

# Creating Projected Surfaces

Spectra Geospatial, 10368 Westmoor Drive, Westminster, CO 80021, USA  
Spectra Geospatial, Rue Thomas Edison, ZAC de la Fleuriaye - BP 60433, 44474 Carquefou (Nantes), FRANCE

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## About this tutorial

In this tutorial, you will create a projected (non-horizontal) surface for each of two point clouds of an exterior building wall that were collected before and after adjacent ground excavation to determine wall movement resulting from the excavation.

**Note:** If you need additional help at any time you are using the software, press **F1** to display the online help.

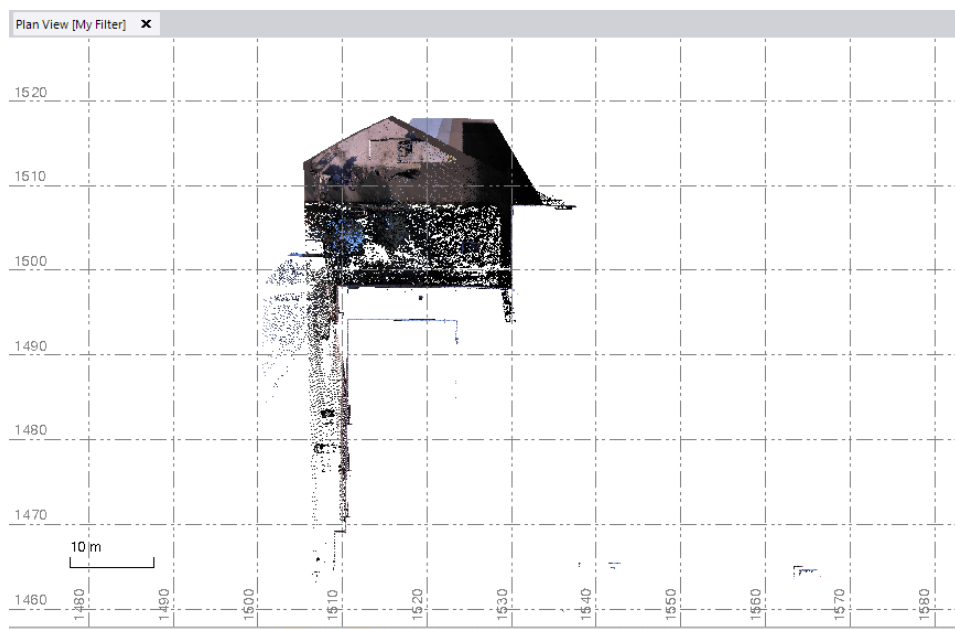
## Step 1. Open the project

For this tutorial, you will work with a project that includes two imported points clouds that include a section of an exterior wall that is being monitored for changes. One point cloud was collected before adjacent ground excavation work and one was collected after excavation was completed.

**Note:** The downloaded *CreatingProjectedSurfaces* folder contains this PDF file, a *Creating Projected Surfaces.vce* project file, and a *Creating Projected Surfaces* project folder.

1. In SO, select **File > Open**.
2. In the **Open File** dialog, browse to `..\CreatingProjectedSurfaces\Creating Projected Surfaces.vce` and click **Open**.

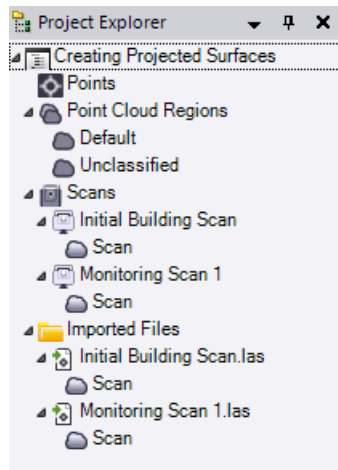
The project opens in the **Survey Office** window.



The project file is read-only. You can perform the tutorial steps without saving the project file. However, if you are interrupted while performing the tutorial, you can save it with a new name by selecting **File > Save Project As**. Then, you can re-open the project to continue the tutorial at a later time.

3. If the **Project Explorer** is not already displayed, in the **SO** ribbon, select **Home > Data > Project Explorer** to display it.

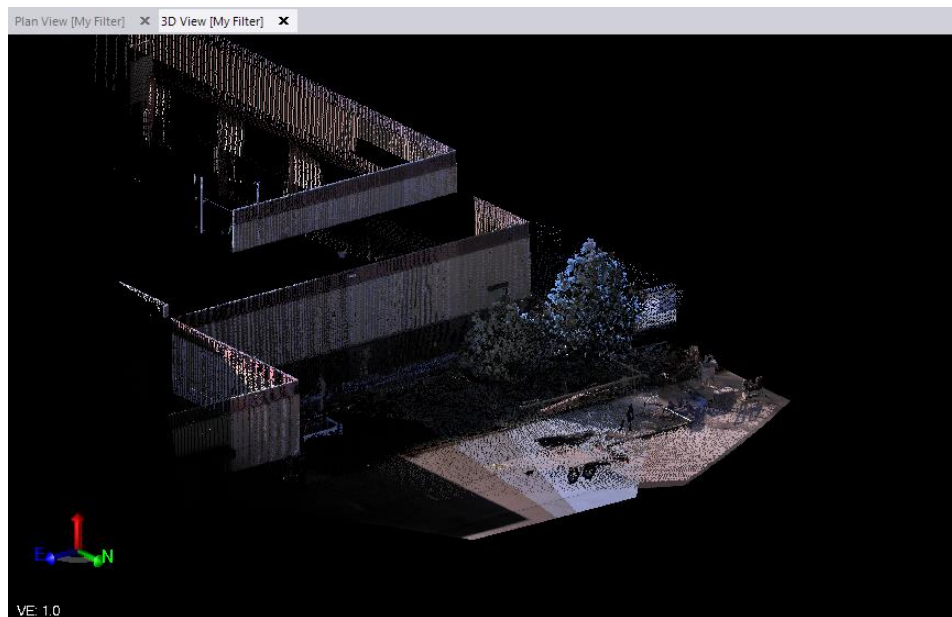
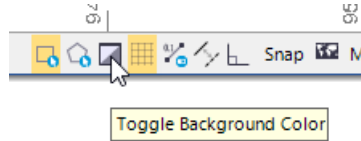
In the **Project Explorer**, you can see the two point clouds that have been imported into the project: *Initial Building Scan* and *Monitoring Scan 1*.



4. In the **SO** ribbon, select **Home > View > 3D View**. Then, use your right-mouse button and mouse wheel (roll and press-and-drag) to navigate the 3D view to see the exterior wall you want to monitor, as shown here.



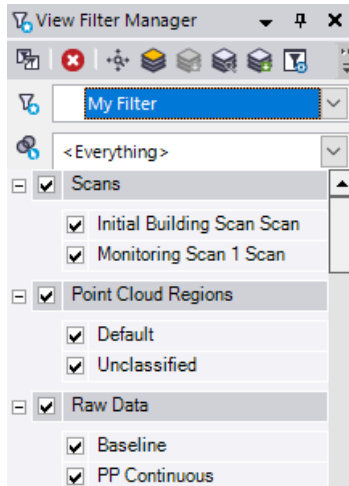
Optionally, you can change your background to black (if it is not already black), which is typically used to view point clouds on the **3D View** tab. Just click the **Toggle Background Color** button located at the bottom of the **SO** window. However, for this tutorial you will continue to use a white background to make it easier to make selections on the **Plan View** tab and avoid toggling back and forth



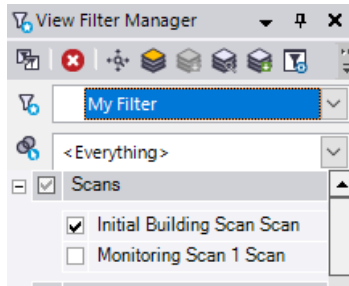
## Step 2. Create the first projected surface

In this step, you will create a projected surface on the building wall for the *Initial Building Scan* point cloud.

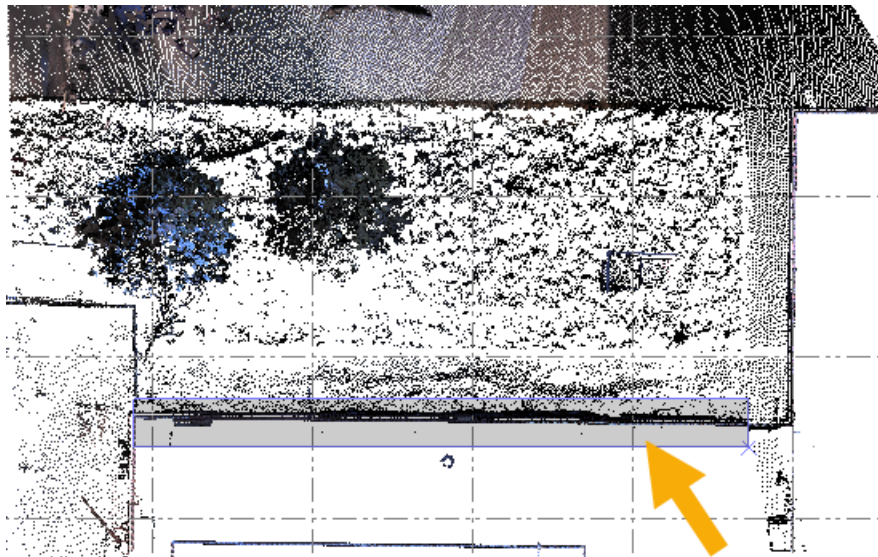
1. In the **SO** ribbon, select **Home > View > View Filter Manager** to display the **View Filter Manager**.



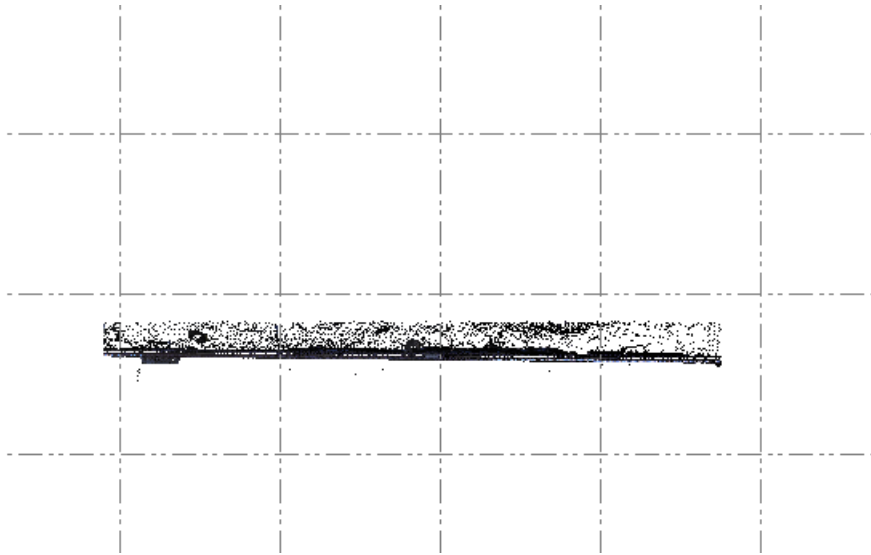
2. Uncheck the *Monitoring Scan 1 Scan* check box and ensure that the *Initial Building Scan Scan* check box is checked so that only the *Initial Building Scan* point cloud is displayed.



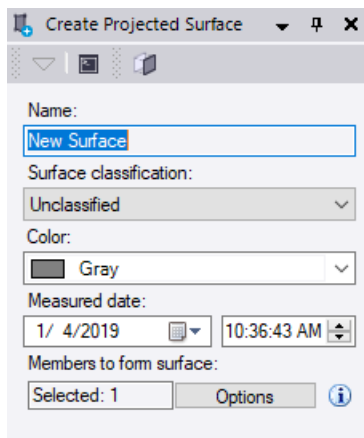
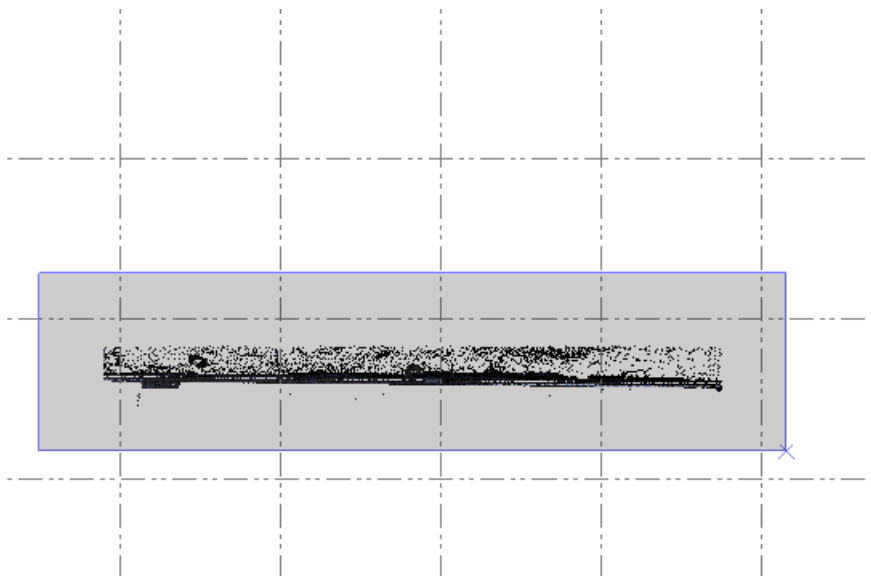
3. On the **Plan View**, use your cursor to make a selection of the wall points as shown here.



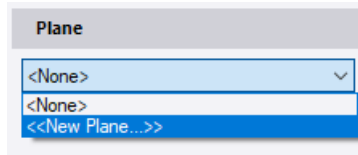
4. In the **SO** ribbon, select **Point Clouds > Regions > Keep In** to hide all of the non-selected scan points.



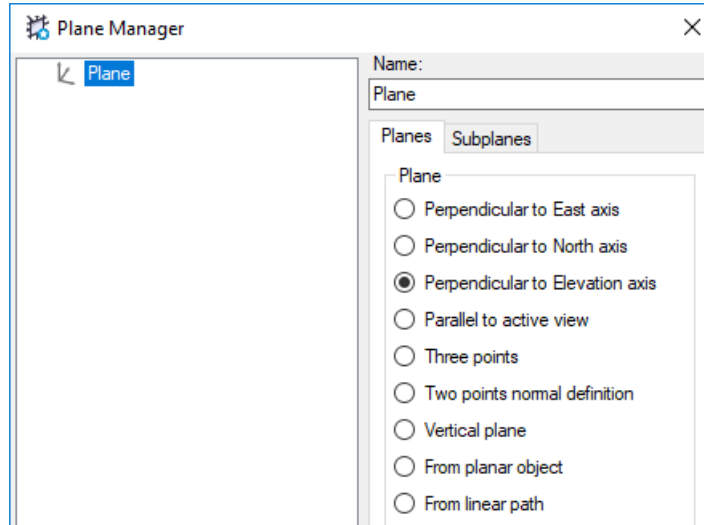
5. Select the remaining points in the **Plan View** and then select **Surfaces > Projected > Create Projected Surface**.



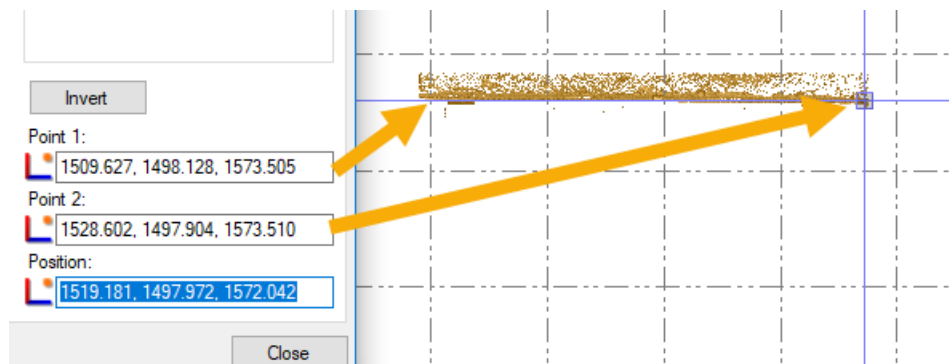
6. In the **Name** field, enter *Initial*.
7. In the **Plane** drop-down list, select <<New Plane...>>.



The **Plane Manager** displays.



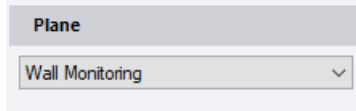
8. In the **Plane Manager**, do the following:
  - a. Click the **New** button.
  - b. In the **Name** field, enter *Wall Monitoring*.
  - c. Select the **Vertical plane** option.
  - d. Click in the **Point 1** field and click on the left end of the selected points in the **Plan View**. Then click on the right end to make your **Point 2** selection.



The intent is to ensure the plane is roughly parallel to the entire wall.

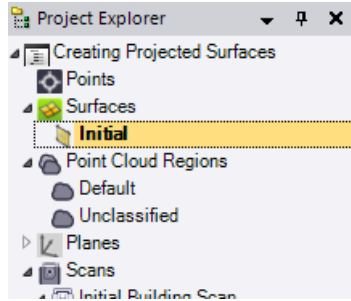
- e. Click **Close**.

*Wall Monitoring* is selected in the **Plane** drop-down list in the **Create Projected Surface** command pane.

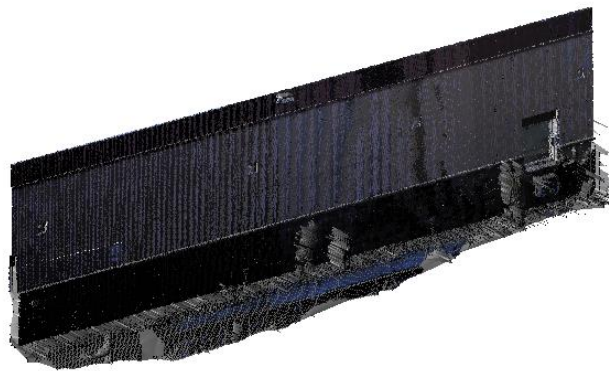


9. Click **OK**.

Processing status is displayed at the bottom of the window. When complete, the new **Surfaces > Initial** node displays in the **Project Explorer**.



10. Visually inspect the new surface in the **3D View**.



VE: 1.0

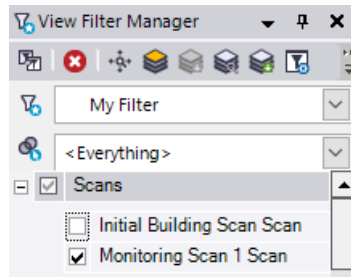
Note that flags may display due to errors in the triangulation of the surface. Flags typically indicate that two points are on top of each other, with respect to the plane definition. This is not a big concern if they are isolated. If necessary, they can be cropped out of the surface later in this procedure when you create a surface boundary.

### Step 3. Create the second projected surface

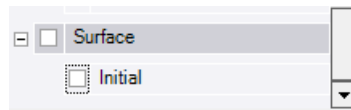


In this step, you will create a projected surface on the building wall for the *Monitoring Scan* point cloud.

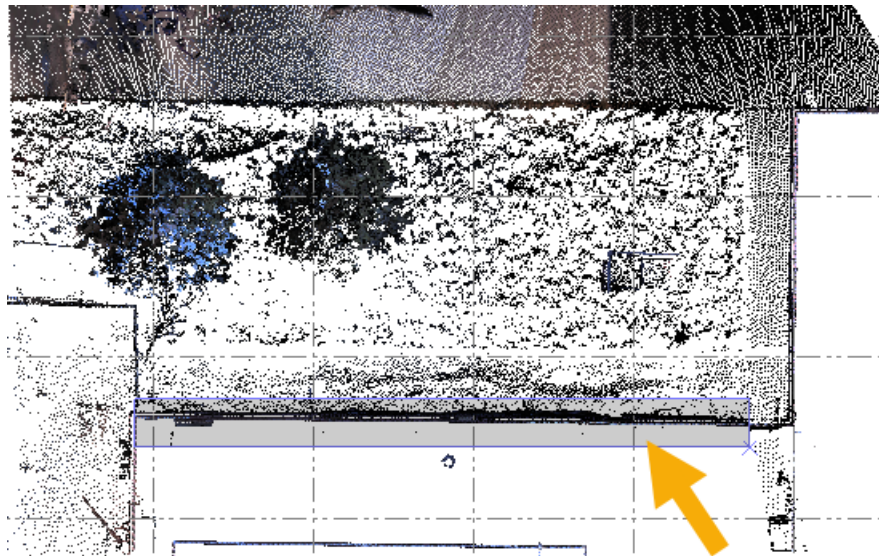
1. In the **View Filter Manager**, uncheck the *Initial Building Scan Scan* check box and check the *Monitoring Scan 1 Scan* check box so that only the *Monitoring Scan 1* point cloud displays in the graphic views.



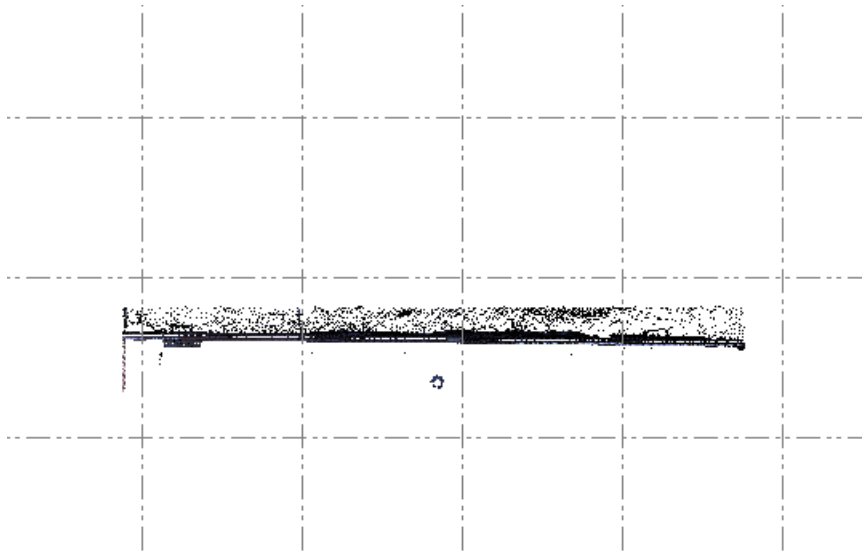
Then, in the **Surface** section, uncheck the new *Initial* surface check box.



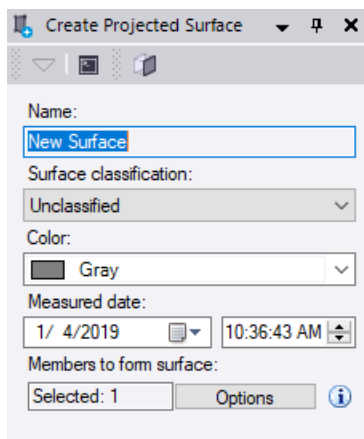
2. In the **SO** ribbon, select **Point Clouds > Regions > Restore All** to display all of the *Monitoring Scan* point cloud scan points
3. On the **Plan View**, make a selection of the wall points as you did for the first projected surface.



4. Select **Point Clouds > Regions > Keep In** to hide all of the non-selected scan points.

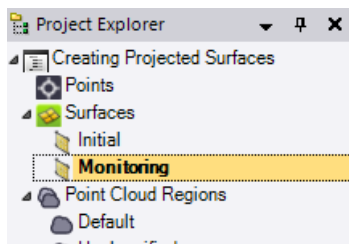


5. Select the remaining points in the **Plan View** and then select **Surfaces > Projected > Create Projected Surface**.



6. In the **Name** field, enter *Monitoring*.
7. In the **Plane** drop-down list, ensure *Wall Monitoring* is selected.
8. Click **OK**.

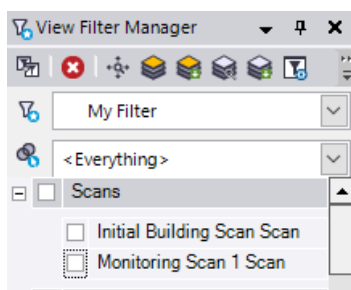
Processing status is displayed at the bottom of the window. When complete, the new *Monitoring* surface node displays in the **Project Explorer**.



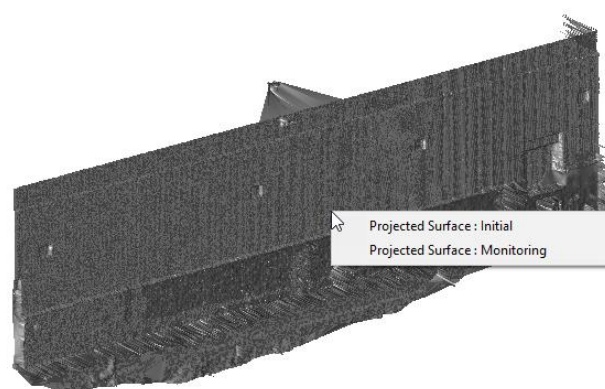
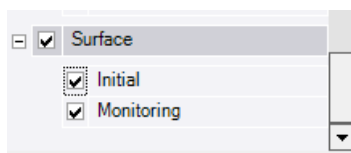
## Step 4. Create a surface boundary

In this step, you will create a surface boundary to crop out parts of the surfaces that will be invalid for analysis: areas where the surface mesh did not triangulate properly. This can be caused by geometric irregularities in the surfaces or by points that define other surfaces perpendicular to the specified plane.

1. In the **View Filter Manager**, uncheck the *Monitoring Scan 1 Scan* check box so that neither point cloud is displayed in the graphic views.



Then, in the **Surface** section, check the *Initial* surface check box so that both surfaces are displayed in the graphic views.

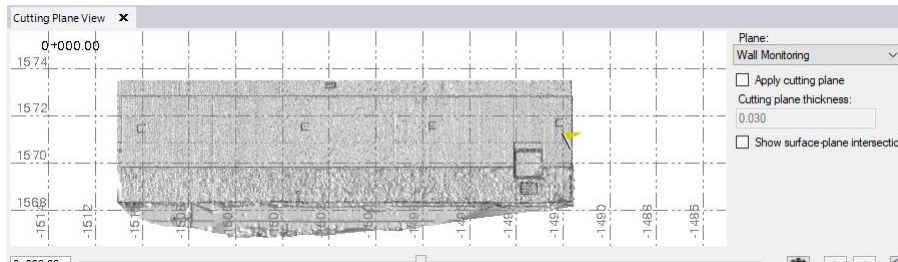


VE: 1.0

2. In the **SO** ribbon, select **Point Clouds > View > Cutting Plane View** to display the **Cutting Plane View** tab.

The **Cutting Plane View** tab displays showing a 2D view of the **Wall Monitoring** plane, which includes the two projected surfaces.

3. In the **Cutting Plane View**, ensure that both check boxes are unchecked.

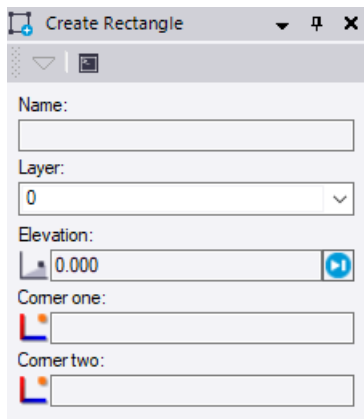


The **Cutting Plane View** is a powerful tool that provides a 2D view of any user-defined plane in your project. You can use it, for example, to create CAD line work (for example, linework tracing features on a building facade) that can be printed as a dynaview in a sheet set and/or exported to other applications via various CAD exporters. For this tutorial, you will use it to draw a CAD rectangle to use as a surface boundary.

Optionally, the **Apply cutting plane** check box can be used in conjunction with the specified **Cutting plane thickness** value to define the thickness of the plane, which in turn causes more or less scan points to be displayed. In this case, it is not necessary.

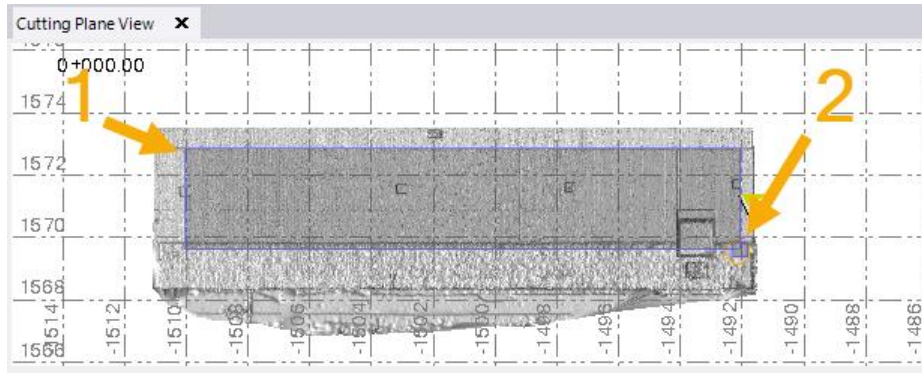
Next, you will draw a rectangle around the area you want to include in each of the two surfaces.

4. To draw a rectangle that defines the boundaries for the two surfaces, do the following:
  - a. In the **SO** ribbon, select **CAD > Lines > Create Rectangle**.



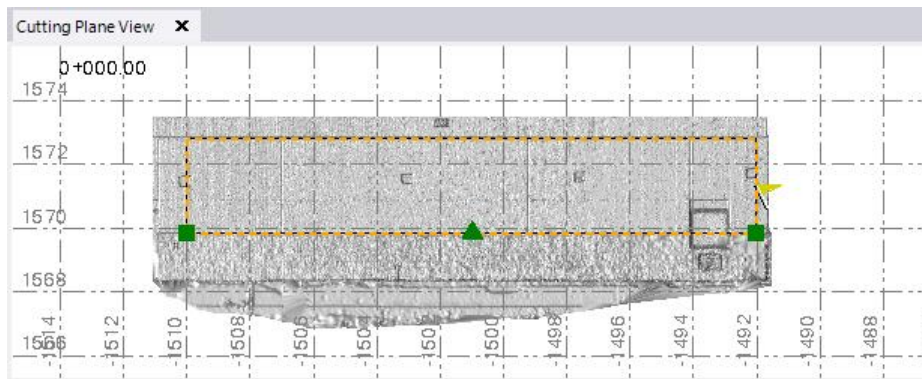
There is no need to enter a **Name**, change the **Layer**, or change the **Elevation**.

- b. Click in the **Corner one** field and then click once in the upper-left corner as shown here (1). Then move the cursor to the lower right corner and click a second time (2).

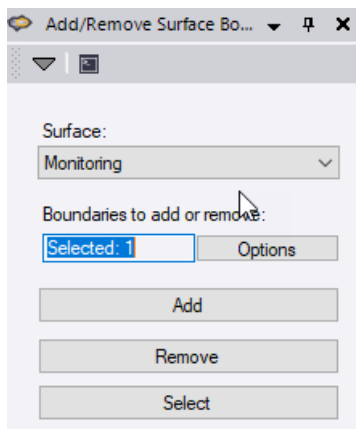


- c. Right-click and select **[Close]** to close the **Create Rectangle** command pane.
- d. In the **Cutting Plane View**, select the new rectangle (*CAD Polyline*).

Note that the bottom portion of the wall has been cropped out because points collected there were partially blocked by a fence.



5. Close the **Cutting Plane View** tab.
6. In the **SO** ribbon, select **Surfaces > Create > Add/Remove Surface Boundaries**.



7. In the **Add/Remove Surface Boundaries** command pane, do the following:
  - a. In the **Surface** list, select the new projected surface *Initial*.

b. Ensure that the new rectangle is selected in the **Boundaries to add or remove** field.

c. Click the **Add** button to add the new boundary to the surface.

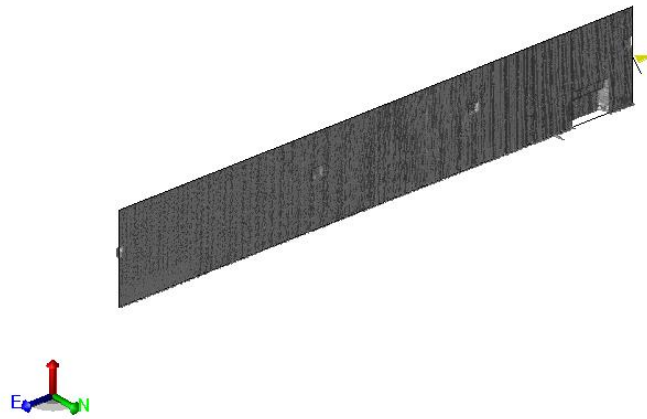
The progress of the process is displayed in the **Status Bar** at the bottom of the SO window.

d. When the process is complete, in the **Surface** list, select the new projected surface *Monitoring*.

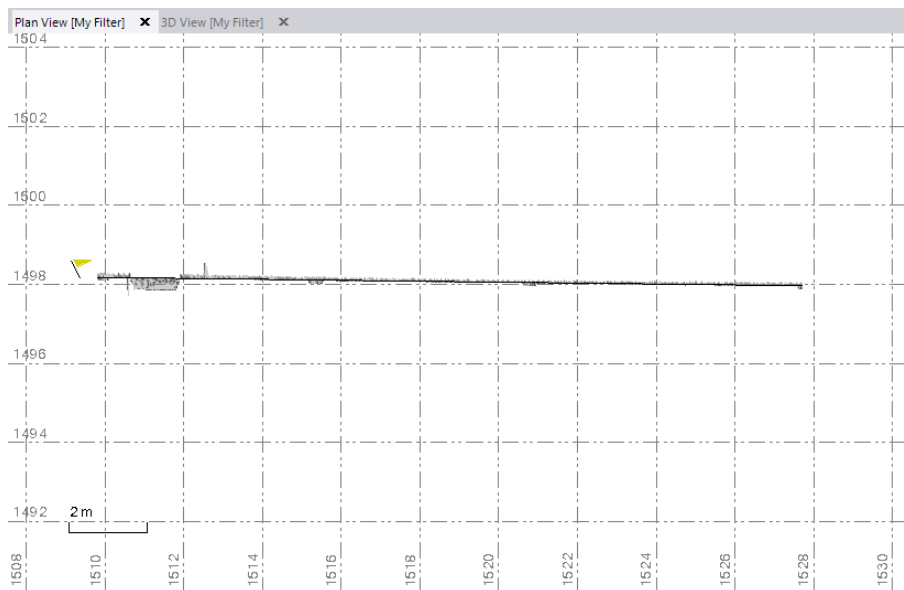
e. Click the **Add** button

When processing is complete, the two cropped surfaces display directly on top of each other in the graphic views.

Plan View [My Filter] x 3D View [My Filter] x



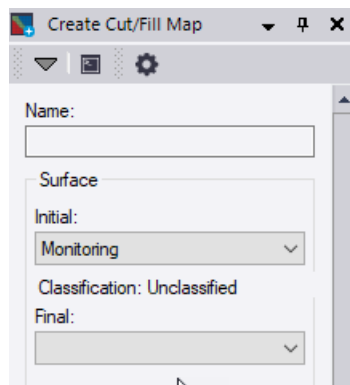
VE: 1.0



## Step 5. Create a cut/fill map

In this step, you will create a cut/fill map and modify its properties. The map will be used to illustrate the movement of the wall from prior to post-excavation. This tool can be used to make judgments on whether shoring is appropriate, or if work conditions are safe.

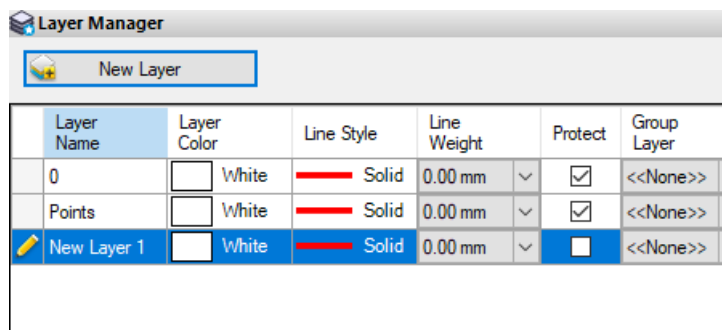
1. In the **SO** ribbon, select **Surfaces > Edit > Create Cut/Fill Map**.



2. In the **Name** field, enter *WallCutFill*.
3. In the **Initial** drop-down list, select *Initial*.
4. In the **Final** drop-down list, select *Monitoring*.

Since the display of a cut/fill map can affect performance, you will create a new layer for this cut/fill map so that you can show and hide it as necessary using the **View Filter Manager**.

5. In the **Layer** drop-down list, select *<<New Layer>>* to display the **Layer Manager** dialog.

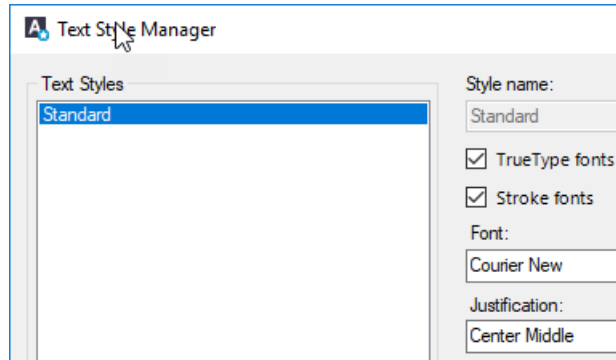


6. In the *New Layer 1* field, enter *WallCutFill*. Then, click **Close**.

*WallCutFill* is selected in the **Layer** drop-down list in the **Create Cut/Fill Map** command pane.

Next, you will specify a text size for cut/fill map labels that is smaller than the default *Standard* size of 10.0 sheet units.

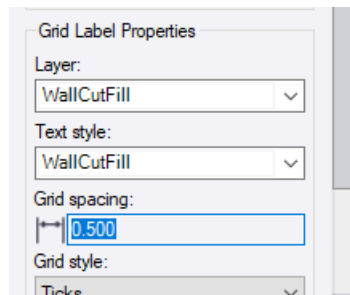
7. In the **Text style** drop-down list, select <<New style>> to display the **Text Style Manager** dialog.



8. Do the following:
  - a. Click the **New** button.
  - b. In the **Style name** field, enter *WallCutFill*.
  - c. In the **Size: Height** field, enter *0.10*.
  - d. Click **OK**.

*WallCutFill* is selected in the **Text style** drop-down list in the **Create Cut/Fill Map** command pane.

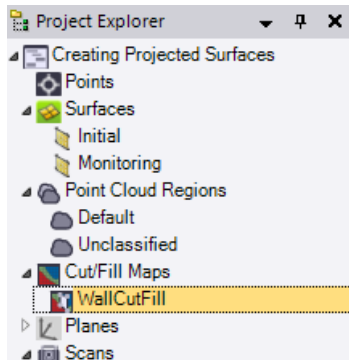
9. In the **Grid spacing** field, enter *0.50*.



10. Click **OK**.

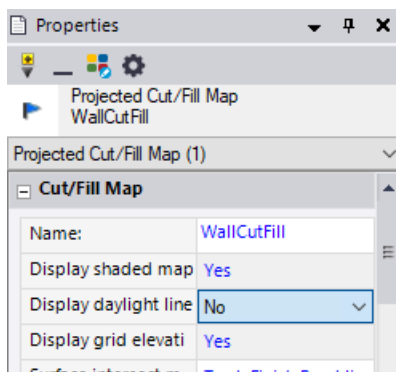
Processing may take several minutes to complete (progress is displayed in the **Status Bar**). When processing is complete, the new *WallCutFill* map node displays in the **Project Explorer**.



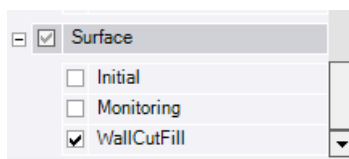


Next you will make a modification to a property for the *WallCutFill* map that will enable you to shorten processing times if you make any changes.

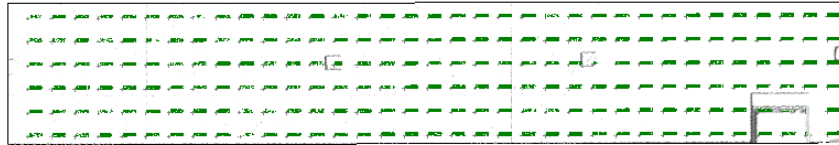
11. In the **Project Explorer**, right-click the new *WallCutFill* node and select **Properties**. Then, in the **Display daylight line** drop-down list, select **No**



12. In the **View Filter Manager**, uncheck the *Initial* and *Monitoring* surfaces, leaving just the *WallCutFill* surface checked.



When viewed straight on, the *WallCutFill* map displays in the **3D View** as shown here (). A cut or fill value is displayed every *0.500 m* along the wall. The small cut and fill values indicate very little (millimeter-level) movement in the wall.



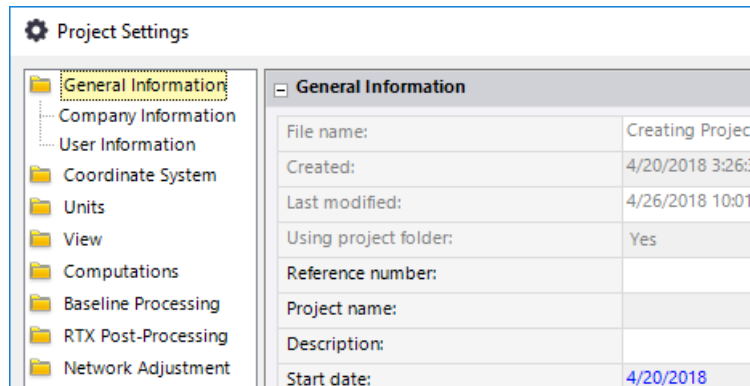
VE: 1.0

Zoomed-in view:

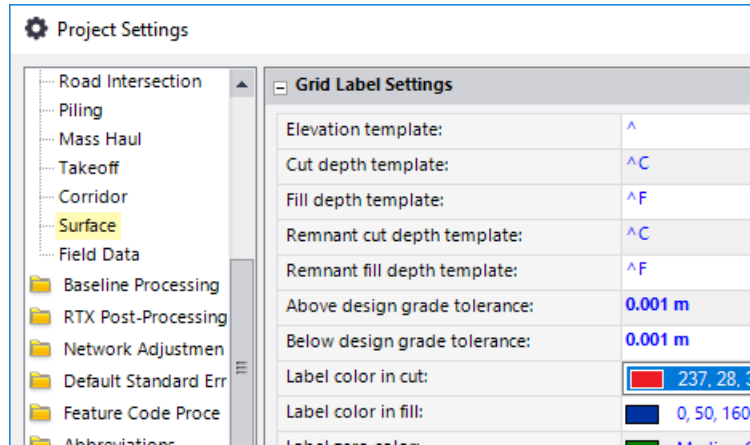


The wall's movement is on the order of millimeters, so changing the color mapping will not have as much of an affect as if you were changing it for an earthwork project. However, to create a better visual representation of the wall's movement, you will make a change to the **Project Settings** for the *WallCutFill* map.

- In the **Quick Access** tool bar (located at the top of the **SO** window), select **Project Settings**.



14. In the **Project Settings** dialog, do the following:
  - a. In the left navigation pane select **Computations > Surface**.
  - b. In the **Grid Label Settings** section, enter *0.001 m* for **Above design grade tolerance** and **Below design grade tolerance**.



- c. Click **OK**.

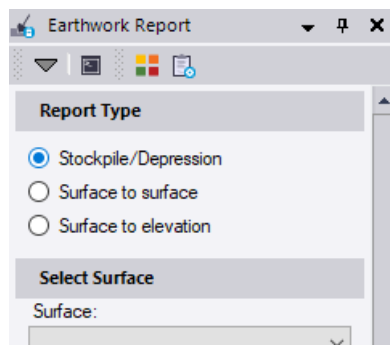
When processing is complete, you can zoom out to see a preponderance of red on the right end of the wall, which indicates that more "cuts" are required for the *Initial* surface to match the *Monitoring* surface. In other words, it indicates more movement (slight as it may be) on that end of the wall.



## Step 6. Create an Earthwork report

In this step, you will create an **Earthwork** report to further determine movement in the wall.

1. In the **Quick Access** toolbar, select **Reports > Earthwork Report**.



2. Select the **Surface to surface** option.
3. In the **Initial** drop-down list select *Initial*.
4. In the **Final** drop-down list, ensure *Monitoring* is selected.
5. Ensure the **Volume totals only** option (farther down in the command pane) is selected.
6. Click **OK**.

When the report generation process is complete, the **Earthwork Volume** report displays in your browser window.

## Earthwork Volume Report

### Unclassified surface compared to Unclassified surface

Surfaces	
Initial	Classification: Unclassified
Monitoring	Classification: Unclassified

Bank Volumes Based on Surface Geometry Alone	
Cut material	0.0 m <sup>3</sup>
Fill material	0.0 m <sup>3</sup>
Excess	0.0 m <sup>3</sup>

Bank Areas Based on Surface Geometry Alone	
Cut area	2.9 m <sup>2</sup>
Fill area	0.1 m <sup>2</sup>
Zero volume area	50.3 m <sup>2</sup>
Total	53.2 m <sup>2</sup>

Depth summary	
Maximum depth of cut material	0.599 m
Maximum depth of fill material	0.243 m

Note that although no volumes were identified, due to the very slight movement of the wall, the "cut" and "fill" areas in this example are 2.9 m<sup>2</sup> and 0.1 m<sup>2</sup> respectively, indicating at least some movement. (Your results may vary.) Also note that the maximum depth of cut and fill material in this example is 0.599 m and 0.243 m respectively. (Again, your results may vary.) Typically, this would indicate larger cut and fill volumes. But in this case, these values represent large deviations in the cut/fill map resulting from the fact that some areas of the surfaces were nearly vertical with respect to the plane definition.

This completes the tutorial.