OceanaGold NZ Ltd

Martha Mine

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Waihi

Assessment of Environmental Effects – Ventilation Discharge

Report 23494
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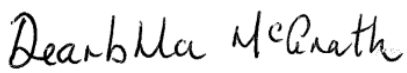

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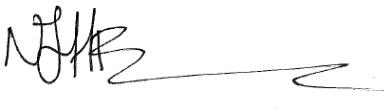

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Terms and Abbreviations

Terms & Abbreviations	Explanation
AAQG	New Zealand Ambient air quality guidelines: 2002 update
OEHHA	The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment
NESAQ	Resource Management (National Environmental Standards for Air Quality) Regulations 2004
USEPA	United States of America Environmental Protection Agency

Executive Summary

OceanaGold currently holds resource consent AUTH124859.01.04 which permits a discharge to air from underground mining activities at its Waihi site. In 2007 the discharge to air from the Favona vent shaft was tested, as part of the consent requirements. In 2019 the location of the ventilation system's point of discharge was moved to the bottom of the Martha Open Pit following an expansion of the Martha Underground Mine. Waikato Regional Council (WRC) have been informed of the location change; however, air quality testing and an assessment of the off-site effects has not been undertaken since the discharge point was relocated. Air Matters was engaged by OceanaGold to undertake an assessment of effects based on the relocated discharge.

The main discharges to air from the underground operation will be particulate matter, oxides of nitrogen and carbon monoxide. Emission testing to a prescribed method is not practical as the new ventilation exit is a 'rough cut' mining tunnel with approximate dimensions of 6 x 6 meters. Emission testing following a revised methodology was carried out as part of this study and results compared to the 2007 testing.

The scale and nature of the emissions were very similar with the exception of carbon monoxide (CO) which was elevated during the 2024 testing. A number of factors will affect CO emission rates and therefore a reasonable amount of variability is expected.

Dispersion modelling was carried out to estimate the off-site effects of the ventilation's discharge following the completion of the testing. The discharges contribution to off-site concentrations for the assessed contaminants is low when compared to the relevant criteria. When an appropriate, but conservative, background level is taken into consideration the ventilation emissions will not cause any assessment criteria to be exceeded in an off-site location. Based on this assessment the adverse effects from the ventilation emissions are considered less than minor.

1. Introduction

1.1 Overview

OceanaGold holds resource consent AUTH124859.01.04 which permits a discharge to air from underground mining activities at its Waihi site. In 2007 the discharge was tested, as part of the consent requirements, and the results provided to Waikato Regional Council (WRC). The location of the discharge was from the Favona vent shaft, through a conical cylindrical stack with appropriate sampling ports. The design of the ventilation exit allowed stack testing to be performed in general accordance with the prescribed USEPA methods.

In 2019 the location of the ventilation system's point of discharge was moved to the bottom of the Martha Open Pit following an expansion of the Martha Underground Mine. WRC have been informed of the location change; however, air quality testing and an assessment of the off-site effects has not been undertaken since the discharge point was relocated. The new ventilation exit is a 'rough cut' mining tunnel with approximate dimensions of 6 x 6 meters (refer Figure 1 (insert) & Appendix C - Figure 1).

The main discharges to air from the underground operation will be particulate matter, oxides of nitrogen and carbon monoxide. Air Matters was engaged by OceanaGold to undertake an assessment of effects based on the new discharge location.

This report details the methodology and results of the assessment and compares the nature and scale of the discharge to the previous discharge from the Favona vent shaft. The effects assessment follows standard dispersion modelling methodology as outlined in the Ministry for the Environment good practice guide (2016), with the intention of quantifying the potential effects on the wider Waihi community.

1.2 Site Location

The Martha Open Pit is situated generally within the urban confines of Waihi township, in Hauraki District at the foot of the Coromandel Peninsula, approximately 8km west from the coast. The base of the Martha Mine is approximately 220 m below the surrounding ground level and 100 m below sea level whereas Waihi has an altitude averaging about 90 m above sea level.

The mining license covers approximately 400 hectares, comprising two main elements: an open pit (around 100 hectares) and the processing and waste disposal area, linked by conveyor that crosses under State Highway 25.

The urban area immediately surrounding the Martha Open Pit is typically flat with residential, recreational and commercial land use dominating. The wider site is located in a rural zone under the Hauraki District Council Plan (2019). Dairy farming and horticulture dominate activities in the rural setting. An aerial plan of the locality can be found in Figure 1.

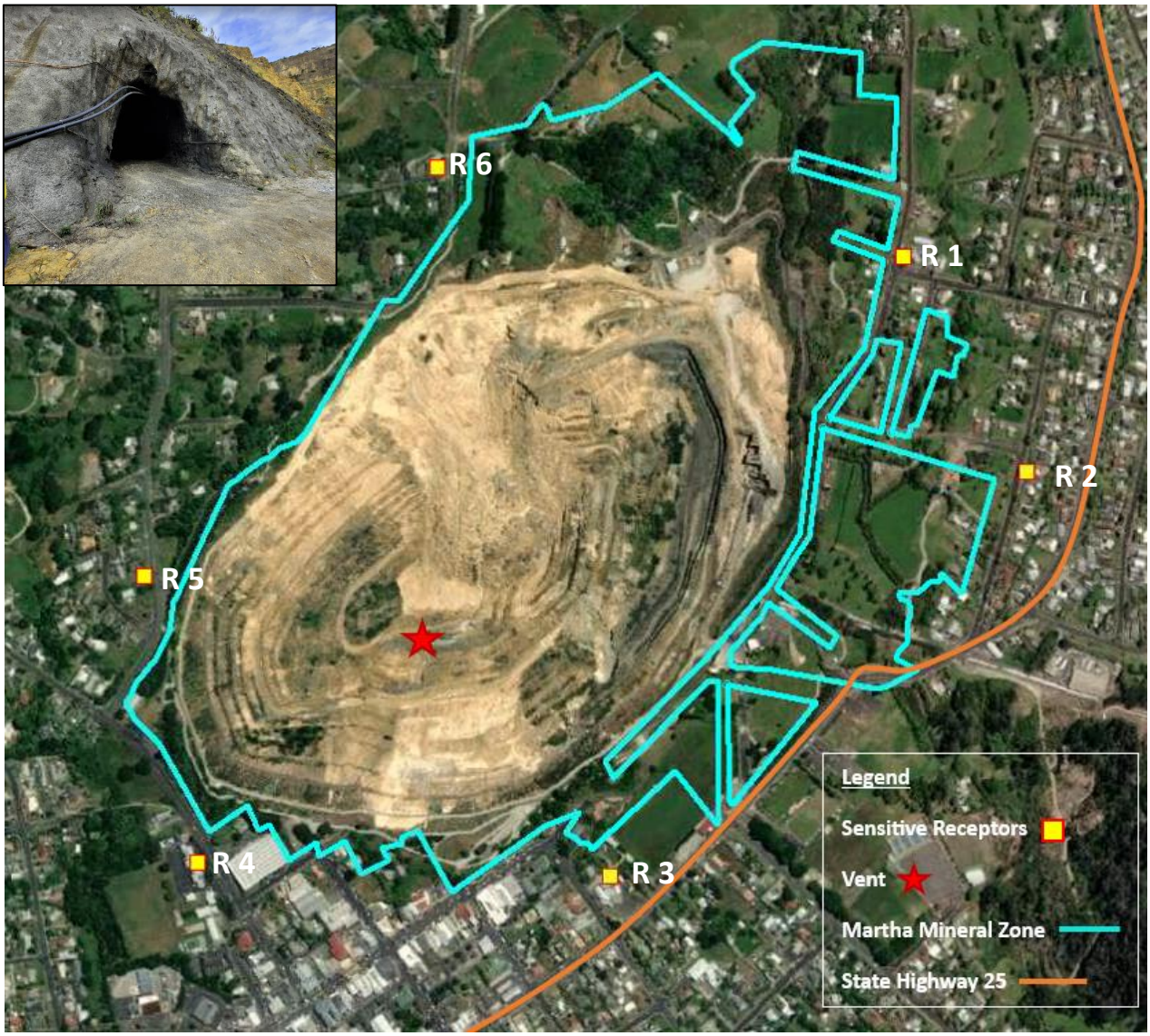

Figure 1. Site location map illustrating the site boundary (Martha Mineral Zone) which has been used in this assessment to define the site boundary. Insert photo: Ventilation exit at base of the Martha Open Pit.

2. Process Description

2.1 Mining Process and Emissions to Air

Underground mining in Waihi commenced in the early 1880's and was ceased in the 1950's. Martha Open Pit mine was commissioned in 1988 and finished current operations in 2016 following a large landslide. Current day underground operations commenced in the early 2000's and has comprised of a number of areas, including the Correnso, Trio and Favona Mines. Access to the underground mine is via the existing Favona portal. Current underground workings are generally contained within the footprint of the Martha Open Pit and extend approximately 300 metres below the pit floor.

The underground gold mining process at Waihi[1] follows a typical mining operation which involves blasting the rock with explosives, removal of the broken ore from the tunnel via dump trucks to the surface portal where the gold bearing ore is further processed and non-target material is disposed of. Backfilling of the stopes is also undertaken within the mine where possible.

These underground processes have the ability to generate emissions which are captured and discharged via the ventilation system. The rate and type of emissions will vary depending on the underground processes being undertaken at any particular time. For this assessment only the discharges from the underground ventilation system are being considered as they relate to the air discharge consent.

Expected emissions discharged via the ventilation system are as follows:

Particulate Matter

Particulate Matter is generated underground from a number of sources including from vehicle movements, handling and transport of the mined material and during blasting events. Health effects are primarily due to particles less than 10µm (PM_{10}) in diameter. Processes, such as combustion of fuel and blasting within the mine are likely to be sources of these fine particulates. Particulate in the form of silica is also emitted as the gold bearing materials contains a high proportion of silica-based rock (Quartz).

Combustions Gases (underground machinery)

The combustion of diesel from underground machinery including loaders, dump trucks and light vehicles will release combustion gases in the form of oxides of nitrogen and carbon monoxide.

Combustion Gases (explosives)

During blast events combustion gases are released. A deficiency of oxygen favours the formation of CO and unburned organic compounds and produces little, if any, nitrogen oxides (NO_x). An excess of oxygen causes more nitrogen oxides and less CO and other unburned organics. For ammonium nitrate and fuel oil (ANFO) mixtures, a fuel oil content of more than 5.5 percent creates a deficiency of oxygen (USEPA, 2007) and therefore likely to result in the formation of CO over NO_x.

[1] OceanaGold Waihi Operation (2024). https://www.waihigold.co.nz/about-mining/the-mining-process/. Accessed 6 May 2024.

2.2 Hours of Operation

Operations in the underground mine are 24 hours a day, 7 days a week. Underground blasting is scheduled for up to 3 times per day, Monday to Saturday, with no blasting on Sundays or public holidays. Discharges from the ventilation system, which is the subject of this assessment, occurs 24 hours a day 7 days per week.

3. Environmental Setting

3.1 Waihi's Air Quality

Regional Councils and unitary authorities have identified areas where air quality could reach levels higher than the national air quality standards. These areas are called airsheds.

Airsheds have been identified based on the Regional Councils' knowledge of existing air quality data and the location of significant sources and factors that affect the spread of pollution (such as local geography and weather). These airsheds have been published in the New Zealand Gazette. Martha Open Pit is located within the Waihi Airshed, however, this airshed is not currently being monitored and is not considered polluted in respect to any contaminants contained within the National Environmental Standard (NES).

The existing air quality in the assessment area can be characterised as typical of a township environment. The main local sources of air emissions will include a combination of wood and coal-fired domestic heating, transport emissions from the local roads and influence from surrounding farming activities[2].

The Waikato Regional Plan (Air Module) describes Waihi (Coromandel Peninsula) as having generally acceptable ambient air quality. Typical characteristics of the area include moderately warm temperatures with sea breezes common. The risk of adverse long term and cumulative effects on air quality in this area is regarded as low.

Waikato Regional Council undertook continuous PM_{10} monitoring in Waihi at Grey Street (~90m from the north-east of the Martha Open Pit) between 2008 - 2011. The measured concentrations did not exceed the NES over this period. To determine an appropriate background concentration the guidance from MfE 2016 has been followed by selecting a highest value excluding outliers. 2011 was chosen as a conservative estimate as it had the highest annual mean and peak daily concentrations over the 4 years of monitoring.

Measurements of quartz dust was undertaken in Waihi between January – April 2014. The average concentration over the 25 daily measurements is shown in Table 1. Despite the limited number of measurements, it is still expected to represent a reasonable estimate of the background concentrations.

Air quality in Waihi township is not considered polluted in respect to nitrogen dioxide and carbon monoxide. Monitoring of combustion gases in Waihi has not been undertaken therefore the background values used are based on the Waka Kotahi default values which are considered reasonable.

[2] Waikato Regional Council. 2024. Waikato Regional Plan – 6 Air Module – Regional and Local Air Management.

Table 1. Assumed Background Air Quality for Waihi

Contaminant	Averaging Period	Background Value ($\mu g/m^3$)	
PM_{10}	24-hour average	30	WRC (2011)
	Annual	13	
NO_2	1-hour	58	MfE (2016) default (Secondary or minor urban areas)
	24-hour	38	
	Annual	4.5	NZTA
Carbon Monoxide*	1-hour	5	MfE (Secondary or minor urban or rural)
	8-hour	2	
Silica	Annual	1	Watercare (2014)

*mg/m^3

3.2 Wind Conditions

Wind measured at the boundary of Martha Open Pit is shown in Figure 2 for calendar years 2020-2021. This monitor is a standard 10-meter-high mast and is expected to provide a good representation of the local wind conditions. A number of gaps were present in the data record (~20%), however as these were spread over the 2-year period, seasonal variations in meteorological conditions are still well represented.

Overall, the most prevalent wind direction is from the west to south-west which also represents the strongest wind speeds. The second most prevalent wind is from the North-East quadrant. Calm wind conditions (<0.5m/s) occur for 4.3% of the record. This wind direction and strength seems typical of a location within the north-eastern extent of the Waikato and influenced by the coastal region of the Bay of Plenty.

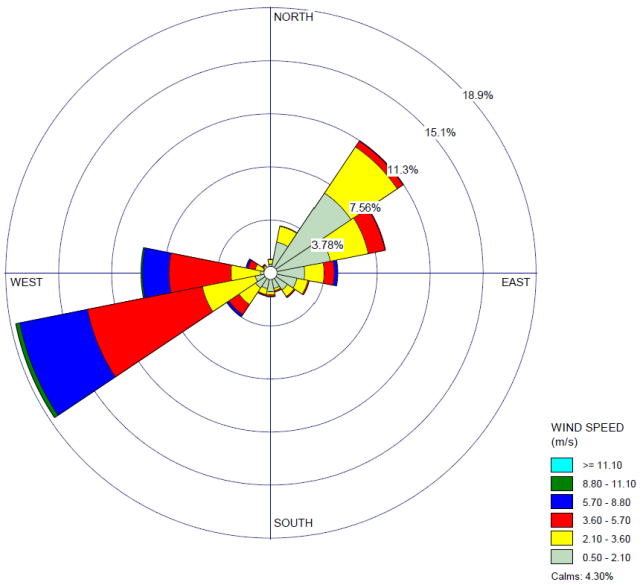

Figure 2. Wind Rose for 2020 - 2021 as measured at Waihi

4. Emission Testing

4.1 Methodology

The discharge from the ventilation system presents a number of challenges for undertaking emission testing including:

- The irregular rough-cut shape and its large dimensions;
- There are no sampling ports and therefore sampling will need to be completed directly in the flow (~ 30 km/h);
- The site can only be accessed through the tunnel system, limiting equipment size and availability of power.

Based on the above, standard methods for measuring the flow rate, particulate matter and gas concentrations cannot be practically applied. The full methodology described in Appendix C provides a robust estimation of the emission rates but does not follow standard emission testing techniques. A summary of the methodology is provided below and is considered appropriate to achieve the intent of the monitoring.

Particulate matter, carbon monoxide, oxides of nitrogen and crystalline silica were all measured throughout the testing period. Particulate matter was measured by drawing an air sample and collecting it on a PVC fibre filter. The mass of particulate was determined gravimetrically. Combustion gases were measured using a real time gas monitor capable of measuring both NO_2 and NO. Temperature and humidity were taken as spot readings at the start and commencement of sampling.

Flow measurements in the tunnel were taken using a wind anemometer that was positioned at different locations in the cross section of the tunnel. An average flow was then derived and a volumetric flow rate determined based on the measured cross-sectional area.

Emission testing was undertaken over the 12th and 13th of March and aimed at capturing a number of blasting events. These blast events are of relevance as they will increase the particulate and combustion gas emissions. Over the testing period there were three blast events as described in Table 2 below along with the weight of explosives used.

Table 2. Blast events during the emission testing

Blast event	Time of blast (based on vibration data)	Type	Explosives used (kilograms)
Morning	13th 07:10	development	480
Afternoon	12th 14:25	stope	800
		development	80
Evening	12th 19:36	development	160

4.2 Results

Table 3 below illustrates the results of the emission testing in comparison with the 2007 testing from the Favona vent shaft.

Table 3. Measured emission rates and conditions during the 2007 and 2024 testing

Parameter	Units	2007 results	2024 results
Temperature	°C	21.9	26.5
Pressure	hpa	1030	1027.3
Water vapour	%	1.8	2.3
Velocity	m/s	16.9	8.6
Cross sectional area	m^2	5.3[#]	38.4
Flow rate	m^3/s*	79.2	297.2
Particulate	mg/m^3*	1	0.3
	Kg/hr	0.283	0.28
Crystalline Silica	mg/m^3*	-	0.03
	Kg/hr	-	0.028
Carbon Monoxide (morning blast)	ppm (peak)	5	37
Carbon Monoxide (afternoon blast)	ppm (peak)	3	19
Carbon Monoxide (evening blast)	ppm (peak)	4	8
Carbon Monoxide (average)[+]	ppm	1.3	2.7
Nitrogen Dioxide (morning blast)	ppm (peak)	0.3	<1[^]
Nitrogen Dioxide (afternoon blast)	ppm (peak)	0.5	<0.1[$]
Nitrogen Dioxide (evening blast)	ppm (peak)	0.2	<1[^]
Nitric oxide (morning blast)	ppm (peak)	<0.1[$]	-
Nitric oxide (afternoon blast)	ppm (peak)	<0.1[$]	2
Nitric oxide (evening blast)	ppm (peak)	1	-

*Corrected to STP (0 °C, 1013hpa & dry gas basis)
[#] Based on the reported 2.6m diameter stack
[^] Gas monitor resolution of 1ppm
[$] Gas monitor resolution of 0.1ppm
[+] Average over three test runs from 2007 and entire testing period from 2024.

In regards to the physical conditions there was a slight increase in the temperature from 2007 to 2024 testing, however water vapor and pressure at the monitoring location was consistent. The 2007 testing was carried out in August (winter) whereas the 2024 testing was completed in March (summer). The observed increase in temperature may be due to a difference in the ambient (intake) air temperature. Flow rate within the tunnel was significantly higher in the 2024 testing; and is expected to represent the change in ventilation requirements when shifting from the Favona vent shaft to the current location at the base of the Martha Open Pit.

Particulate concentrations were lower in the 2024 testing, however, when taking into account the higher flow rate the mass emission (kg/hr) closely matched. A non-reference method was used for testing particulate emission rates and therefore a degree of uncertainty should be assumed with these

results. A real-time particulate monitor was also deployed to measure the concentration of particulate over the duration of monitoring to assist in understanding the timing and extent of peak concentration during blast events (refer Appendix E; Figure 1).

Real-time monitoring is not a reference standard, however, the results can provide a useful comparison. Over the monitoring period an average concentration of 0.21 mg/m^3 was recorded by the real-time monitor, which is comparable to the derived concentration of 0.28 mg/m^3. Consequently, a level of confidence can be placed on the accuracy of the particulate emissions results.

Carbon monoxide concentrations over the blast events were elevated above the 2007 test results. The highest concentration of CO (morning blast) did not coincide with the highest explosive use (afternoon blast); although the lowest CO did coincide with the lowest volume of explosives used (evening blast). In comparison the 2007 testing results showed an overall lower peak CO concentrations despite the volume of explosives used in each blast (223-537kg) being comparable to the 2024 morning and evening blasts. Factors such as the type of explosives, effectiveness of the ventilation to extract gases and distance from the explosion to the measurement location would affect the measured concentration. For example, stope areas are ventilated at a lower rate than areas of development blasts. A lower extraction rate would have the effect of reducing peak concentrations at the ventilation shaft exit. This may explain the lower peak concentration observed during the afternoon blast despite it containing more explosives than the morning blast.

NO_X emission rates were low and in line with the 2007 measurements. Two gas monitors were deployed, one that measured NO_2 with a resolution of 1ppm and a higher resolution monitor (0.1ppm) that measured both NO_2 and NO. The higher resolution monitor only operated for 2.5 hours which included the afternoon blast on the 12th. The lower resolution monitor operated over the entire monitoring period capturing all three blast events.

Gas monitor's calibration information is included in Appendix F. Both monitors were zeroed in fresh air prior to deployment.

4.3 Conclusion

Taking into account the methodology and comparing to the 2007 results it is considered that the scale and nature of the discharge has not materially changed between the Favona and Martha Open Pit discharge locations. Carbon monoxide concentrations did show an increase during blasting activities in the 2024 results. A range of factors including the effectiveness of extraction at the blast location as well as the type and volume of blasting material will affect the emissions generated at the ventilation exit. To account for this variability the off-site effects assessment in Section 5 has taken a conservative approach to assessing CO.

5. Assessment of Off-site Effects

5.1 Dispersion Modeling

Dispersion modelling was carried out to estimate the off-site effects of the ventilation discharge following the testing. The discharge location (~180 meters below surface) is unique and would require a high-resolution model to resolve the complex terrain and wind patterns that exist at the surface and within the pit. A three-dimensional, advanced, non-steady-state, meteorological and air quality model such as CALPUFF may be suitable for this purpose; however, given the intention is to undertake a screening level assessment this complexity is not warranted.

The Gaussian atmospheric dispersion model AERMOD is a two-dimensional, steady-state, plume model that incorporates air dispersion and can simulate surface and elevated sources and both simple and complex terrain. As the assessment is intended as screening level the use of AERMOD is appropriate and will account for the advection and dispersion of contaminants.

Dispersion modelling requires accurate emission rates and were based on the updated sampling described in Section 2 above. The model will be set up to release the contaminants (particulate matter and combustion gases) near the base of the pit. Predicted ground level concentrations (GLC) at the site's boundary and at sensitive receptors will be compared to the relevant assessment criteria including WRC's Regional Ambient Air Quality Guideline and the National Environmental Standards (2004). An appropriate background concentration (as outlined in Table 1) will be taken into consideration when assessing the actual and potential affects.

5.2 Meteorological Data

Air dispersion modelling requires good meteorological data that is representative of the conditions near the emission sources and across the modelling domain. For this modelling exercise a meteorological dataset (wind speed, direction, temperature, rainfall, humidity, solar radiation) was generated from two years of measurements (2020-2021) from the meteorological station located in Waihi on the edge of the Martha Open Pit (refer Section 3.2).

As no upper air soundings were available that would be applicable to this site, AERMET's upper air estimation tool was used. Cloud cover, which is a required parameter for AERMOD, is not measured at the site and this was sourced from the Metservice meteorological site at Auckland Airport.

5.3 Site Layout and Discharge Locations

The site includes one emission source being the ventilation tunnel at the base of the Martha Open Pit as shown in Figure 1. The terrain data (SRTM1 - Global 30m) provides good spatial resolution for modelling assessments within New Zealand. However, given the data's limited horizontal resolution (30 meters) the full depth of the pit (~200m) was not resolved and the modelled depth was ~140m. From a dispersion and advection standpoint the modelled terrain (less pit depth and volume) will result in conservative estimates of off-site concentrations.

5.4 Source Parameters

The emissions and associated parameters are summarised in Table 4 below. Emission rates are based on the testing undertaken across 2007 and 2024 with the intention of providing a conservative assessment where practical. For particulate matter the measurements captured inhalable particulate (mean aerodynamic diameter of 100 µm) that is more closely related to the environmental dust descriptor of total suspended particulate. A conservative assumption has been made that all TSP is PM_{10}.

Values were based on the 2024 tests other than NOx which was founded on the 2007 emission rates. To account for any variability CO was conservatively set as an average of the peak values across the three blasts from 2024. In reality the CO emission would be much lower than this when averaged across 24 hours as demonstrated in Table 3.

Table 4. Modelled discharge parameters and emission rates

Variable	Parameter
Modelled years	2020-2021
Number of sources	1
Release height (above pit base)	15
Release type	Horizontal
Modelled operational hours	24/7
Exit velocity (m/s)	8.6
Exit temperature (˚C)	26.5
Emission rates (kg /hr)	
Carbon monoxide	26.1
Nitrogen dioxide	0.6
Crystalline silica	0.03
PM_{10}	0.28

5.5 Identification of Sensitive Receptors

A sensitive receptor is a location that may be more vulnerable to the effects of air contaminants (e.g. homes, hospitals, aged-care facilities). For this assessment a range of sensitive receptors were chosen from around the Martha Open Pit. The intention is to provide representative locations around the pit within close proximity of the discharge location.

Maximum ground level concentrations (MGLC) have also been provided in the results. This represents an off-site location that has the highest predicted concentration. MGLC are not tied to a sensitive receptor location and therefore may represent a range of land uses. However, they are a useful comparison tool for assessing worst case concentrations.

Table 5. Sensitive receptors included in modelling assessment.

ID (refer Figure 1)	Address	Description
R1	Dobson Street, Waihi	Residential
R2	Roycroft Street, Waihi	Residential
R3	Gilmour Street, Waihi East	Waihi Baptist Church
R4	Moresby Avenue, Waihi	Waihi Central School
R5	Savage Road, Waihi	Residential
R6	Bulltown Road, Waihi	Residential

5.6 Results

The results for dispersion modelling are shown in Table 6. These results are used to assess potential effects on human health. Results have been provided as both a maximum off-site concentration and at the highest Sensitive Receptor location (refer Section 5.5 for a description). Contour maps showing the concentrations can be found in Appendix B.

Table 6. Predicted maximum off-site ground level concentrations.

Contaminant	Averaging Period	Background	Max. off-site GLC (µg/m³)		Max. sensitive receptor GLC (µg/m³)		Assessment Criteria (µg/m³)	
			Modelled	Modelled + Background	Modelled	Modelled + Background		
PM_{10}	24-hour	30.3	1.6	31.9	1.5 (R4)	31.5	50	NESAQ
	Annual	11.5	0.2	11.7	0.2 (R4)	11.7	20	AAQG
Carbon Monoxide #	1-hour	5	0.4	5.4	0.4 (R5)	5.4	30	AAQG
	8-hours	2	0.3	2.3	0.28 (R4)	2.3	10	NESAQ
NO_2	1-hour*	58	9.2	67.2	9 (R4)	67	200	NESAQ
	24-hour	38	3.4	41.4	3.3 (R4)	41.3	100	AAQG
	Annual	4.5	0.4	4.9	0.3 (R4)	4.8	30 (10)	Regional AAQG - Waikato Regional Plan (WHO 2021)
Crystalline Silica	Annual	0.1	0.02	0.12	0.016 (R4)	0.116	3	OEHHA

mg/m³
*99.9th Percentile
^ Bracketed number = Sensitive Receptor ID (refer Figure 1 and Table 5 for locations).

5.7 Discussion

Particulate Matter - PM_{10}

The maximum predicted 24-hour averaged off-site ground level concentration of PM_{10} (excluding background) is 1.6 µg/m^3. Including a background concentration, this is increased to 31.9 µg/m^3 which does not exceed the assessment criteria outlined in Table 6 above. The annual average off-site ground level concentrations are 0.2 µg/m^3 (without background) and 11.7 µg/m^3 (with background), which is well below the AAQG of 20 µg/m^3.

The maximum predicted 24-hour averaged ground level concentration for sensitive receptors was recorded at Receptor 4 (Waihi Central School) and was 1.5 µg/m^3 and 31.5 µg/m^3 when background concentrations are added, well below the NESAQ criteria of 50 µg/m^3. The maximum annual average concentration was 0.2 µg/m^3 at R4, significantly below the AAQG level of 20 µg/m^3 including when a background was added.

The results of this modelling indicate that the emissions from the Martha Open Pit ventilation discharge are not likely to increase the daily, off-site maximum concentration of PM_{10} by more than 1.6 µg/m^3 or annual concentration by 0.2 µg/m^3 in the local area. In conclusion the level of particulate matter including PM_{10} are acceptable and the effects on any off-site receptor will be less than minor. Contour maps of PM_{10} MGLC are provided in Appendix B.

Carbon Monoxide

The maximum predicted 1-hour averaged ground level concentration (off-site) of CO was 0.4 mg/m^3, or <2% of the standard (30 mg/m^3 per AAQG). The maximum predicted 1-hour averaged ground level concentration for sensitive receptors was 0.4 mg/m^3 at R5 (Savage Road). The 8-hour rolling average for off-site CO is 0.3 mg/m^3 well below the assessment criteria of 10 mg/m^3. In conclusion, taking into account the conservative assessment, the effect of CO is acceptable and the effects on any off-site receptor will be less than minor.

Nitrogen Dioxide

There are a number of methods for estimating the downwind conversion of nitric oxide to nitrogen dioxide. MfE (2016) recommends a tiered approach from simple to complex with an assessment beginning with the screening methodology (in which all nitric oxide is assumed to be nitrogen dioxide), and if this turns out to be too conservative then use more complex methodology. This assessment has used the conservative screening method.

The maximum predicted 1-hour averaged ground level concentration (off-site) of NO_2 was 9.2 µg/m^3 and 67.2 µg/m^3 when accounting for background. For the maximum predicted off-site 24-hour average this was 3.4 µg/m^3 and 41.4 µg/m^3 including background. The maximum predicted off-site annual average was 0.4 µg/m^3 and 4.9 µg/m^3 including the background concentrations. All off-site results are well below the relevant assessment criteria even when an appropriate background level is added. For annual concentrations the 2021 updated WHO target of 10 µg/m^3 will also be meet at all off-site locations when taking into account relevant background concentrations. The effect of NO_2 is acceptable and the effects on any off-site receptor will be less than minor.

Crystalline Silica

The maximum predicted off-site crystalline silica concentration was 0.02 µg/m^3 which represents 0.7% of the annual assessment criteria. With an appropriate background added the value is still significantly less than the assessment criteria. The effect of crystalline silica is acceptable and the effects on any off-site receptor will be less than minor.

5.8 Conclusion

Off-site concentrations of all assessed contaminants are low when compared to the relevant criteria. When an appropriate, but conservative, background level is also taken into consideration the ventilation emissions will not cause any criteria to be exceeded in an off-site location. Based on this assessment the adverse effects from the ventilation emissions are considered less than minor.

6. References

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Appendices

Appendix A: AERMOD input summary

Parameter	Description
AERMOD Version	19191
Model year	2021-2022
Surface meteorological data	Hourly meteorological data generated from Newmont Waihi Gold data for Barry Road, Waihi
Upper Air meteorological data	Generated by AERMET upper air estimator
Terrain data	Shuttle Radar Topography Mission (SRTM) 1
Map projection system	UTM
Building downwash	No
Terrain Height Modelled	Yes (Elevated)
Receptors Grids	Uniform Cartesian @ 50m spacing
Adjusted U Velocity	Yes
Dispersion co-efficient	Rural

Appendix B: AERMOD contour maps

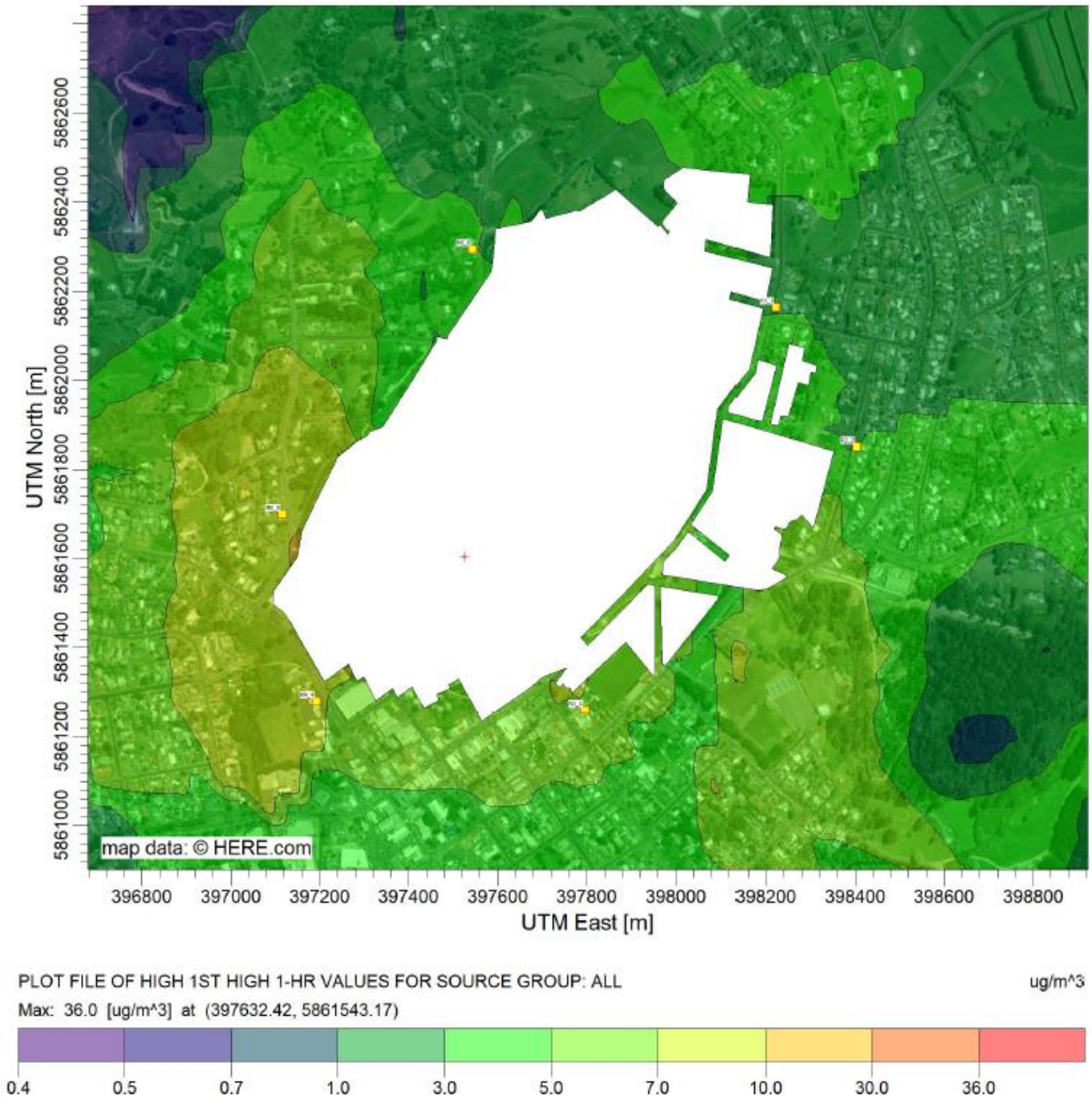

Figure 1. Nitrogen dioxide - 1-hour contour plot

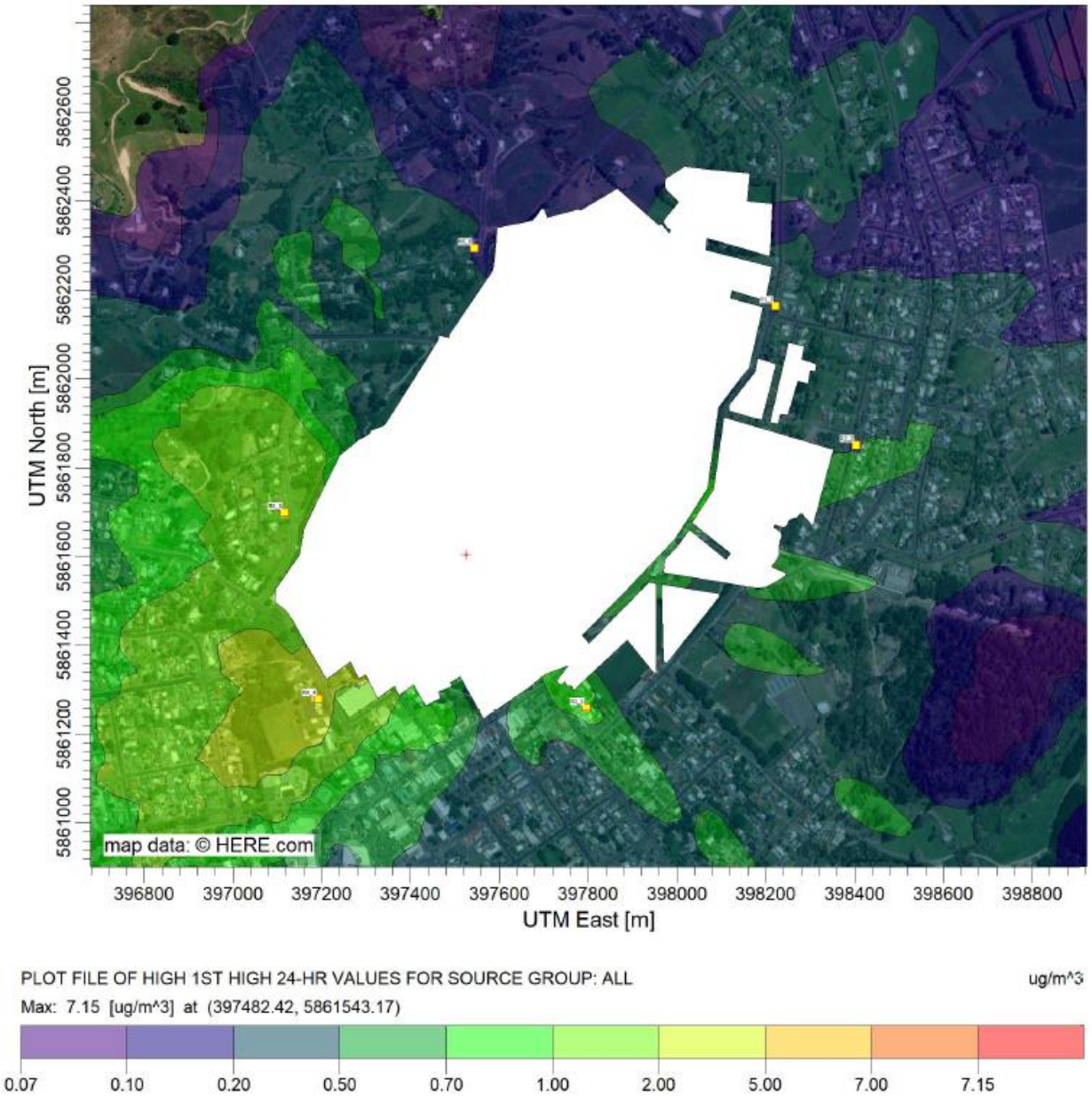

Figure 2. Nitrogen dioxide - 24-hour contour plot

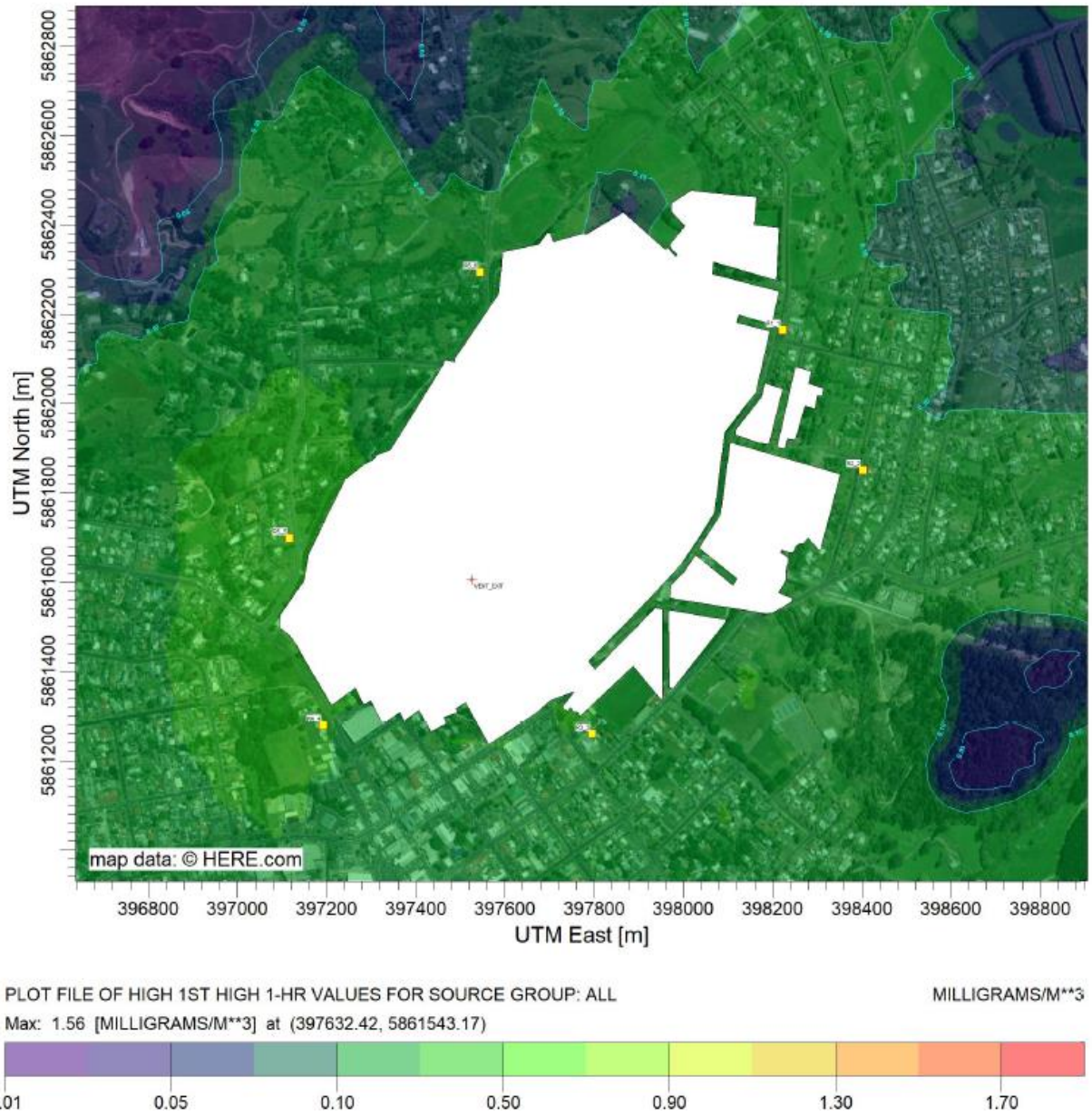

Figure 3. Carbon Monoxide - 1-hour contour plot

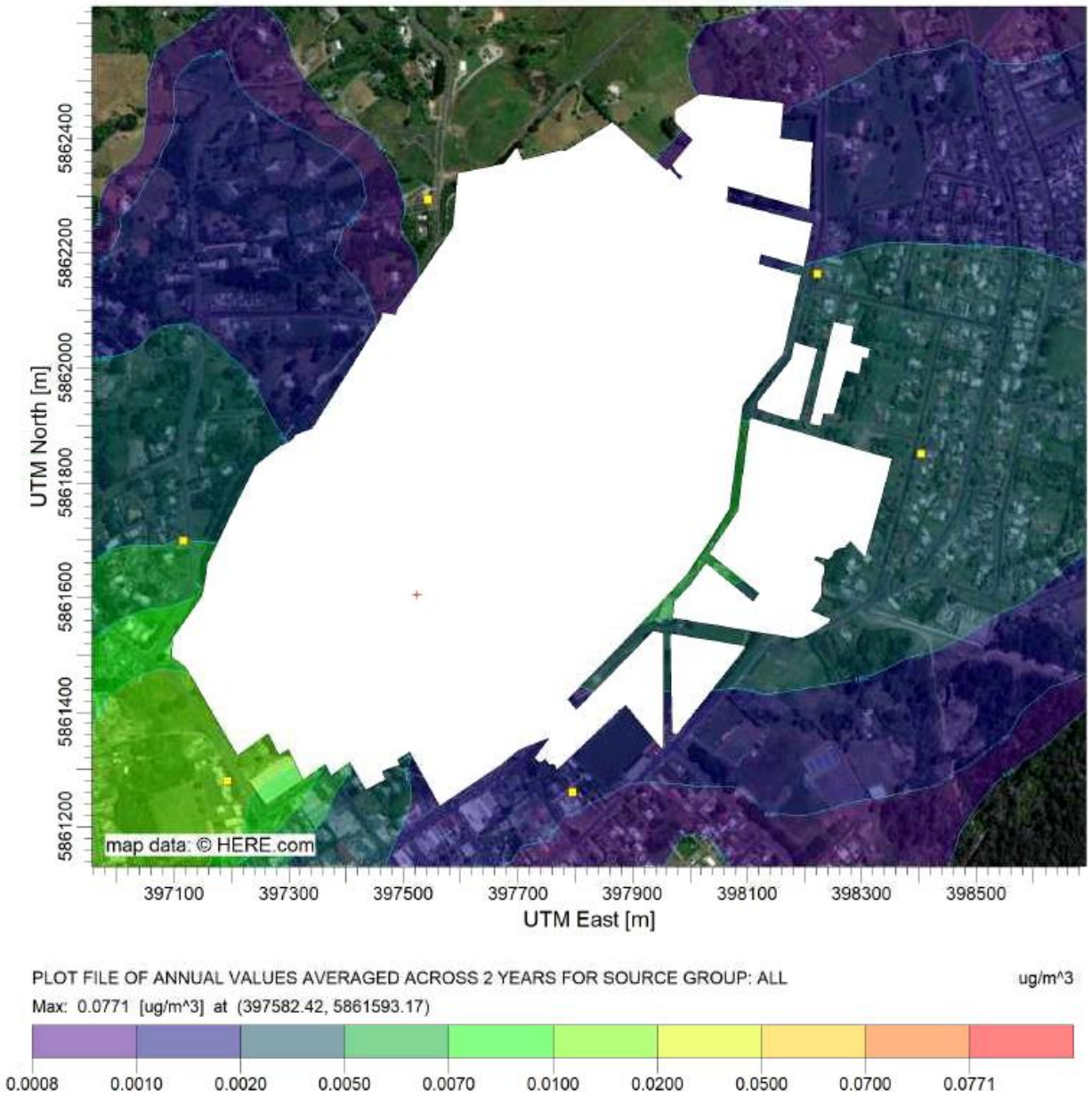

Figure 4. Crystalline silica - Annual contour plot

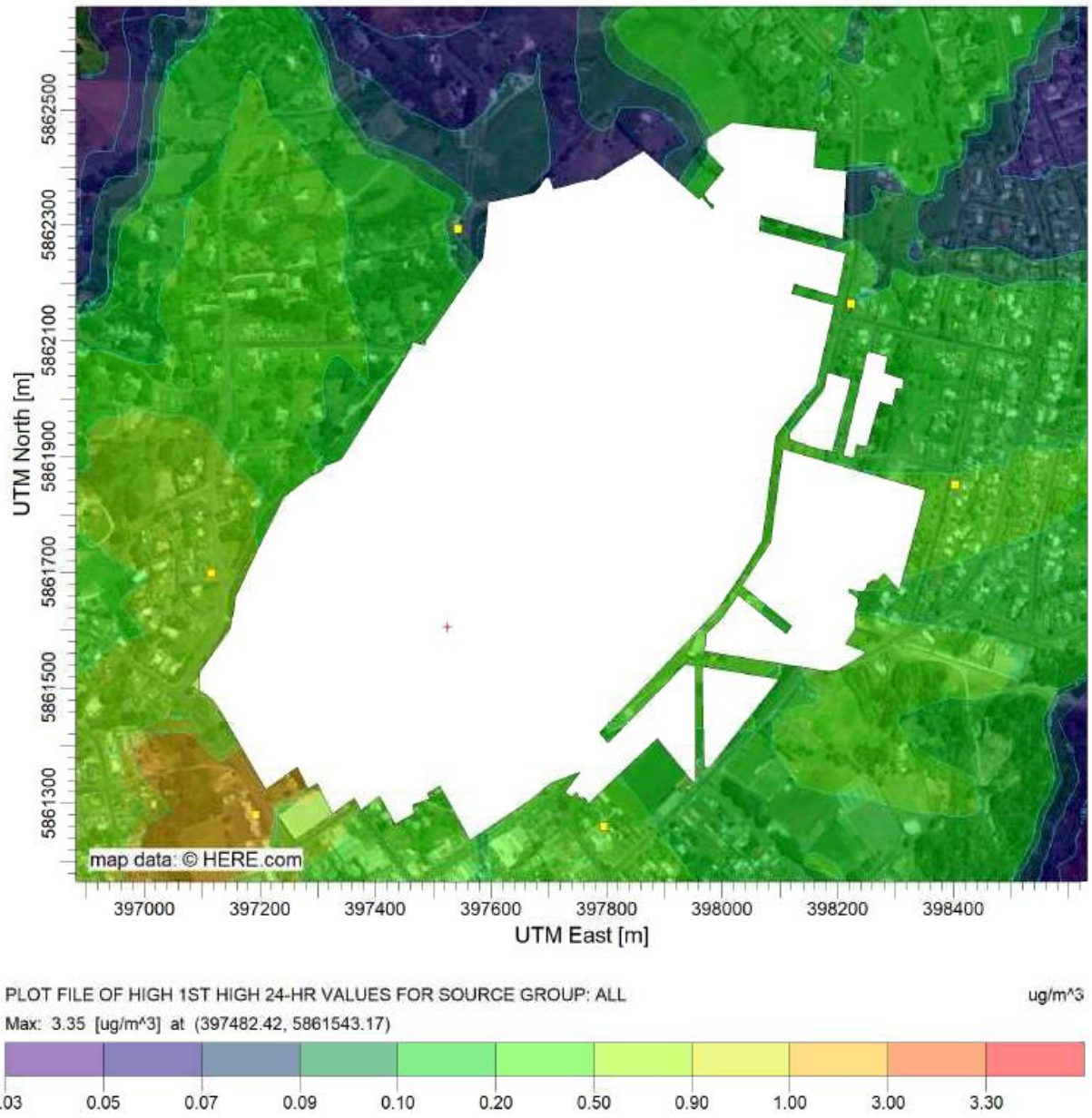

Figure 5. PM10 - 24h contour plot

Appendix C: Sampling methodology

This appendix describes the monitoring methodology that was undertaken on the 12th and 13th of March 2024. Figure 1 provides a picture of the monitoring setup. Table 1 provides an overview of the methodology for each parameter.

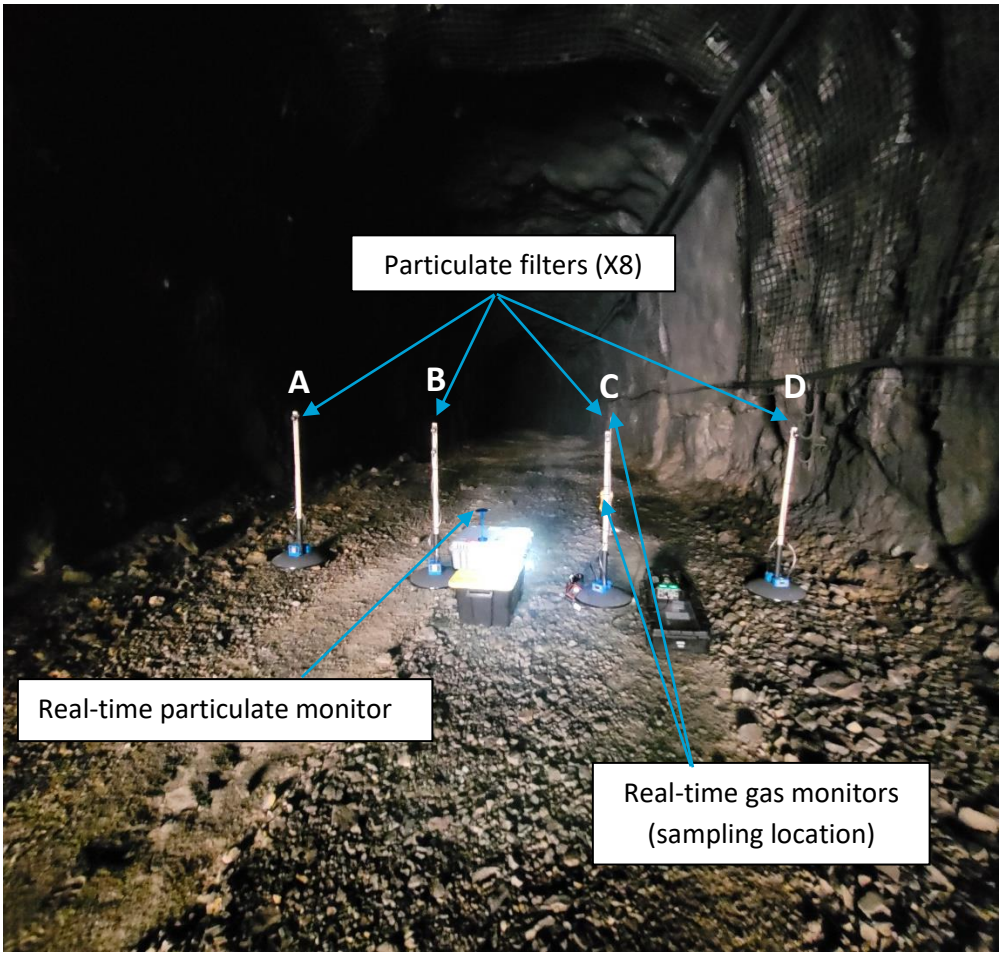

Figure 1. Annotated photo illustrating the monitoring setup within the ventilation tunnel. Picture is taken facing into the tunnel with the exit located 20 meters behind the monitoring location.

Table 1. Description of the monitoring methodology

Parameter	Method
Particulate Matter	Static inhalable dust samples were collected per AS/NZS 3640-2009. The inlets were located 1.2 metres above ground level (refer Figure 1). Air was drawn through IOM inhalable particulate samplers (SKC 225-70A), loaded with pre-weighed 25-millimetre MCE filters (0.8 micron pore size) using pulsation-dampening air sampling pumps calibrated to two litres per minute (pre & post-sampling). Run times varied based on battery life with sample periods ranging from 14.2 – 20.8 hours and capturing a minimum of two blast events. Gravimetric sample analysis was performed by Hill Laboratories per AS/NZS 3640-2009 (modified). Based on the expected exit flow rates (30-50km/hr) this sampling methodology will not be able to achieve isokinetic conditions. To reduce this uncertainty samples were: • Collected both facing towards and away from the flow direction at each location to determine the impact of not meeting isokinetic conditions; • Include 4 evenly spaced sample pairs extending across the tunnel to understand the cross-tunnel variations (refer Figure 1) • Sample were undertaken at a location 20-meters within the tunnel in the most uniform section of the tunnel. Real-time area dust levels were monitored using a DustTrak™ Aerosol Monitor 8533. The DustTrak™ displays a real-time digital readout of dust concentration using a laser photometer which was set up to measure PM1, PM2.5, PM10 and Total Dust. The unit takes a reading every second and was set to data log one-minute averages. A zero calibration was performed prior to commencing sampling.
Products of Combustion	Concentrations of combustion gases (CO, NO and NO_2) were measured using a Testo-350 and MultiRAE Lite gas analysers. Gas concentrations were initially checked across the ventilation tunnel to understand any variation and the analysers were located in a central stationary position to log gas concentrations at 1-minute intervals over the sampling period. This allowed a comparison of short-term mining activities (i.e. blasting) against background levels (i.e. from mobile plant).
Flow Rate	Flow rates were measured at multiple locations using a hand-held Testo 410i Vane Anemometer. Horizontal and vertical variations were measured as far as practical. The average flow was calculated using a measured cross-sectional area and corrected to standard conations (0 degrees Celsius, 1030 Hpa and dry gas basis).

Temperature	Temperature was monitored at the commencement and end of the sampling over 15-minute period using a Kestrel Heat Stress Tracker 5400 logging thermometer.
Oxygen	Oxygen throughout the testing was logged by the MultiRAE Lite multi-gas analyser.
Moisture content	Moisture content was monitored at the commencement and end of the sampling over 15-minute period using a Kestrel Heat Stress Tracker 5400 logging humidity meter.
Pressure	Pressure was monitored at the commencement and end of the sampling over 15-minute period using a Kestrel Heat Stress Tracker 5400 logging pressure monitor.

Appendix D: Air flow and emission data

Table 1. Ventilation discharge physical parameters

Parameter	Unit	Value
Temperature	^{O}C	26.5
Humidity	%	88.3
Water content (calculated)	%	2.3
Pressure	Hpa	1027.3
Velocity (actual)	m/s	8.56
Cross sectional area	m^2	38.4
Flow rate (actual)	m^3/s	328.7
Flow rate (corrected to STP*)	m^3/s	297.2

*273 degrees k, 1013 hpa and dry gas basis

Table 2. Ventilation discharge combustion gas concentration

Time period	Statistic	CO (ppm)	NO (ppm)	NO_2 (ppm)
Afternoon Blast (MultiRAE Lite)	Average	10	-	0
	Max	19	-	0
	Min	4	-	0
Afternoon Blast (Testo 350)	Average	-	-	0
	Max	16	2	0
	Min	-	-	0
Evening Blast	Average	3.9	-	0
	Max	8	-	0
	Min	0	-	0
Morning Blast	Average	6.7	-	0
	Max	37	-	0
	Min	0	-	0
All monitoring	Average	2.65	-	0
	Max	33	-	0
	Min	0	-	0

Table 3. Particulate and crystalline silica concentrations

Sample ID	Location (Appendix C Fig. 1)	Sampled Volume (m^3) *	Particulate Mass (mg)	Particulate conc. (mg/m^3)	Silica mass (mg)	Silica conc. (mg/m^3)
I41	D (AF)	1.54	0.2	0.13	-	-
I42	D (TF)	1.92	0.7	0.36	-	-
I43	C (TF)	1.83	0.7	0.38	0.066	32
I44	C (AF)	2.00	0.4	0.20	0.047	21
I45	B (TF)	1.60	0.6	0.37	0.057	32
I46	B (AF)	2.36	0.4	0.17	0.053	20
I47	A (TF)	2.14	0.7	0.33	0.069	29
I48	A (AF)	1.98	0.3	0.15	0.045	20
	Average concentration (mg/m^3)			**0.26**		**0.056**
	Average mass emission (kg/hr)			**0.28**		**0.030**

*273 degrees K, 1013 hpa and dry gas basis
TF = towards flow (facing into tunnel)
AF = away from flow

Note: further information relating to pre and post sampling calibrations can be provided upon request.

Appendix E: Time series graphs of real-time data

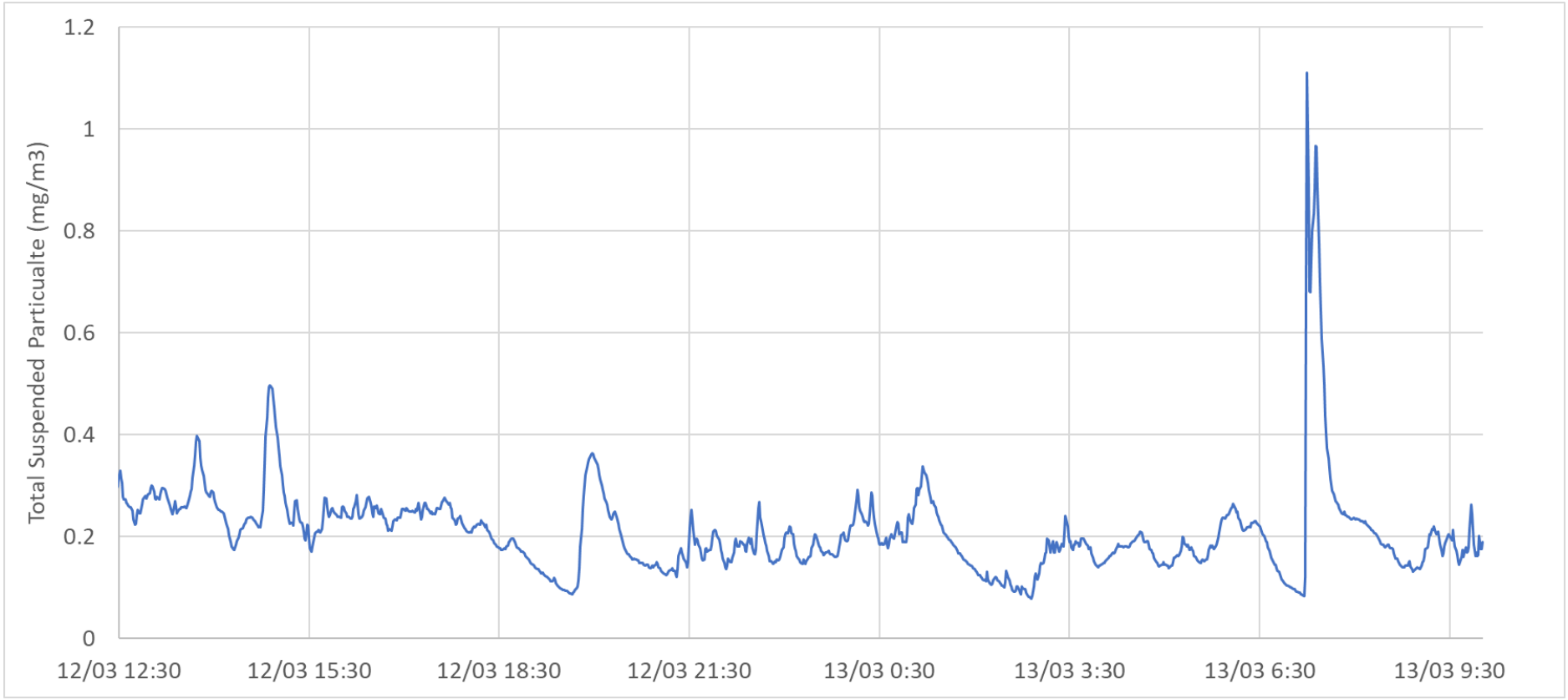

Figure 1. Total suspended particulate concentrations over the sampling period

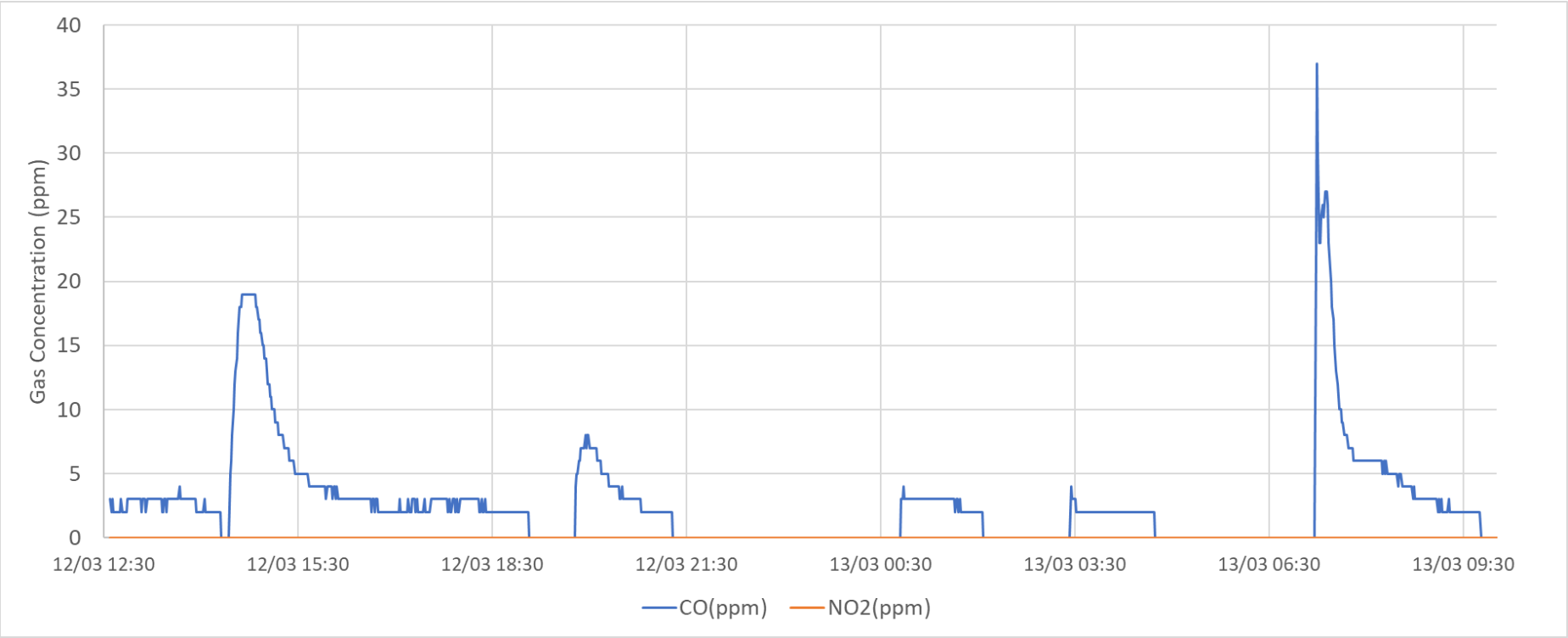

Figure 2. Gas (CO and NO_2) concentrations over the sampling period

Appendix F: Calibration information

Monitor	Serial Number	Calibration date
Testo 410i Vane Anemometer	2280568	17/11/2023
DustTrak 8533	8533104301	15/5/2023
MultiRAE Lite	M01C002194	7/6/2024
Testo XL 350	62087459	22/2/2024

Calibration Certificate Testo Smart Probes – HVAC Set

EUROTEC
People • Technology • Solutions

Owner: AIR MATTERS
Address Office 3, 17 Banks Ave, Mount Maunganui
Contact: Alice
Cert# CC23171103D

Ambient Temperature: 22.1 °C
Ambient Humidity: 80.0 % rH
Ambient Pressure: 1018 hPa
Service/Cal Centre: After-Sales Lab

Model Number	Part Number	Equipment ID	Serial Number	Instrument Type	FCC ID	IC ID	CMIIT ID	Reference Value	Actual Value	Correction Factor	Measuring Unit
Testo 805i	0560.1805	E56647	49636595 / 0619	Temp / Infrared	2ACVD-1805	12231A-1805	2015DP6562	79.9	80.6	-0.7	°C
Testo 405i	0560.1405	E56647	48946379 / 0619	Velocity / Hot-Wire	2ACVD-1405	12231A-1405	2015DP6558	0.49	0.49	0.0	m/s
Testo 410i	0560.1410	E56647	49038995 / 0619	Velocity / Vane	2ACVD-1410	12231A-1410	2015DP656612	1.37	1.34	0.03	m/s
Testo 605i	0560.1605	E56647	83030489 / 0619	Humidity Sensor	-	6127B-0560	-	46.1	46.1	0.0	% rH
Testo 605i	0560.1605	E56647	83030489 / 0619	Temp Sensor	-	6127B-0560	-	23.4	23.1	0.3	°C

Visual Inspection: OK | Functionality Test: PASSED | Last Calibration: 17/11/2023 | Next Calibration: 17/11/2024 | Final Status: Calibrated

Calibrated by: Verified by:

Note: The validity of this calibration certificate is held for a period of 12 months from date of issue, and represents the instruments readings at date of calibration.

Note: The Reference instruments used for calibration are IANZ and/or DKD (ISO/IEC 17025) traceable and bears Certificate no: 46840836; Validity 17/11/2024 or 46797073; Validity 17/11/2024

Head Office: Unit C, 750 Great South Road – Penrose, Auckland, New Zealand – 1061, P.O Box 14 543 Panmure, Auckland, New Zealand – 1741

Auckland, Ph: (09) 579 1990 Wellington, Ph: (04) 499 3591 Christchurch, Ph: (03) 366 0017 Email: aftersales@eurotec.co.nz Website: www.eurotec.co.nz

kenelec scientific

TSI Dusttrak
Calibration Certificate

Document	KF501
Revision	D

Report Number: DT229754

As Found Concentration Results				
Testing Number	Calibration Reference mg/m3	Instrument Output mg/m3	Allowable Range +/- 10%	
1	0.028	0.067	0.025	0.031
2	0.464	0.894	0.418	0.510
3	2.991	5.704	2.692	3.290
4	26.169	50.81	23.552	28.786

As Found Pressure/Flow Results							
Flow				Pressure			
Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow Lpm	3	2.980	2.850 - 3.150	Pressure kPA	100.369	100.310	95.351-105.387
Pump Run Hours:	899						

As Left Concentration Results				
Testing Number	Calibration Reference mg/m3	Instrument Output mg/m3	Allowable Range +/- 10%	
1	0.029	0.028	0.026	0.032
2	0.473	0.464	0.426	0.520
3	3.031	2.997	2.728	3.334
4	27.861	26.9	25.075	30.647

As Left Pressure/Flow Results							
Flow				Pressure			
Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow Lpm	3	3.040	2.850 - 3.150	Pressure kPA	100.268	100.258	95.255-105.281

KENELEC SCIENTIFIC PTY LTD
ABN 88 064 373 717
23 Redland Drive
Mitcham Vic 3132
T 03 9873 1022
F 03 9873 0200
info@kenelec.com.au www.kenelec.com.au

kenelec scientific

TSI Dusttrak
Calibration Certificate

Document	KF501
Revision	D

Report Number: DT229754

Customer	Air Matters Ltd
Address	587B Mount Eden Rd.
	Mount Eden, Auckland, NZ 1024
Contact	Alice
Equipment	TSI Dusttrak
Model	8533
Serial Number	8533104301
Calibration Date	September 15, 2023
Condition as Received	*As Found Failed*

Reference Instruments

Measurement Variable	Model No.	Serial No.	Calibration Due
Photometer	8587A	8587205101	1/11/2023
DC Voltage (Keithley)	2700	1260416	24/03/2024
Pressure	276140-SP	4146296	2/12/2023
Flow and Temperature	4140	41401016005	15/11/2023
1 um PSL	19518-500	A817797	May-24
2.8 um PSL	19520-500	702200	May-24
10 um PSL	DC-10	261682	May-24

ENVIRONMENTAL CONDITIONS

Ambient Temp	25ºC
Humidity	34%RH
Barometric Pressure	1002hPa

Kenelec Scientific Pty Ltd Certifies That :-

All performance and acceptance tests required were successfully conducted according to required specifications. All test and calibration data supplied by Kenelec Scientific has been obtained using Emery Oil and has been nominally adjusted to respirable mass standard ISO 12103-1 A1 Test Dust. Calibration of sizing is performed using the above particles and verified on the TSI calibration bench.

Procedures Followed:	LABP1
Approved Signatory:	
Date:	18/09/2023

KENELEC SCIENTIFIC PTY LTD
ABN 88 064 373 717
23 Redland Drive
Mitcham Vic 3132
T 03 9873 1022
F 03 9873 0200
info@kenelec.com.au www.kenelec.com.au

NZ Safety Blackwoods
TECHNICAL SOLUTIONS

660 Rosebank Rd, Avondale,
Auckland 1026
Ph: 64 9 827 6001
Fax: 64 9 827 7897
Email: service@apc.co.nz

CERTIFICATE OF CALIBRATION

Certificate No. 0000095729

Account No:	122122	**Technician:**	Sarah Reed
Account Name:	AIR MATTERS LTD	**Calibration Date:**	7/06/2023
Cust Order No:	No Charge	**Calibration Due Date:**	4/12/2023
Serial No:	M01C002194	**Location:**	
Description:	MultiRAE LITE [O2,LEL,CO,NO2,PID] Gas Detector		
Test Configuration:	APC O2, CH4, CO, NO2, PID	**Overall Result :**	PASS
Comments:	Warranty Service. Warranty Sensor Replacement.		

Test Name	Test	Result Description	Result
OXYGEN [O2]			PASS
METHANE [CH4]			PASS
CARBON MONOXIDE [CO]			PASS
NITROGEN DIOXIDE [NO2]			PASS
ISOBUTYLENE [C4H8]			PASS
AUDIBLE ALARM			PASS
VISUAL ALARM			PASS
PUMP			PASS

Sensor	Alarm 1	Alarm 2	STEL	TWA
OXYGEN [O2]	19.5 % V/V	23.5 % V/V	-	-
METHANE [CH4]	5 % LEL	10 % LEL	-	-
CARBON MONOXIDE [CO]	25 PPM	200 PPM	50 PPM	20 PPM
NITROGEN DIOXIDE [NO2]	1.0 PPM	3.0 PPM	3.0 PPM	1.0 PPM
ISOBUTYLENE [C4H8]	50 PPM	100 PPM	25 PPM	10 PPM

Calibration Gas	
212800-4	Calibration Gas 100ppm Isobutylene i-C4H8, BAL Air
6636-1-1	Calibration Gas 100ppm CO, 25ppm H2S, 50% LEL CH4, 18% O2
9422-3-1	Calibration Gas 5ppm NO2, BAL Air

Service Charges		Quantity
480057	Service Charge 5-6 Gas	1
482146	SPR SENSOR OXYGEN MULTIRAE 4R+	1
482146	SPR SENSOR OXYGEN MULTIRAE 4R+	1

APC Techsafe certifies that the unit described above has passed calibration in accordance with the manufacturer's calibration procedures. Calibration and function tests have been done against a certified and traceable gas to ensure the test accuracy. APC Techsafe recommends function testing prior to use to ensure correct and accurate operation between calibration intervals.

Users are reminded that correct care, use and maintenance of the unit is required for proper operation. Refer to the product manual for details

Certified Technician: SARAH REED **Signed** _____

NZ Safety Blackwoods
TECHNICAL SOLUTIONS

660 Rosebank Rd, Avondale,
Auckland 1026
Ph: 64 9 827 6001
Fax: 64 9 827 7897
Email: service@apc.co.nz

CERTIFICATE OF CALIBRATION

Certificate No. **0000101431**

Account No:	122122	**Technician:**	Amal Babu
Account Name:	AIR MATTERS LTD	**Calibration Date:**	15/01/2024
Cust Order No:	MTMRAECAL8-01-24	**Calibration Due Date:**	13/07/2024
Serial No:	M01C002194	**Location:**	
Description:	MultiRAE LITE [O2,LEL,CO,NO2,PID] Gas Detector		
Test Configuration:	APC O2, CH4, CO, NO2, PID	**Overall Result :**	PASS
Comments:	Service, Calibration and Function Test. Gas bottle replaced with WO417802-1		

Test Name	Test	Result Description	Result
OXYGEN [O2]			PASS
METHANE [CH4]			PASS
CARBON MONOXIDE [CO]			PASS
NITROGEN DIOXIDE [NO2]			PASS
ISOBUTYLENE [C4H8]			PASS
AUDIBLE ALARM			PASS
VISUAL ALARM			PASS
PUMP			PASS

Sensor	Alarm 1	Alarm 2	STEL	TWA
OXYGEN [O2]	19.5 % V/V	23.5 % V/V	-	-
METHANE [CH4]	5 % LEL	10 % LEL	-	-
CARBON MONOXIDE [CO]	25 PPM	200 PPM	50 PPM	25 PPM
NITROGEN DIOXIDE [NO2]	1.0 PPM	3.0 PPM	3.0 PPM	1.0 PPM
ISOBUTYLENE [C4H8]	50 PPM	100 PPM	25 PPM	10 PPM

Calibration Gas	
10700-4-3	Calibration Gas 5ppm NO2, BAL N2
A01264	Calibration Gas 10ppm Isobutylene, BAL Air
11034-1-1	Calibration Gas 100ppm CO, 25ppm H2S, 50% LEL CH4, 18% O2

Service Charges		Quantity
481631	GAS 112L NO2 in Air 5ppm	1
480057	Service Charge 5-6 Gas	1

APC Techsafe certifies that the unit described above has passed calibration in accordance with the manufacturer's calibration procedures. Calibration and function tests have been done against a certified and traceable gas to ensure the test accuracy. APC Techsafe recommends function testing prior to use to ensure correct and accurate operation between calibration intervals.

Users are reminded that correct care, use and maintenance of the unit is required for proper operation. Refer to the product manual for details

Page 1 / 1

Calibration Certificate

EUROTEC
People • Technology • Solutions

testo

No:	CC24220202D
Date:	22/02/2024
Instrument SN:	62087459
Equipment ID:	E48760
Model Name :	Testo 350 Combustion Flue Gas Analyzer CU & Measuring Box
Customer Name:	Tech Rentals NZ Ltd; Auckland

Probe Type:	0600.8765	Type : **Flue Gas Probe**	**SN:** 605
Cell Type:	0393.0000	Type : **Oxygen (O2)**	**SN:** 407016389
Electrochemical Gas Sensors	0393.0250	Type : **Sulphur Dioxide (SO2)**	**SN:** 37946726
	0393.0200	Type : **Nitrogen Dioxide (NO2)**	**SN:** 47617338113
	0393.0150	Type : **Nitric Oxide (NO)**	**SN:** 00116598
	0393.0104	Type : **Carbon Monoxide CO**	**SN:** 37721427
	0393.1400	Type: **Carbon Dioxide CO2 iR**	**SN:** 119

For calibration and test has been performed using Testo GmbH instructions and software, resulting the following parameters:

	Actual Value	Measuring Unit
Ambient Temperature	**23.0**	°C
Ambient Humidity	**75**	rh %
Ambient Pressure **[2]**	**1015**	hPa

Gas Values:

Certificate Number [1]	Reference Values	Actual Value	Permissible deviation	Measuring Unit
BE139272	0.0 % < 10 ppm	**0.00**	± 0.2 VOL %	% N2
BE166252	2.4 % ± 0.03	**2.35**	± 0.2 VOL %	% O2
030000059049/1	5.02 % ± 0.03%	**5.10**	± 0.2 VOL %	% O2
030000059049/1	400 ppm ± 4ppm	**398**	± 5 % of READING	ppm CO
BE166252	680 ppm ± 20	**688**	± 5 % of READING	ppm CO
BC558244	50 ppm ± 2%	**48**	± 5 % of READING	ppm NO
BC558673	400 ppm ± 2%	**390**	± 5 % of READING	ppm NO
NB437175	100 ppm ± 2%	**95**	± 5 % of READING	ppm NO2
BC103987	1000 ppm± 2%	**990**	± 5 % of READING	ppm SO2
BE72784	40% ± 2%	**39.39**	± 5 % of READING	% CO2 By Vol
Ambient Test	20.9	**21.0**	± 0.2 VOL %	% O2
Final status:		**Calibrated**		

Note: The validity of this calibration certificate is held for a period of 12 months from date of issue, and represents the instruments readings at date of calibration.

Note: The Gases used for calibration bears Certificate Number [1]; & are traceable to NPL (National Physical Laboratory) standards & is also internationally recognised & directly equivalent to the USA N.I.S.T standards.It is also accredited to International Accredition New Zealand to ISO Guide 17025.

Calibrated by: Verified by:

Head Office: 750C Great South Road – Penrose, P O Box 14 543 Panmure, Auckland,
Ph: (09) 579 1990 fax: (09) 525 3334 Wellington: Ph 04 499 3591 Christchurch: Ph 03 366 0017
Email: **aftersales@eurotec.co.nz** Internet: **www.eurotec.co.nz**

Appendix G: 2007 emission test report

Newmont Waihi Gold

Particulate, Carbon Monoxide and Oxides of Nitrogen Emission Testing, August 2007

AMENDED

Prepared for
Newmont Waihi Gold

By
Laboratory Services - Air Quality Group

September 2009
AQ8024-01

Particulate, Carbon Monoxide and Oxides of Nitrogen Emission Testing, August 2007
AMENDED

A report for
Newmont Waihi Gold

43 Moresby Avenue
Waihi

10 September 2009

Watercare Services Ltd
52 Aintree Avenue
Airport Oaks
PO Box 107 028
Airport Oaks
AUCKLAND

Ph 09 539 7600
Fax 09 539 7601

[ ] [ ]

Jonathan Harland
Author

Dominic Hitchen
Peer Reviewer

DISCLAIMER

This report or document ("the Report") is given by Watercare Services Ltd solely for the benefit of Newmont Waihi Gold as defined in the Contract or Terms and Conditions between Watercare Services Ltd and Newmont Waihi Gold, and is strictly subject to the conditions laid out in that Contract or Terms and Conditions.

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AMENDMENTS

This report supersedes the Newmount Waihi Gold Report (AQ8024-01) released on 10 September 2007.

The amendments made to this report:
Original calculations of flow rate where based on a stack diameter of 1.4 metres. Staff at Newmount Waihi Gold brought it to our attention that the stack diameter was in fact 2.6 metres. This error has affected the reported flow rate and subsequently the emission rate. This has meant that Table 3 on page 8 and the flow rates in Appendix A have been amended.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

In July 2007, Laboratory Services, a division of Watercare Services Ltd, was commissioned by Newmont Waihi Gold Ltd to carry out emission testing on the ventilation shaft during blasting operations. This report presents the results of the emission testing carried out at Newmont's Waihi Underground Gold Mine on 15 and 16 August 2007. The results relate to conditions existing at the time of the testing, which may not be the same as those obtained at other times.

2 METHODOLOGY

The following section outlines the sampling methodology employed to measure particulate, Carbon monoxide and Oxides of Nitrogen emissions at the ventilation shaft, at Newmont's Underground Gold Mine, Waihi,

Unless stated in the Deviations from Methods, testing was carried out according to the following test methods.

Sample and Velocity Traverse Method:	USEPA Method 1
Gas Analysis for Determination of Dry Molecular Weight Method:	USEPA Method 3
Moisture Content Determination Method:	USEPA Method 4
Determination of Particulate Matter Emissions from Stationary Sources:	USEPA Method 5
Nitrogen oxides by instrument analysis:	USEPA Method 7E
Carbon monoxide by instrument analysis:	USEPA Method 10

Watercare Services Limited is IANZ accredited for USEPA Methods 1,3,4 and 5, but currently we are not accredited for USEPA Method 7E and 10.

Deviations from Methods

USEPA Method 5:

1. USEPA state standard conditions as 20 ^{0}C and 101.3 kPa. Laboratory Services standardised conditions to 0 ^{0}C and 101.3 kPa.
2. To avoid surface effects, Laboratory Services employ a minimum sampling distance from the interior wall of the stack of 5 cm.
3. The Ventilation Shaft at Waihi Gold did not comply with USEPA Method 1 as the sampling point was less than two stack diameters downstream and eight stack diameters upstream of any flow disturbance.

Critical Parameter Determination Methods

Temperature	K Type Thermocouple[1]
Pressure	Digital Manometer[1]
Gas Velocity	S Type Pitot Tube[1]
Oxygen	Infrared Analyer[2]

Notes:

1. Equipment integrated into TCR Tecora Isostack Plus sampling system.
2. Equipment integrated into Testo 350XL, combustion gas analyser.

2.1 Particulate Sampling

USEPA Method 5 requires that particulate emission monitoring be carried out under isokinetic conditions. This requires that the velocity of the gas upon entry to the sample extraction nozzle must be equal to the velocity of the gas at corresponding point in the duct. Nozzle velocities lower than the stream velocity cause an enrichment of larger particles in the sample, while higher nozzle velocities cause fewer large particles in the sample.

Laboratory Services use a TCR Tecora Isostack Plus Sampling Train to conduct isokinetic source sampling as detailed in Figure 1. The Isostack Plus is designed to collect emission samples from stacks or ducts while maintaining an isokinetic flow rate, by automatically compensating for flow fluctuations in the gas stream. Critical parameters required to determine isokinetic conditions are monitored every few seconds during the sampling run by the control unit and the pump extraction rate adjusted to maintain isokinetic sampling conditions. This means higher quality results can be gained compared with manual sampling trains.

2.2 Combustion gas Analysis, Oxides of Nitrogen and Carbon Monoxide

Testo 350 XL, combustion gas analyser is EPA verified for carrying out analysis of combustion gases. The calibration of various cells of the analyser need certified calibration in the range in which the analyser is expected to be working during testing. The analyser was tested for NO, NO_2, CO, SO_2, and O_2.

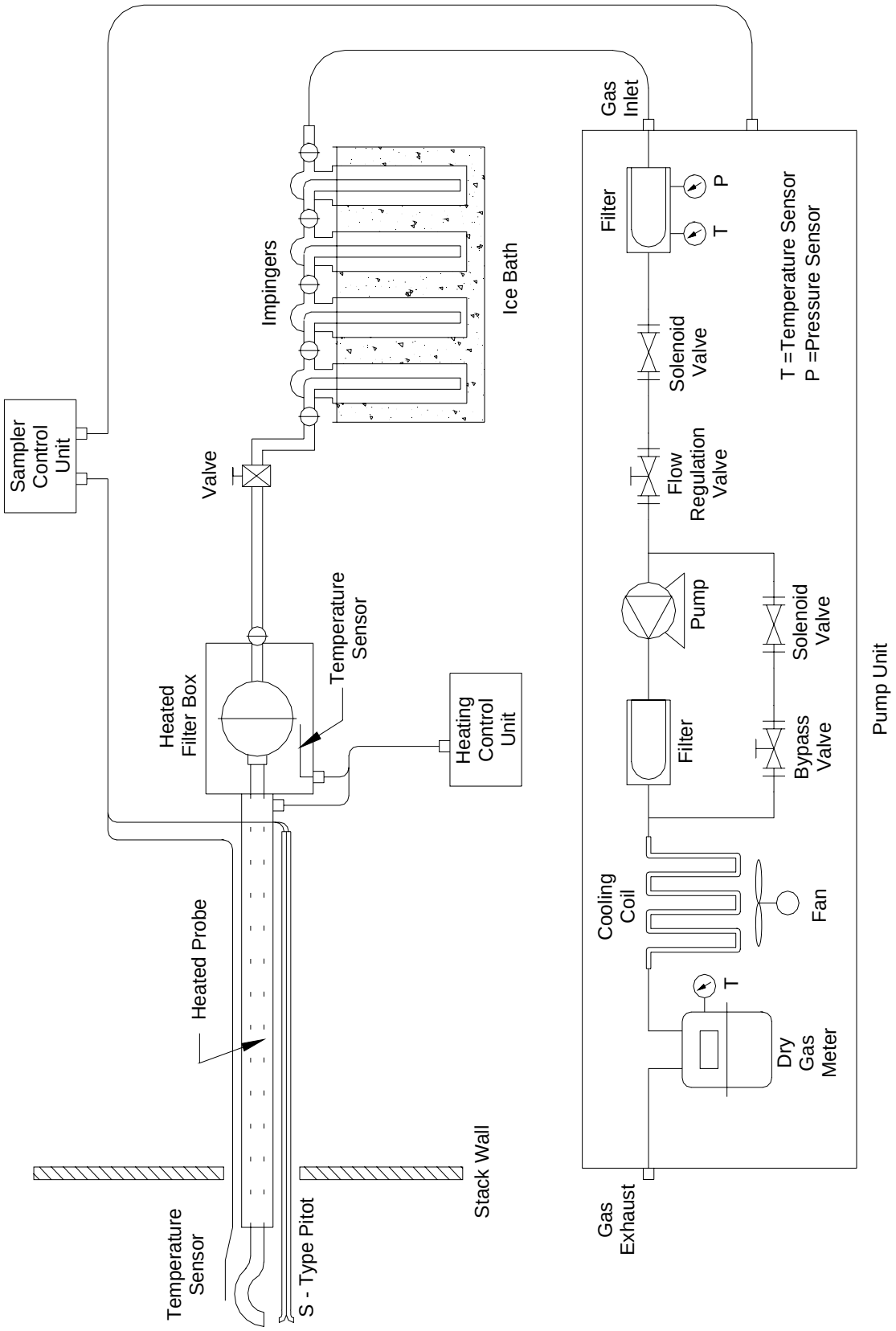

Figure 1 Tecora Isokinetic Sampling Train

3 RESULTS

The following sections presents the results of the particulate, Carbon monoxide and Oxides of Nitrogen emission testing conducted at Newmont Waihi Gold on 15 and 16 August 2007.

3.1 Stack Data

Table 1 below presents results of various stack parameters measured during particulate emission testing carried out on the 15 and 16 August 2007.

Table 1 Stack Data

Duct Dimensions	2.6m
Sampling Port	4”
Distance from Upstream Disturbance	<8m
Distance from Downstream Disturbances	<1m
Discharge	Vertical

Figure 2 Ventilation Shaft

Table 2 Stack Conditions

Source	Average Moisture Content (%)	Average Velocity (m/s)	Average Temperature (°C)
Run 1	1.2	16.3	21.2
Run 2	1.7	16.0	23.4
Run 3	1.7	15.8	22.5
Run 4	2.4	16.1	22.5
Run 5*	2.1	20.3	20.0
Average	1.8	16.9	21.9

* Run 5 Isokinetic Deviation was above ±10%

3.2 Ventilation Shaft Particulate Emission Results

The Ventalition Shaft at Newmont Waihi Gold was tested on 15 and 16 August 2007 for particulate. For particulate and stack conditions, two runs were carried out on 15 August 2007 during the afternoon and evening blasts, three more runs were carried out on 16 August 2007 during the morning, afternoon and evening blasts. A summary of the results are presented below, with further information in the appendices.

Table 3 Particulate Emission Results for Ventilation Shaft

Run	Sampling Date	Sampling Period	Volume Sampled (m^3)*	Stack Flow Rate (m^3/h)*	Mass (mg)	Concentration (mg/m^3)*	Emission Rate (kg/h)
Run 1	15/08/2007	16:41-17:21	0.77	280,469	0.8	1.0	0.293
Run 2	15/08/2007	18:52-19:45	1.11	273,247	0.4	0.4	0.108
Run 3	16/08/2007	07:00-07:46	1.07	268,439	2.2	2.0	0.546
Run 4	16/08/2007	13:41-14:12	1.14	272,022	0.6	0.5	0.143
Run 5**	16/08/2007	18:40-20:01	1.22	330,818	1.2	1.0	0.320
Average			**1.06**	**284,999**	**1.0**	**1.0**	**0.282**

* Corrected to 0°C and 101.3 kPa, dry gas basis
** Run 5 Isokinetic Deviation was above ±10%

3.3 Oxides of Nitrogen and Carbon Monoxide

The Ventalition Shaft at Newmont Waihi Gold was tested on 16 August 2007 for Oxides of Nitrogen and Carbon Monoxide. A summary of the results are presented below.

Table 4 Oxides for Nitrogen and Carbon Monoxide, Morning blast

	CO (ppm)	NO (ppm)	NO_2 (ppm)
Average	1.22	0.00	0.03
Maximum	5.00	0.00	0.30
Minimum	0.00	0.00	0.00

Table 5 Oxides for Nitrogen and Carbon Monoxide, Afternoon blast

	CO (ppm)	NO (ppm)	NO_2 (ppm)
Average	1.28	0.00	0.09
Maximum	3.00	0.00	0.50
Minimum	0.00	0.00	0.00

Table 6 Oxides for Nitrogen and Carbon Monoxide, Evening blast

	CO (ppm)	NO (ppm)	NO_2 (ppm)
Average	1.35	0.01	0.00
Maximum	4.00	1.00	0.20
Minimum	0.00	0.00	0.00

4 PROCESS INFORMATION

Below is a summary of the blast information supplied by Newmont Waihi Gold for 15 and 16 August 2007.

Site	Number of blasts	Explosive Type a	Explosive Type b	Explosive Type c	Explosive Type A weight	Explosive Type B weight	Explosive Type C weight	Total Explosive used (kg)
15/8/2007 Afternoon	1	Emulsion	-	-	220	-	-	
								220
15/8/2007 Evening	1	Emulsion	Powergel (short)	-	211	12	-	
								223
16/8/2007 Morning	2	Emulsion	Powergel (short)	-	222	12	-	
	2	Emulsion	Powergel (short)		311	12	-	
				-				557
16/8/2007 Afternoon	2	Emulsion	Powergel (short)	-	150	12	-	
	2	Emulsion	-	-	183	-	-	
								345
16/8/2007 Evening	2	Emulsion	Powergel (short)	Powergel (long)	212	12	12	
	2	Emulsion	Powergel (long)	Powergel (short)	276	12	12	
								536

5 DISCUSSION

Testo 350 XL, combustion gas analyser recorded higher levels of Carbon Monoxide compared to the level of Oxides of Nitrogen being emitted from the ventilation shaft. As in other combustion reactions, a deficiency of oxygen favours the formation of carbon monoxide and unburned organic compounds and produces little, if any, nitrogen oxides. An excess of oxygen causes more nitrogen oxides and less carbon monoxide and other unburned organics. For ammonium nitrate and fuel oil (ANFO) mixtures, a fuel oil content of more than 5.5 percent creates a deficiency of oxygen (USEPA, 2007).

6 REFERENCES

United States Environmental Protection Agency. *Miscellaneous Sources*. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s03.pdf. (Accessed 20/08/2007).

APPENDIX A

Summary of Sampling Data for TSP

Appendix A contains 3 pages including cover

Summary of Sampling Data for TSP

Site:	Newmont Waihi Gold		
Pollutant:	TSP		
	Run 1	**Run 2**	**Run 3**
Sample Description:	Run 1	Run 2	Run 3
Sampling Date:	15/08/2007	15/08/2007	16/08/2007
Filter ID:	7/80	7/81	7/82
DGM Initial:	1071.8910	1072.6970	1073.8660
DGM Final:	1072.6970	1073.8660	1075.0010
DGM Sample Volume (m^3):	0.8060	1.1690	1.1350
DGM Std. Sample Volume (m^3):	0.7660	1.1099	1.0721
Final Leak Test Vacuum (kPa):	50	50	50
Final Leak Test Flow Rate (L/min):	0.00	0.00	0.10
Moisture Collected (g):	7.6	15.1	15.1
Moisture Content (%):	1.2	1.7	1.7
Sampling Period	16:41-17:21	18.52-19.45	7.00-7.46
Sampling Time (sec):	1229	1804	1824
Sampling Period (mins):	20.5	30.1	30.4
Sampling Plane Mean Velocity (m/s):	16.3	16.0	15.8
Isokinetic Deviation - Tecora(%):	-2.3	-2.6	-2.5
Calculated Isokinetic deviation (%):	-4.3	-3.0	-6.0
****Duct Volumetric Flow Rates****			
Moist (m^3/h):	310656.6	306033.1	301124.8
Moist Standards (m^3/h):	283930.8	277871.9	273142.5
Dry Standard (m^3/h):	280469.1	273247.2	268439.2
****Mean Temperatures****			
At Sampling Plane (^{o}C):	21.2	23.4	22.5
At DGM (^{o}C):	10.0	10.4	10.8
Duct pressure (kPa)	100.3	100.3	100.3
Ambient Pressure (kPa):	99.8	99.8	99.5
Nozzle diameter (mm)	7.5	7.5	7.5

Site:	Newmont Waihi Gold	
Pollutant:	TSP	
	Run 4	**Run 5**
Sample Description:	Run 4	Run 5
Sampling Date:	16/08/2007	16/08/2007
Filter ID:	07/83	07/90
DGM Initial:	1075.0310	1076.2520
DGM Final:	1076.2520	1077.6130
DGM Sample Volume (m^3):	1.2210	1.3610
DGM Std. Sample Volume (m^3):	1.1407	1.2189
Final Leak Test Vacuum (kPa):	50	50
Final Leak Test Flow Rate (L/min):	0.10	0.00
Moisture Collected (g):	22.3	20.6
Moisture Content (%):	2.4	2.1
Sampling Period	13:41-14:12	18:40-20:01
Sampling Time (sec):	1822	1807
Sampling Period (mins):	30.4	30.1
Sampling Plane Mean Velocity (m/s):	16.1	20.3
Isokinetic Deviation - Tecora(%):	-1.9	-13.4
Calculated Isokinetic deviation (%):	-1.6	-16.7
****Duct Volumetric Flow Rates****		
Moist (m^3/h):	308240.7	388035.5
Moist Standards (m^3/h):	278637.9	337772.7
Dry Standard (m^3/h):	272022.2	330817.8
****Mean Temperatures****		
At Sampling Plane (^{o}C):	22.5	20.0
At DGM (^{o}C):	13.0	11.8
Duct pressure (kPa)	100.3	100.3
Ambient Pressure (kPa):	99.1	94.6
Nozzle diameter (mm)	7.5	7.5

APPENDIX B

Moisture and Particulate Determinations

Appendix B contains 2 pages including cover

Moisture Content Determination

Run	Moisture Mass Collected (g)	Gas Volume Sampled (m^3)*	Moisture Content (%)
Run 1	7.6	0.766	1.2
Run 2	15.1	1.110	1.7
Run 3	15.1	1.072	1.7
Run 4	22.3	1.141	2.4
Run 5	20.3	1.219	2.1

Particulates Mass Determination

Run	Filter ID / Rinse ID	Volume (ml)	Initial Wt (g)	Final Wt (g)	Mass (g)	Net Mass (g)	Total Mass (g)
Run 1	0.0875		0.35607	0.35685	0.00078	0.00080	0.00080
	Run 1	60	137.04670	137.0483	0.00157	0.00243	
Run 2	0.09		0.35507	0.35549	0.00042	0.00044	0.00044
	Run 2	60	136.4858	136.4873	0.00150	0.00237	
Run 3	0.09		0.35690	0.35906	0.00216	0.00218	0.00218
	Run 3	60	134.6244	134.6252	0.00083	0.00170	
Run 4	07/83		0.35889	0.35947	0.00058	0.00060	0.00060
	Run 4	60	135.5532	135.5516	-0.00160	-0.00160	
Run 5	07/90		0.34448	0.34564	0.00116	0.00118	0.00118
	Run 5	60	114.0956	114.0957	0.00010	0.00097	
Acetone Blank	**Blank**	60	133.2940	133.2932	-0.00087	-0.00087	-0.00087
Filter Blank	07/91		0.34347	0.34345	-0.00002		

APPENDIX C

Laboratory Reports

Appendix C contains 2 pages including cover

water Care services limited

Page: 1
Copy to 1: Johnathan Harland
2: File

Watercare Services Ltd
Laboratory Services
52 Aintree Avenue
Airport Oaks
Auckland, New Zealand
Phone: 539 7614
Facsimile: 539 7620

LABORATORY SERVICES AIR LAB
PO Box 107028
AIRPORT OAKS

Batch Number: 07/22062 Sampling/Yes
Received....: 17/08/07 17:24:00

Sample No / Test Code	Date / Identification	Description	Method	Units
01	15/08/07	AQ8024-01A Run 1 Filter 07/80		
02	15/08/07	AQ8024-01B Run 2 Filter 07/81		
03	15/08/07	AQ8024-01C Run 3 Filter 07/82		
04	15/08/07	AQ8024-01D Run 4 Filter 07/83		
05	15/08/07	AQ8024-01E Run 5 Filter 07/90		
06	15/08/07	AQ8024-01F Blank Filter 07/91		
DustGaFi		Dust Final Weight (g)		g
DustGaIn		Dust Initial Weight (g)	T110	g
DustGaWe		Dust Filter Difference GA55 (g) Stack	T110	g

Sample No.	01	02	03	04	05	06
DustGaFi	0.35685	0.35549	0.35906	0.35947	0.34564	0.34345
DustGaIn	0.35607	0.35507	0.35690	0.35889	0.34448	0.34347
DustGaWe	0.00078	0.00042	0.00216	0.00058	0.00116	-0.00002

Sampling/Yes:= As per Laboratory Services sampling manual.
Sampling/No := Results are reported on an as received basis.

Section Head: _____ Date: 4,9,07

---------- END OF REPORT : 1 PAGE ----------

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