Assessing the Accuracy of Stockpile Volumes Obtained Through Aerial Surveying

Martin Remote Sensing share surveying insight
Introduction

This report comes to us from Kelsey Martin, President of Martin Remote Sensing. Martin has 12 years of experience in the mining industry, and has been responsible for all aspects of mine planning and surveying, including measuring millions of dollars worth of stockpiled material on a quarterly basis.

Many people have recently enquired whether aerial surveying utilizing unmanned aerial vehicles (UAV’s) is as accurate as other generally accepted methods, in particular, high-precision GPS. This is a very valid question since ultimately, the reason that we conduct stockpile surveys – regardless of the industry – is to accurately determine the volume of materials. This information could be required for financial reporting of inventories, ensuring a certain stockpile will cover a particular area, or even as an important piece of legal information should Party A look to purchase certain stockpiled assets from Party B. The accuracy of any survey – regardless of method used – is therefore a matter of critical importance.

In an effort to determine the accuracy of our survey methods versus historically accepted methods, Martin Remote Sensing conducted comparative analysis on a stockpile that had previously been surveyed utilizing GPS methods. As the survey had been conducted by a reputable firm, we chose to use this as the “gold standard” by which we would measure our performance.

The accuracy of any survey – regardless of method used – is of critical importance as there is a financial impact.
Typically, GPS is used to determine the position of several hundred to thousands of data points for a typical stockpile, to an error of less than 5 cm. This is a very precise method for determining the X, Y and Z coordinates of each point, however there are limitations in the number of points that can be taken for a given survey before becoming cost prohibitive. With aerial surveying, complex photogrammetry software is used to stitch hundreds to thousands of high resolution photographs into complex three-dimensional models. This step-change to using big data and powerful software to calculate volumes can provide exceptional results at a lower cost compared to traditional methods. By having many more data points, the resulting volumes from this method are very accurate.
The Process

Ground-based GPS and aerial surveying, a side-by-side comparison.

We'll begin by describing the process for each survey method to understand the key differences and how they influence accuracy.

**Ground-based GPS Surveying**
The first step in ground-based GPS surveying is collecting GPS point measurements of latitude, longitude and elevation using ground-based survey equipment. The coordinates of the collected points are then uploaded into a three-dimensional space and connected through 3D rays or lines, creating multiple lines emanating from each point. Once the lines have been connected to the neighboring points, they define a surface. Essentially, GPS creates points, points create lines, lines create surfaces and finally surfaces can calculate volumes.

**Aerial Surveying**
Aerial surveying leverages drones to capture geo-tagged imagery of the area of interest. Once the photos have been gathered from multiple angles, with high degrees of overlap, they are uploaded into software that then uses photogrammetry to generate a high-resolution orthomosaic map, point cloud and 3D model. Photogrammetry works by identifying points that are common between overlapping photos and then comparing the geo-tagging data and relationship between overlapping photos to model the points in 3-dimensional space. From there, the software revisits the imagery

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to find more shared points and create a very dense point cloud, as illustrated in Fig 1. The dense point cloud can also be used to generate a 3D mesh model or 2-dimensional orthomosaic map.

Martin Remote Sensing uses DroneDeploy’s mobile app to automatically fly and capture imagery and then uploads imagery to DroneDeploy’s cloud-based Map Engine for processing using photogrammetry.

Aerial surveying relinquishes some of the precision of GPS in exchange for the generation of substantially more points. Where typical GPS surveys for stockpile volumes are measured in square meters per point, aerial surveying creates hundreds of points per square meter. For example, the stockpile volume that was measured in this study was calculated using 275 points for the GPS method, while our method generated 368,400 points. Of course, having 135,000% more data points alone is not adequate to create highly repeatable, accurate surveys.

GPS may be used to find survey pins prior to excavating a foundation, but once that has been accomplished, a home takes its highly accurate form based on measuring points within the project.
For measuring stockpile volumes, the most important component of accuracy is relative accuracy, or the accuracy of the distances between points within model. This is very similar to the footing of a home being squared against itself using angles and distances. The relative accuracy of a point cloud or volume measurement is determined by the photogrammetry software being used, the experience of the technician conducting the survey and their attention to detail in the field. By contrast, global accuracy, the precision of the x,y,z point measurements when compared to global absolute GPS measurements, is far less important. For a volume measurement, as long as you know your locations relative to other local points, you will have a very accurate final product. For this same reason, our 3-dimensional volumes are extremely accurate.

Once the photos have been triangulated, by having many more points, the breaklines that connect the points are much shorter and therefore are less likely to vary considerably from the actual stockpile profile. Let’s look at a theoretical example through three cross sections, as shown in Fig 2.
The Results

Aerial surveying provides highly accurate volume measurement.

Returning to our case study, below are the results of our field testing, which will instill confidence in our methods, as the numbers are the primary factor in forming an opinion:

**GPS Surveyed Stockpile**

*Point density:* 3.25 square meters per point  
*Volume:* 3,394.9 cubic meters

**Same Stockpile – Surveyed with UAV**

*Point density:* 400 points per square meter  
*Volume:* 3,375.0 cubic meters

Based on our field tests conducted this past summer, we are very pleased with the results.

Comparing our survey to the “gold standard” yielded a variation of only 0.6%
Conclusion

Aerial surveys are cost effective, safer, and provide comparable accuracy.

Beyond proving the accuracy of our methods compared to traditionally methods, customers have also found considerable benefit in the following:

**Cost**
Aerial surveying saves our customers money as it is able to cover larger areas than a typical survey crew in the same amount of time, reducing costs almost in half. In fact, on a recent project we were able to survey 19 gravel stockpiles in just four hours – a task that would have taken 10-12 hours with two surveyors. This 48-hectare project generated 190 million data points or an astounding 47 million points per hour!

**More Information**
Unlike a ground-based GPS survey, an aerial survey also captures visual information that can be a helpful management tool. We are able to generate high resolution air photos as well as high-resolution 2-dimensional maps and 3-dimensional models. Typical GPS surveys only provide computer generated surfaces as displayed above in Fig.3.

**Safety**
Putting survey crews near steep slopes – especially on active piles – can pose safety risks to individuals. By utilizing aerial surveys, the survey instruments are 80 metres above the ground surface with the UAV pilot stationed on the ground in a safe location.

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Make Drone-based Volume Measurements on Your Job Site

With DroneDeploy, it’s easy to automatically fly your DJI drone to make a map and 3D model. You can then make volume calculations instantly from any device simply by selecting the perimeter of the pile or pit you want to measure.

To get started, just download the free DroneDeploy app for iOS or Android or signup to start your free trial.

Try DroneDeploy for Free

Interested in learning more about how DroneDeploy can help your business? Request a consultation here www.dronedeploy.com

In Canada? - Contact Martin Remote Sensing for a free quote. From gravel stockpile surveys to drainage planning for agriculture, see how our experience will save you money.