



IN-STOPE DUST CONTROL AT BEATRIX MINING OPERATIONS

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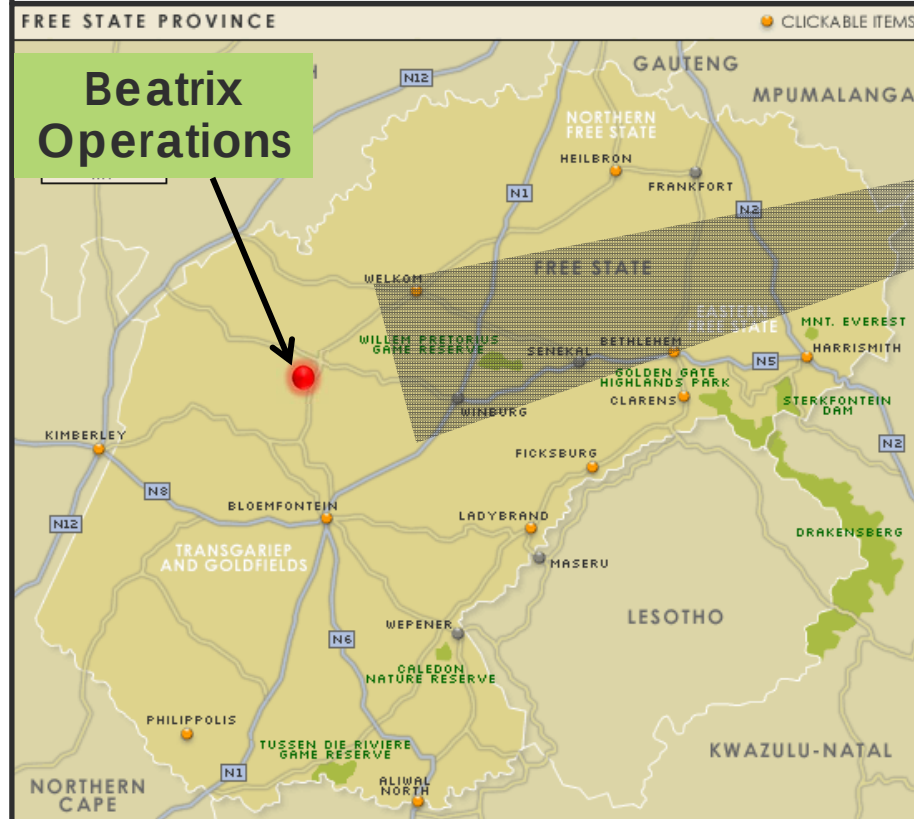
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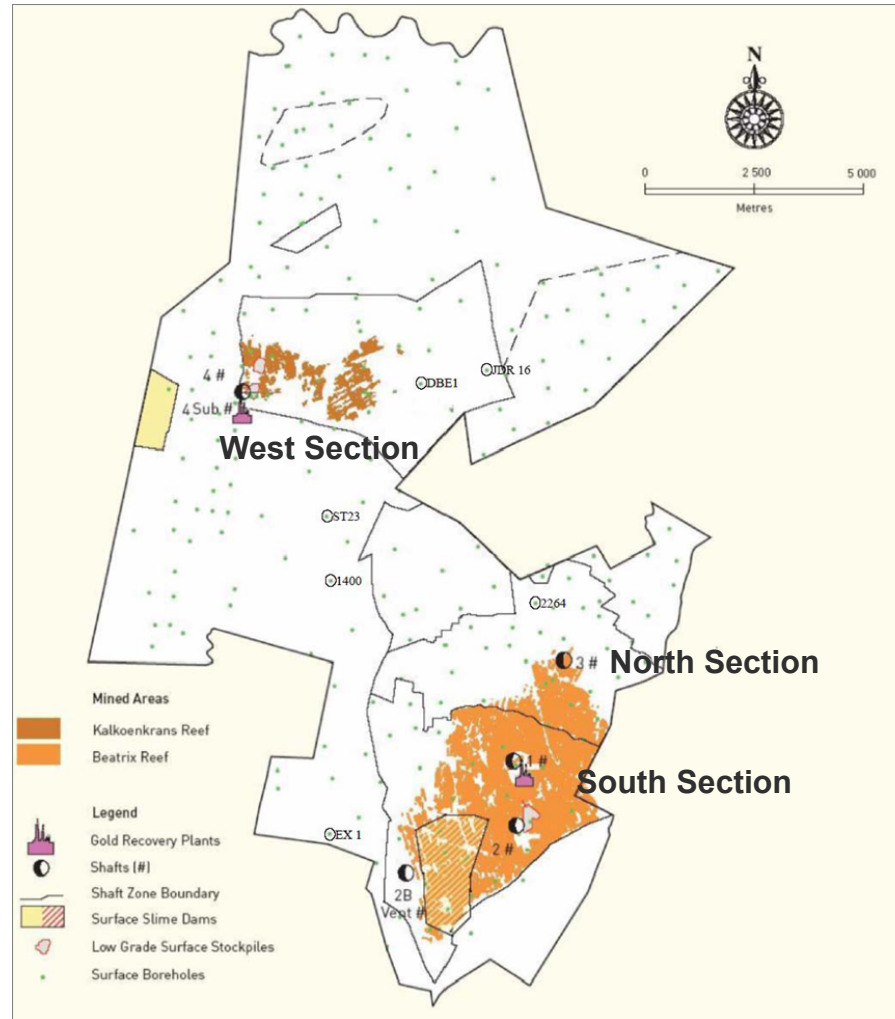
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Location of Beatrix Gold Mine

Located in the Free State Province of South Africa 280km South of the city of Johannesburg



Background of Beatrix Gold Mine



Arial view of Beatrix Gold Mine

Sibanye^{AU}



HEALTH AND SAFETY MOMENT



Progression to a multi-commodity company required to support value strategy

SUPERIOR VALUE CREATION FOR ALL OUR STAKEHOLDERS

**Through mining our multi commodity
resources predominantly in
South Africa**



Values



Commitment

Deliver on our promises to all our stakeholders



Accountability

Accept responsibility and consequences for our actions



Respect

Show regard and consideration for others



Enabling

Make it easy to work productively and safely



Safety

Nothing is so important that it cannot be done safely

Umdoni Tree





Industry Target: Zero rate of fatalities and injuries



- Every Fatality is one too many, we will eliminate fatalities by December 2020.
- Every mining company must have a target of ZERO FATALITIES.
- Up to December 2016, 20% reduction in Serious Injuries (SI) per year
- From January 2017, 20% reduction In Lost Time Injuries (LTI) per year.

Industry Target: Elimination of Silicosis



- By December 2024, 95% of all exposure measurement results will be below the milestone level for respirable crystalline silica of 0.05 mg/m³ *(these are individual readings - not average results).*
- Using present diagnostic techniques, no new cases of silicosis will occur amongst previously unexposed individuals *("These are those unexposed to mining dust prior to December 2008 i.e. equivalent to a new persons who entered the Industry in 2009)*

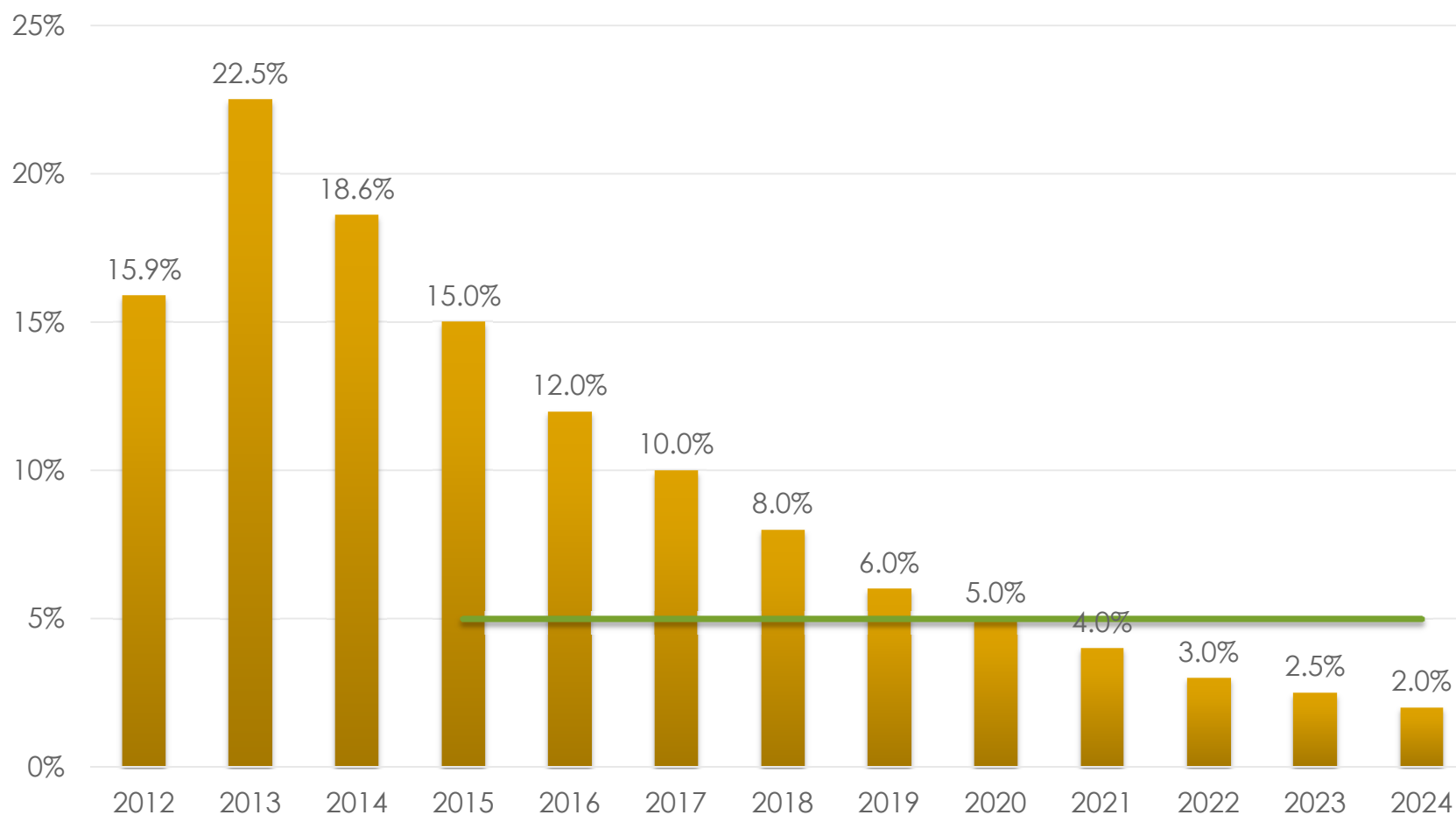
Industry Target: Elimination of Noise Induced Hearing Loss (NIHL)



- By December 2024, the total operational or process noise emitted by any equipment must not exceed a milestone sound pressure level of 107 dB(A). *(This milestone of the sound pressure levels will be verified by initiatives under the CoE and MOSH and reviewed in 2016)*
- By December 2016, no employee's Standard Threshold Shift (STS) will exceed 25 dB from the baseline when averaged at 2000, 3000 and 4000 Hz in one or both ears



2014 SILICOSIS MILESTONE – 20% ANNUAL IMPROVEMENT



Sibanye Gold Initiatives



- The mine is committed to reduce the exposure of its employees to noise and silica dust.
- Sibanye Gold has introduced an operational Noise and Dust Management Document with the purpose of reflecting the application of management's responsibility towards noise and dust control.
- A number of interventions have been introduced as part of the mine's initiative to achieve zero harm.
 - Sibanye Gold is constantly investigating initiatives to reduce exposure to noise and dust as far as reasonably practicable

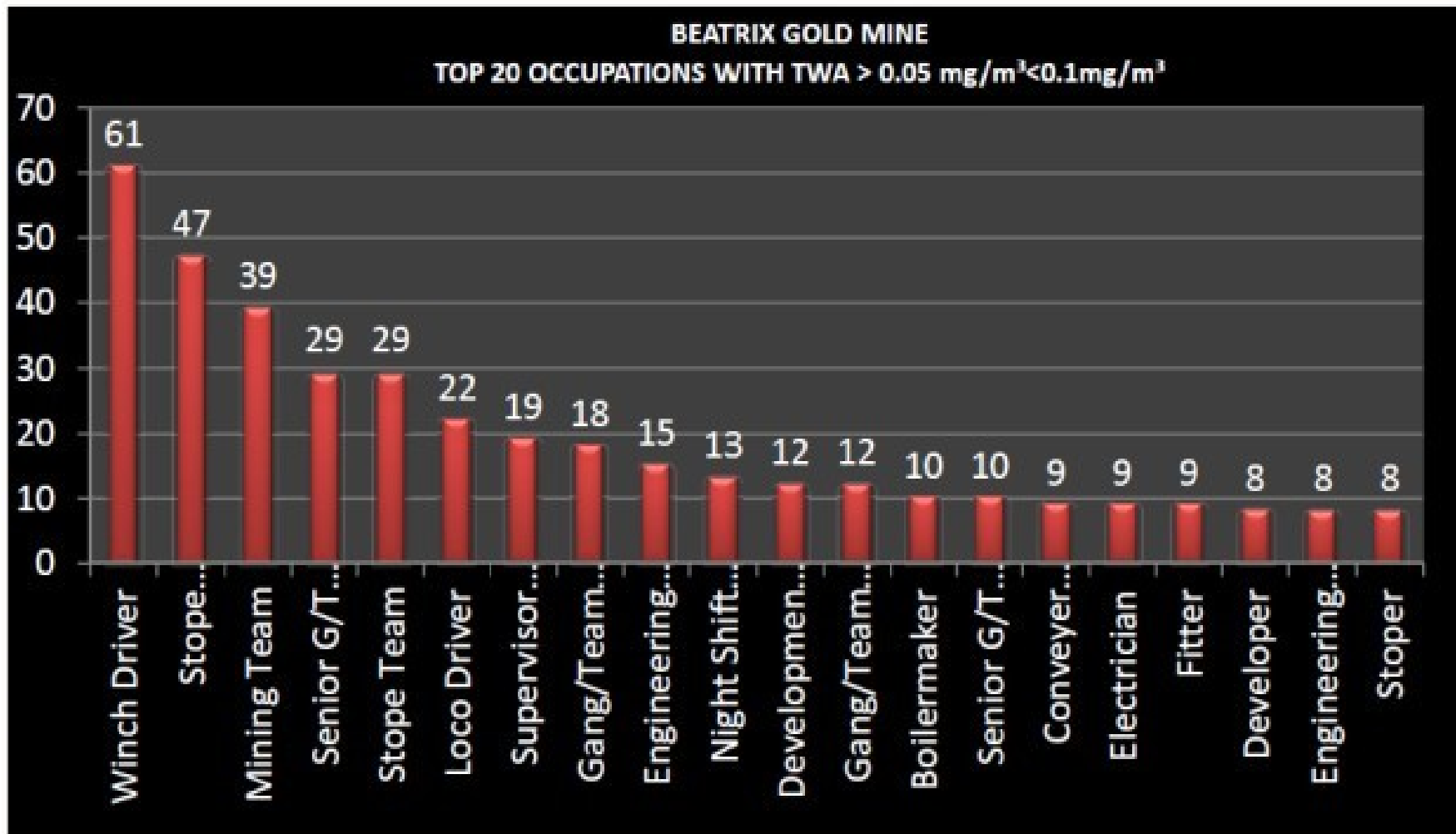
A HEALTHY WORKER IS A SAFE & PRODUCTIVE WORKER

Introduction to In-stope dust control



- Stope areas of gold mines pose a higher risk of exposure to airborne silica dust.
- Previous studies at Beatrix operations showed that watering down of the stope and development areas remains ineffective.
- Top 20 most-exposed occupations at the Beatrix Mining Operations.
- Conduct a study to identify the more effective practices, as well as to identify additional controls that could be used within the stope area.
- During the second part of the study, the value of implementing an in-stope water-blast was investigated.

Introduction to In-stope dust control



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Underground study

- Watering down is usually done with an open-ended hose, resulting in dust being liberated into the atmosphere.
- The “watering-down tool” (spray gun) is effective when used correctly, but is very time-consuming not always effective.
- The night-shift crew normally consists of only two or three winch drivers and a team leader. They usually first get their rigging installed and sometimes start work without watering down. *“To water down effectively is too time consuming”*.
- The perception is that as they are on the intake-air side of the panel, they are not exposed. They do not consider that they could be working in a stope return as stopes are often ventilated in series.

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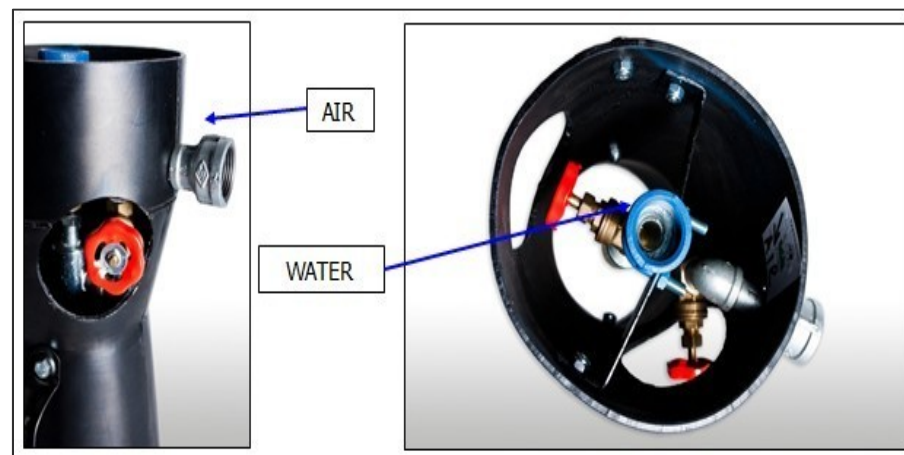
Underground study

- Watering down before scraping is started has limited benefit, and after scraping has been done for a few minutes there is very little evidence of any benefit or even of any watering down having been done at all.
- Watering down during scraping and loading is very seldom done.
- It was decided to use a water-atomising device, similar to a development water-blast, to water down a panel before and during dust-creating and liberating activities. This will also remove the additional human/equipment interface requirement for effectiveness.
- One atomising spray was sufficient for a panel.

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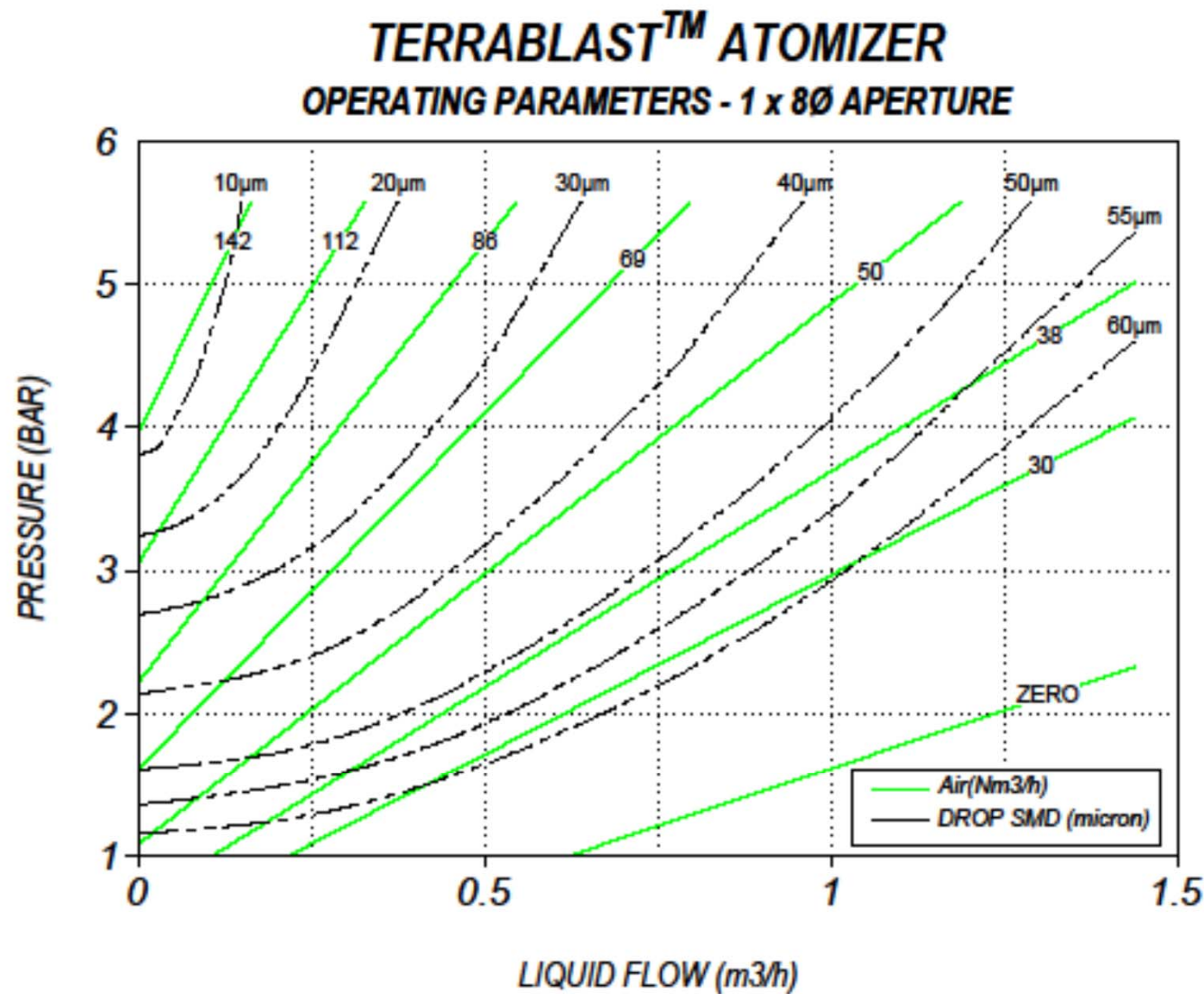
Description of the stope atomising spray

- The device chosen as a water-blast was a Terrablast™ unit.
- Uses both water and compressed air to atomise the water droplets.
- Uses an 8 mm nozzle, therefore does not require fine water filters.
- Water flow rate is 0.75 l/s at normal mine water pressure, and connection is through a standard 25 mm PVC hose.
- The optimal operating point is when the compressed air supply is between 4 and 6 kPa, with water consumption of between 250 and 500 l/h (maximum).



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Description of the stope atomising spray



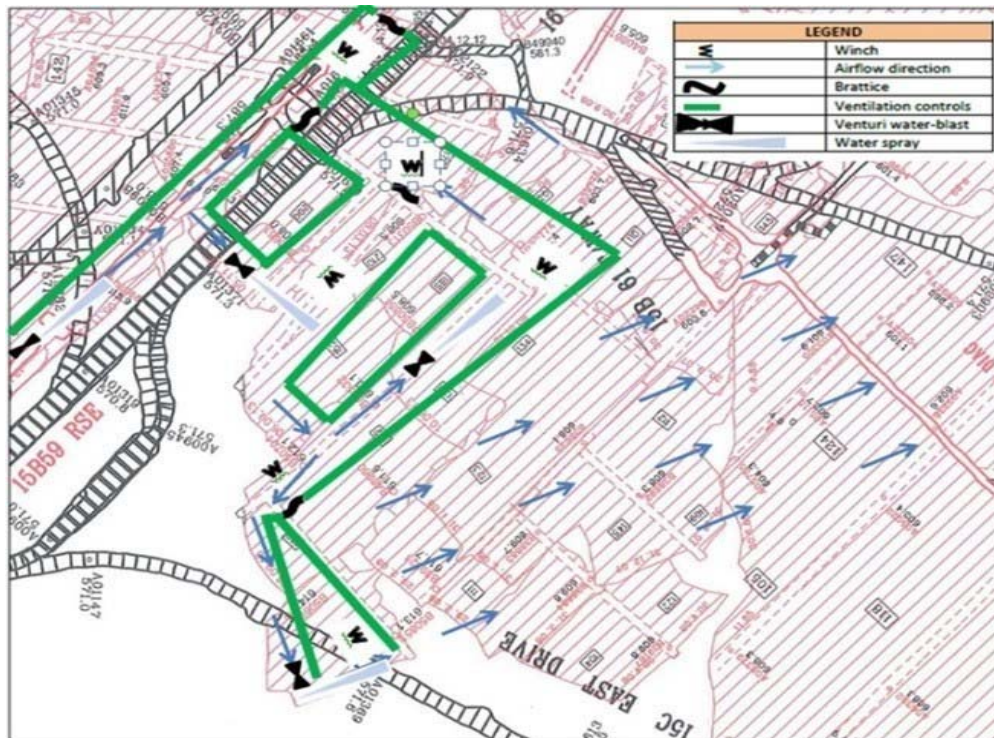
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Underground site

- Identified a workplace that could be considered as the potential worst-case scenario to trial the unit's effectiveness.
- The workplace was a stope area with two mining panels, using six winches to clean the face areas.
- Positions of the atomising sprays were chosen to ensure proper watering down of all areas without wasting resources through overdesign.
- The main objective was to demonstrate that one could achieve the desired dust concentration results within the whole of the stope area.
- The ease of installation, as well as both the water and compressed air pipes was of paramount importance.

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Underground study



Plan view of the underground trial site



One of the underground installations

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- The effectiveness of the atomiser spray was evaluated by comparing personal respirable dust exposure levels of different occupations of in-stope workers before and after the installation of the water-blasts.
- Personal exposure monitoring was conducted on both the day shift and night shift using gravimetric sampling pumps.
- Monitoring focused on the occupations that are mostly deployed in the stoping faces, strike gullies, centre gullies and back area sweepings.
- Team leaders, winch drivers, stope teams and rock drill operators were measured and observed during the study period.
- A total of 20 personal exposure samples was collected over the 8-week period.

Field trial results



Average measured dust concentrations

Occupation	Before concentration (mg/m ³)	After concentration (mg/m ³)	Exposure reduction (%)
RDO	1.163	0.231	80.1
Winch operator	1.358	0.200	85.3
Stope team	1.450	0.317	78.1

Average respirable dust concentration as determined from personal exposure monitoring results decreased significantly.

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Field trial results



- The historical average quartz percentage for Beatrix is between 22 - 28%
- The project average quartz percentage was between 11 - 18.8%, this was attributed to the fact that mining had just started in the shaft pillar area.

Average measured TWA quartz dust concentration

Occupation	Before concentration (mg/m ³)	After concentration (mg/m ³)	Exposure reduction (%)
RDO	0.129	0.02	79.8
Winch operator	0.249	0.0366	85.3
Stope team	0.168	0.046	72.6

- The combined average reduction in the TWA quartz concentration across all occupations was calculated to be 79.2%.
- Although the reduced TWA quartz concentration is still well within the current OEL, it is close to the new proposed OEL of 0.05 mg/m³.

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Additional field observations made during the study:

- Water covers the total face area from a fixed point.
- There is no need to enter any unsafe area to water down.
- The water spray washes the blasted face, assisting in exposing misfires.
- Induces airflow with a measured air quantity of up to $2.5\text{m}^3/\text{s}$.
- There is an increased face velocity measured 15 m from the water-blast of 3.3 m/s.
- There is an increased face velocity measured 30 m from the water-blast of 1.6 m/s.
- The measured water flow rate was 0.75 ℓ/s or 45 ℓ/min .
- No additional watering down was done during the trials.

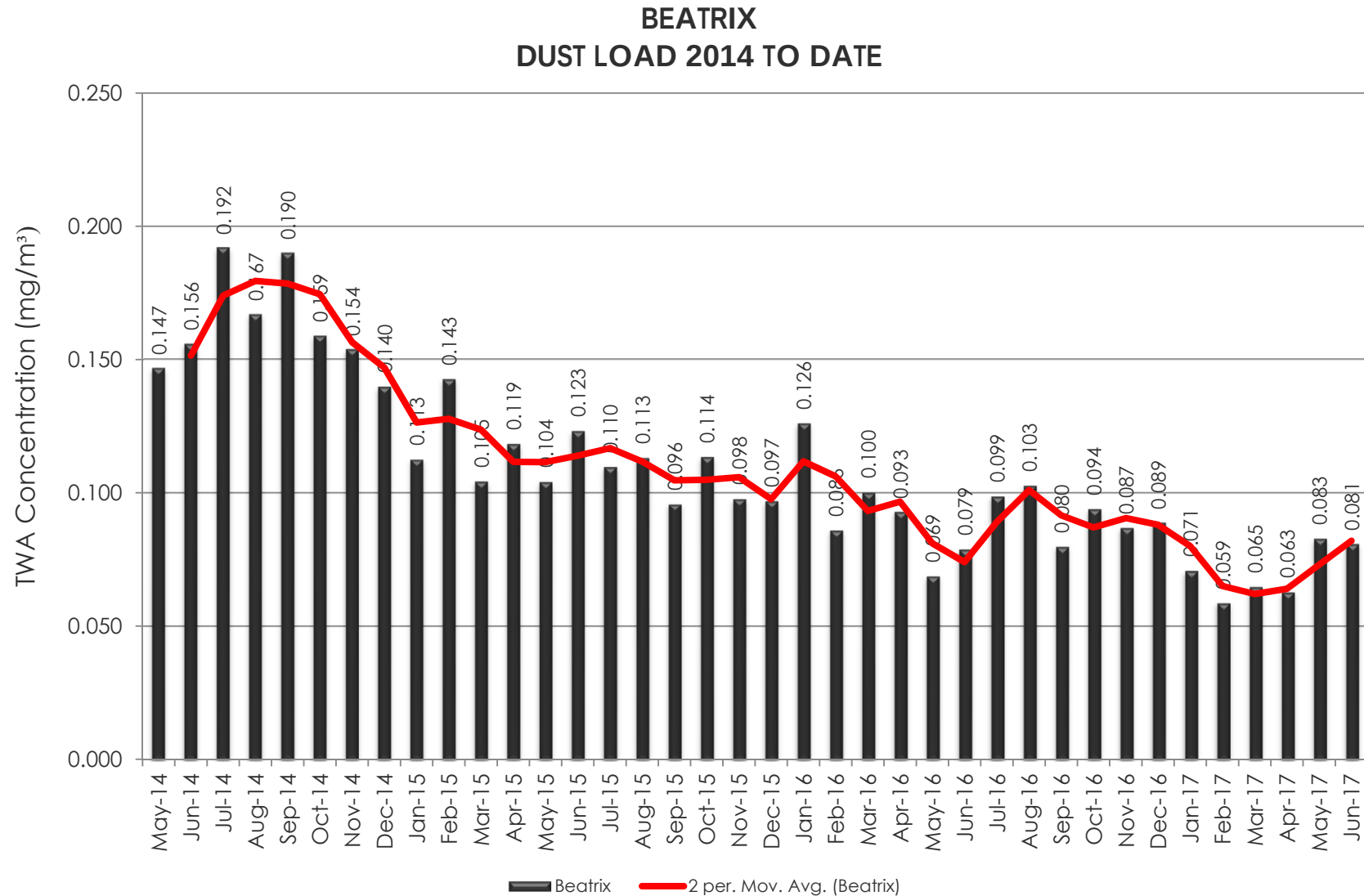
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Conclusion

- MHSC Milestones require that 95% of all individual exposure measurement results be below the milestone level for respirable crystalline silica of 0.05 mg/m³. For the industry to meet this exposure level, significant and focused efforts will be required and alternative dust control methods will have to be developed and implemented.
- A significant reduction in worker exposure is possible when effective in-stope dust control is implemented.
- The combined average reduction in the TWA quartz concentration across all occupations of **79.2%** was achieved.
- When comparing the different occupations, the in-stope team members are now the occupation with the highest average exposure, but this is still well within the current OEL.
- From the results achieved and the physical observations made the application of this technology will also be beneficial during vamping.
- One atomising spray is sufficient for watering down a panel.

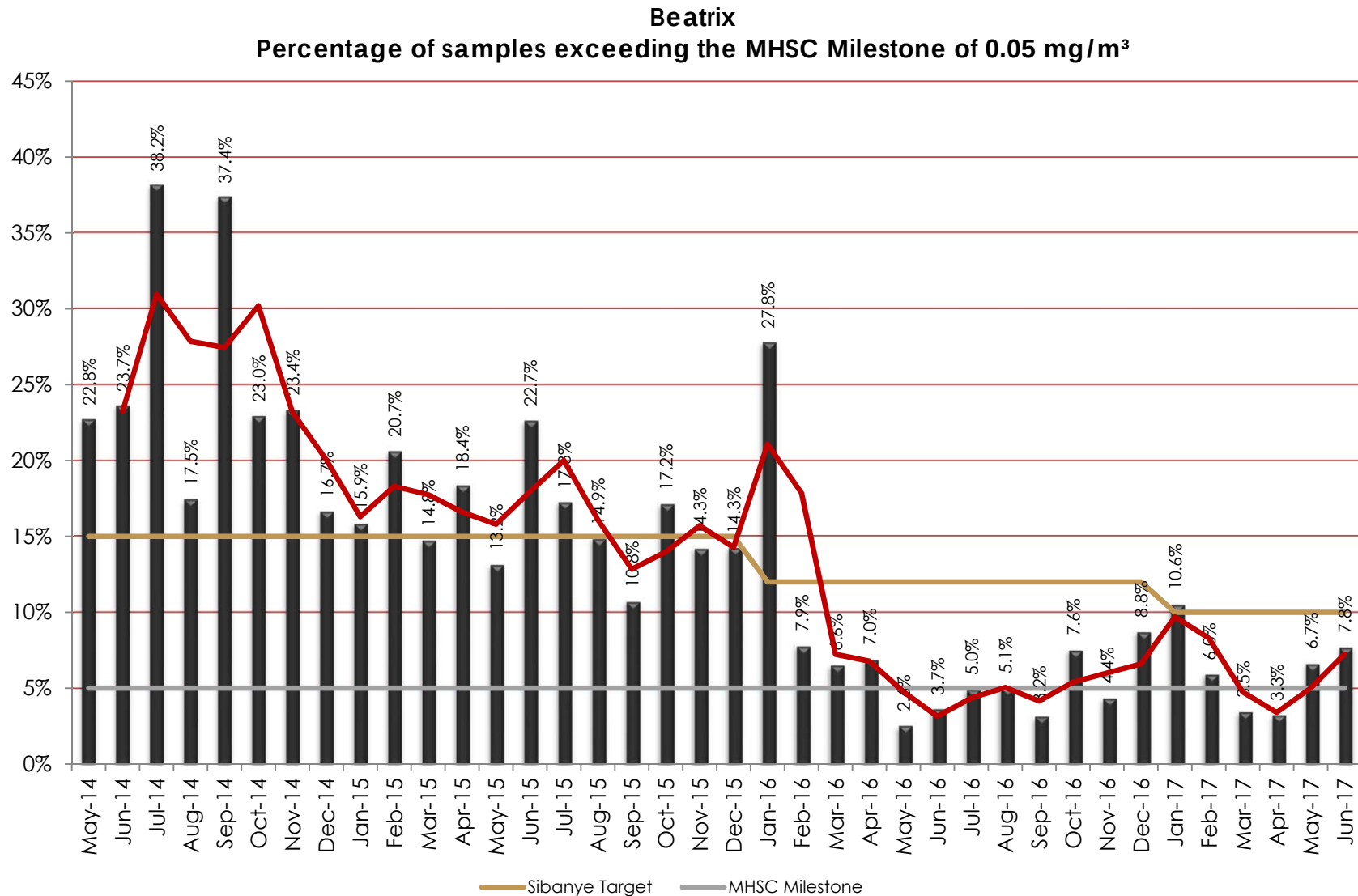
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Silica dust sampling results



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Silica dust sampling results



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QUESTIONS

