



Leica Cyclone 3DR Volumes in complex environments and structures - Stockpile halls & Silos

Table of Contents

3	Inspector 5	9	Flight Plan
3	Oversight	9	NB - Instructional video
4	Inspector 5 workflow	9	Calculating the Silo's dead stock volume
4	Export Point Cloud	10	Import Point cloud
5	Stockpile Halls	10	Adjust point cloud view settings
5	Import Point cloud	11	3D Meshing
5	Point cloud imported	11	Segmentation
5	Adjust point cloud view settings	11	Results
5	Segmentation	11	Segmentation selection
6	Stockpile Measurements	12	Measure Volume
7	Generating a Report	12	Dead Stock volume
7	Workflow for the next flight in the same asset	12	Conclusion
9	Volumes in Silos		

About Leica Cyclone 3DR

Leica Cyclone 3DR, a robust reality capture software within the Leica Geosystems Cyclone suite, is designed to work with point clouds and 3D models. Its powerful features make it especially useful for professionals in construction, engineering, and surveying.

Key features include point cloud processing, AI-driven automated workflows, interoperability with various file formats, 3D meshing and modeling, analysis and quality control, BIM and CAD integration, and visualization and reporting.

Common Applications

- **Construction:** Verify that as-built structures adhere to design specifications.
- **Infrastructure:** Monitor roads, bridges, and tunnels for signs of deformation.
- **Mining:** Calculate stockpile volumes and track excavation progress.
- **Heritage:** Create detailed 3D models for historical preservation.
- **Renovation:** Document existing factory and plant conditions to support renovation planning.

For this paper we will focus on measuring stockpiles in complex or challenging environments.

About Inspector 5

Flyability's Inspector 5 is a specialized software solution tailored for processing, analyzing, and reporting data acquired by Flyability's Elios series of indoor drones. These drones are specifically designed for industrial inspections where confined spaces are prevalent, including but not limited to power plants, oil and gas facilities, mining sites, and various infrastructure inspections.

The software facilitates the efficient management and interpretation of inspection data, enabling inspectors to generate comprehensive reports that include visual representations, measurements, and annotations.

By streamlining the inspection workflow, Flyability Inspector 5 enhances the safety and effectiveness of industrial inspections while reducing downtime and associated costs.

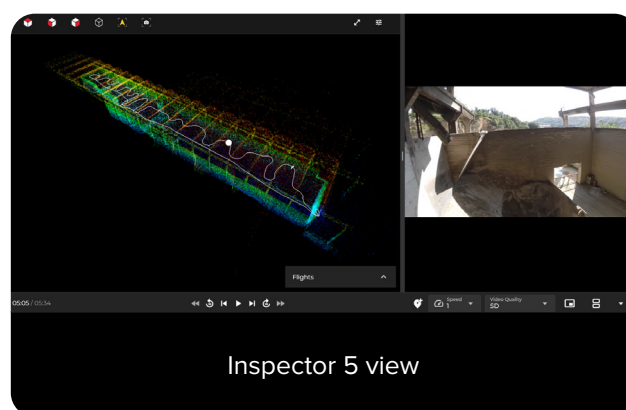
Oversight

When considering whether to reprocess data in **FARO Connect**, the size and geometry of the stockpile building are key factors. For large stockpile buildings, especially those exceeding 100 meters (330 feet) in length and breadth, reprocessing is often necessary.

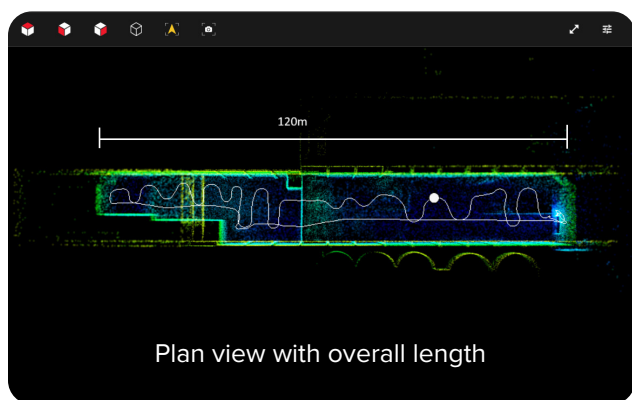
The reason for this lies in the potential for excessive drift factor in FlyAware data. This excessive drift can negatively impact the accuracy of total volume calculations. In particular, the floor reference may be affected by deflection or bending within the point cloud.

Therefore, to ensure accurate results, point cloud data from large stockpile buildings should be processed in FARO Connect. This additional processing step helps mitigate the issues associated with drift factor and maintains the reliability of volume calculations.

For example, a stockpile hall exceeding 100 meters (330 feet) in length and exhibiting a high overall drift factor in FlyAware would be a prime candidate for reprocessing in FARO Connect. The excessive drift in this scenario could lead to a false positive in the overall volume accuracy, highlighting the importance of using FARO Connect for data processing in such cases.

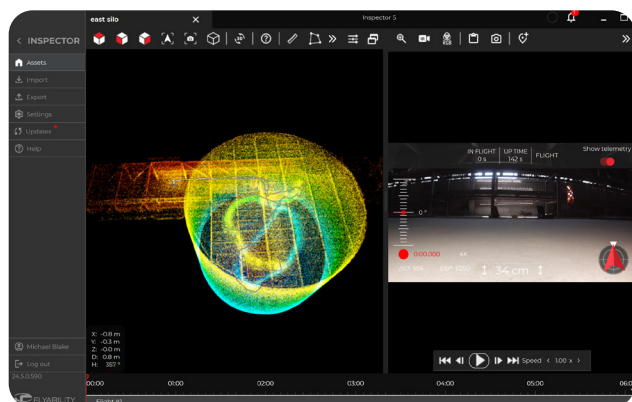


Inspector 5 view



Workflow for Exporting from Inspector 5:

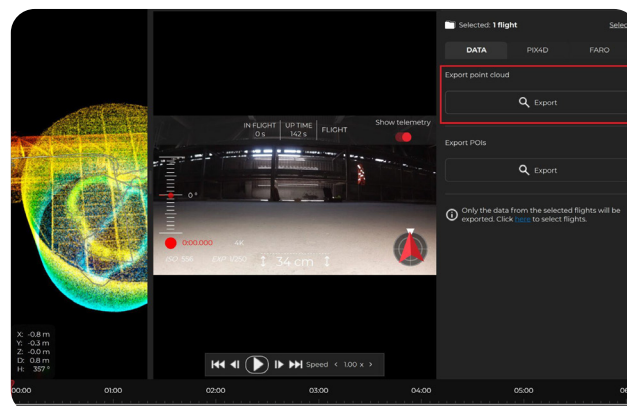
To export the Point Cloud data from Inspector 5:
Open the Asset and the flights in question.



Export Point Cloud (The live map from Flight)

Go to the Export tab -> Export Point Cloud
Name the file and Save it to a local drive.

Export the FARO .Geoslam file

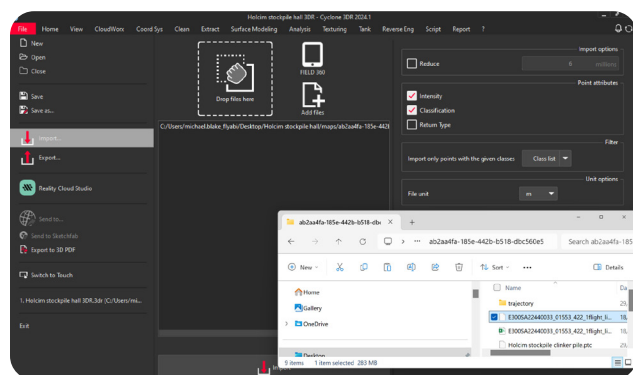


Leica Cyclone 3DR Volumes workflow.

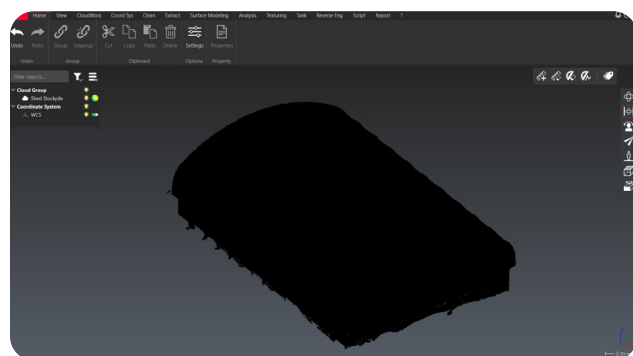
Importing the Point cloud.

Use the Import feature to drag and drop the point cloud.

- Do not reduce the number of points.
- Set units to desired options.



The imported point cloud looks like this in Inspector:

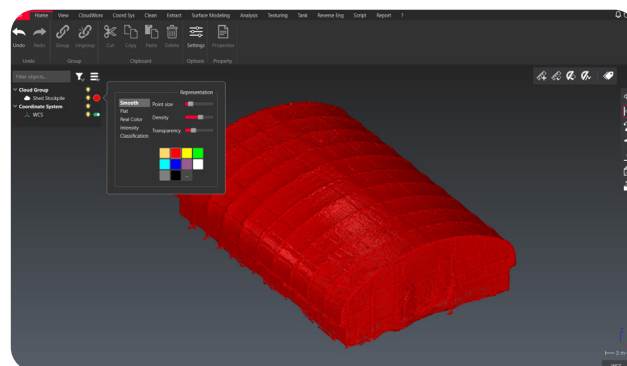


Adjust point cloud view settings

Click on the Las file layer and select the Edit colors tool.

- Adjust the Transparency, Density, and Point cloud size to your preference.
- Selecting "Smooth" will produce an 'Eye Dome Lighting Effect', making the pointcloud easier to read

Note: Increasing the Density may slow down the viewer response and may generate a lag

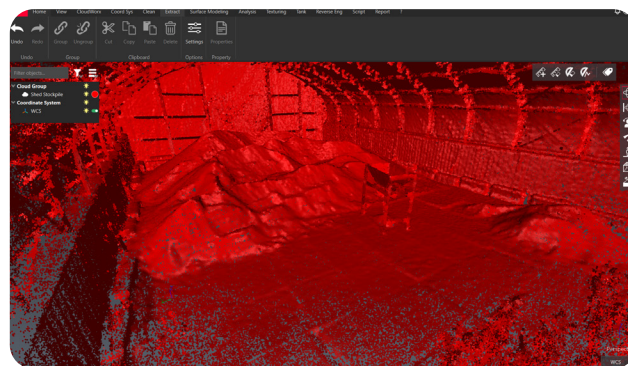


Segmentation

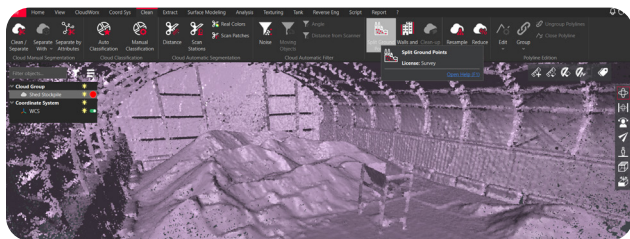
One of the main steps when measuring the volume of indoor stockpiles is to remove the building super-structure and sub-structure elements. This is vital as elements of the structure may affect the overall volume accuracy. Luckily, Cyclone 3DR has a very easy method for doing just that.

Steps for segmenting the point cloud:

- Zoom into the point cloud so that most of the volume material is in view
- Adjust the Cloud group view settings if needed (Usually increasing the Point size helps to visually depict the stock material from the structure)

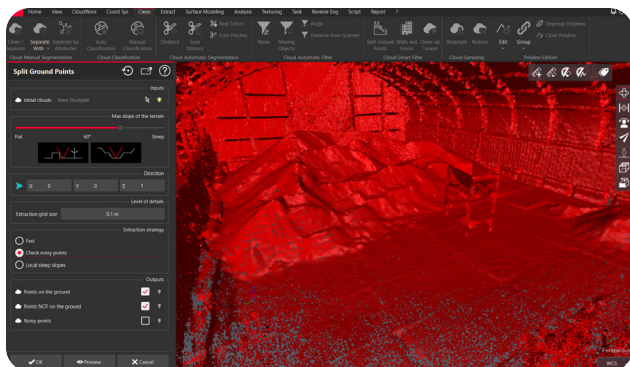


- Select the point cloud
- Go to: Clean -> Split ground points



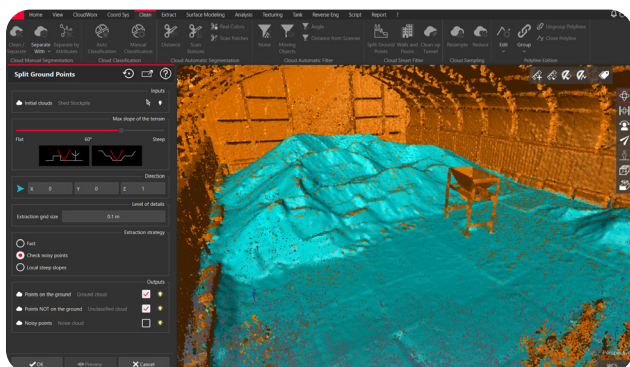
Adjust the following settings:

- Set the Max slope of the terrain - This will depend on the geometry of the stockpile material, however between 55-70 degrees works well.
- Level of detail - Set to 0.1m
- Extraction strategy - Check noise points

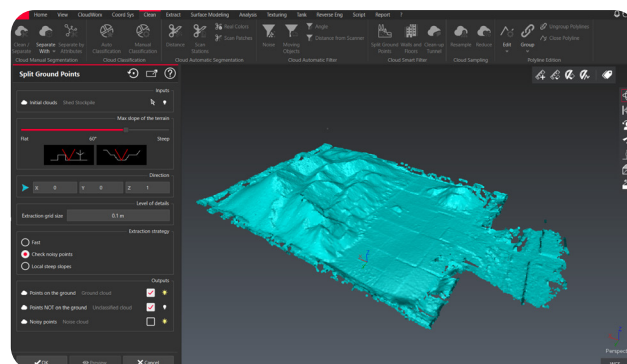


Press "Preview" - Once you are happy with the results, press ok.

If the results do not match your wishes, adjust the settings and slope angle until 90% of the stockpile material has been detected by the point extract algorithm.



Turn on and off the points NOT on the ground to view the extraction quality.

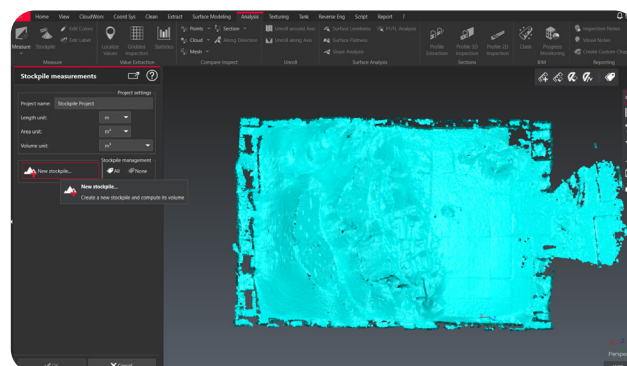


Stockpile Measurements

To measure the stockpiles from the segmented and converted point cloud. Select the point cloud layer.

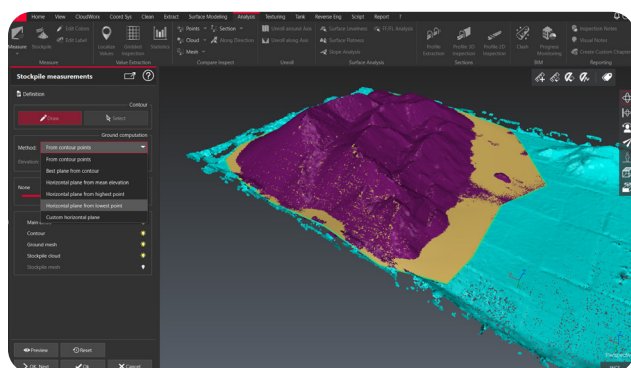
Go to the Analysis tab:

- Stockpile
- Name project: "Stockpile warehouse" for example
- New Stockpile measurement
- Add the material name, type, and bulb density or grain size if required.



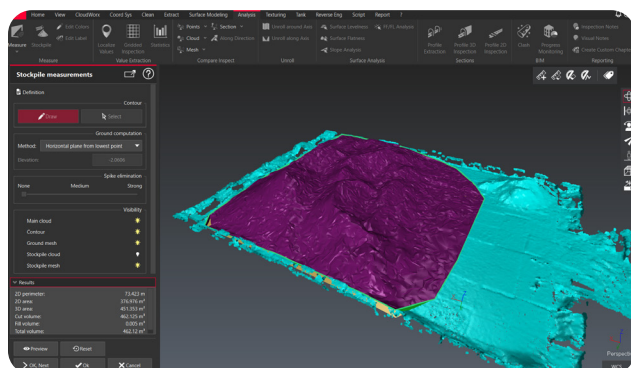
Draw the new boundary around the border edges of the stockpile, using tools in the Analysis tab:

- Go to Ground Computation
- For Method, select Horizontal plane from the Lowest point
- For Spike elimination, select None or Medium, depending on if there is still some dust in the point cloud.
- Next, press “Preview”

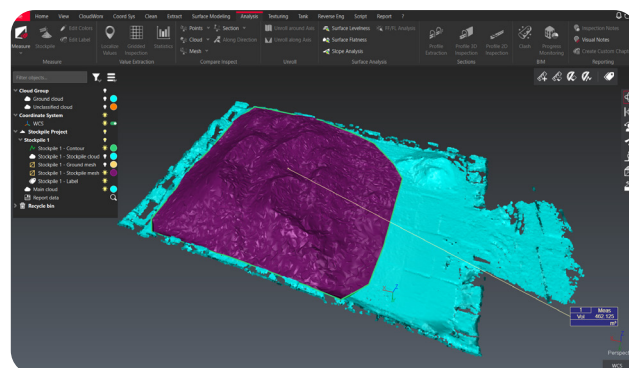


The Stockpile Volume will now be measured.

- Stockpile computation will automatically mesh the point cloud and generate the volumes and areas.
- Once complete: Press Ok, Next to repeat the procedure on the remaining stockpiles if needed.

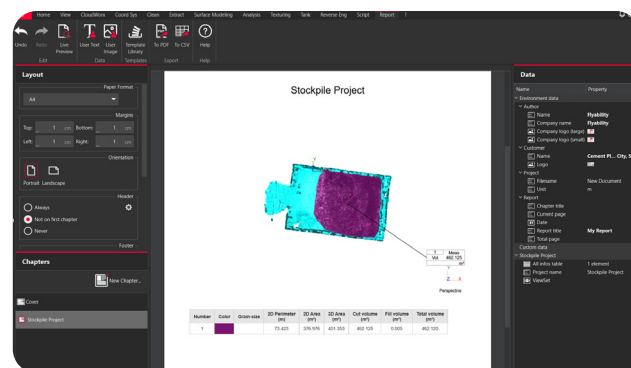


Repeat the process for all other stockpiles if present in the dataset.



Generate report.

Use the automatic report generation tool to generate the report for all of the stockpiles. Here is an example:



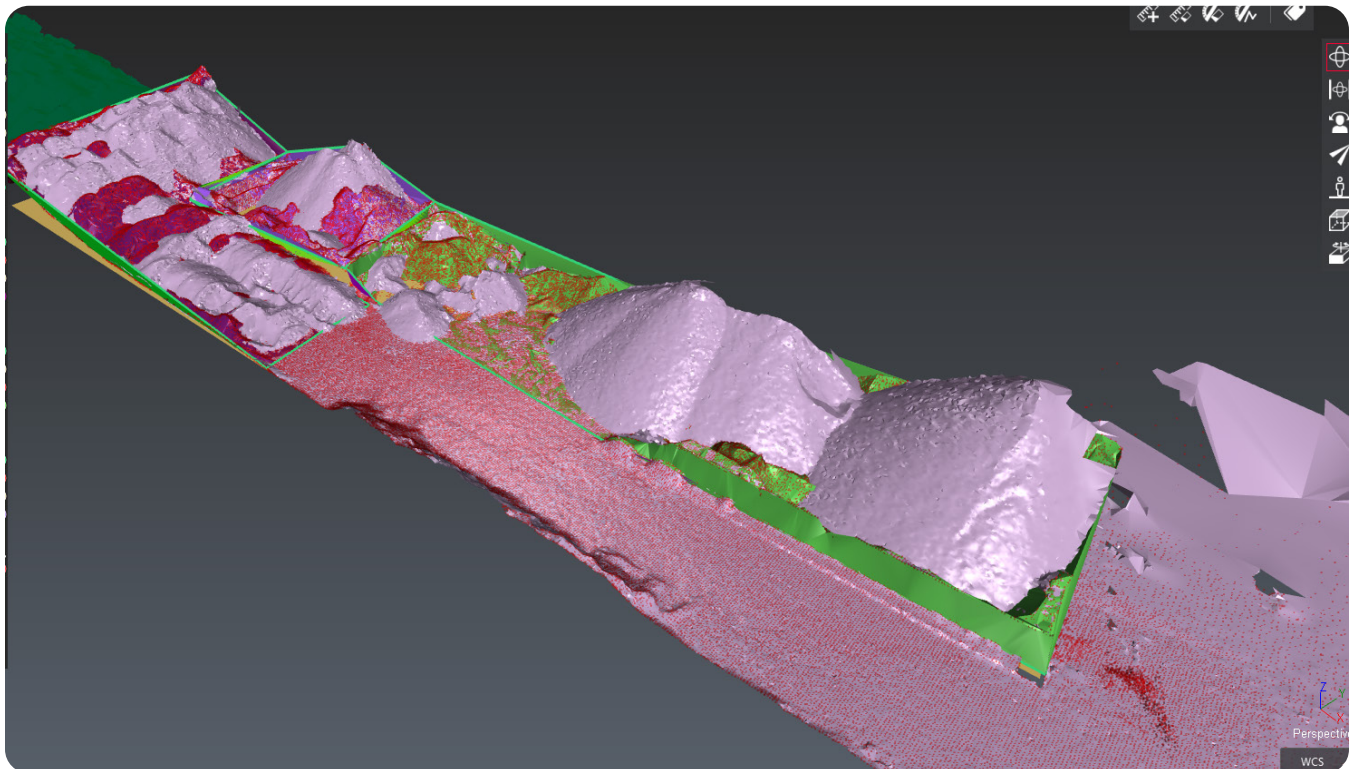
Workflow for the next flight in the same asset.

Using the relocalization feature on Cockpit, the Elios 3's flight management app, the new stockpile flight can be automatically aligned with the previous flight before takeoff.

This means that when the new point cloud is dragged and dropped into the same project in Cyclone 3DR, the new flight is aligned perfectly with the previous flight, with no need to finely align the clouds together or use reflective targets for registration.

Please see the example below of the new flight overlaid with the previous scan. Take note to:

- Repeat the same process as described above for the new flight.
- Select both Meshes to see the volume difference between the old and new flights.
- When measuring the new stockpile, the previously drawn contour line can be reused for the new flight (Make sure that the contour line fits with the stock material area. If not, redraw and extend the contour area to suit).



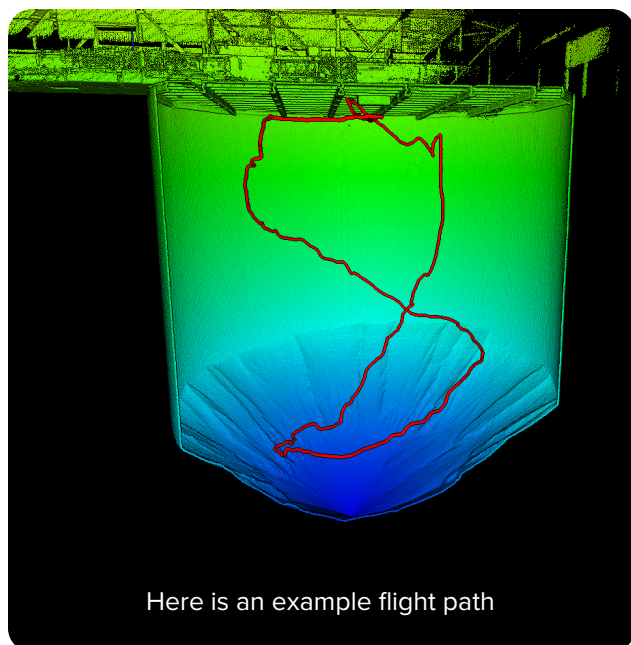
Volumes in Silos

We will now guide you through measuring volumes inside silos. This includes the data collection process with the Elios 3 where we provide an overview of the best practices for flying in silos.

Best Practices: Flight Plan

When flying inside a Silo, it is important to achieve 100% coverage. Due to the amount of suspended dust inside the silo, some simple procedures can be followed:

- Only use the Rev 7 Survey LiDAR, as the Rev 6 may not be able to penetrate the dust.
- When entering the silo, fly close to the room until you meet the silo wall.
- Once you meet the silo wall, descend in a spiraling pattern along the wall down to the actual dead stock material. This is to maintain LiDAR assist during the flight and avoid the drone losing the LiDAR fix and switching to ATTI mode.
- The front-facing camera may be blocked from view due to the dust. Switch to the LiDAR map on Cockpit and use the map to Navigate.



Here is an example flight path

- Once the stock is reached, continue to fly in a spiral pattern until all of the dead stock is covered on the live map.
- To ascend out of the silo, continue to use the spiral method and maintain a few meters distance from the wall.

Please follow the steps as per the Flyability training video on safe operation inside a silo.



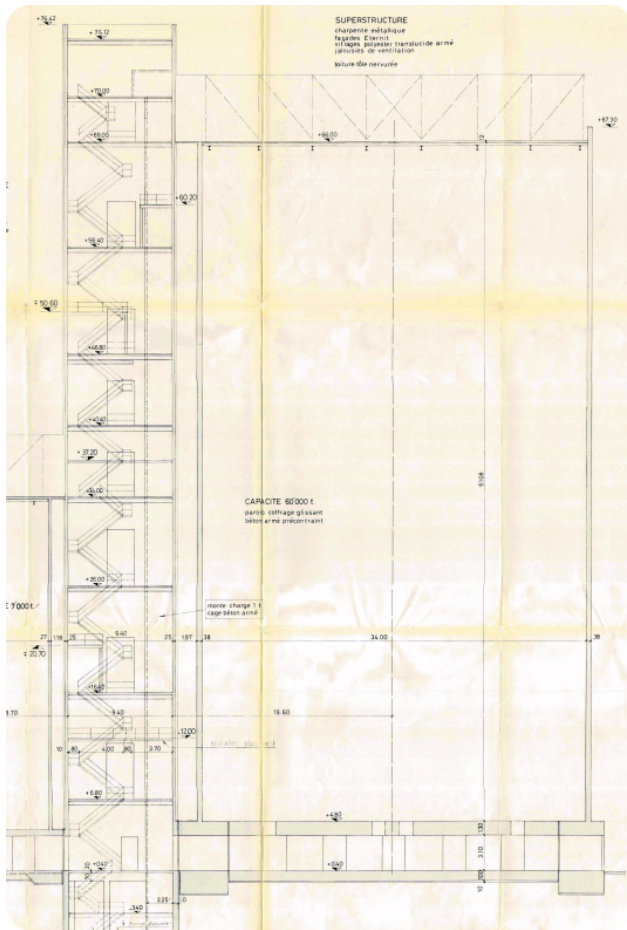
Cement inspection tutorial:
Silo Preparation and Inspection

Technique: Calculating the Silo's dead stock volume.

To calculate the 'Dead Stock' volume remaining in the Silo, use the inverse volume method.

For this, we will need to understand the total volume of the silo and take away the empty volume of the silo from the total volume.

It is important to be able to understand the entire volume of the silo. For this, usually, there are some old construction drawings of the silo with the radius and height.



Simple trigonometry is used to work out the total volume of the right cylinder.

The total volume is as follows in this example:

Right cylinder

Solve for volume

$V \approx 55564.72$

r Radius

h Height

17

61.2

Solution

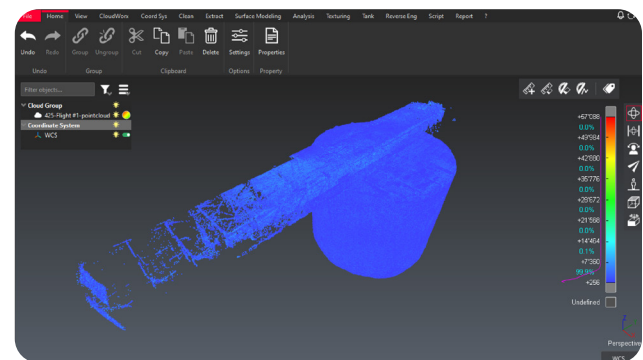
$V = \pi r^2 h = \pi \cdot 17^2 \cdot 61.2 \approx 55564.72095$

Import Point Cloud

Use the Import feature to drag and drop the point cloud.

Note:

- Do not reduce the number of points.
- Set units to desired options.

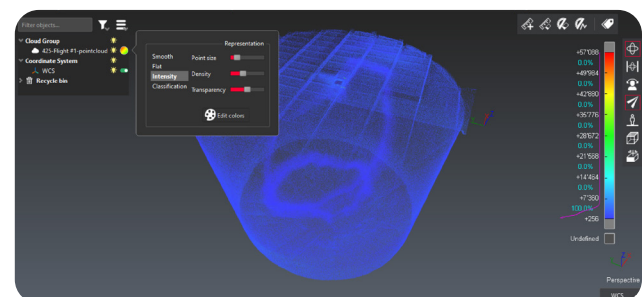


Adjust point cloud view settings

Click on the Las file layer and select “Edit colors”.

- Adjust the Transparency, Density, and Point cloud size to your preference.

Note: Increasing the Density may slow down the viewer response and may generate a lag

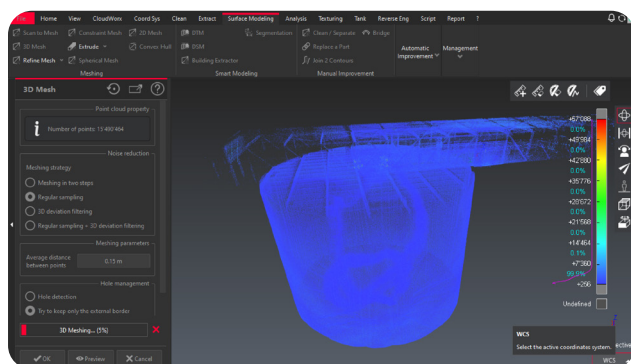


3D Meshing

Before calculating the volume of the silo, the point cloud has to be converted into a 3D Mesh.

Go to: Surface Modeling - 3D MESH

- Regular Sampling
- Average distance between points - 0.15m (Usually works well)
- Hole management - Try to create a watertight mesh.
- Press preview to confirm the mesh is correctly computed.
- Once satisfied - Press 'OK'
- A new Mesh layer will be created.



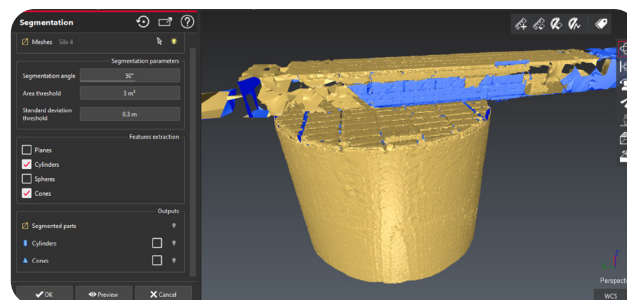
Segmentation

The segmentation tool can be used to automatically segment out the stockpile material from the building and surrounding structure.

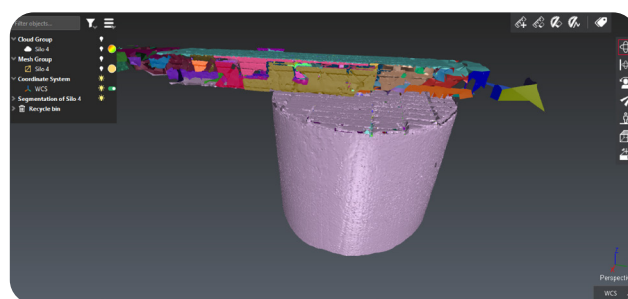
First: Select processed Mesh

Go to: Surface Modeling - Segmentation

- Segmentation angle - Select between 40-60° (Adjust depending on the angle of the stockpile material)
- Area threshold: 2-3m²
- Standard Deviation threshold: 0.2-0.4m
- Feature Extraction: Cylinders and cones.
- Press: Preview to begin processing



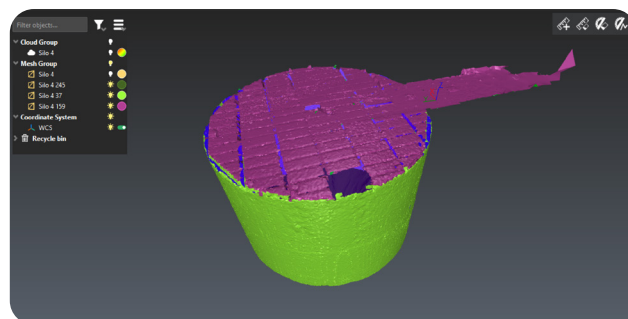
Results: The Silo's surroundings will be divided into many separate entities



Next: Segmentation selection.

Zoom in to the segmented Silo

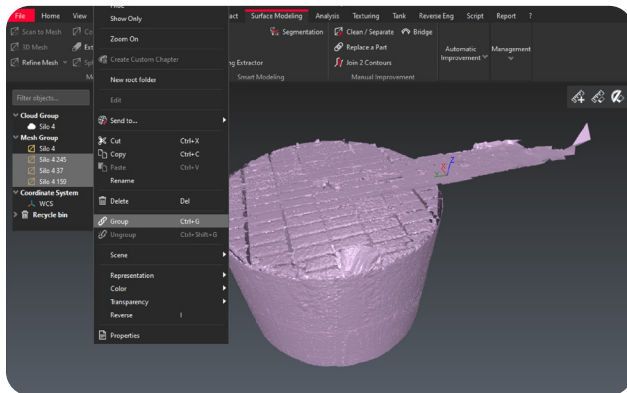
- Select the elements of the silo data that need to be retained (This will be the ceiling, wall, and dead stock material segments)
- Right-click and copy the Meshed layers
- Go to the Mesh group tap
- Paste the ceiling, wall, and dead stock material segments to separate them from the rest of the segmented sections.
- Delete the rest of the segmented group as it is not needed.



Before measuring the Volume of the silo the separate Mesh layers need to be merged.

Go to: Mesh Group

- Select the separated segmented layers
- Right-click on the selection and go to “group”
- The separated mesh layers will now be merged into one mesh group layer.



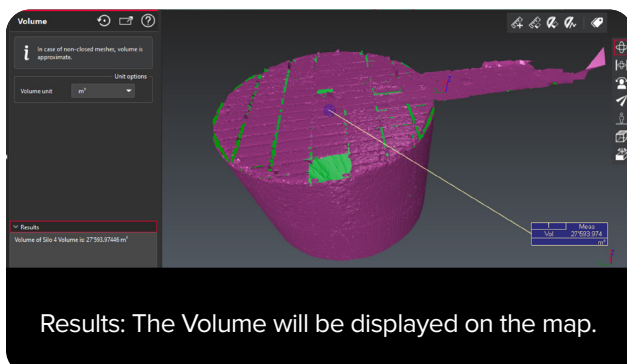
Measure Volume

To measure the volume of the dead space inside the silo.

Select the newly grouped Mesh layer.

Go to: Analysis

- Measure
- Volume.
- Select the desired units.
- Press ‘OK’



Results: The Volume will be displayed on the map.

Dead Stock volume

To measure the Dead stock remaining inside the Silo, subtract the volume of the dead space from the overall volume of the Silo.

Total volume of the **dead stock**.
 $55'565\text{m}^3 - 27'993\text{m}^3 = \underline{27'971\text{m}^3}$

Conclusion

The document focuses on utilizing Flyability's Inspector 5 software in conjunction with Leica Cyclone 3DR for volume measurements in complex industrial environments, specifically stockpile halls and silos.

The workflow showcased above involves data capture with Flyability's Elios drones, processing in Inspector 5, and then utilizing Cyclone 3DR for volume calculations and analysis.

By reaching this stage, you should have seen that the key advantages highlighted include:

- Enhanced safety and efficiency of inspections.
- Accurate volume measurements in challenging environments.
- Improved data visualization and analysis.
- Streamlined workflow between Inspector 5 and Cyclone 3DR.

The document emphasizes the importance of proper flight planning, data processing settings, and segmentation techniques to achieve accurate volume measurements. More information on this is available on the Flyability knowledge base, linked in the following page.



If you would like more information, please refer to the Flyability knowledge base to learn more about the Elios 3 or get in touch with our team in the case of any questions.

