only contain First Returns?***

3. Zoom in on the data and notice how much denser this point cloud is when compared to the LiDAR point clouds we have been viewing so far.
4. On the **Point Cloud** tab, in the **Display** group, change **Color by** to **Intensity**.

Q:

Why is the entire data set gray?

Point Clouds which have been created in ImageStation and Imagine Photogrammetry are RGB encoded at creation, so you can view them in True Color.

5. On the **Point Cloud** tab, in the **Display** group, change **Color by RGB**.
6. Zoom and pan around the data and see how closely it resembles an orthophoto.

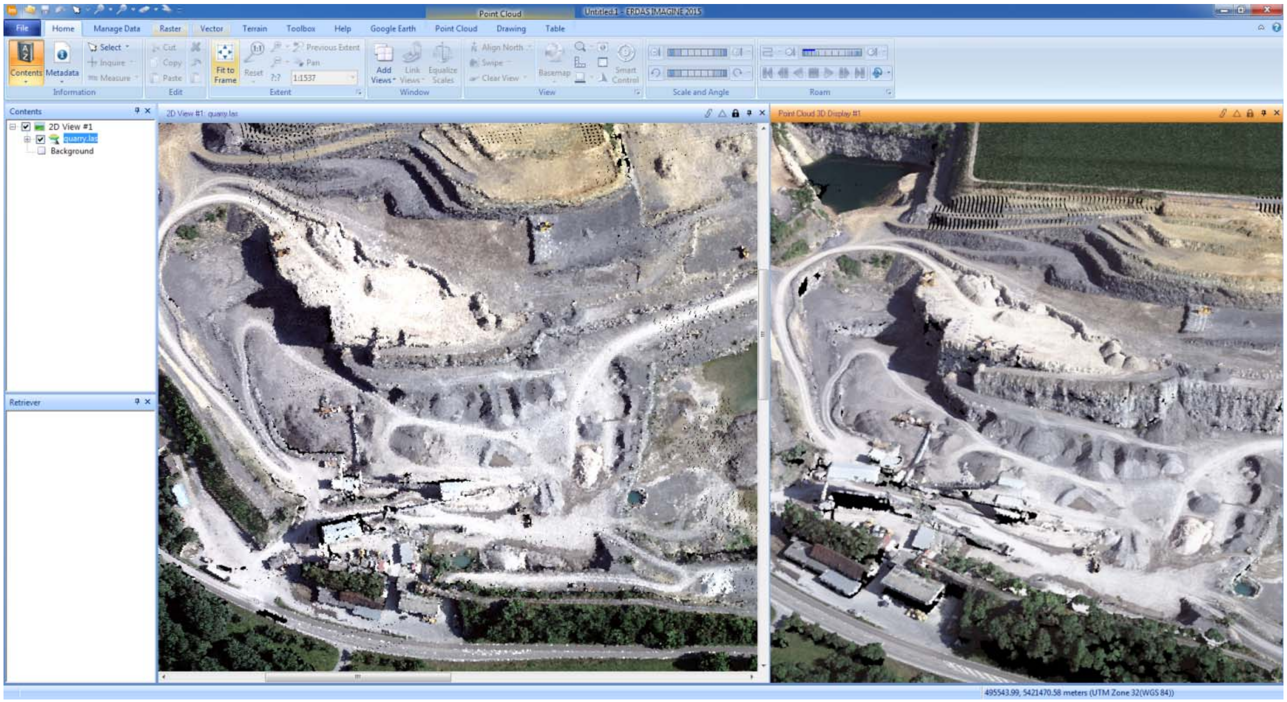
Task 4.2: View Point Cloud in 3D

Because an RGB-encoded point cloud contains the information of an image with every point in its real-world X, Y, and Z position, it can be thought of as a “True Ortho”.

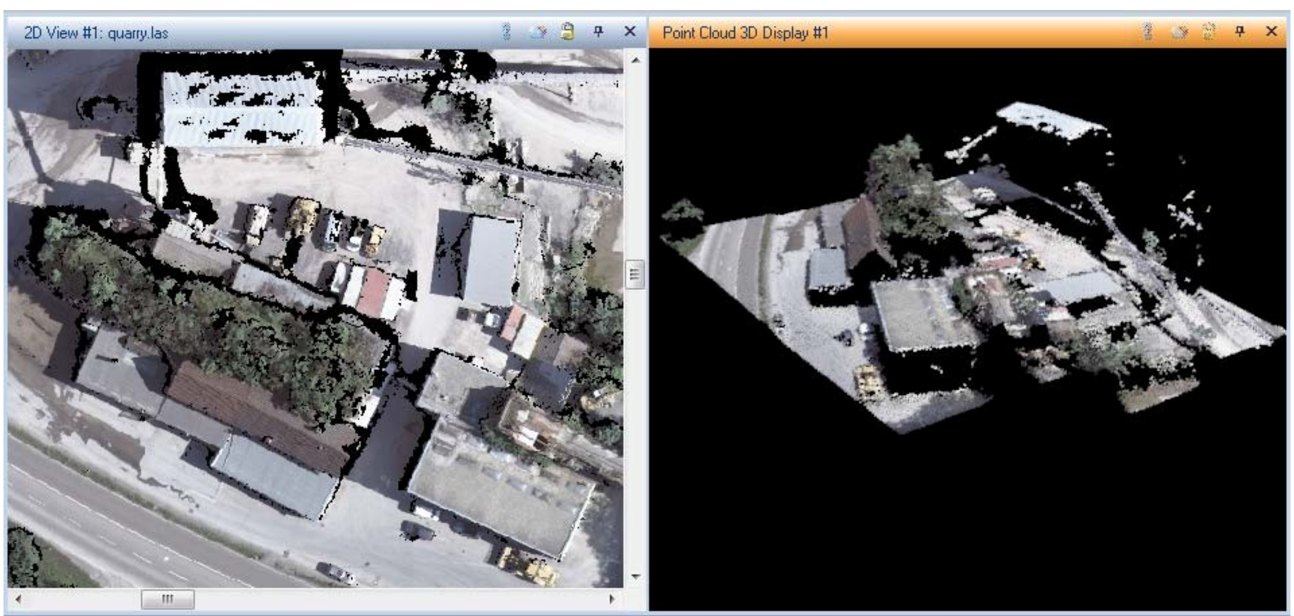
1. In the 3D View group, click **Show 3D**. .
2. The point cloud comes in zoomed to the data extent. To zoom in, use the mouse scroll wheel to scroll away from you.
3. Now, using the left mouse button, pan up to the quarry at the north end of the dataset.

Navigation	**Mouse Command**
Zoom In	Scroll wheel up; Right-button drag up
Zoom Out	Scroll wheel down; Right-button drag down
Pan	Left-button drag
Tilt	Middle-button drag up/down; Ctrl + scroll up/down; Crtl + right-button drag up/down
Rotate	Middle-button drag left/right; Shift + scroll up/down; Shift + right-button up/down

4. Click and hold down the middle mouse button/scroll wheel. Move the mouse forward and backward to tilt the point cloud. Move the mouse left and right to rotate.



5. Continue roaming, zooming, tilting and rotating around the quarry in the 3D view.
6. In the 2D View, zoom in on the buildings indicated in the above image so that.
7. Make sure that those same buildings are visible in the 3D View.
8. In the 3D View group on the Point Cloud tab, click **Clip to 2D** . The 3D View is clipped to only the extent currently viewed in the 2D view.



9. Tilt and rotate the 3D view to see the buildings.

Q:

Why do the buildings appear to be floating rooftops?

10. Zoom out and pan in the 2D View. Note that the 3D View updates to only display the extent of the 2D View.
11. Close the 3D View and clear the 2D View.

Exercise 5: Classifying and Filtering Point Clouds

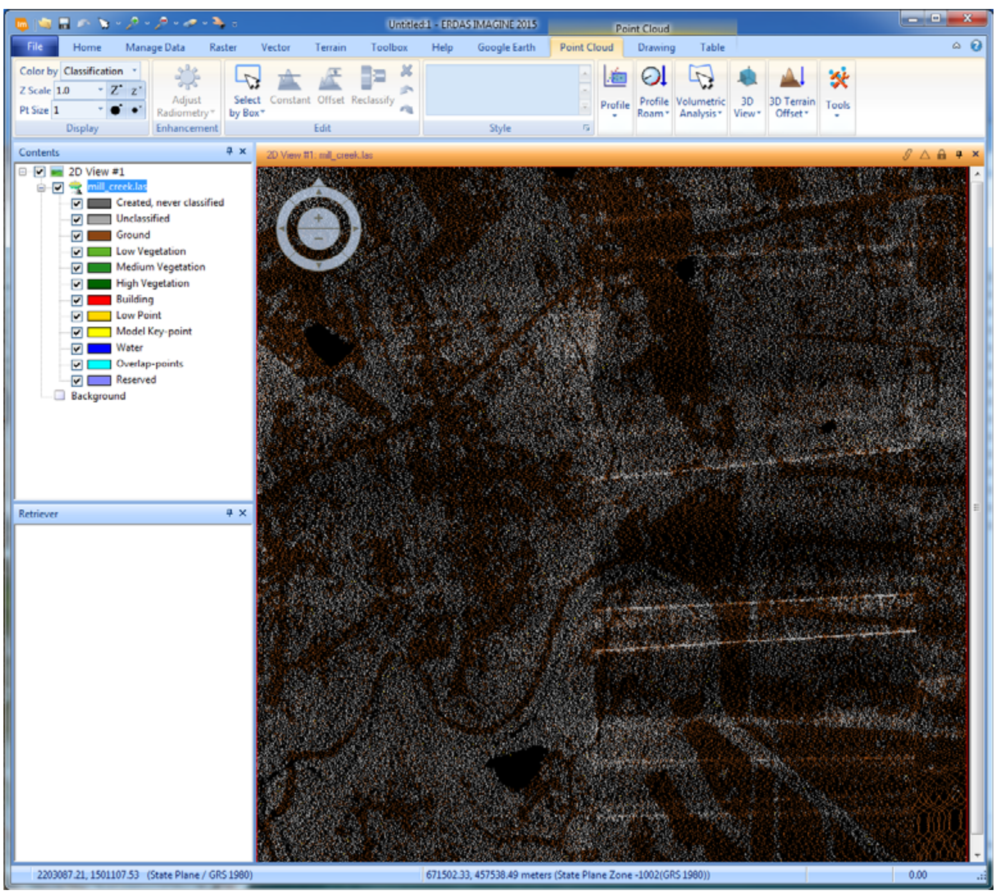
Objective:

Students will view a photogrammetric point cloud, select the points that represent a building, and classify those points. Then they will filter the point cloud so that only the building points remain. This data is then ready for rasterization and conversion to a 3D vector.

Task 5.1: View Point Cloud by Classification

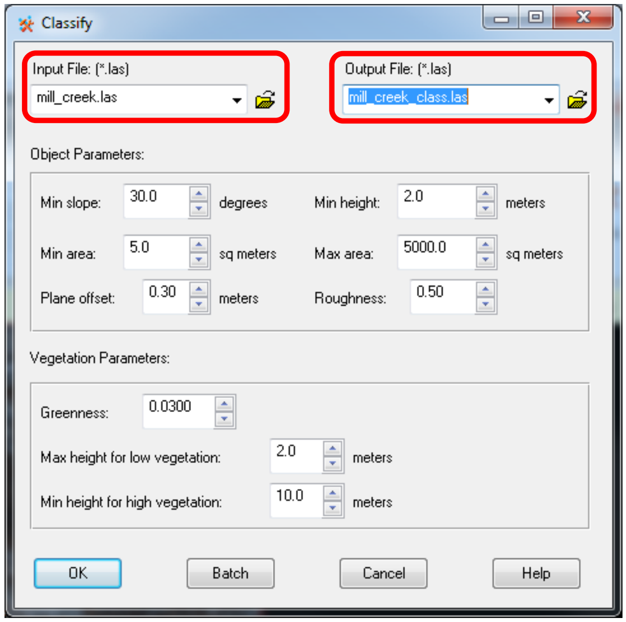
The point cloud we are looking at in this exercise was derived from 2 cm imagery.

1. Select **File** > **Open** > **Point Cloud Layer...** Browse to your input directory and select ***mill_creek.las***. Click **OK** on the LiDAR File Name dialog.
2. Change the **Color by** display method to **Classification.**

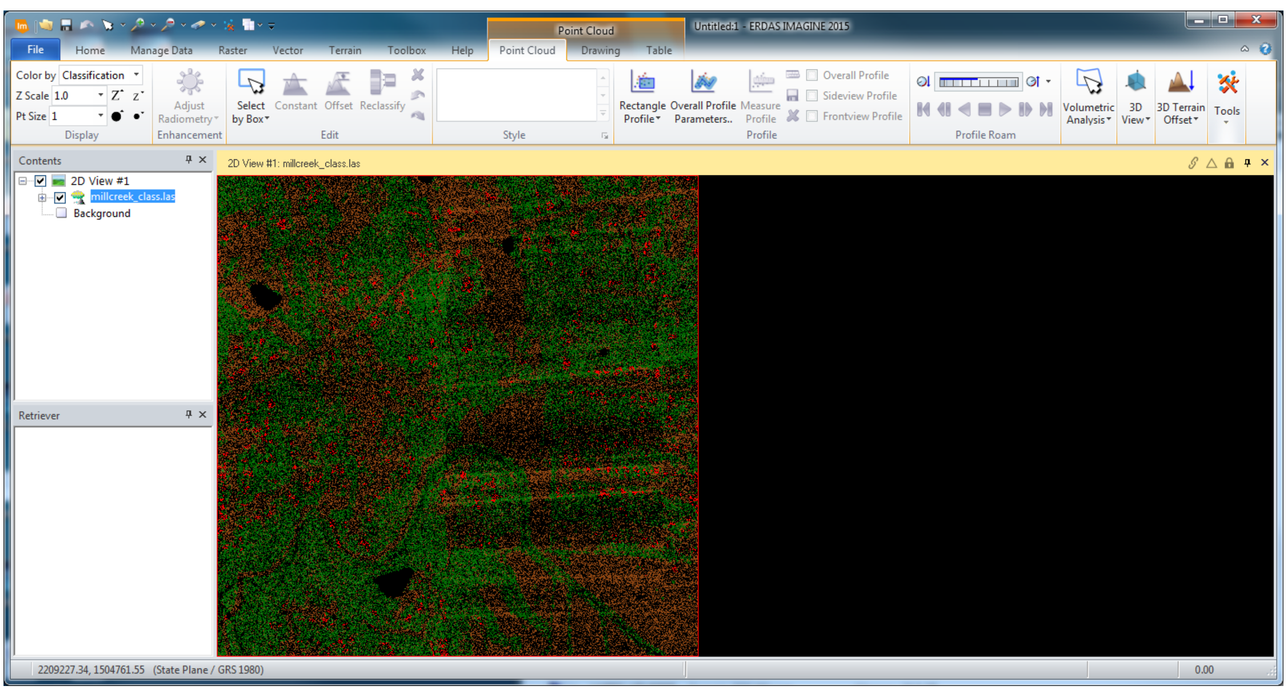


The points are color coded based on the classes into which they have been gathered. The classes are specified in the LAS 1.3 Spec. In this example only the bare earth was classified. We are going to classify the entire scene as per the spec.

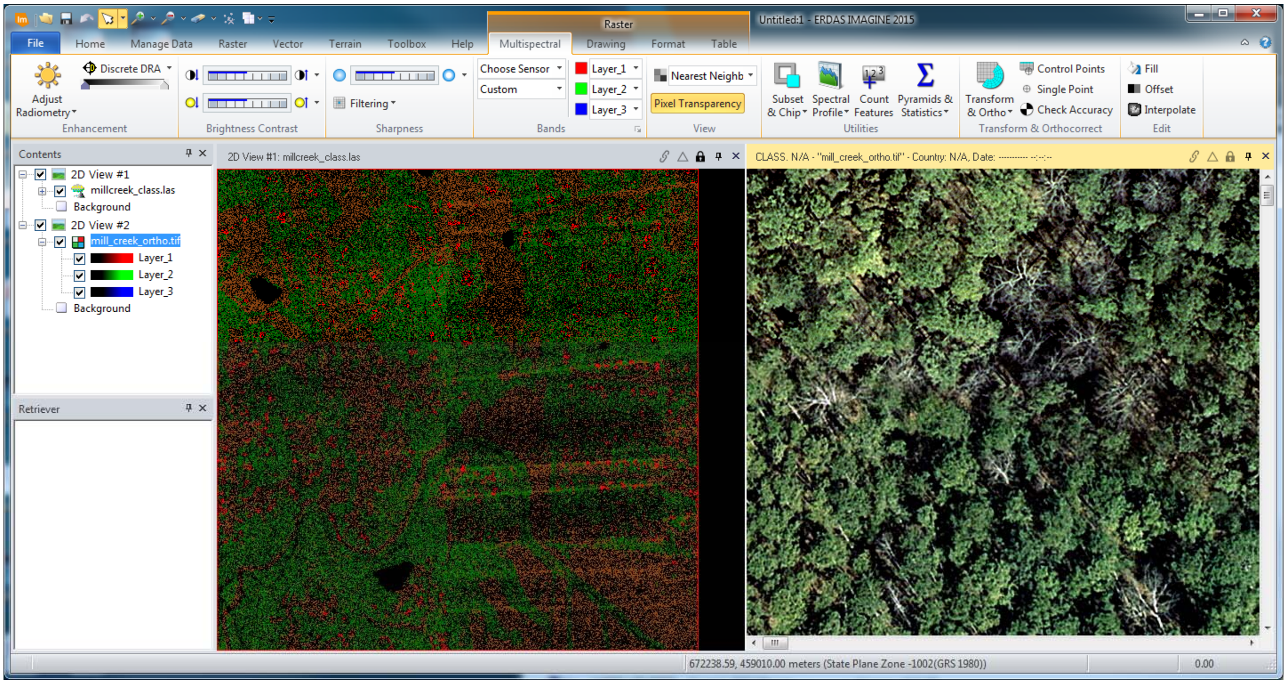
3. Select **Tools** > **Classify** from the **Point Cloud** toolbar. For the input file select ***mill_creek.las*** and ***mill_creek_class.las*** for the output. This will yield an unsupervised classification of the point cloud.



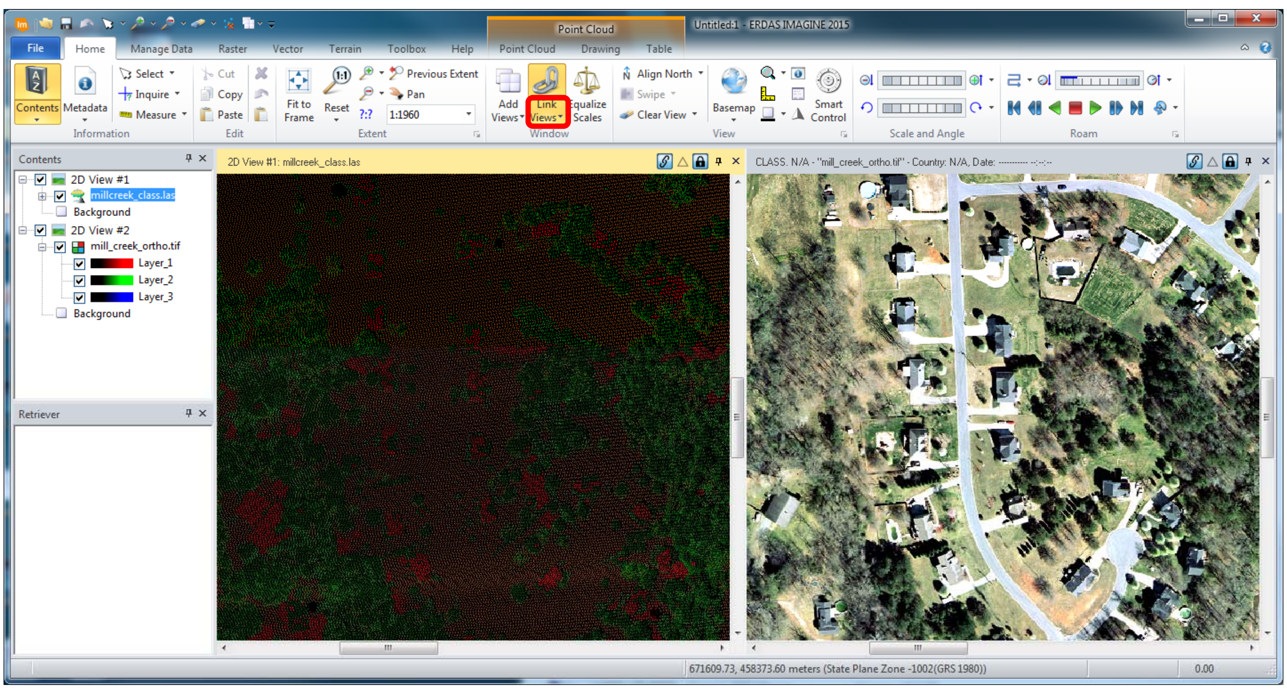
4. Upon completion, clear the view and then open ***mill_creek_class.las***, fit to frame and select **Color by Classification**.



5. From the **Home** tab select **Add Views** > **Create new 2D view**. In the new view open ***mill_creek_ortho.tif***.

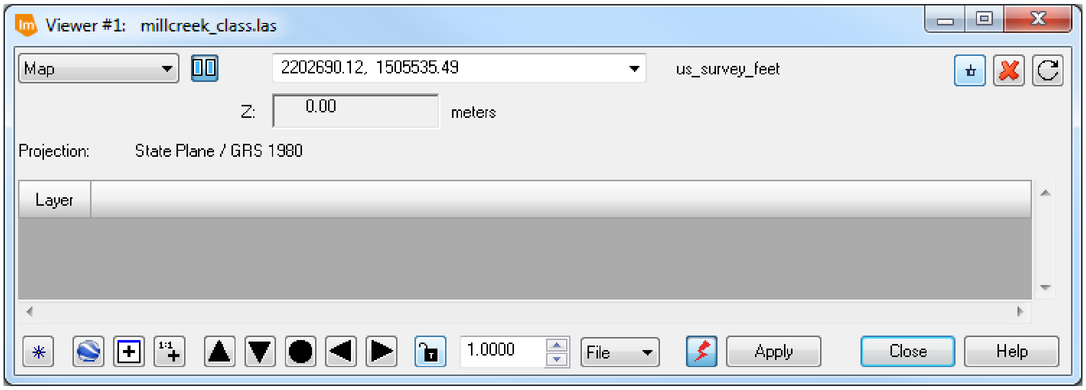


6. On the **Home** tab select **Link Views**, then equalize the scales. From the **Link Views** pull down menu select **Sync Views**. Zooming and panning in either view will produce the same results in both views.

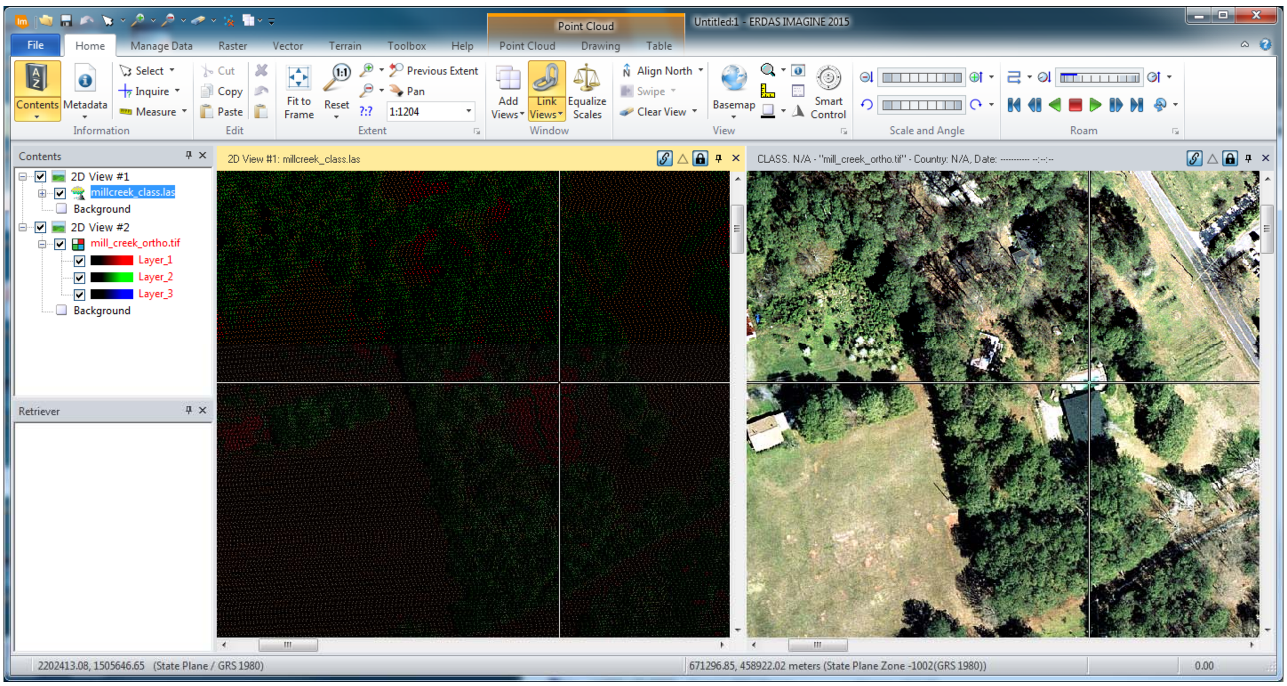


Task 5.2: Reclassifying a Building

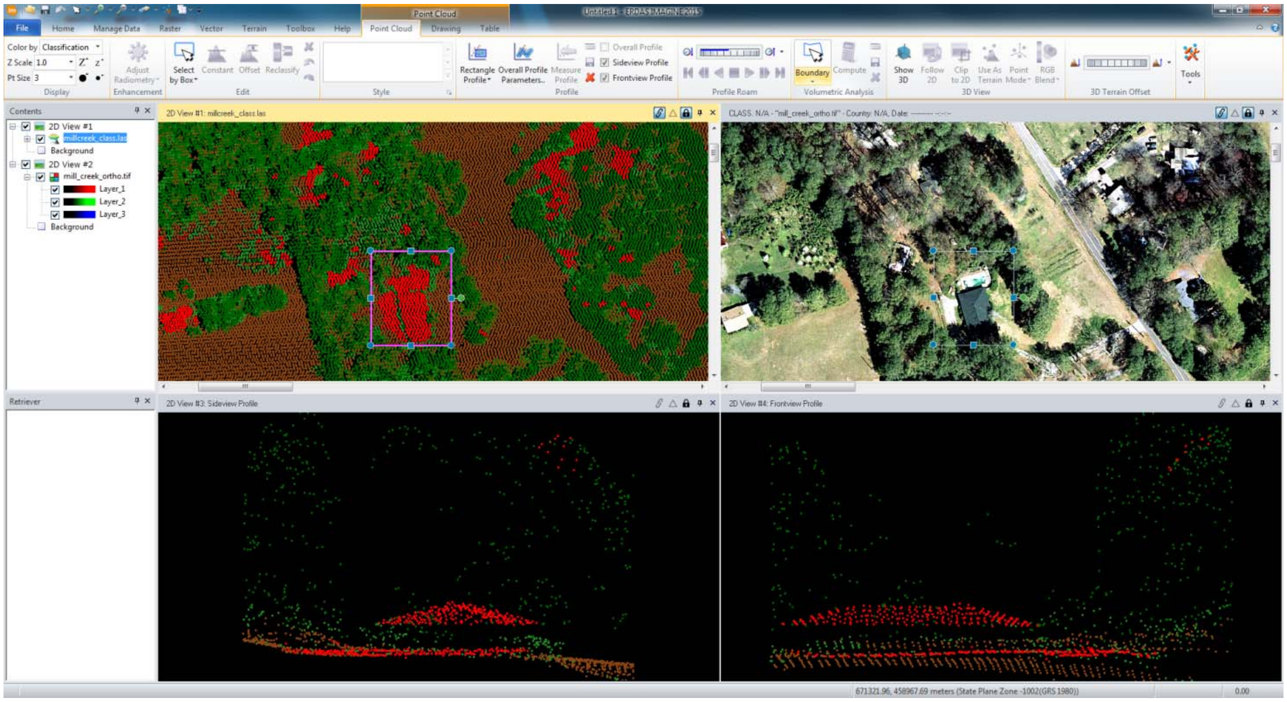
1. On the **Home** tab launch the **Inquire Cursor** and navigate to the following coordinates.



2. The pool area and some of the surrounding area have been misclassified as buildings.

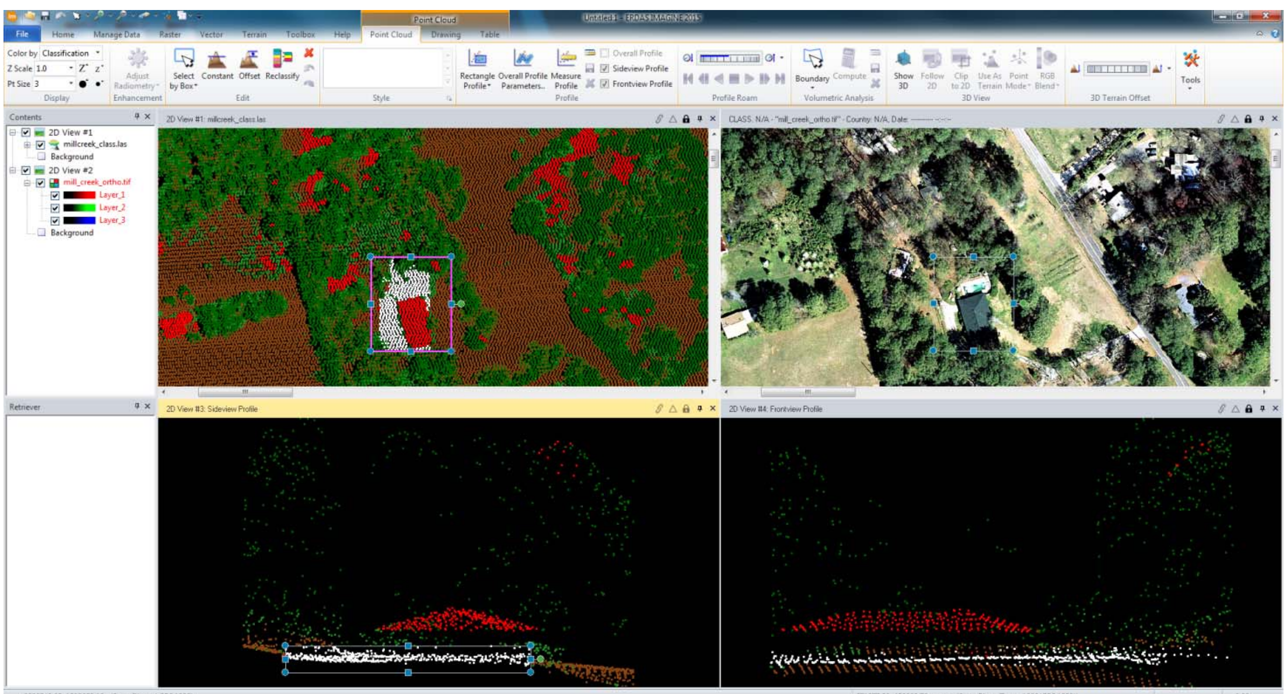


3. Close the **Inquire Cursor**.
4. On the **Point Cloud** tab select **Rectangular Profile** and draw a box around the misclassified area.



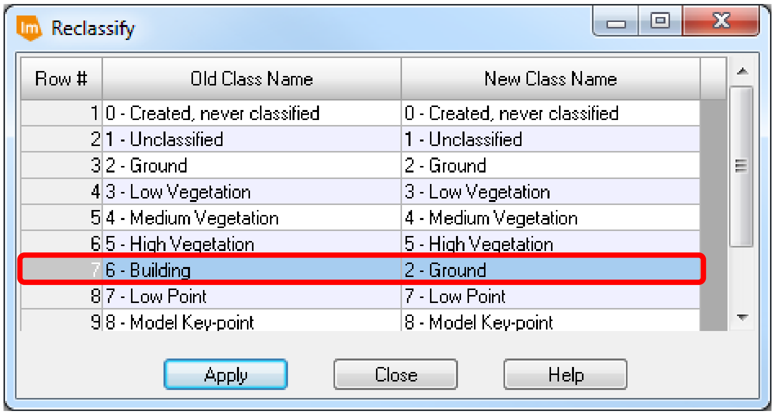
The red in the forefront should have been classified as bare earth.

5. On the **Point Cloud** tab > **Select by Box** and draw a rectangle in one of the profile views containing the points that should be bare earth.

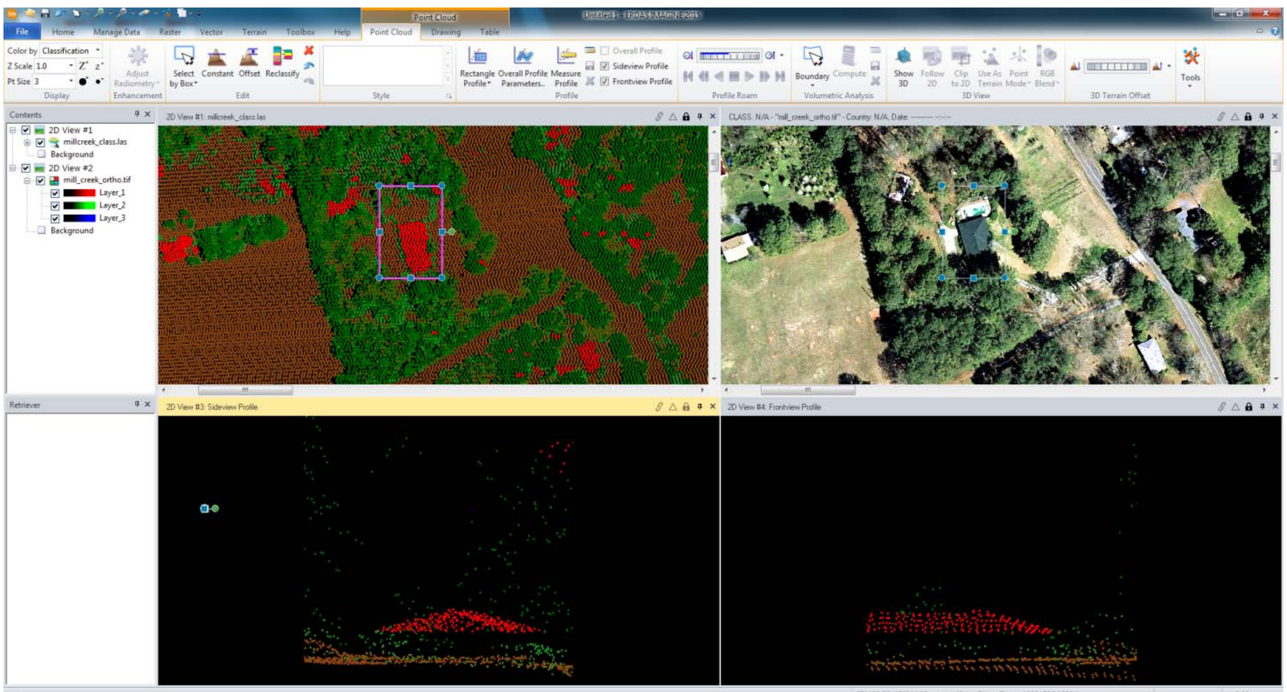


Note how the points are selected in all views.

6. Select reclassify. The areas were originally classified as buildings, select ground for the new value and then click apply and close.



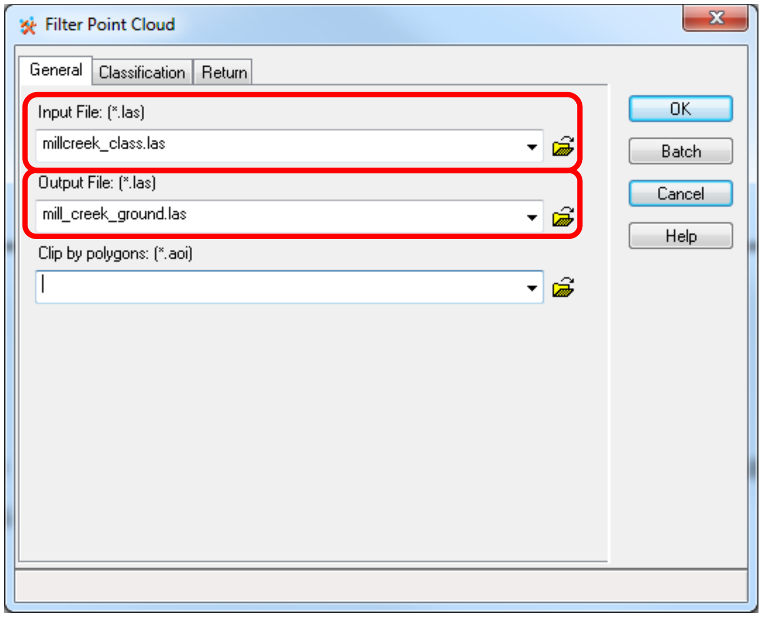
The area is now classified as ground.

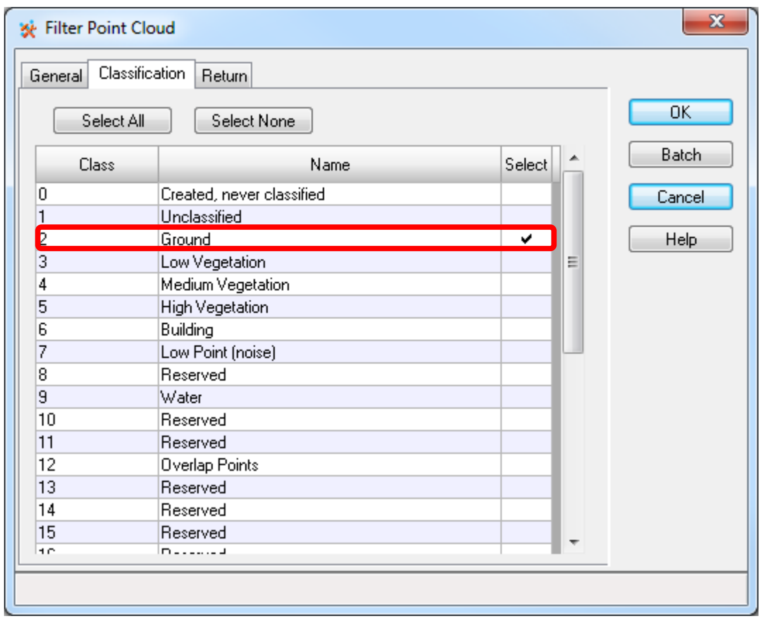


Task 5.3: Filtering a Point Cloud by Class

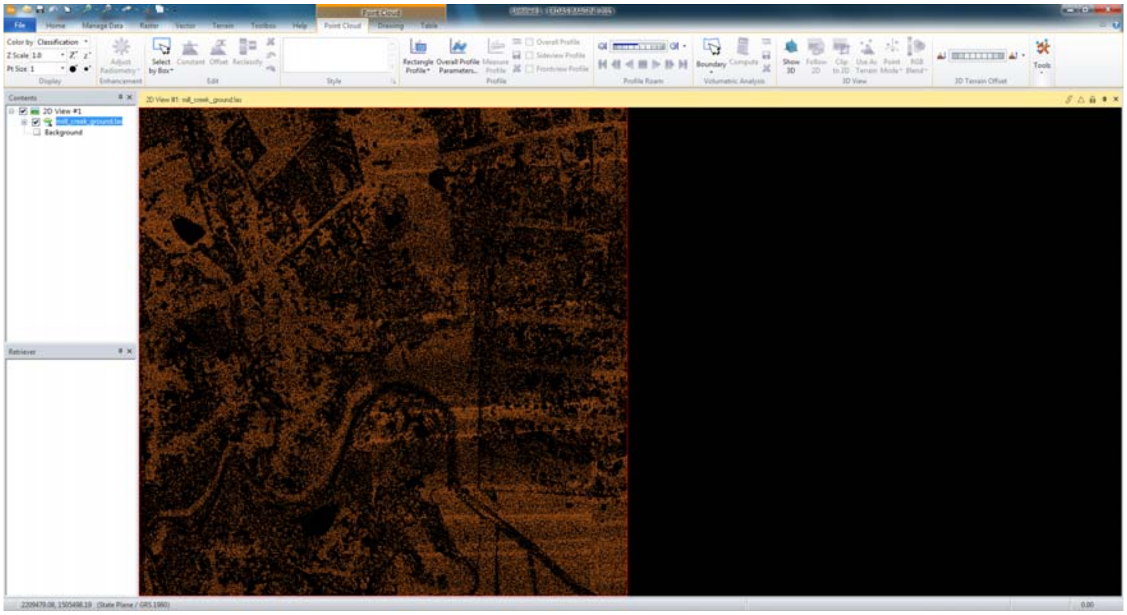
Filtering allows you to select the points you would like to include in a new file. You can filter by class, return, or both. We will be creating an output LAS file that only contains our buildings.

1. Ensure that ***mill_creek_class.las***, with your reclassification changes, is displayed in the 2D View.
2. From the **Tools** group on the **Point Cloud** tab, select **Tools > Filter**.
3. Name the new file ***mill_creek_ground.las***. Click on the **Classification** tab. Check **Ground** and click OK.





4. When complete open ***mill_creek_ground.las*** in a new view and **Color by Classification**.



You now have a bare earth model of mill creek.

Challenge 2: Creating Vector Contours

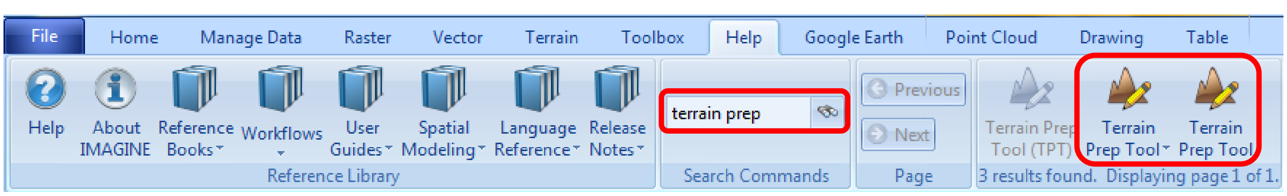
Objective:

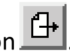
Students will use the **Terrain Prep Tool** to generate **Vector Contours** on a subset of the Quarry data. These contours will be visualized and symbolized with the point cloud data.

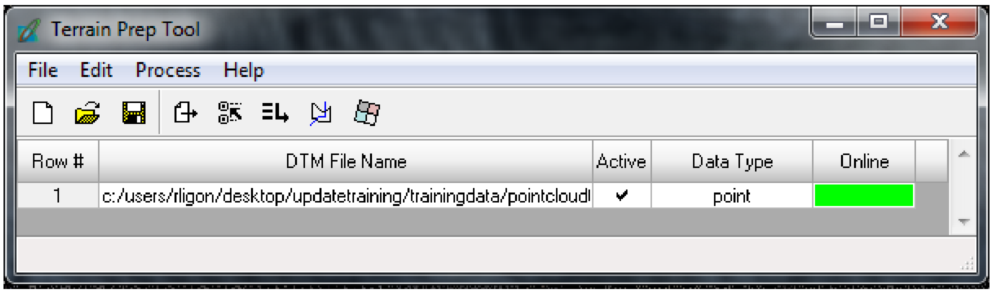
Task 2.1: Using the Terrain Prep Tool to Create Contours

The **Terrain Prep Tool** is used to do a lot of processing on elevation files. It can be used to **Merge terrain**, **Tile terrain**, **Thin Points**, and **Surface Points**. A side process of **Surfacing** can be the generation of **Vector Contours**.

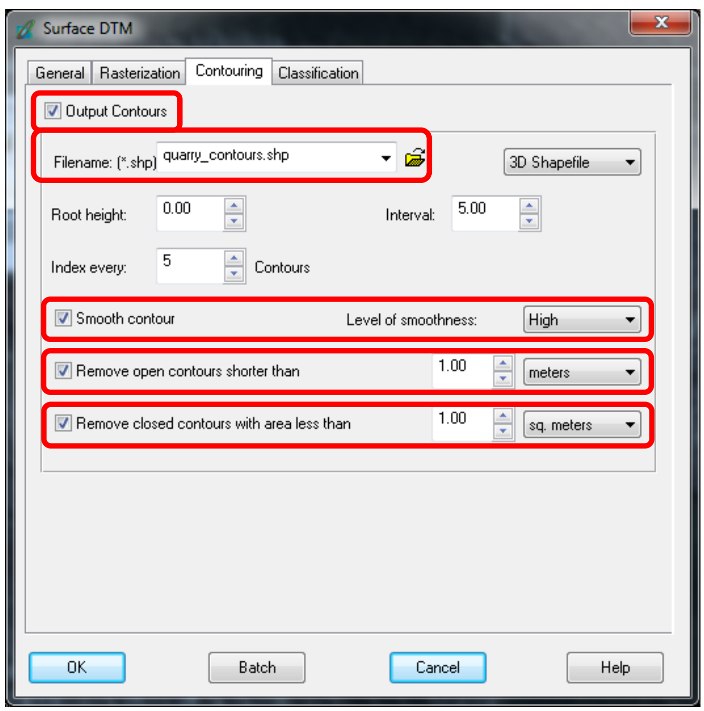
1. Display ***subset_contours.las*** in the 2DView.
2. Change **Colored by** to **RGB**, if it has not already been set.
3. To find the **Terrain Prep Tool**, go to the **Help** tab.
4. In the **Search Commands** field, type ***terrain prep*** and press **Enter**.



5. In the search results, click the **Terrain Prep Tool** . The **Terrain Prep Tool** opens.
6. On the **Terrain Prep Tool**, click the **Add DTM Files to the list** icon .
7. In the **Add DTM from...** dialog, change the Files of Type to **LiDAR (.las)** and select ***subset_countours.las***. Click **OK**.



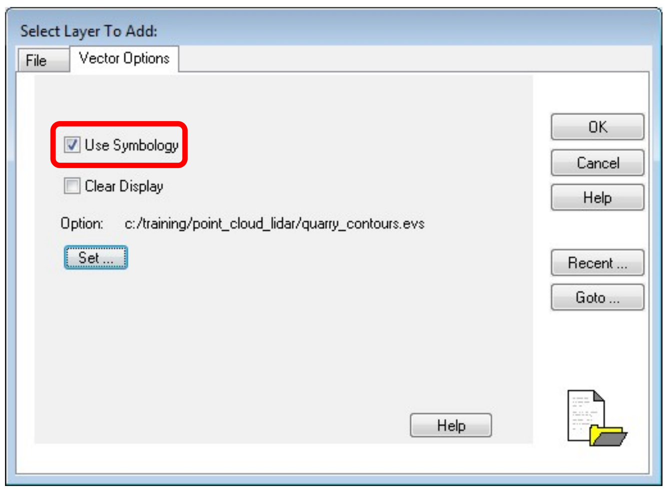
8. The **Contouring** function is included as part of the **Surfacing** process, so click the **Surface DTM** icon .
9. Leave everything on the **General** tab as it is and open the **Contouring** tab. Check the **Output Contours** checkbox to generate contours.



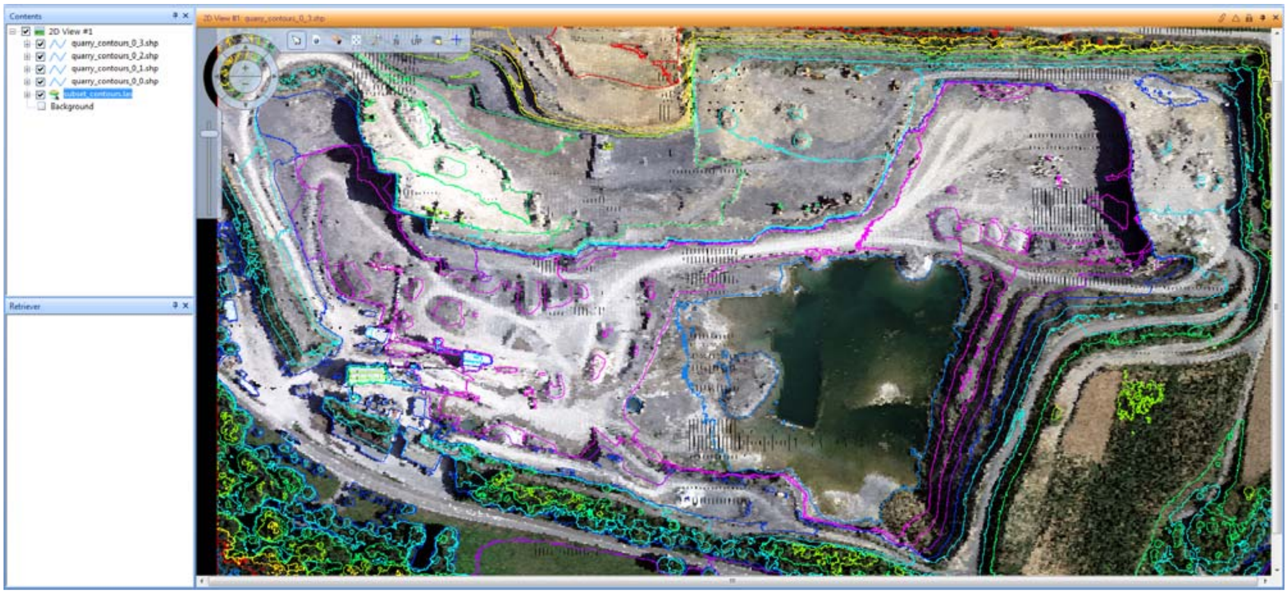
10. For the **Output Filename**, type ***quarry_contours.shp***
11. Check **Smooth contours**. Change this setting to **High**.
12. Check **Remove open contours shorter than** and **Remove closed contours with area less than**. Leave these set to their defaults.
13. Click **OK** to begin generating the contours.
14. When the process finishes, select **File** > **Open** > **Vector Layer**.
15. Navigate to your Outputs directory. Use **Shift + click** to select all of the ***quarry_contours_*_*.shp*** files. In our case there are four Shapefiles created by the software. **Do NOT click OK yet.**

The **Contouring** function creates tiled contour shapefiles. The filename we provided was the rootname for the files. The software uses the rootname_RowNumber_ColumnNumber template when naming the files.

16. Click on the **Vector Options** tab.



17. Check the **Use Symbology** box.
18. Click **Set...** Navigate to your Inputs directory and select ***quarry_contours.evs***. Click **OK** on the Choose Symbology dialog.
19. Click **OK** on the Select Layer to Add dialog. The vector contours are displayed on top of the ***subset_contours.las*** file.



20. **Close** the Terrain Prep Tool. Do not save the changes to the project.
21. **Clear** the View.

Exercise 6: Viewing Point Clouds as Relief

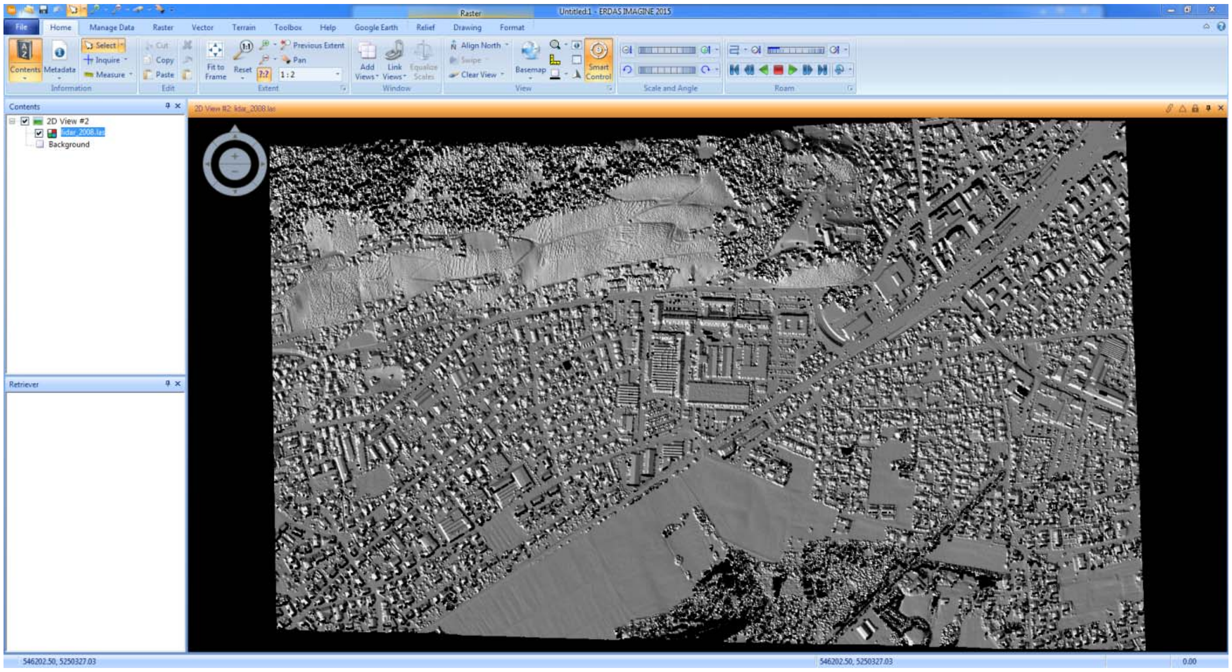
Objective:

The students will view the Point Cloud data as a raster image. This will allow visualization as a shaded relief, which allows you to simulate the position of the sun to better understand the topography of the region. The student will also create a **Painted Relief** image and a **Shaded Relief** image with a colored level slice Overlay.

Task 6.1: Visualizing Data as Shaded Relief

By knowing the topography of a geographic region and the position of the sun, it is possible to create an image which represents the amount of light reflected to a position directly above the scene.

1. Select **File** > **Open** > **Raster Layer**. Change the Files of Type to **LAS as Raster (.las)**.
2. In the Select Layer to Add dialog, select ***lidar_2008.las***. The software creates a rasterized version of the LAS file.
3. On the **Raster Options** tab, change the **Display As** to **Relief** and click **OK**.



Q: ***Why are there black “holes” in the image?***

4. On the **Relief** tab, move the **Sun Aspect** circle around the diagram to change the sun angle and the shadows in the relief image.
5. Roam and Zoom about the image, getting used to seeing this data in a new way.
6. When you find a Sun Position that highlights a feature you like, make a note of it here.

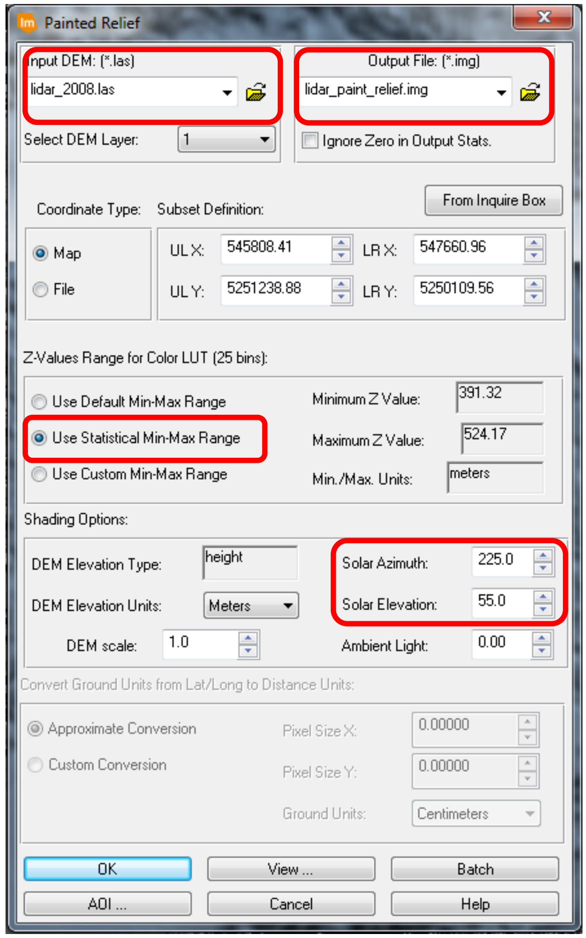
Solar Azimuth	Solar Elevation

Q: ***What features are visible in the relief image that weren’t apparent in the point cloud?***

Task 6.2: Creating Painted Relief Image

There are two methods for creating a painted relief with color. The first method is an automated process which uses a default color ramp.

1. From the eWorkspace, click **Terrain** tab >  **Painted Relief**. The Painted Relief dialog box appears.

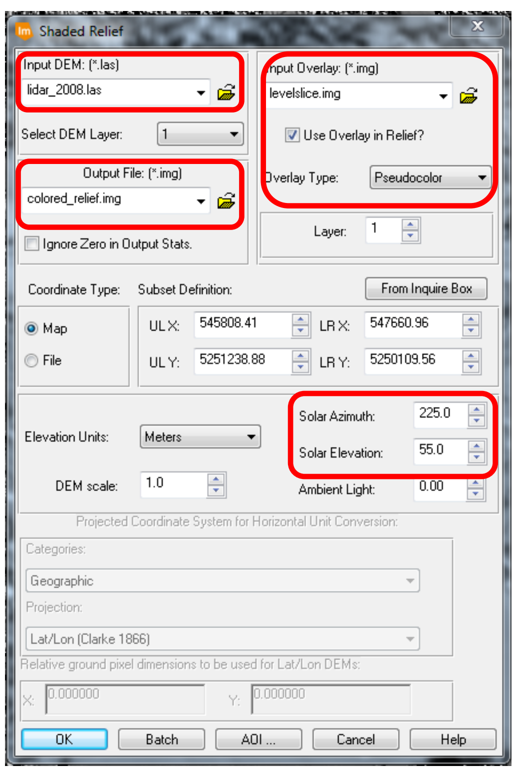


2. Use ***lidar_2008.las*** for the input and name the Output File: ***lidar_paint_relief.img***.
3. For the Z-Values Range for Color LUT, click the **Use Statistical Min- Max Range** radio button.
4. Change the **Solar Azimuth** and **Solar Elevation** to the settings you wrote down in the previous task.
5. Click **OK** to begin the process.
6. Open the file in a View.

Task 6.3: Shaded Relief with Level Slice Overlay

The second method allows you to use a customized color ramp image created in IMAGINE (**the Level Slice** function) or any raster overlay on the shaded relief image.

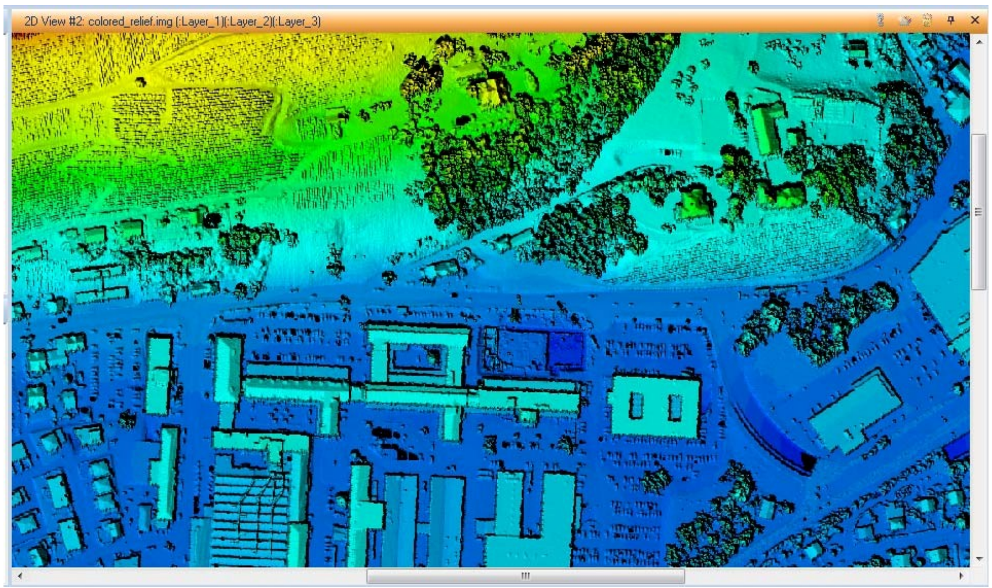
1. From the eWorkspace, click **Terrain** tab > **Shaded Relief**. The Shaded Relief dialog displays



2. Use ***lidar_2008.las*** as the Input DEM and enable the **Use Overlay in Relief** checkbox.
3. Browse to your input directory and use ***levelslice.img*** as the Input Overlay, and ensure the **Overlay Type** is set to **Pseudocolor**.
4. Set the **Solar Azimuth** and **Solar Elevation** to the settings you identified in Task 1, then name the Output file ***colored_relief.img*** and click **OK**.
5. Display ***colored_relief.img*** in a View.

Q: ***Could you also use a Multispectral Satellite Image as an Overlay?***

6. **Clear** all open Views and close dialogs.



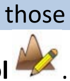
Exercise 7: Surfacing a Point Cloud for Viewshed Analysis

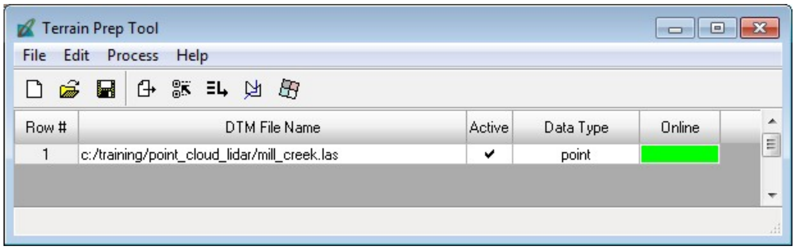
Objective:

Students will learn to use the **Surfacing** function in the **Terrain Prep Tool** to interpolate a raster surface from a Point Cloud file. They will then perform a **Viewshed Analysis** to identify visible and hidden areas within a set range.

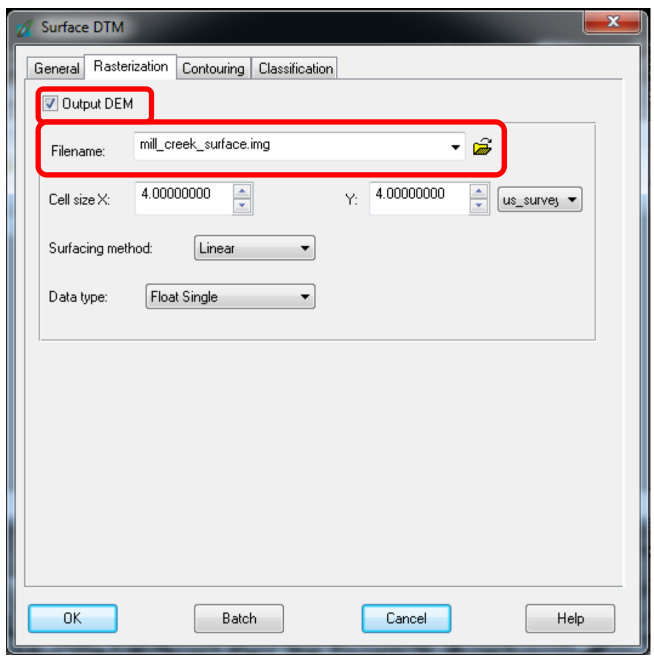
Task 7.1: Surface a LiDAR Point Cloud

You may have noticed in the previous exercises that when we created a raster from the point cloud, the areas of NoData (the holes) were passed through to the output files. Surfacing the data tells the software to interpolate a raster surface over those holes.

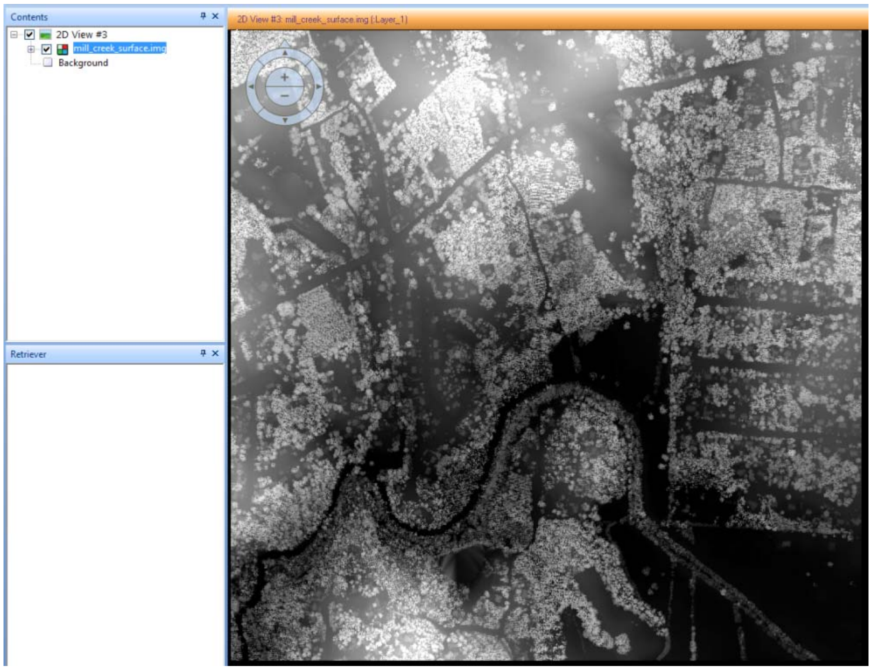
1. On the Terrain tab, click the **Terrain Prep Tool** . The Terrain Prep Tool opens.



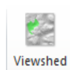
2. On the Terrain Prep Tool, click the  **Add DTM Files to the list** icon.
3. In the **Add DTM from...** dialog, change the Files of Type to **LiDAR (.las)** and select ***mill_creek.las***. Click **OK**.
4. Click the **Surface DTM** icon. 
5. Leave everything on the General tab as it is and change to the **Rasterization** tab. Check the **Output DEM** checkbox to generate a Surface image.

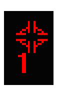


6. Enter ***mill_creek_surface.img*** for the **Output DEM Filename**. Leave everything else set to defaults and click **OK**.
7. When the process finishes, open ***mill_creek_surface.img*** in a View.

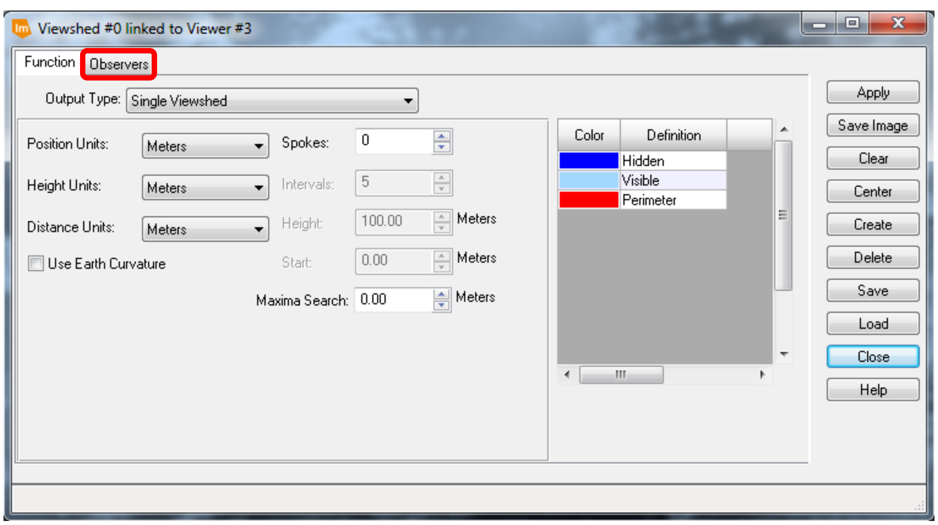


Task 7.2: Create a Single Viewshed Layer

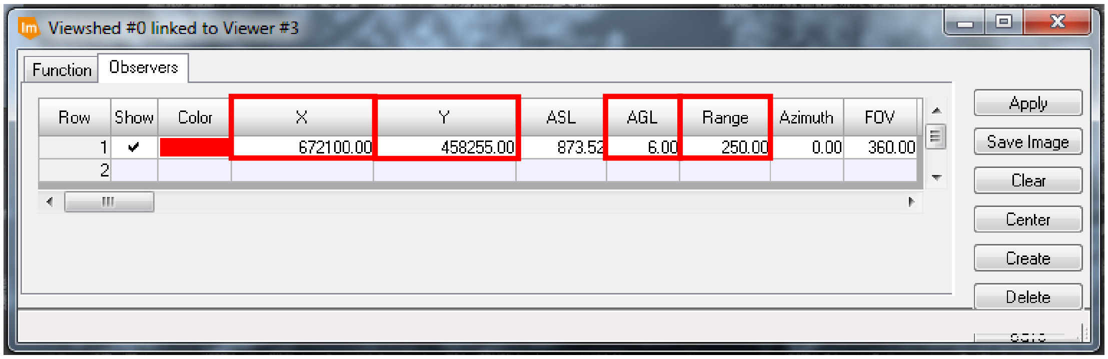
1. Click the **Terrain** tab > **Viewshed**. 

A point marked 

will appear in the center of the Viewer and the Viewshed dialog box will appear.

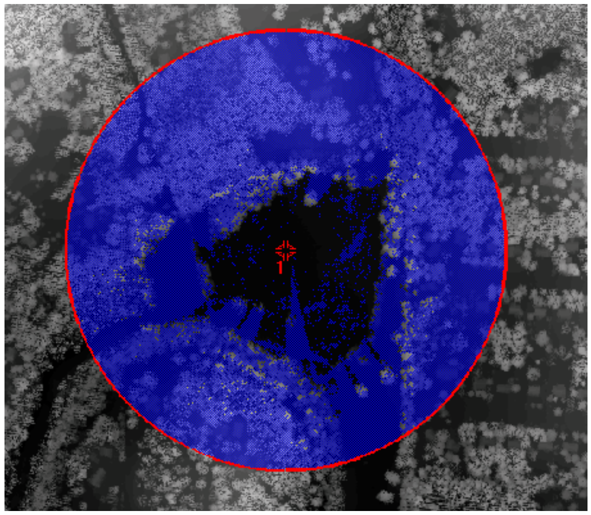


2. Click the **Observers** tab and type:

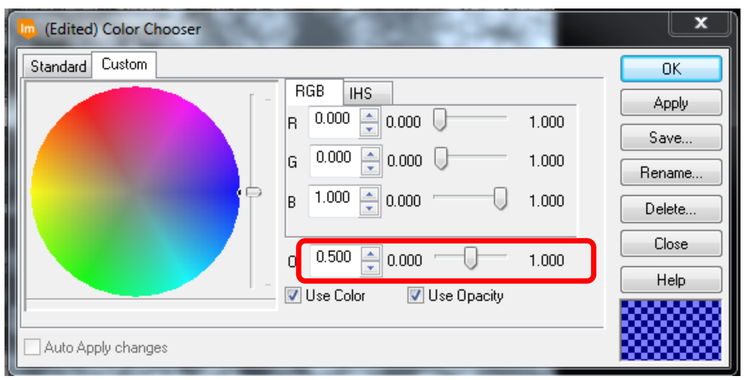


X =	**672100**
Y =	**458255**
AGL =	**6**
Range =	**250**

3. Click **Apply**. A Viewshed is generated in the View.



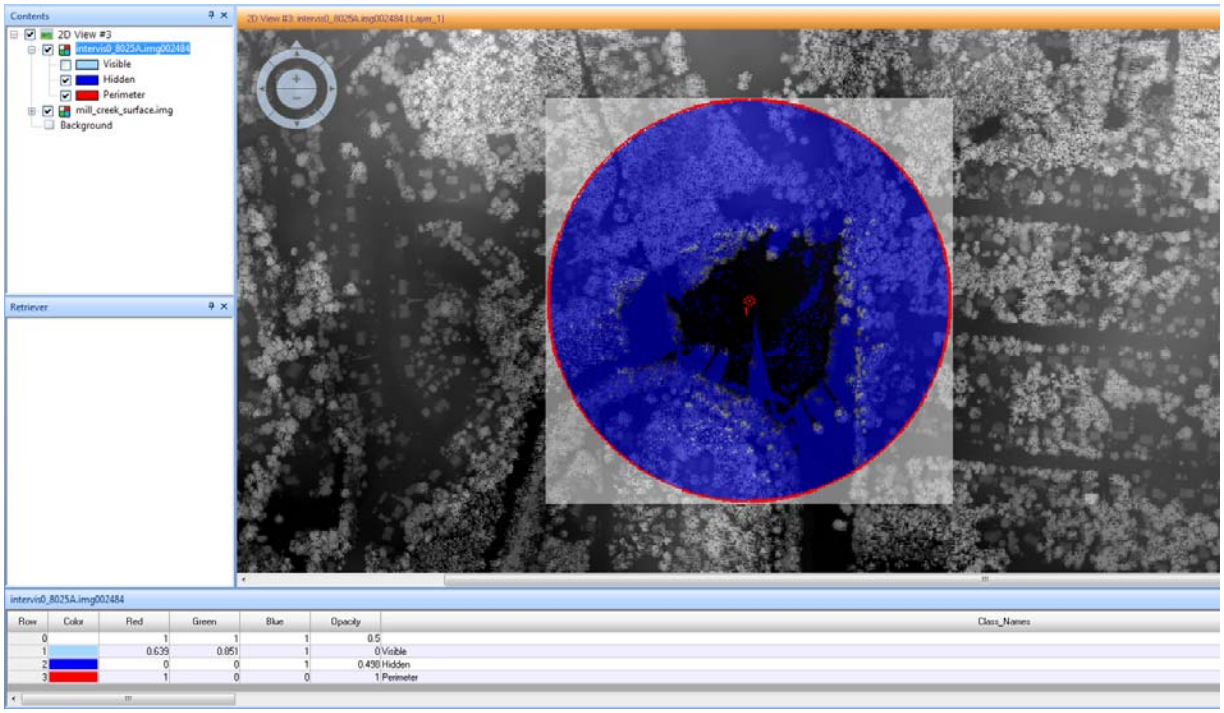
4. Click the **Function** tab.
5. Click on the blue color patch next to **Hidden**. Select **Other**.



6. In the Color Chooser dialog box, enable the **Use Opacity** checkbox and move the slider bar for **O** at the bottom to **0.5**.
7. In the Color Chooser dialog, click **OK**.
8. Click **Apply** again in the Viewshed dialog box.

Q: ***Why isn't the visible color turned on when the Viewshed is created in the Viewer?***

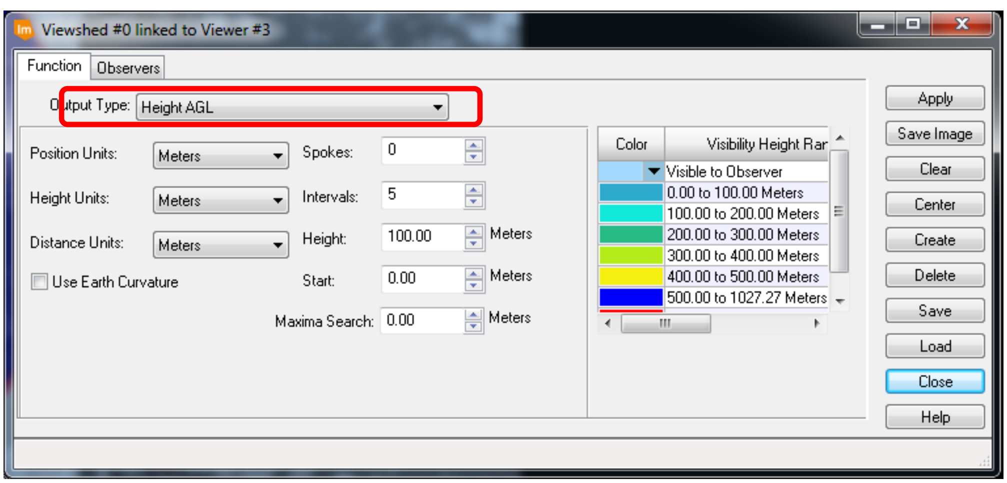
9. Right-click on the ***intervis*** layer in the Contents pane. Select **Display Attribute Table**.
10. Type **0.5** in the Opacity cell of **Row 1**. This will allow you to set the Visible parts to 50% Opacity.



Task 7.3: Height above Ground Level

> You will now create a new Viewshed layer that produces a gradient of viewing regions above ground level.

1. In the Viewshed dialog box under the Function Tab, change the Output Type to **Height AGL**.



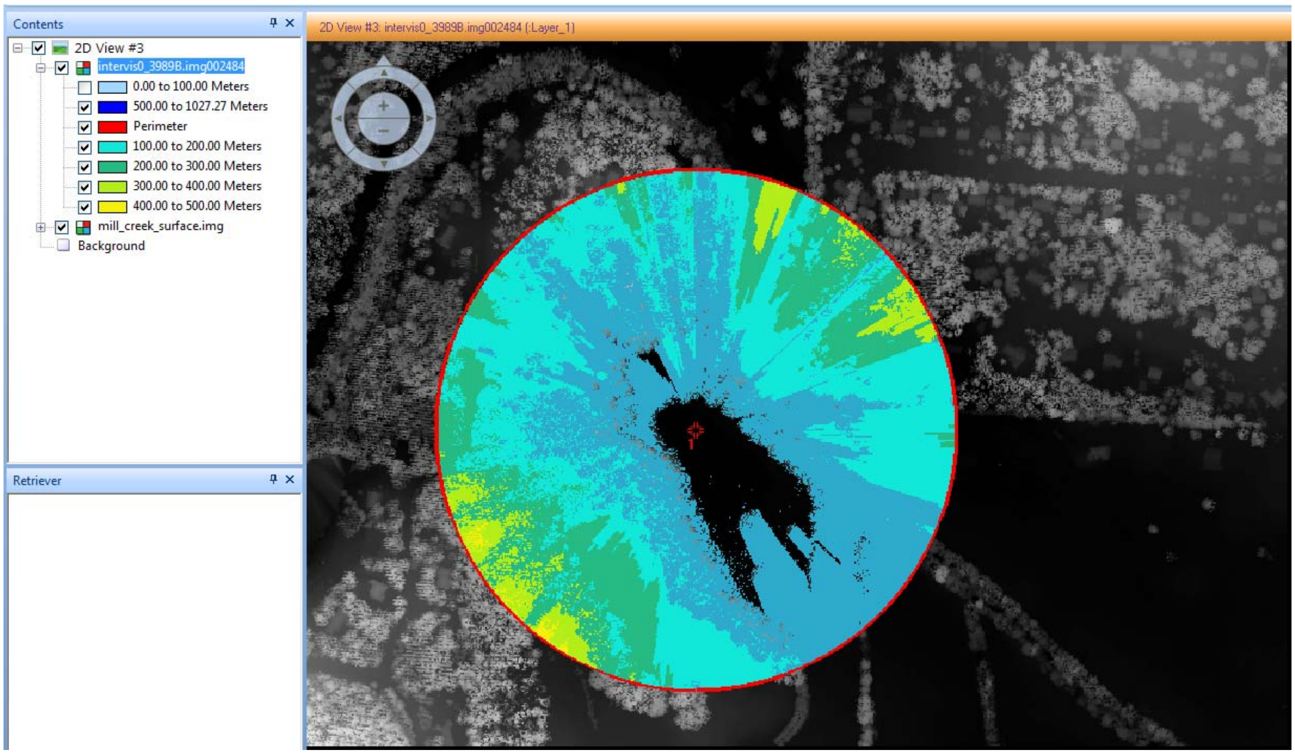
2. Change to the Observers tab and type the following:

X =	**672125**
Y =	**457810**

AGL =	**30**
Range =	**250**

3. Click **Apply**. Select **Yes** if you are asked to save.

A new viewshed is generated that shows color-coded levels above ground level. The resulting display shows how high above ground an object must be in order to be seen by the observer.

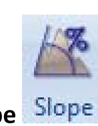


Challenge 3: Slope and Aspect Images

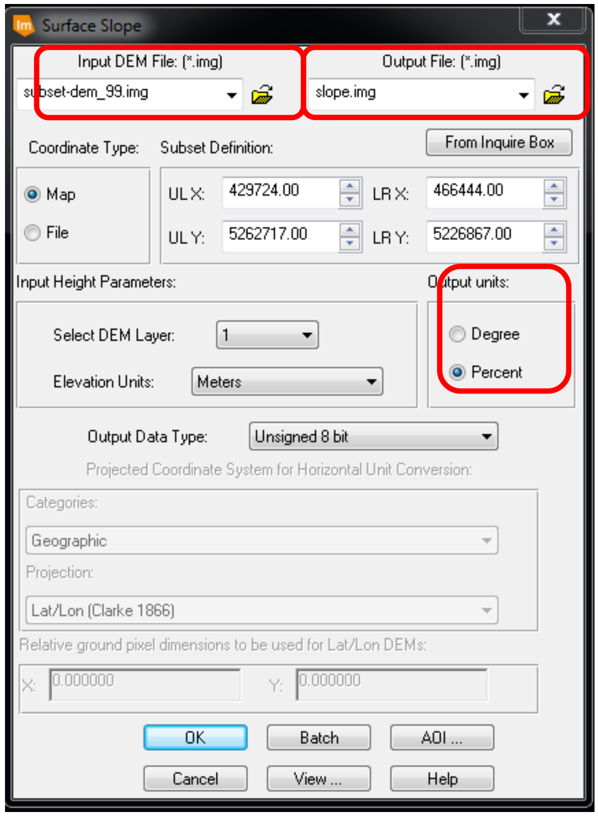
Objective:

The student will use a traditional 30-meter resolution DEM image to create **Slope** and **Aspect** images.

Task 3.1: Create a Slope Image

1. From the eWorkspace, select **Terrain** tab > **Slope** 

. The Surface Slope dialog displays.



2. Use ***subset-dem_99.img*** for the Input File, name the Output File: ***slope.img.***
3. Set the **Output units** option to **Percent**.
4. Click **OK** to start the process.

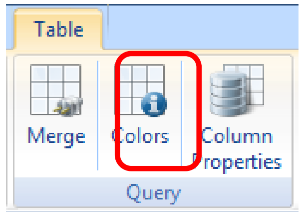
100% slope is equivalent to 45° slope and 200% slope is equivalent to 90° slope. See the ERDAS Field Guide™ for more information.

5. Select **File** > **Open** > **Raster Layer...**
6. Browse to your outputs directory, change the **Files of Type:** to ***IMAGINE Image (*.img).***
7. Select ***slope.img*** and click on the **Raster Options** tab.
8. Change **Display As** to **Pseudo Color** and click **OK**.
9. Right click on ***slope.img*** in the Contents pane. Select **Display Attribute Table**.

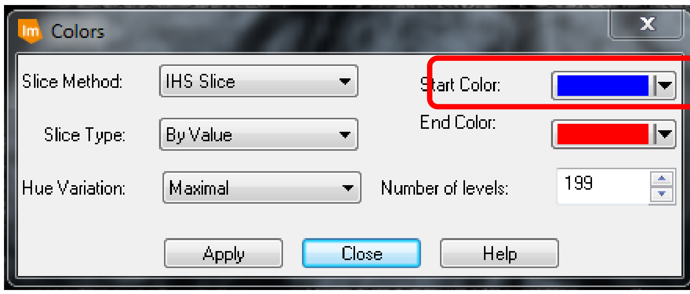
Q: ***How many classes were created?***

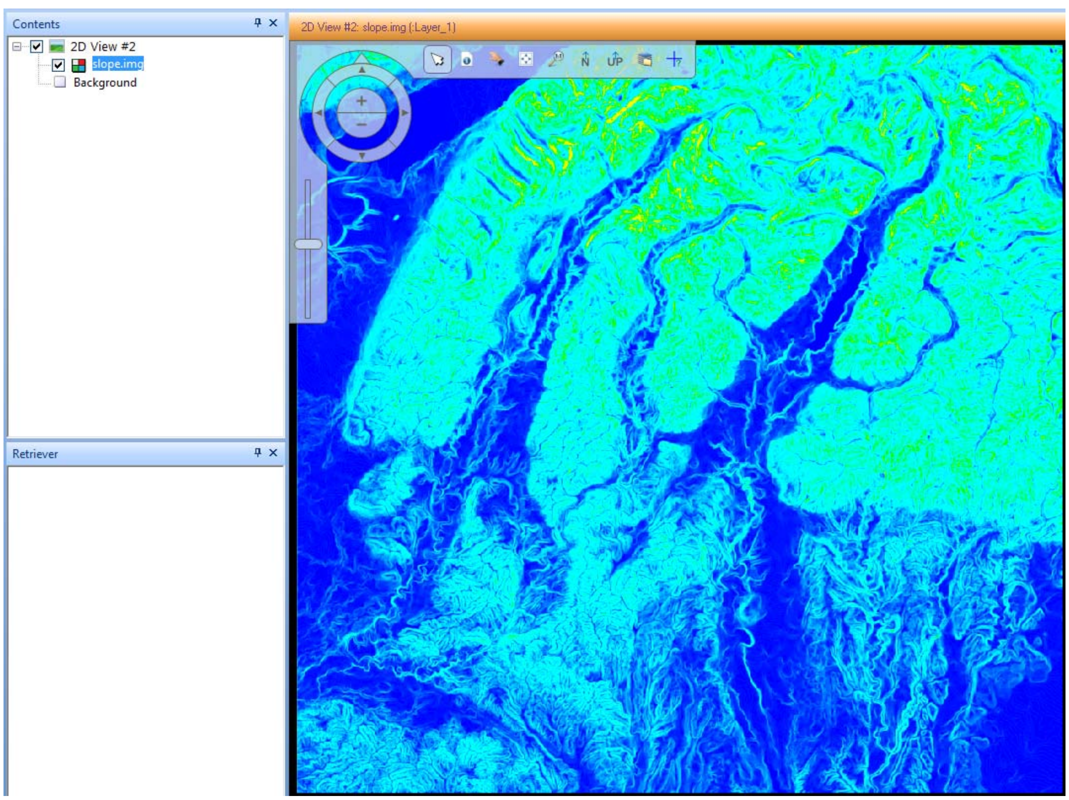
Q: ***What type of surface does class 0 represent?***

10. Click **Table** tab > **Query** group > **Colors**.



11. Change the **Start** color to **Blue** and click **Apply**.

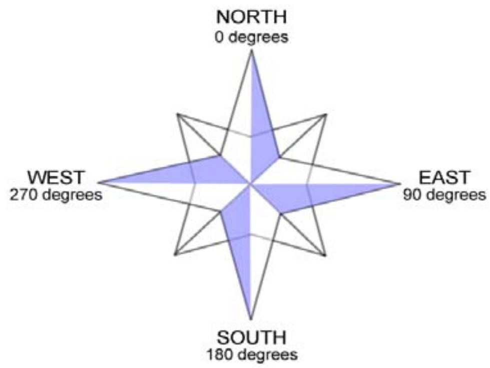




12. **Clear** all open Views and close dialogs.

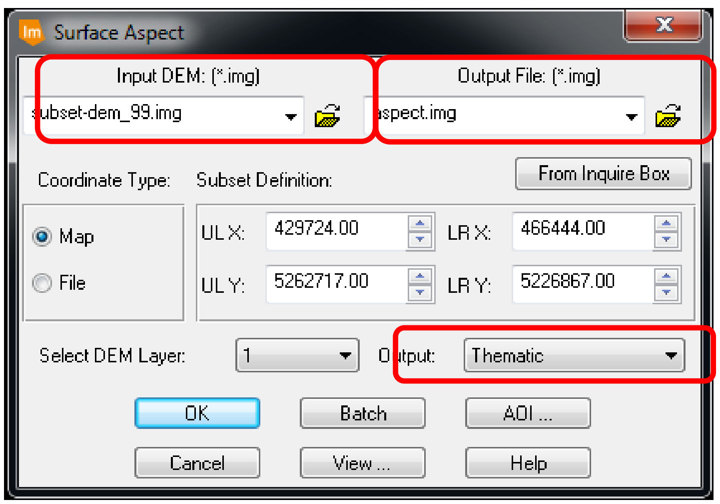
Task 3.2: Create an Aspect Image

Aspect represents a direction in degrees measured clockwise from north.



1. From the eWorkspace, select **Terrain** tab > **Aspect** 

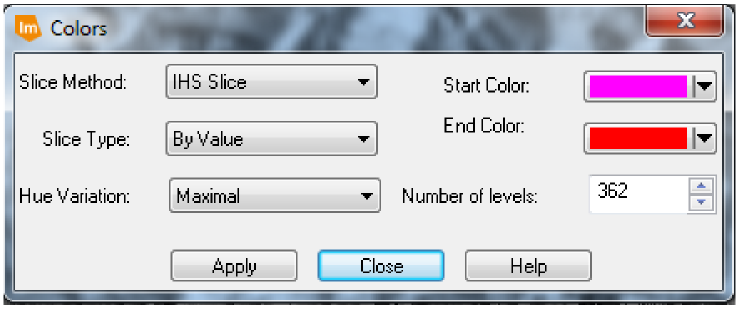
. The Surface Aspect dialog displays.



2. Use ***subset-dem_99.img*** for the Input File and name the Output File: ***aspect.img***.
3. Set the **Output** option to **Thematic**.
4. Click **OK** to create the output file.
5. Display the output file in a View.
6. Right click on ***aspect.img*** in the Contents pane. Select **Display Attribute Table**.

Q: ***How many classes were created in this image? What do Classes 0, 360, or 361 represent?***

7. Click **Table** tab > **Query** group > **Colors**.



8. Leave the settings at their defaults and click **Apply**.
9. **Clear** all open Views and close dialogs.