

Accurate stockpile measurement  
and reporting for construction and  
aggregates operations.

# Stockpile Measurement and Reports

With Drone Surveying

# Why Drone Surveying?





This ebook will cover how drone surveying can improve the accuracy of stockpile measurements and make stockpile reports easier than ever. Surveying with a drone is fast and affordable, and is a great way to supplement traditional methods.

Further, drone surveying software platforms like Trimble Stratus render everything in 3D, so you can view your site as it actually is. It makes the 3D survey as close to the real world as possible.

It'll come as no surprise, but stockpile measurement and reports account for the most frequent use case for drones on worksites. People use drone surveying and software to get accurate volumetrics more than anything else.

It can make or break your budget to oversell or undersell material, and you need to have accurate measurements of your stock on hand to do your job right.

Here, we'll be explaining how to get those numbers, and:

- ▶ Stockpile measurement methods with drone surveying
- ▶ How stockpile volume measurements work
- ▶ What drone stockpile measurement software you need
- ▶ Stockpile reports using measurement software
- ▶ Stockpile report costs using drones

Before we can get into the ways to use stockpile measurement data to improve efficiency on your site and spot problems before they become expensive, we need to understand how drones and software measure your stockpiles, using photogrammetry (taking measurements from photography).

# Stockpile measurement methods with drone surveying



Before you can take a single measurement of your stockyard, you need to fly your drone to capture site data.

There are a few ways to do this. “Drone surveying,” at its core, means using a drone to take aerial photos of your site and some form of GPS and ground control to tie the images down.

With recent technological advancements, there are two major workflows to get the job done: Ground Control Points (GCP) -based drone surveying and post-processed kinematic (PPK) drone surveying.

## DRONE SURVEYING WITH TRADITIONAL GROUND CONTROL

For this workflow, you need a sufficient number of known points to verify and pin your drone imagery to the ground. This is because a drone without on-board GPS correctional processing capabilities is only a vehicle for capturing site imagery.

Its position in the sky is not accurately geotagged, so you don’t get reliable positional data from its hardware alone; that accuracy comes from ground control.

Having multiple (GCP) on your site when surveying ensures 1/10 foot (3 cm) accuracy or better but they can be time consuming to set up on a large worksite.

There are a couple ways to set up traditional ground control:

- ▶ Known-point method. A surveyor has to physically walk your site, locate the points with a rover, and mark them for visibility.
- ▶ Using AeroPoints. AeroPoints are smart GCPs meaning that they automate referencing and data upload. Just lay on the ground in an optimal distribution across the entire surveyed area. You drop in an optimal distribution across the entire surveyed area.



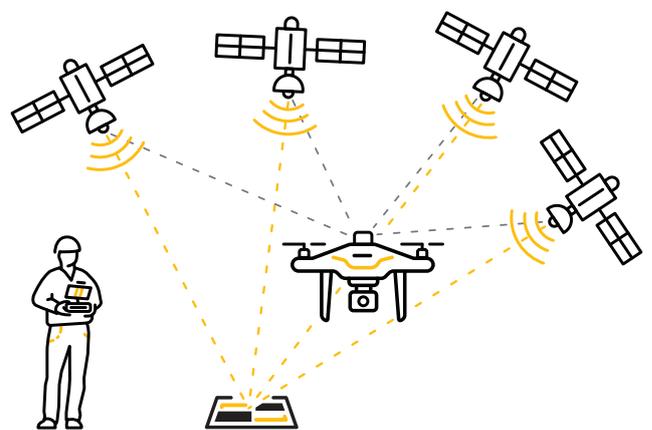
## DRONE SURVEYING WITH ONBOARD DIFFERENTIAL GPS HAS REDUCED THE AMOUNT OF GROUND CONTROL NEEDED.

PPK drones record data which can be used to accurately geotag the images taken. While there are different kinds of GPS correction processing technology, we'll be covering (PPK) here.

With PPK, the drone records GPS data. While this is happening, a base (be it a base station, an AeroPoint, or the continuously operating reference stations (CORS) network) on the ground is also recording GPS data.

After the flight is completed, those two sets of GPS data are post-processed to recreate the precise flight path for the drone. Images taken in flight are given timestamps when the camera shutter was triggered. From those time stamps and the drone trajectory, precise positions can be calculated for each image. The calculated position replaces less accurate on-board GPS position recorded in the image in flight.

Due to its ease-of-use and reliability, we recommend a PPK workflow for drone surveying on any site—from mines to landfills and every construction site in between.



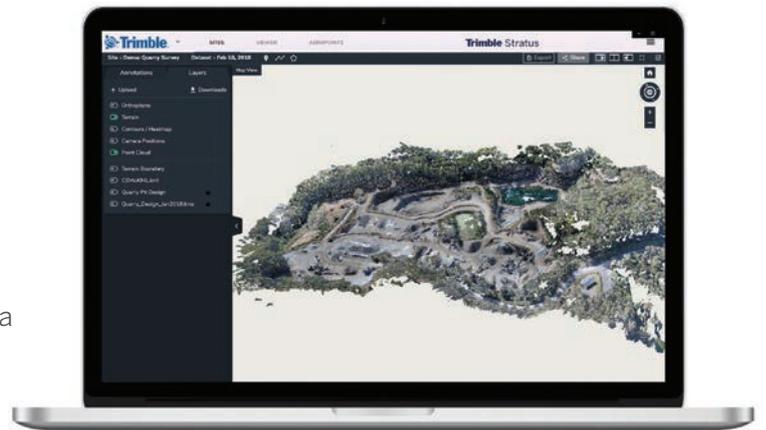
# Drone Photogrammetry

TURNING YOUR SITE DATA INTO A 3D SURVEY

When that data is processed into the final product—a 3D site survey—powerful processing engines are crunching numbers for many, many images and using photogrammetry to stitch them all together.

At its most basic, “photogrammetry” is measuring via photos. It might sound dry and complicated, but its inner workings define the way you fly.

We can’t overstate the importance of steady, consistent flight in getting these photos right for drone photogrammetry.



## ACTUALLY PERFORMING A SURVEY ON SITE

When it comes time to head out on site to capture your data, everyone’s exact workflow will look a little different, but here are the basics of what you can expect.

- ▶ Preplanning
- ▶ Ground control placement
- ▶ Launching your drone
- ▶ Landing and wrap up

## HOW THE SCIENCE OF PHOTOGRAMMETRY WORKS

Essentially, if you see the same feature from three or more known positions, you can triangulate its location in space (get those exact X, Y, and Z coordinates). A feature is any visually distinct point in an image.

If you took an average image from your survey, you’d easily be able to pick out many “features” between images. The more features you match, the better you can relate images to each other and reconstruct objects within them. This is exactly what photogrammetry software does for one feature, and the next, and the next, and so on, until it’s covered your entire site.

Once you have a lot of these features—think millions—you can create a “cloud” of points. Each point has a matched feature describing your surveyed area in that location. You can then turn your point cloud into any regular outputs used in geospatial software, like a 3D mesh or digital elevation model (DEM).



# How stockpile volume measurements works

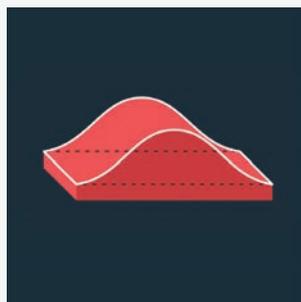
Ideally, a stockpile would be something with an easy volume to calculate, like a perfect cube or cone. But even in good cases, stockpiles are an irregular shape.

Surveying stockpiles with a drone is different because it can capture all these irregularities and faithfully render them in your survey. This allows the computer to calculate the volume of the true shape, not a rough approximation. This accuracy starts with the imagery. Drone photos capture significantly more detail than shooting points with a rover, as photos let you see the physical details between the individual points.

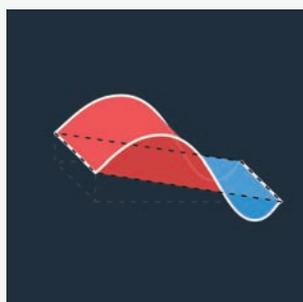
Drones are able to capture and render higher resolution data horizontally and vertically (Z values) to create very accurate surveys. And, the better your data is, the better your model. Drones combined with ground control can produce 3D surveys with 20–50mm accuracy when used correctly.

## HOW TO MEASURE STOCKPILE VOLUMES WITH DRONE SURVEY DATA

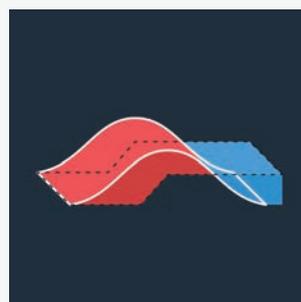
There are different types of stockpiles—from ramp- and bin-style to regular—and you want to measure them accordingly. The following are a few examples of the different ways you can measure volumes using Trimble Stratus.



Measure volume from a reference level. Set the baseline to a desired figure and get your total volume from there up.



Measure using a smart volume, and let the computer do the work. For a smart volume, the platform extrapolates where the base of your pile is and gives you a total volume from there.



Compare volumes between two surfaces. This could be survey to survey, in order to see changes and progress over time, or measure against a design surface to see how far you have left to go.

And because these volumes are accurate, you can enter in a known material density into the software's on-screen calculator to get the tonnage for any stockpile.

# Find the software that's right for you

Drone imagery and ground control are only half of the puzzle. Your data, no matter how good, is useless unless you can visualize it. That's where software comes in.

Beyond the digital model of your stockpiles, you want to make sure that the processing software has tools that increase efficiency and actually get you the answers you need from your data.

For the Trimble Stratus software, measuring stockpile volume is simple and quick. To streamline accurate measurement and reporting, there are number of templates available to create common

measurements you need on site. A few of which we touched on above, but beyond that Trimble Stratus allows you to copy measurements to multiple surveys—great for piles that don't move around.

You also want a software that allows you to automate repeated tasks. If you have dozens of stockpiles, measuring each one can take more time than you've got. Trimble Stratus has automated stockpile detection, which reduces the time it takes to calculate volumes—and thus all other measurements—by automatically spotting all your stockpiles during data processing. So when you're ready to do some site analysis, you can find all these piles in one place.

Quarry Survey, Feb 18, 2018

Material	Density	Value (\$/T)	Volume (Cut)	Tonnage (Cut)	Total (\$)
Sand	2.50 T/m <sup>3</sup>	\$14.50/T	2 358.09 m <sup>3</sup>	5 895.21 T	\$85,480.58
10 mm Aggregate	1.80 T/m <sup>3</sup>	\$25/T	9 845.08 m <sup>3</sup>	17 721.15 T	\$443,028.83
12 mm Aggregate	4.20 T/m <sup>3</sup>	\$18/T	1400 m <sup>3</sup>	2824.34 T	\$50838.12

The real value, however, comes with calculating the material properties of your stockpiles. Using the built-in calculator you can find out the density of your material and the dollar value of your stockpile. With Trimble Stratus you can easily see how much money is really sitting in your stockyard.



# Stockpile reports using measurement software

Now that you know how to get your measurements, you need to be able to report out on them easily. It does no good to have a bunch of data you cannot use and share.

When it comes to reporting on your stockpiles, look for software that enables easy, automated report creation. And make sure its reporting capabilities include all the report types you actually use in your day-to-day job.

No matter how often you report out on your stock, you want to be able to pull those reports without too much hassle, and have them in the file formats you need. Look for software that provides a range of download options, and allows you to export your raw data.

For the Trimble Stratus software, in addition to numerous file format outputs, there are both PDF and CSV options for inventory reporting. Each take only three steps to create and download.

## CSV REPORTS INCLUDE:

- ▶ Name, description, and any material properties.
- ▶ All measurement quantities based on how you created the measurement.
- ▶ A link to each individual measurement.

## PDF REPORTS INCLUDE:

- ▶ Name, description, and any material properties.
- ▶ All measurement quantities based on how you created the measurement.
- ▶ Full orthophoto (geometrically corrected aerial image) of the site.
- ▶ Image of each measurement, including the outline.
- ▶ A link to each individual measurement.

And if you've added those monetary values to your material, the stockpile's value will also be listed in these reports for each individual pile.

### eom-stockpiles-1

Created by Shaun Macintosh on 10/17/2018 10:14 AM

[VIEW IN STRATUS](#)

<https://app.ppiclr.com/p/viewer/2?share=lvQd4pp6fAwd5E>



MATERIAL	10mm rock
TONNAGE (CUT)	685.90 T
VALUE (\$)	\$17,147.52
FROM DATASET	Feb 18, 2018
TO DATASET	smart volume level
SMART VOLUME FILL	0.680 yd <sup>3</sup>
SMART VOLUME NET	-380.376 yd <sup>3</sup>
SMART VOLUME CUT	381.056 yd <sup>3</sup>
TONNAGE DENSITY	1.5 T/yd <sup>3</sup>
FILL TONNAGE	1.020 T
NET TONNAGE	-570.564 T
CUT TONNAGE	571.584 T
MATERIAL TYPE	10mm
MATERIAL	

Annotation	Template	Material	Tonnage (Cut)	Value (\$)	From Dataset	To Dataset	Smart Volume Fill (yd <sup>3</sup> )
eom-stockpiles-1	EOM Stockpiles		685.9008	17147.52	Feb 18 2018	smart volume level	0.68
eom-stockpiles-2	EOM Stockpiles				Feb 18 2018	Quarry Design Stage 2	16.177
eom-stockpiles-3	EOM Stockpiles				Feb 18 2018	smart volume level	8.57
3A coarse	Stockpile	Sand	3 dp	2 dp	Feb 18 2018	reference level	
3A fine	Stockpile	Sand	2235.945	2 dp	Feb 18 2018	smart volume level	27813
stockpile-10	Stockpile	20 mm rock	224.226	4484.52	Feb 18 2018	smart volume level	4.443
stockpile-16	Stockpile	10 mm rock	386.8362	9670.90	Feb 18 2018	smart volume level	5.438
stockpile-17	Stockpile	25 mm rock	1384.5225	9361.87	Feb 18 2018	smart volume level	13.989
stockpile-18	Stockpile	30 mm rock	5537.375	1267.57	Feb 18 2018	smart volume level	10.718
stockpile-19	Stockpile				Feb 18 2018	smart volume level	17.211
stockpile-20	Stockpile				Feb 18 2018	smart volume level	10.602
stockpile-3	Stockpile	Railway ballast	2088.12	25057.44	Feb 18 2018	smart volume level	4.093
stockpile-4	Stockpile	Railway ballast	1481.57	17778.84	Feb 18 2018	smart volume level	46.086
stockpile-5	Stockpile	Sand	757.4475	10982.98875	Feb 18 2018	reference level	



# Sharing your reporting with stakeholders

Sharing should likewise be simple and straightforward. Trimble Stratus allows you to share your site with others. All you need is an email address. You can set up permissions at a granular level for individuals or teams—from view-only to administrator.

But if you just want to share a single stockpile measurement with someone on your team or your manager, you can share those via a link. Through email, chat, etc., the recipient simply clicks on the URL and it opens your site to show the measurement selected and the camera focused on that pile.



## STOCKPILE REPORTING COSTS USING DRONES

Surveying with drones is more affordable and takes less time to complete, so you're not paying personnel for days or weeks of work. Accessible, accurate data can save your business from huge write-offs that, in the past, have been accepted as the cost of doing business.

Trimble Stratus charges per dataset and isn't limited to stockpiles alone. You can survey your whole site for that price and get back an interactive, visual 3D survey.

Rather than asking how much stockpile reporting costs, a better question is, "How much does stockpile reporting with drones save my business?"

## BETTER FINANCIAL FORECASTING

When it comes down to it, processing platforms like Trimble Stratus allow you to accurately measure your stockpiles. The benefits of that trickle down to even the smallest parts of your operations. Accurate information that is easy to share can help you create more accurate financial forecasts.





## TIGHTER SUPPLY-CHAIN MANAGEMENT

Knowing what you actually have on your site also allows you to tighten up supply-chain management. For example, contractors can see when you need more stock and how much you should order. Producers can plan out when you need to start drilling and blasting. If you use an external supplier you can plan out purchases and budget better. Don't be surprised by a big order again.

## SEE HOW MUCH YOUR INVENTORY IS WORTH

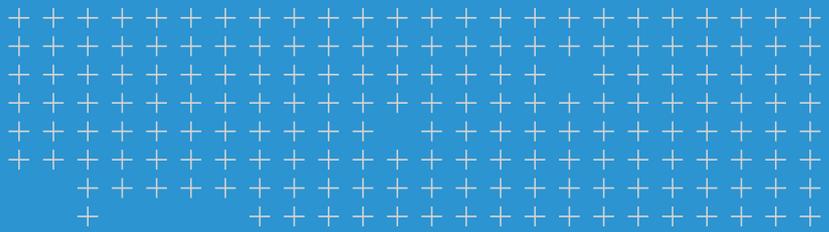
And with material property calculators built in, all the reporting you already need to complete can now show you the actual dollar value of your piles—or the money sitting in your whole stockyard. See just how much your inventory is worth with every single survey.

## FAST, AFFORDABLE, AND ACCURATE

Measuring and managing your stockpiles with a drone is fast, affordable, and accurate. Because you can count on accurate, exact numbers on your stockpiles and get them more frequently than ever before, you can tighten up operations from financial forecasting to supply-chain management to accurate reconciliation. This makes accurate inventory management possible.

Updated information about your stockyard is now available as often as you want to fly. And with easy-to-share digital reporting, you can have a visual conversation with your team or your boss. Get everyone on the same page with Trimble Stratus.





# Trimble Stratus: Real Solutions

Here are a few examples of how real people are solving real problems with Trimble Stratus:

- ▶ “Trimble Stratus gives us the ability to compare underground field work to construction models quickly and accurately, this enables us to have more efficient and effective coordination meetings.”

— **Hamzah A. Shanbari**, *Haskell*

- ▶ “I can go out and fly a site in two to three hours and then just upload everything to Trimble Stratus and come in the next day, and it’s done. If I have a question, I can just email someone and usually within a few hours— or within 24 hours—I have a solution back. It simplified everything that we do.”

— **Jim Croan**, *JRC Construction*



## TRIMBLE Civil Engineering and Construction & Aggregates

10368 Westmoor Drive  
Westminster, Colorado 80021 USA  
800-361-1249 (Toll Free)  
+1-937-245-5154 Phone

construction\_news@trimble.com  
[construction.trimble.com/stratus](https://www.construction.trimble.com/stratus)

aggregates@trimble.com  
[aggregates.trimble.com](https://www.aggregates.trimble.com)

© 2019, Trimble Inc. All rights reserved. Trimble and the Globe & Triangle are trademarks of Trimble Inc., registered in the United States and other countries. PN 022482-4128A (07/19)