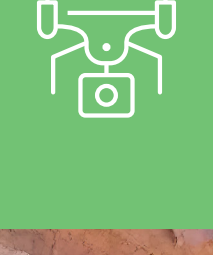


Comparative Analysis of Topographic Surveying Technologies for Mining Use Cases

This infographic compares the four primary topographic surveying methods for the mining industry.

When used together, these technologies offset each other's limitations and can be part of a robust survey program:

1. High-Resolution Optical Satellites
2. Rapid-Revisit Optical Satellites
3. Drones
4. LiDAR

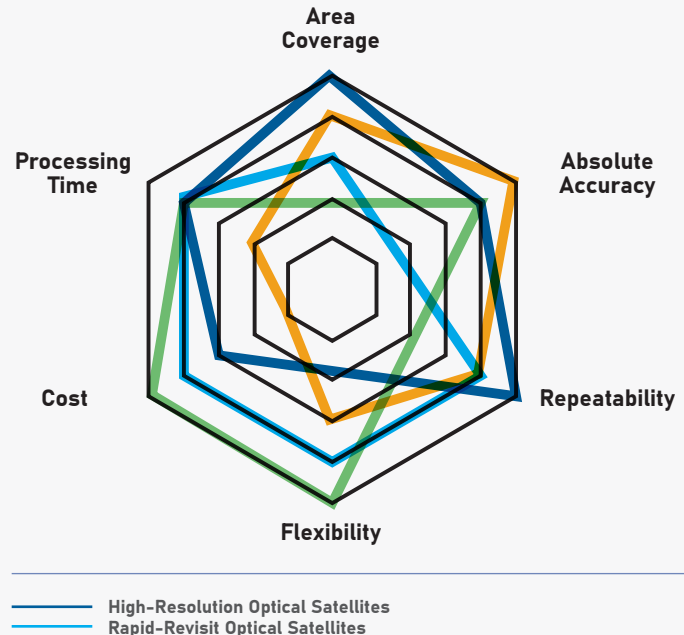
Technology	Strengths	Limitations	Best Mining Use Cases
High-Resolution Optical Satellites 	- Covers full sites remotely - Suitable for periodic monitoring - Baseline data - High accuracy with ground control* - Fast processing - Archive imagery available	- Lower resolution than drones or LiDAR - Impacted by clouds, dust, smoke - Obstructed by vegetation - Limited by orbit schedule and satellite demand	- Full site/TSF monitoring - Topography for dam breach analysis - Verifying drone or rapid-revisit optical satellite data - Tracking historical changes with archived imagery
Rapid-Revisit Optical Satellites 	- Harnesses larger constellations of satellites to capture imagery of a mine site as often as once a week - Frequent revisits are enabled by the size of the constellation - Fast processing times	Lower overall resolution and accuracy compared to the other technologies	Monitoring TSF, stockpiles, waste dumps, and other facilities on a frequent basis (e.g., monthly or weekly)
Drones (UAV) 	- With proper ground control, drones have the highest absolute accuracy - Can carry multiple sensors (often one per flight) - Frequent deployment possible	- Weather-dependent - Requires on-site operators - Limited coverage - Variable processing time - Constrained by battery, weight and flight permits	- Localized, detailed surveys - Small-scale mapping and volumetric analysis
LiDAR 	- Highest absolute accuracy - Penetrates vegetation to reveal ground surfaces	- Costly operations and processing fees - Requires flight permits - Long processing times	- Highly detailed topographic surveys - Baseline site topography

<15 cm RMSE
when High-Resolution Optical Satellites are paired with appropriate ground controls

Creating a Comprehensive Set of Data

Using multiple tools offsets the limitations of any single technology and works to create a more comprehensive set of data

- **High-resolution optical satellite** imagery monitors changes over the entire mine site over a longer time frame (quarterly and yearly).
- **Rapid revisit optical satellites** monitor TSF, waste dumps, and other facilities on a frequent basis (e.g., monthly or weekly)
- **Drones** focus on weekly changes in a targeted area, such as TSF.
- **LiDAR surveys** serve as quality control for drone data



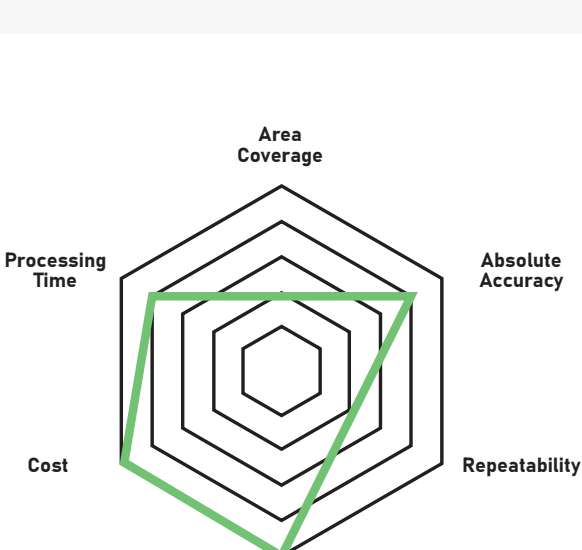
Detailed Characteristics

High-Resolution Optical Satellites

- **Coverage:** 50 km² or greater with 30 cm resolution
- **Accuracy:** <15 cm RMSE with ground control
- **Repeatability:** Consistent sensors enable reliable comparisons and processing
- **Flexibility:** Quick capture; timing depends on demand and atmospheric conditions
- **Cost:** Typically less expensive than LiDAR
- **Processing Time:** 1-2 weeks for standard mine site coverage

Rapid-Revisit Optical Satellites

- **Coverage:** ~7 km² or greater with 1 meter resolution
- **Accuracy:** Lower than high-resolution, but more frequent collection
- **Repeatability:** Quick revisit times
- **Flexibility:** Very flexible; collection in as little as 3 hours
- **Cost:** Much lower than high-resolution optical satellites
- **Processing Time:** Faster than high-resolution optical satellites

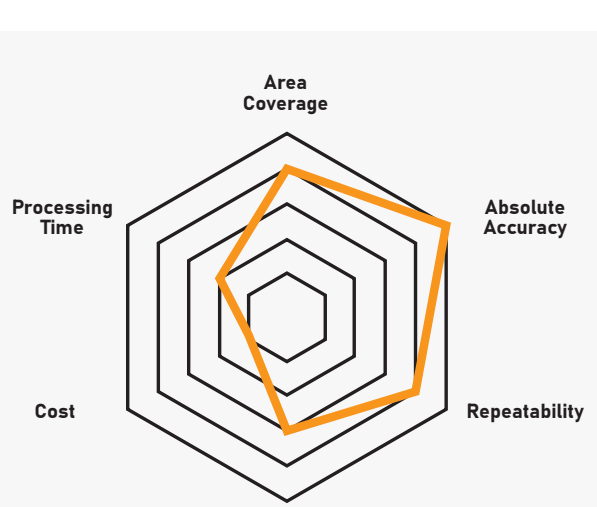


Drones (UAV)

- **Coverage:** typically up to 4 km² per flight
- **Accuracy:** Dependant on operator skill, ground control, and processing
- **Repeatability:** Limited by flight duration and area coverage; data may misalign
- **Flexibility:** Quick deployment, but limited by batteries, permits, weather and operator availability
- **Cost:** Low once in-house program is established; higher with third-party services
- **Processing Time:** Fast (within hours); may require extra data processing needed to correct for discrepancies between flights and to generate a bare ground surface

LiDAR

- **Coverage:** 100s of km² but smaller than high-resolution optical satellites
- **Accuracy:** Vertical accuracy as low as 5 cm, highest among compared technologies
- **Repeatability:** Highly repeatable with consistent data collection
- **Flexibility:** Less flexible due to permits and logistics
- **Cost:** Often cost-prohibitive, varies by area
- **Processing Time:** Several weeks to months



The Right Data at the Right Frequency

