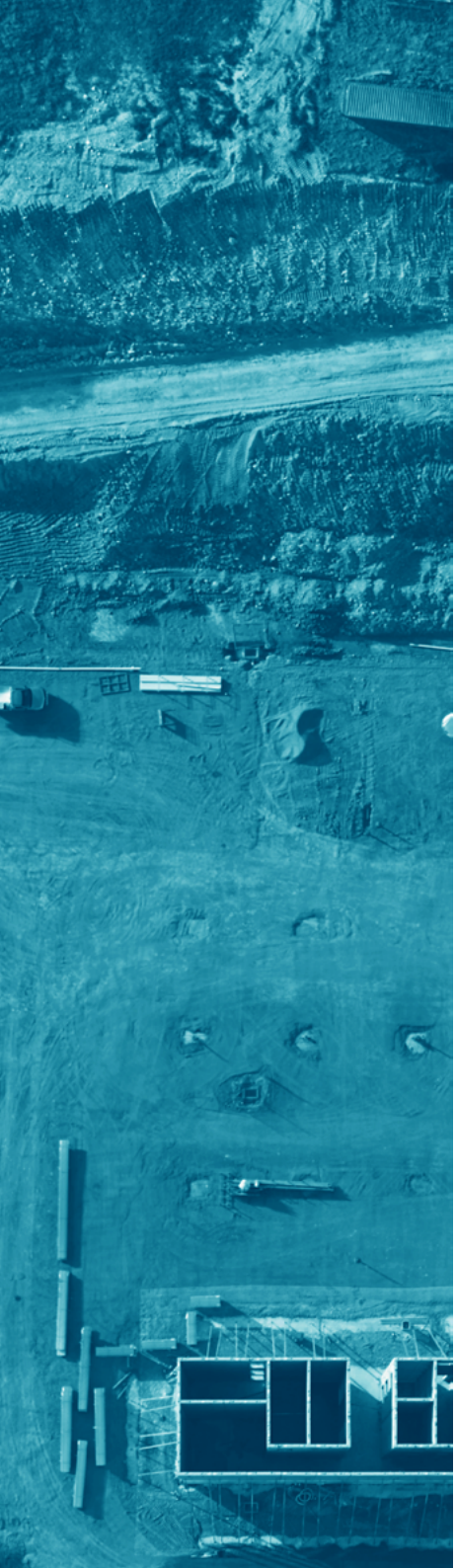
White Paper

DRONE REGULATIONS AND DATA QUALITY FOR QUARRY APPLICATIONS

Landair surveys



CONTENTS

WE UTILISE BOTH PILOTED AND DRONE

AERIAL SURVEYING TECHNOLOGIES

1. ABOUT LANDAIR SURVEYS

Landair Surveys is an aerial, land and engineering surveying company servicing the quarry, landfill, construction and architectural industries Australia-wide. We specialise in flyover imagery and mapping, drone surveys, airspace calculations and spatial data management systems.

With over thirty years of aerial mapping experience we are CASA-certified and utilise both piloted and drone aerial surveying technologies.

The information given in this paper is advisory only. The relevant legislative framework and guidelines should be consulted in addition to the general principles found in this paper.

2. INTRODUCTION

Remotely Piloted Aircraft (RPA)—more commonly known as **drones**—have become increasingly useful in many aspects of quarry operations. The quick uptake of the technology has raised some key questions from quarry managers concerning regulations, drone safety and data quality. This paper seeks to address these key concerns and offer practical suggestions moving forward in utilising drone technology and data.

Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 101-01 v2.1

Remotely piloted aircraft systems - licensing and operations

Date July 2018
File ref D17/43474

3. DRONE REGULATIONS

The Civil Aviation Safety Authority (CASA) is Australia's national authority for aviation regulation. They set the framework for all piloted and remotely piloted aerial applications through the issue of licenses, approvals and ongoing enforcement of aviation laws. CASA has created drone-specific advisory notes and regulations to answer the key questions:

- What are drones?
- Who can fly drones?
- What are the general operating requirements for flying drones?

DRONES ARE CATEGORISED BY PLATFORM TYPE

AND AIRCRAFT WEIGHT CLASSES

3.1. WHAT ARE DRONES?

FIXED-WING PLATFORM

MULTI-ROTOR PLATFORM

Drones, defined in the regulations as Remotely Piloted Aircraft, are any aircraft (other than a balloon or kite) where the pilot is not on board the aircraft and controls the aircraft's movements remotely.

They are categorised by platform type and aircraft weight classes. The two platforms are **fixed wing** (i.e. a remote-controlled aeroplane) and **multi-rotor** (i.e. a drone with multiple helicopter-type props.)

According to weight class drones fall into five categories:

1. **Micro**—gross weight of 100g or less.
2. **Very small**—gross weight of more than 100g and less than 2kg.
3. **Small**—gross weight above 2kg and less than 25kg. The majority of drones used for quarry operations fall in this weight class.
4. **Medium**—gross weight above 25kg and less than 150kg.
5. **Large**—gross weight above 150kg.

Australian Government
Civil Aviation Safety Authority

RPA OPERATOR'S CERTIFICATE (ReOC)

Number CASA.ReOC.00458 Revision No: 3

This certificate is granted pursuant to regulation 101.335 of the Civil Aviation Safety Regulations 1998 (CASR) to:

LANDSUR PTY LTD

ABN: 10177020 ACN: 078 606 185

The holder of this certificate is certified as a Remotely Piloted Aircraft (RPA) operator and is authorised to operate the RPA described in the attached schedules subject to any limitations and conditions in those schedules.

This certificate is effective from 01 February 2018 and will expire on 28 February 2021.

Dan Burie
Section Manager Permissions Issue
Client Services Centre
Stakeholder Engagement
Delegate of the Civil Aviation Safety Authority

01 February 2018

safe skies for all

Australian Gov

LANL
Unit 1
87-91
RINGW

Email: ray

Dear Sir / Ma

RE: RPA Ope

I refer to your ad
The enclosed cer
regulation 101.33

The Certificate is va

Please review your R
be changed or you ha
Permissions Issue Tea

Reconciliation of your acc
to the initial estimated cost

If you should require additio
contact the Permission Issue

Yours faithfully

Lana Brittingham
Permissions Issue Team
Client Services Centre

Enc: ReOC

GPO Box 2005 Canberra ACT 260

Canberra, Brisbane, Darwin, Cairns, Townsville, Tamworth

3.2. WHO CAN FLY DRONES AND WHAT ARE THE OPERATING REQUIREMENTS?

This is where most of the confusion arises as there are different regulations based on whether the flying is for commercial or recreation purposes; what type of drone weight-class is utilised; whether the operator is the landholder or not; and, where the drone activity takes place.

At the foundational level anyone who operates a drone must do so according to the CASA-defined **Standard Operating Procedures** (S.O.P.), as follows:

- Maintain visual line of site at all times
- Do not fly higher than 120m / 400 ft
- Do not fly within 5.5km of a controlled aerodrome
- Do not fly in the approach and departure paths of an aerodrome
- Do not fly within a prohibited area
- Do not fly autonomously without any way to take direct control of the aircraft
- Do not fly at night
- Do not fly over populous areas
- Do not fly closer than 30m from people not associated with the flight

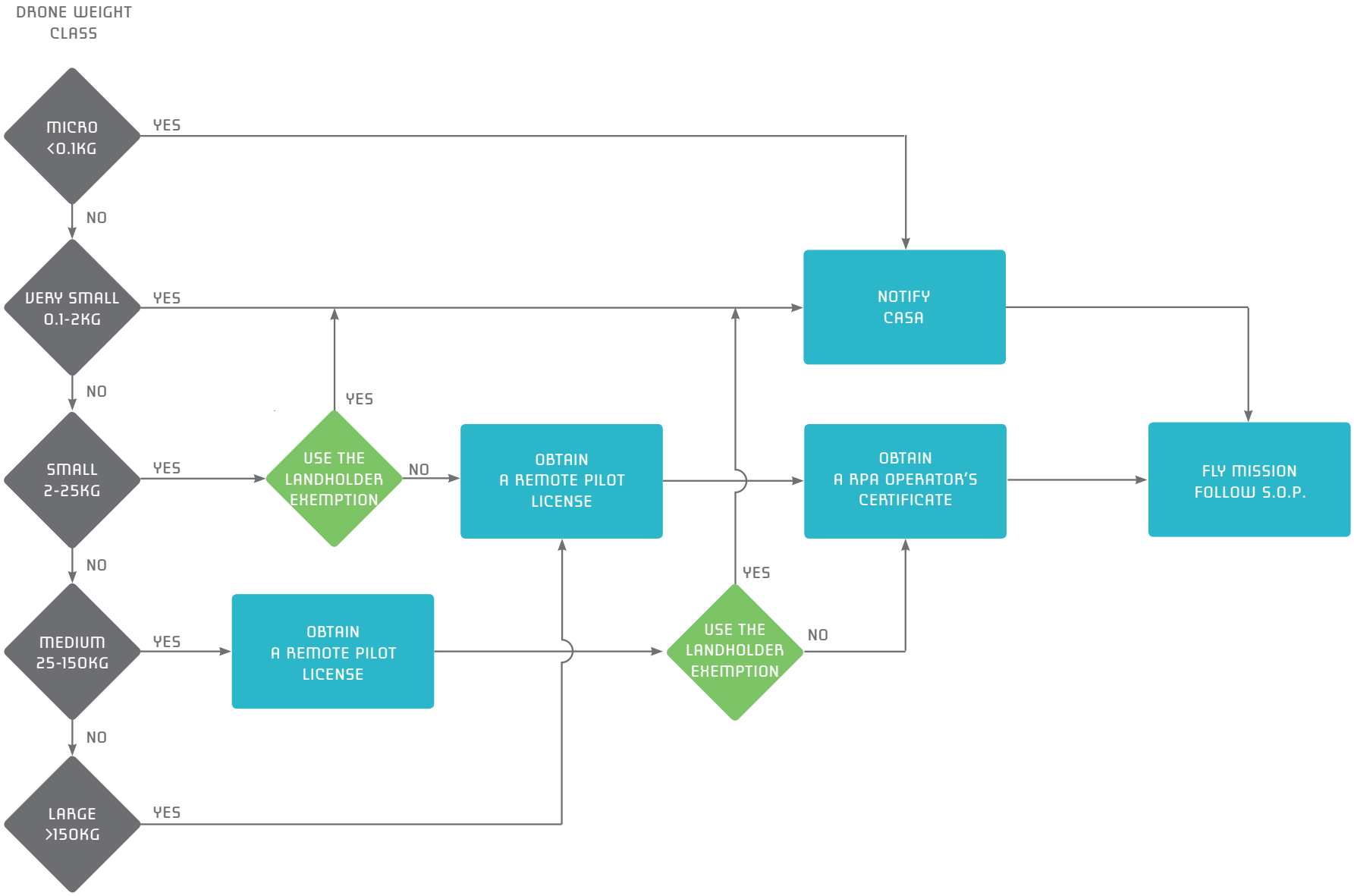
The majority of recreational drone users do not require a license to fly as long as they follow the Standard Operating Procedures above and do not fly their drone in a way that creates a hazard to other aircraft, people or property.

Almost all flights within quarry boundaries, though, would be considered to be for the commercial benefit of the landholder. All commercial drone operators regardless of license requirements must hold an Aviation Reference Number (ARN) which can be applied for using CASA's website. An ARN is a CASA-supplied identification number needed for approvals, permissions and communication regarding aerial operations.

For commercial drone usage the key question concerns what weight-class of drone will be used. For drones with a take-off weight less than 2kg, no license is required. However, CASA will need to be notified of the flight location at least five days before the first mission. This notification will last for three years for the location specified and operators must follow Standard Operating Procedures.

For drones with a take-off weight greater than 2kg, the drone operator will need to possess a **Remote Pilot License (RePL)**. There is one key exemption to this requirement (the landholder exemption – listed below), but for most drone operators a license is necessary and is issued on the basis of attending a CASA-approved training school. Once a RePL is granted, the drone operator then

Commercial Drone Operation Permission Flowchart



needs to apply to fly under an existing **RPA Operator's Certificate (ReOC)**. The Operator's Certificate specifies approved aerial operations that can be undertaken by the company/individual as well as those who hold legal responsibility to ensure safe operations and legal redress. The final step is to get flight authorisation from the Chief Pilot listed on the RPA Operator's Certificate and undertake the necessary pre-flight safety precautions.

As mentioned above, there is an exemption for the license requirement for operating 2kg – 25kg drones. If the operator of the drone is the landholder (owner or leaseholder) or operates the drone solely on behalf of the landholder as a direct employee (i.e. not a subcontractor); and the area of operation is wholly within the landholder's property; and the drone operator is not receiving direct reward or compensation for the operation (i.e. an employee receiving added renumeration for flying drones on behalf of the landholder), then the drone operator may fly drones without the need for a RePL. CASA will still need to be notified of the time and place of operations and all operations need to maintain CASA Standard Operating Procedures. A copy of the notification receipt should also be held by the operator and available for inspection.

The principles listed above regarding the commercial operation of drones can be illustrated using the permission flowchart shown.

4. DRONE SAFETY

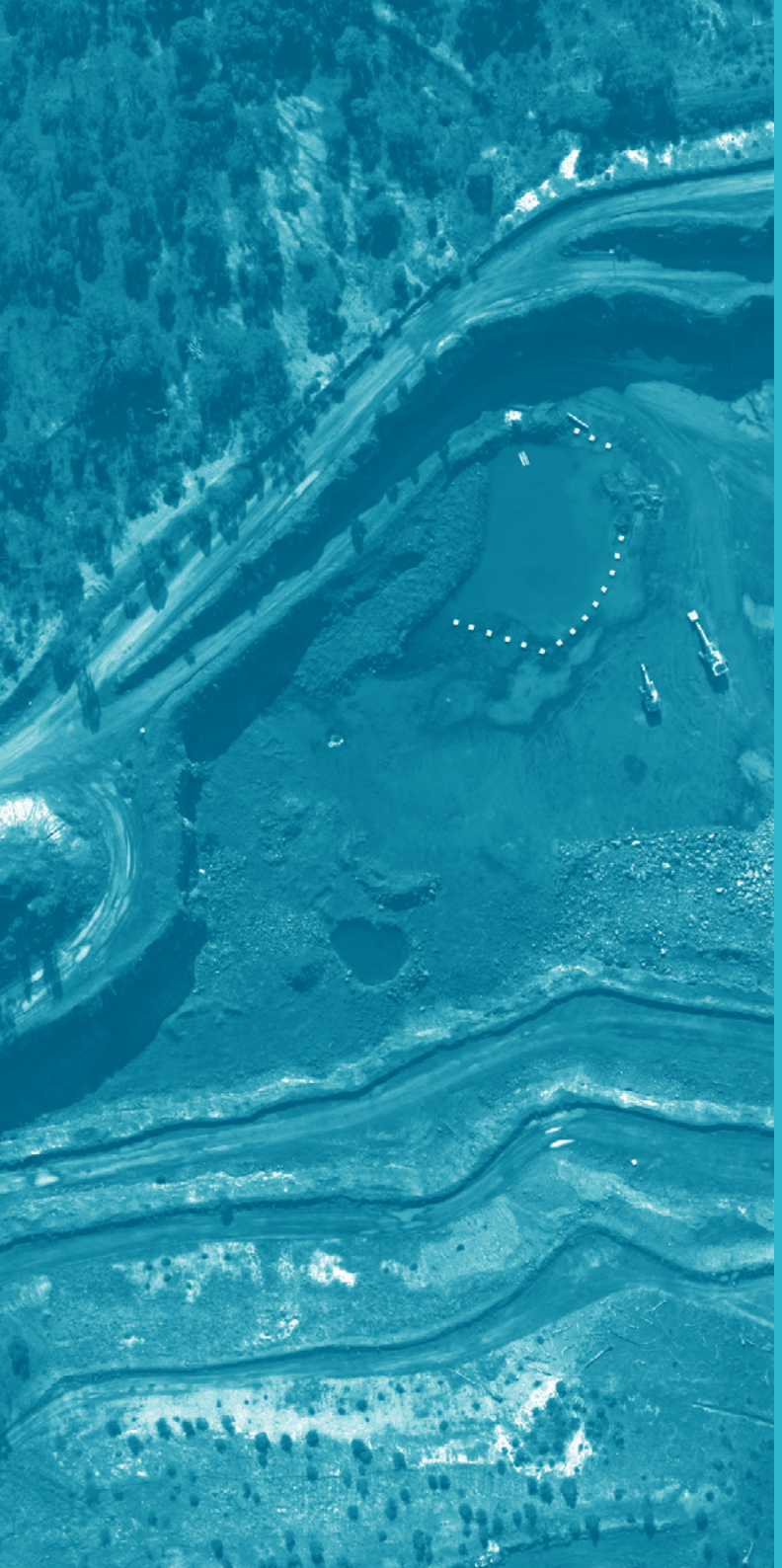
The advances and implementation of drone technology brings along with it a heightened awareness of drone-specific hazards – the most dangerous of which is the drone falling from significant height after engine failure. For example, a 3kg multi-rotor drone free-falling from a height of 80m will reach a speed of over 140km/h when it hits the ground. It's significant impact that needs to be accounted for in undertaking drone operations.

CASA sets the basic requirements for safe drone operations. The Standard Operating Procedures listed above largely focus on where and when you can/cannot fly, but they also set basic principles that govern operating the drone in a way that doesn't pose a heightened risk to the general public and property.

4.1. POPULOUS AREAS

One of the key Standard Operating Procedures states flying cannot occur in populous areas. In its advisory notes, CASA defines populous areas as an area with a high enough population density that if an unforeseen fault or failure of the aircraft were to occur, a significant threat to the personal safety (and property) of those not connected with the operation would occur. Places like beaches, parks, sporting grounds in use, etc. are all classified as populous areas. Essentially, any area where the general public can enter and exit at will while flights are in operation is classified as a populous area. The same can apply to workplaces where employees can access a designated flight area unknowingly.

The Operations Manual that forms the basis of a CASA-approved RPA Operator's Certificate sets the basic requirements to minimise risk to those not part of the operation. Things like area demarcation, warning signs and public re-routing are all useful tools in minimising risk.



4.2. FULLY AUTONOMOUS FLYING

Any flight tasks that do not allow the operator to immediately and effectively take control of the aircraft are not permitted according to CASA Standard Operating Procedures. Semi-autonomous flying (i.e. the use of mapping applications) is permitted only if there is a way to immediately take full control of the aircraft. The operator must be trained in and ready to take over when required.

Landair Surveys

Safe Work Method Statement—UAV Surveys

Job number: **Date:**

Work location:

Induction required? Yes: ☐ No: ☐ Induction completed? Yes: ☐ No: ☐

PPE Required:

High vis clothing	☐	Sun protection	☐
Steel-capped boots	☐	Eye protection	☐
Hard hat	☐	Other	☐
Hearing protection	☐		
Breathing protection	☐		

(If name is listed below it is agreed SWMS has been signed)

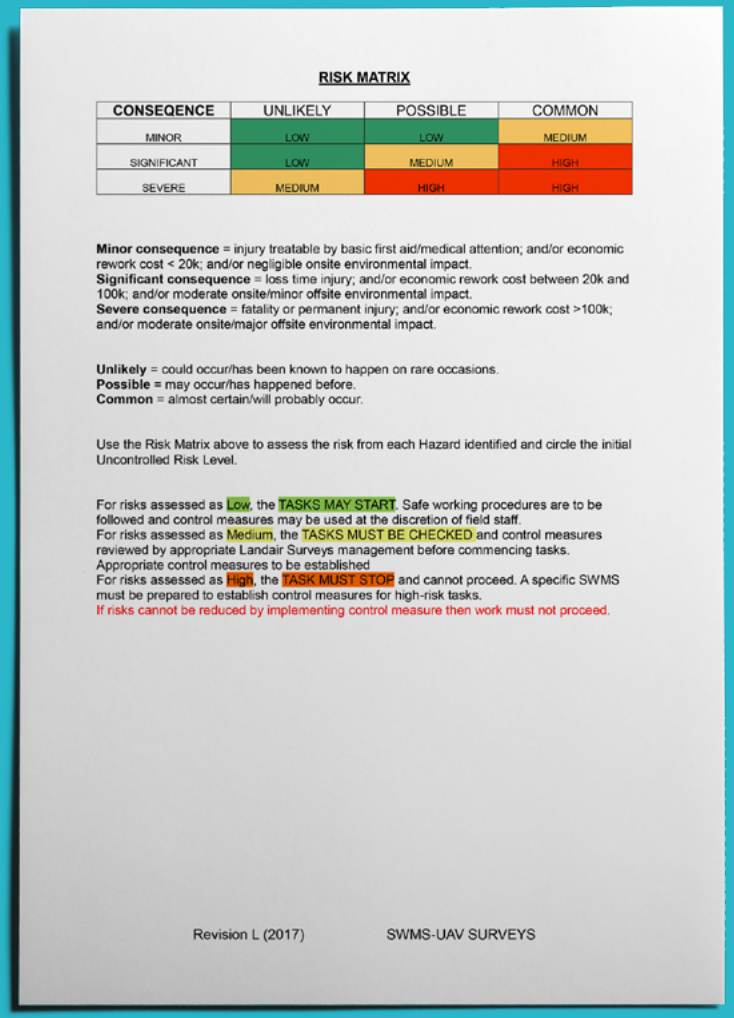
Name: Date:

Pre-flight permission checklist completed: ☐

Flight authoristation given: ☐

Pre-operational briefing given: ☐

Risk assessment undertaken: ☐



RISK MATRIX

CONSEQENCE	UNLIKELY	POSSIBLE	COMMON
MINOR	LOW	LOW	MEDIUM
SIGNIFICANT	LOW	MEDIUM	HIGH
SEVERE	MEDIUM	HIGH	HIGH

Minor consequence = injury treatable by basic first aid/medical attention; and/or economic rework cost < 20k; and/or negligible onsite environmental impact.
Significant consequence = loss time injury; and/or economic rework cost between 20k and 100k; and/or moderate onsite/minor offsite environmental impact.
Severe consequence = fatality or permanent injury; and/or economic rework cost >100k; and/or moderate onsite/major offsite environmental impact.

Unlikely = could occur/has been known to happen on rare occasions.
Possible = may occur/has happened before.
Common = almost certain/will probably occur.

Use the Risk Matrix above to assess the risk from each Hazard identified and circle the initial Uncontrolled Risk Level.

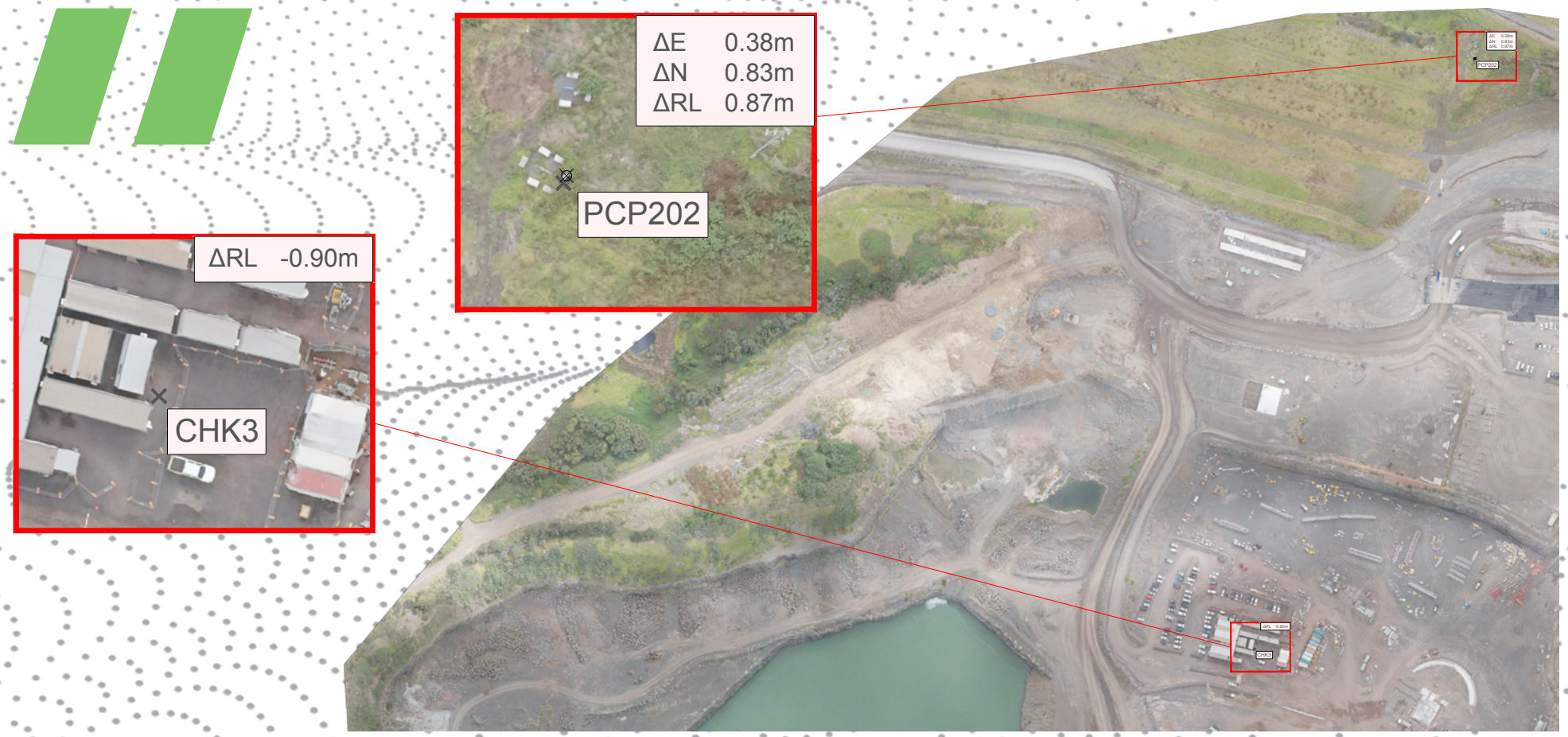
For risks assessed as Low, the TASKS MAY START. Safe working procedures are to be followed and control measures may be used at the discretion of field staff.
For risks assessed as Medium, the TASKS MUST BE CHECKED and control measures reviewed by appropriate Landair Surveys management before commencing tasks.
Appropriate control measures to be established
For risks assessed as High, the TASK MUST STOP and cannot proceed. A specific SWMS must be prepared to establish control measures for high-risk tasks.
If risks cannot be reduced by implementing control measure then work must not proceed.

Revision L (2017) SWMS-UAV SURVEYS

4.3. PRE-FLIGHT ANALYSIS

It is important for all drone operators to take the time before flying to identify the relevant hazards associated with flying and take the necessary steps to either eliminate or mitigate the hazards.

As a bare minimum a Job Safety Analysis (JSA) or Safe Work Method Statement (SWMS) should be worked through. Other documents such as permission flowcharts, authorization forms, pre-operational briefings and mission checklists are all useful tools in enhancing safety.



MANY QUARRY MANAGERS DO NOT KNOW

HOW ACCURATE ANY GIVEN DRONE DATA SET IS

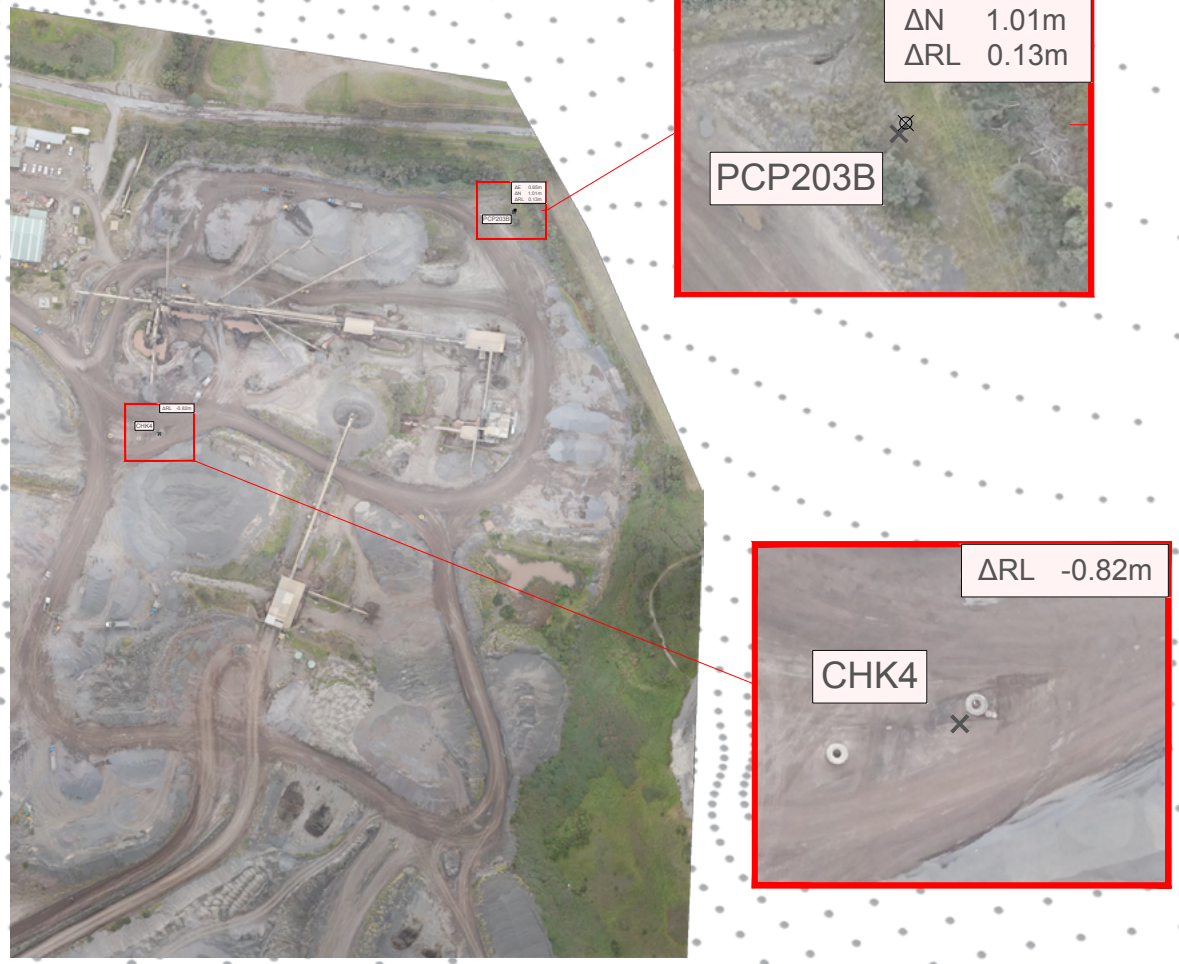
5. DRONE DATA

The area where most of the problems occur with the drone workflow is data accuracy and obtaining useful final deliverables. Many quarry managers do not know how accurate any given drone data set is and often take for granted best-practice manufacturer specifications or software accuracy claims as representative of all drone surveys. This is far from useful in that it gives a false sense of trust in data that, compared to real-world conditions, can ultimately prove inaccurate.

The overall accuracy of a data set can be difficult to ascertain, as it's often not discernible looking at the surface level. It's only as you investigate positional accuracy within each data set that confidence can be gained. Recently, for example, Landair received a request from a company about some outsourced drone data that needed confirmation. The mission was flown using a company employee enacting a pre-determined flight path. The data processing was outsourced overseas and the resulting orthoimage and triangle surface was specified to be accurate and aligned to the site coordinate system. Volumes where then calculated from this data. It was subsequently discovered that this outsourced data set was inaccurate, in some cases metres away from its true real-world position. At a surface level, the orthoimage looked good as did the 3D triangle file, but the positional accuracy was sub-standard. Imagine the difference that being a metre off vertically would have on volumes comparing measured excavation levels to design surfaces. The processing had to be re-done from scratch and additional control measures added to the data set to get the required accuracy.

The final quality and accuracy of drone data hinges on three foundational principles:

- Camera quality—for example, a GoPro will not have the same image quality as a high-end drone camera which, in turn, will not have the same quality as



OFTEN CHEAP DRONE SURVEYS COMPROMISE

FINAL DATA ACCURACY

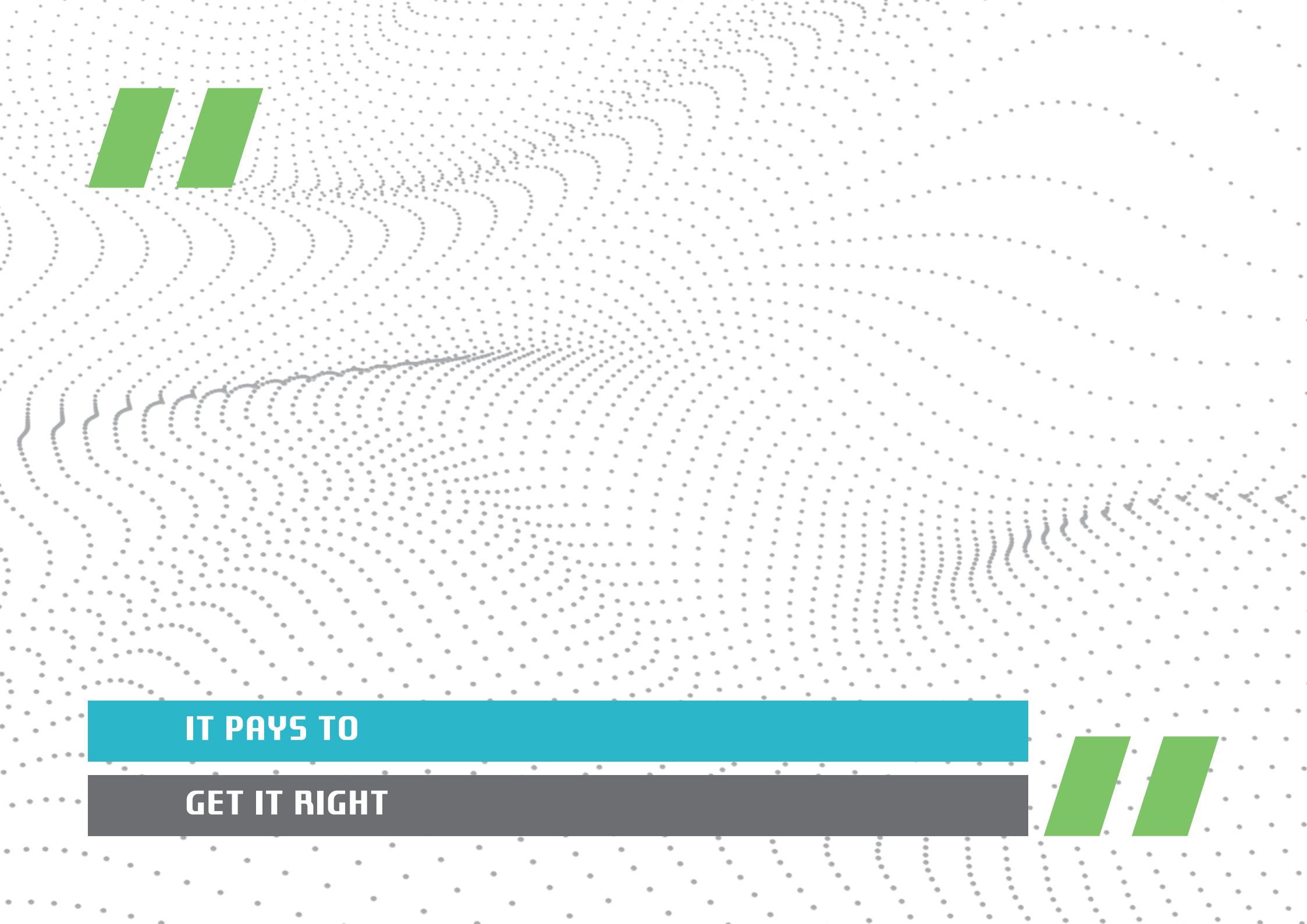
a fully calibrated aircraft camera. Data processing relies heavily on image pixel matching and the better the imagery the better the final deliverable.

- Image stability—mapping-grade multi-rotor drones have the camera attached to a gimbal that allow for on-the-fly camera correction in windy conditions. Fixed wing drones and low-end multi-rotor drones have no way to stabilize imagery in basic windy conditions and the resulting error sources are then distributed throughout the data set.
- Datum control points—when using drone data for mapping, month-to-month volume calculations or comparing existing conditions to quarry design, it is necessary to align the data to a common site co-ordinate system (usually **MGA94** or **MGA2020**). Accurate, well-dispersed control points are essential for accurate data sets. Even new-generation RTK drones with specified 3cm accuracies need at least two well-dispersed ground control points to independently confirm data accuracy.

Often, drone surveys undertaken for significantly cheaper rates than normal make key sacrifices in one or all three of the principles listed above thus compromising final data accuracy.

There is also some confusion regarding image **Ground Sampling Distance (GSD)** as a measure of drone data accuracy. GSD is simply the distance between two consecutive pixel centres measured on the ground. A 2cm GSD doesn't mean accuracy to 2cm. Again, the only way to confirm drone data accuracy is to check against previous independently surveyed points that are not used in the data processing.

Anyone can fly a drone for quarry applications with a bit of training, but not everyone has the expertise and experience to process drone data to the levels needed by most quarry operations. In this instance, it is often most beneficial to have someone process the data (and better still fly the mission) who is experienced in spatial modelling and the resulting calculations. There is a high level of accountability within the surveying and photogrammetry professions that is simply not there for the inexperienced hobbyist turned drone operator. The same principle also applies to online data processing and hosting platforms.


IT PAYS TO
GET IT RIGHT

6. ADVICE FOR QUARRY MANAGERS

Landair Surveys has over thirty years' experience in aerial surveying and utilise both drone and piloted aircraft technologies for their clients Australia-wide. Using this experience, the following questions are asked in order to lead to the best possible data outcome for any quarry manager considering drone surveys:

- **Can a drone be legally flown in the location?** Use the CASA 'Can I Fly There' website or smartphone application to determine flight permissions.
- **Why is a drone survey desired over a traditional piloted aircraft survey?** The most common response is cost. It may be a surprise, though, how economical a piloted aircraft flyover is especially for larger areas. It pays to ask the question because the quality of data from a piloted flyover is often exponentially greater than that of a drone survey. If the price-points are similar, why not get the better data set?
- **Are the drone operators qualified and experienced?** If using the 'landholder' exemption, do they pass the additional landholder rules?
- **Are the drone operators insured and operate under a CASA-approved RPA Operator's Certificate? If using the 'landholder' exemption, does the landholder have additional insurance and has CASA been notified of the flight location?**
- **Has the drone operator completed the necessary pre-flight safety and regulatory paperwork?**
- Can the accuracy and quality of the final data set be independently verified? A few scattered check points around the site that are not used in the processing steps can easily confirm drone data accuracy. If a drone survey has been undertaken at basement-level prices with very fast turnaround times, be especially suspicions that corners have been cut concerning accuracy.
- Would an aerial surveying professional familiar with complicated volume computations and quality control measures be a better option for processing the drone data?

WWW.CASA.GOV.AU

WWW.LANDAIR.COM.AU

7. FURTHER INFORMATION

7.1. CASA

The ‘Can I Fly There’ interactive website: https://casa.dronecomplier.com/external

Drone specific website: https://www.casa.gov.au/aircraft/landing-page/flying-drones-australia

‘Flying Over Your Own Land’ brochure: https://www.casa.gov.au/files/rpabrochurelandholder150dpipdf

Remotely Piloted Aircraft advisory notes: https://www.casa.gov.au/files/101c01pdf

7.2. LANDAIR SURVEYS

Drone solutions: http://www.landair.com.au/our-services/uav-drone-surveys

Third party drone data processing options: http://www.landair.com.au/our-services/drone-data-processing

Solutions for quarries: http://www.landair.com.au/our-solutions/for-quarries

Article on choosing the right aerial survey type: http://www.landair.com.au/_literature_236442/Dispelling_Aerial_Surveying_Myths

Examples of previous drone 3D models: https://sketchfab.com/RAKC/models

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surveys