My name is Lance Lapwood.
I work with Mechanical and Associated Services, such as Ventilation systems.

I'd like to focus on a few things to do with the Ventilation from the under-ground workings of the Martha Mine Project, through to the natural Ventilation of the Martha Pit itself, the Fine Particulates and Respirable Silica, and a little bit about the effect on Air Quality.

General Description of System:

The Applicant proposes the installation of some new Ventilation fans within the Martha Pit, two Exhaust air fans, one Outside-air (fresh-air) fan.

The purpose of the Exhaust fans are to provide ventilation from the under-ground workings, scavenging polluted air from the working face of the mine, conveying this air, gases and particulate to the surface and discharging it to atmosphere.

The Outside air fan pushes in 'fresh air' to the under-ground mine in order to replenish the workings with revitalised air.

Workers and Ventilation:

With regards to the ventilation of the under-ground mining areas, it's most important to consider the well-being of the men and women at the work face.
Workers under-ground will benefit greatly by the added capacity in the proposed ventilation system, and improved airflow.

In my opinion, the expansion of the Ventilation system should be made as soon as practicable, considering that it is already a working mine.

Authority References:

- ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

- OEHHA – The Office of Environmental Health Hasard Assesments.

- MfE – Ministry for the Environment.

- And a paper from Underground Mining Technology 2017.

Discharge to Air:

The following points on the topic of Discharge to Air:

1. Mine Ventilation.
2. Dust and the sizing of particles.
3. Plume rise and Downwind transport.
4. Air quality monitors.
5. Particulate monitoring vs the Resource Consent Certificate.
6. Mitigation measures.

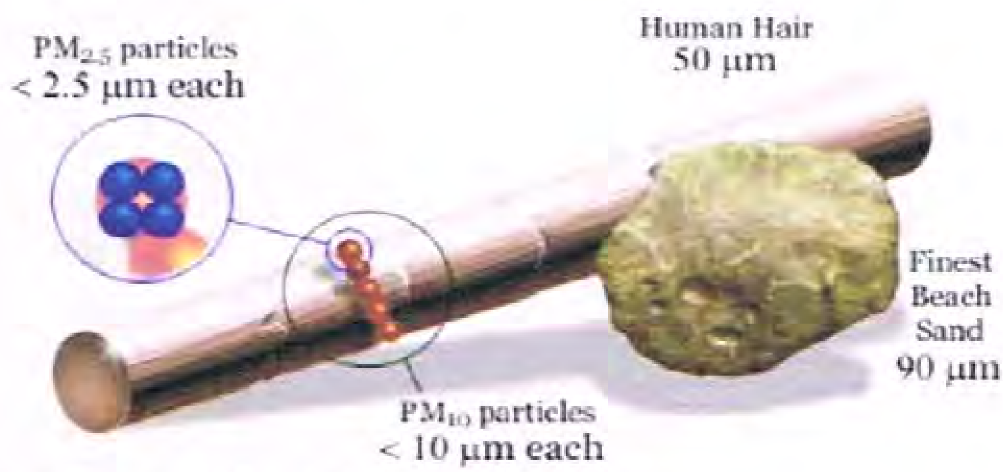
1. Mine ventilation systems:

   Excerpt from ASHRAE –

   "A well designed and properly implemented ventilation system will provide beneficial physiological and psychological side effects that enhance employee safety, comfort, health, and morale".

2. Sizing of Particulate:

   Excerpt from Appendix L, Kevin. Rolfe report.



~~Figure 7.~~ Diagram of Different Size Fractions of Particles

We see from the above diagram, a typical strand of hair may be approximately 50 microns in diameter.
Comparative illustrations of 10 micron diameter, and 2.5 microns diameter shown.

A further excerpt from Appendix L, Kevin. Rolfe report-

> THE California Office of Environmental Health Hazard Assessment reference exposure levels provide assessment criteria for respirable silica and diesel exhaust based on chronic exposure levels by inhalation. They are recognised internationally as being of a high standard and the New Zealand Good Practice Guide (GPG) for Assessing Discharges to Air from Industry[7] recommends their use.

Included this to show that the MfE (Ministry for the Environment) *recommends* the use of the OEHHA.
And note: The MfE produce the GPG (Good Practice Guide) referred to by OGNZL.

The OEHHA have produced a paper titled 'Chronic Toxicity Summary for Respirable Silica'.
Within this, the OEHHA report the ***Median*** particle size of Respirable Silica produced in metaliferous mines to be in the 1 (one) micron range.

The OEHHA also report that the 1 micron range appear to be the most fibrotic in humans.

Regarding the classification of particle size, an example included below, excerpt from ASHRAE on particulate size:
"Particles less than 2.5 micro-metre (micron) in diameter are generally referred to as the *fine* mode, with those greater than 2.5 micro-metre being considered as the *coarse* mode".

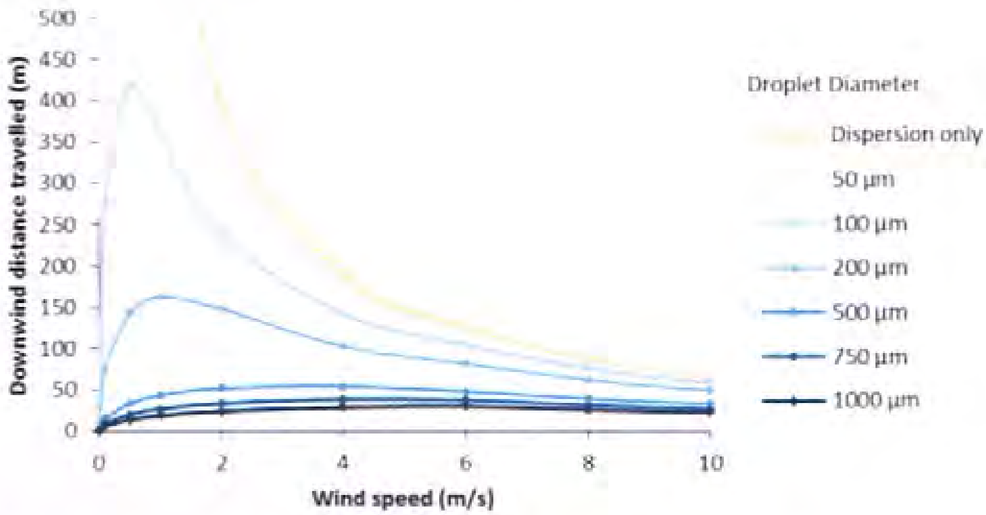
3. Plume rise and Downwind Transport.

Plume rise will occur on hot Summer days with the solar gain on the Martha Pit Rock Wall. This solar gain will cause buoyancy in the air because a thermal convective current produces hot air to rise.

In the case of a fan-forced Exhaust ventilation system, Plume rise will occur again because of the force imposed on the air by the fan blades.
Not forgetting that the exhaust air has already been heated from being underground, thus causing further buoyancy in the air and aiding Plume rise.
The exhaust air may also contain contaminants such as potentially harmful dust, toxic gases, moisture laden air, amongst other things.

If the Exhaust air fan discharges vertically into the atmosphere, a Plume rises, this can be seen every now and then in Waihi coming from the fan discharge at Union Hill. The Plume is visible because water is condensing out of the laden air, whilst the warm exhaust air mixes with the relatively cooler outside air causing condensation to occur.
The Plume is present whenever the fan is in operation, regardless of whether the cloud of condensation is visible or not.

The graph below is an excerpt from 'Underground Mining Technology 2017', titled 'Environmental discharge criteria and dispersion estimation for mine ventilation exhaust stacks':



~~ure 3~~ Downwind transport distance by droplet size for a sample stack

This graph illustrates that low wind speeds typically correspond to farther downwind transport, and also shows that the smaller the particle size the further downwind it will travel.

Excerpt from Appendix L, Kevin. Rolfe report below.

109. **SUSPENDED** particulate – this refers to particles that can remain suspended in the air for significant periods of time, ranging from several minutes for the larger particles through to several days for very fine material. Elevated levels can affect visual air quality and can also have effects on human health, generally by irritating the eyes, mucous membranes and skin. The measurement method involves sucking air through a filter and determining the weight of dust collected from a measured volume of air. The equipment samples particles up to about 50 microns in size, and typically about 20 microns.

- "particles can remain suspended...from several minutes for the larger particles through to several days for very fine material".

Discharges to Air for dispersion of emissions such as in Waihi, is normal practice within this type of industry.
Dispersion to air, is a tool for dealing with emissions.
Excerpt from ASHRAE on Pollution control:
"Where control of pollutant emissions is impossible...ensure dispersion over a wide area to prevent objectionable ground level concentrations".

The addition of exhaust fans in the Martha Pit should aid Plume rise from the Martha Pit.

4. Air Quality Monitors.

Air from exhaust fans designed to jet vertically will cause the fine particulate to be transported downwind for potentially several kilometers if not more, whilst wind is present.
This then, renders the dust collection monitors around Waihi to be far less effective at measuring fine particulate emission from the mine because the majority of fine particulate will be leaving the town of Waihi, by-passing the dust deposition meters much of the time.

In order to assess the emissions from the Ventilation stacks, they should be monitored at the point source. This will give a far more accurate picture of emissions actually entering the Waihi Airshed, prior to dispersal.

There is an example of point source emissions in Appendix L, Kevin Rolfes' Report providing figures from the Favona Ventilation stack.
The results may appear small but this is because they are on a per second basis, however when worked out on an annual basis, the figures are significant.
14,191Kg (Kilo-grams) annually of TSP PM10 micron,
of this 5,045 Kg of respirable dust per annum.

I believe we should accept the fact that these emissions exist, What we should not do is say that they do not exist, or that they are negligible.

Remembering in this instance, the ventilation system is there to protect the workers.
And, by promoting Plume rise as a tool for emissions to disperse, this should help protect the town.

5. Particulate monitoring vs the Resource Consent Certificate.

The Particle monitoring Program appears to not include monitoring of Respirable Silica in the fine range, that is from 2.5 micron and smaller.
This information is verified by Dr Jonathan Caldwell under s42A Appendix C, Dr Caldwell states on Pg.6 para 4, "In addition to this I note that while there has been no assessment of PM2.5".

The Resource Consent Certificate clearly states under Monitoring, point 12; "The consent holder shall undertake monitoring of fine particulate and silica..."

In my view this amounts to a non-compliance of consent and requires some attention.

6. <u>Mitigation measures.</u>

There are mitigation measures in place for keeping the exposed areas of rock etc. from freely emitting dust. One of these methods is the use of Water carts. This can be effective, but only if used effectively.

Note: A comment from a witness earlier this week, 'On hot dry Summer days, the water from the water cart dries out as fast as it goes on'.

Personally, I have observed this same thing occurring with the water on the ground many times, at Martha Pit and Baxter Rd.

I believe OGNZL would do well to have dedicated water cart drivers and extra water carts at the ready, along with more dedicated sprinkler systems. This will help ameliorate emissions to air, and provide a more robust regime.

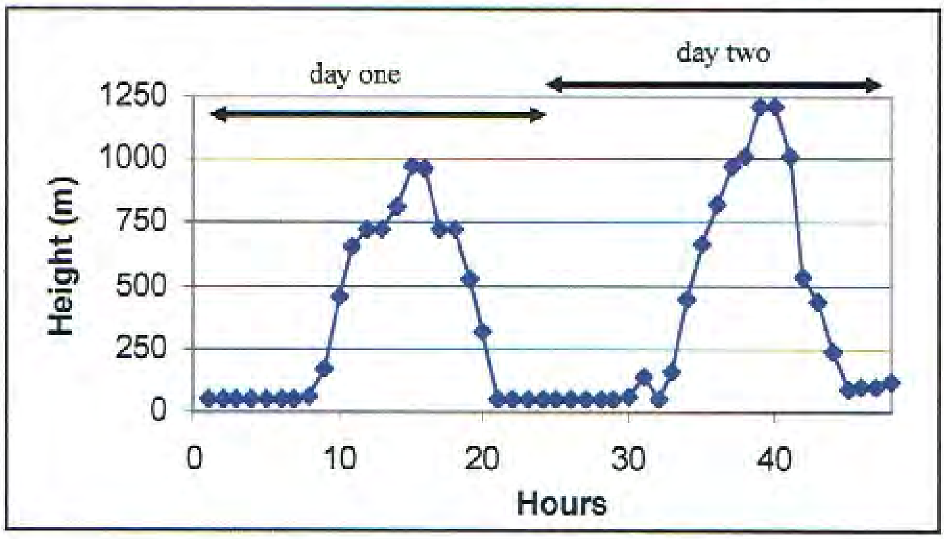
Excerpt from Appendix L, Kevin. Rolfe report below.

> 77. **DUST** suppression measures at the crushing and screening using water sprays and screen barriers are currently practiced, and these will need to continue. A high level of vigilance is required to ensure systems are working correctly. Provided those dust management practices are followed, the air quality effects of the crushing, screening and conveying will be less than minor.

Included the excerpt above to high-light the sentence -"A high level of vigilance is required to ensure systems are working correctly" – I respectfully submit that this comment applies to *all* dust mitigation measures, not just at the Crushing and Screening Plant.

This 'high level of vigilance is required' is a key requirement in order to pro-actively mitigate what can be essentially adverse Discharges to Air.

Figure 5.1: Typical diurnal mixing height variation over two days



If a plume penetrates up through, or is released above, the mixing height, the pollutants will be trapped aloft and their effect will not be observed at ground level. If a plume is trapped within a shallow mixed layer the vertical dispersion will be limited and high ground-level concentrations are likely to occur.

Four methods that are commonly used to determine mixing height are:

- derivation from upper air data (e.g. radiosonde measurements)
- ground-based remote sensing (e.g. Doppler SODAR)
- derivation from routinely measured surface meteorological data (e.g. using a US EPA meteorological pre-processor model such as RAMMET)
- using a prognostic meteorological model (e.g. TAPM, see section 5.3.2).

Determining mixing height is usually an expensive and complex task requiring considerable expertise and should therefore not be undertaken lightly. The uncertainty of mixing heights determined by the methods referred to above increases in the lowest level of the atmosphere. It is generally accepted that mixing heights determined to be less than 50 m contain a significant degree of uncertainty.

Appendix to L.L. - Produced by MfE

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