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PATTLE DELAMORE PARTNERS LTD

Baseline Environmental Monitoring, Program 6: Dust Monitoring – Exploration Permit #51985 at Puhipuhi, Northland

Evolution Mining NZ Pty Ltd

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Prepared for

Evolution Mining NZ Pty Ltd

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Executive Summary

Evolution Mining NZ Pty Ltd (ENZ) is the holder of Mineral Exploration Permit 51985 which covers 2,984 Ha near Puhipuhi, Northland which is prospective for both gold and silver.

The area is geothermal in origin and has a history of being mined for mercury which is present in the area in the form of cinnabar (a mineralised form of mercury sulphide, HgS).

Pattle Delamore Partners Ltd (PDP) has been engaged by ENZ, to undertake baseline environmental monitoring, and to prepare an Environmental Management Strategy for Exploration Drilling. This strategy includes various recommendations to minimise and mitigate potential dust effects.

Baseline dust deposition monitoring was undertaken to provide an indication of baseline dust levels within ENZ's Mineral Exploration Permit. It was expected that the exploration drilling would not impact on observed dust deposition rates due to the small scale of the activity, limited potential for dust generation and large distance from the dust deposition gauge locations. Field observations during this period indicated that this assumption was valid.

Dust deposition rate monitoring was undertaken at three locations within the exploration tenement over 9 months from March until December 2016. One dust gauge was tampered with and subsequently stolen from one of the original locations and so a fourth site was utilised.

Generally similar trends in dust deposition rate over the monitoring period were observed across the monitoring sites indicating that there are different sources of dust within the exploration tenement that impact each of the monitoring sites differently.

The measured dust deposition rates were all below 2 g/m^2/30 days with the majority below 1 g/m^2/30 days. These results are in good agreement with the values quoted in the Good Practice Guide for Assessing and Managing Dust of general dust deposition levels measured in New Zealand being in the range 1-4 g/m^2/30 days with background concentrations usually less than 1 g/m^2/30days[1].

The Ministry for Environment (MfE) recommend a trigger level for deposited dust of 4 g/m^2/30 days **above** background concentration.

The measured background dust deposition rates are all below 2 g/m^2/30 days implying a likely trigger level for any large scale dust generating activity in the area will be in the order of 6 g/m^2/30 days.

[1] Good Practice Guide for Assessing and Managing Dust, MfE, Nov 2016, p50

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1.0 Introduction

Evolution Mining NZ Pty Ltd (ENZ) is the holder of Mineral Exploration Permit 51985 which covers 2,984 Ha near Puhipuhi, Northland which allows ENZ to prospect for both gold and silver.

The area is geothermal in origin and has a history of being mined for mercury which is present in the area in the form of cinnabar (a mineralised form of mercury sulfide, HgS).

During consultation with the local community, ENZ were made aware of local stakeholders concerns about potential adverse environmental effects of the proposed exploratory drilling and the prospect of future gold mining within the permit area.

As a direct result ENZ initiated a number of baseline environmental studies to supplement historical environmental assessments. The purpose of these is twofold; first to address, manage and monitor concerns with the current exploration activities, and secondly provide data and information to inform the management of any future exploration or mining activities.

The purpose of this document is to collect and report on baseline dust deposition rates, specifically background environmental dust deposition rates. Monitoring was undertaken before, during, and after ENZ's exploration drilling.

2.0 Environmental Management Strategy for Exploration Drilling

An Environmental Management Strategy for Exploration Drilling was previously developed[2].

The philosophy behind the strategy is one of identifying potential environmental risks and then developing the exploration drilling program to:

- Eliminate;
- Isolate; or
- Minimise the risks.

Management plans are used to prescribe how various exploration activities are to be carried out in order to ensure that any identified environmental risks are minimised or managed.

Monitoring is used to assess the effectiveness or otherwise of the management plans, and if necessary, the management plans include provision for the plan to be reviewed along with the mitigation or minimisation controls.

[2] Environmental Management Strategy for Exploration Drilling, PDP, 2016

Exploration drilling was carried out using a drilling fluid to line the borehole with a protective coating, lubricate the drill bit and carry drill cuttings to the surface. As a consequence the exploration drilling activity does not generate dust.

The primary source of dust during exploration drilling was identified as being from any soil disturbed during the formation of the drill pads and/or site access tracks (if required).

Recommendations made in the exploration drilling environmental management strategy to mitigate exploration drilling-related dust include:

- Consideration being given to selecting sites and access routes that minimise opportunities for ground disturbance;
- Consideration being given to the type of drill rig to be used. A track-mounted or fly rig/man-portable rig is preferred, if practical, to **minimise** soil disturbance on paths of access;
- Soil disturbance should be kept to a minimum and areas be damped down with water to suppress dust if required; and
- Remedial earthworks and drill site/access track revegetation should be undertaken as soon as practical following the completion of the work.

3.0 Relevant Standards

The relevant standards for dust measurement and assessment in New Zealand are as follows:

- AS/NZS 3580.1.1:2007 Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment standard; and
- ISO/DIS 4222.2 Measurement of atmospheric dust fall – Horizontal deposit gauge method.

In addition to the standards listed above, the Good Practice Guide for Assessing and Managing Dust[3] contains useful information and recommendations on the assessment and management of dust.

The dust measurements and subsequent analysis has been completed in accordance with these standards and the good practice guide.

4.0 Relevant Rules and Guidelines

The National Environmental Standard for Air Quality (NESAQ) does not refer specifically to dust, however dust contributes to the concentration of PM_{10}[4] which is a regulated contaminant due to its adverse health effects.

[3] Good Practice Guide for Assessing and Managing Dust, Ministry for the Environment, November 2016

New Zealand's Ambient Air Quality Guidelines[5] address the impact of air contaminants on human health and therefore do not cover the management of nuisance dust and refer instead to the good practice guide for managing dust.

The Good Practice Guide for Assessing and Managing Dust provides a recommended trigger level for deposited dust of 4 grams per m^2 per 30 days ($4g/m^2/30$ days) above background concentration. Trigger levels are used for the proactive management of dust. Dust values approaching or exceeding this trigger value should prompt a review of dust generating activities and the introduction of additional dust control mitigation if appropriate.

The Northland Regional Council's Regional Air Quality Plan for Northland has specific rules regarding dust. Rule 4 permits the discharge of dust into air from quarrying operations provided that the discharge does not result in any offensive or objectionable dust deposition, or any noxious or dangerous levels of airborne particulate matter, beyond the boundary of the subject property.

The Whangarei District Council's Whangarei District Plan has no specific rules regarding allowable levels of dust however the effects of dust are considered in association with a number of individual rules. Rule 38.3.3 of the Countryside and Coastal Countryside Environmental Rules deal with Mineral Extraction. For restricted discretionary activities, the Council reserves discretion around (amongst other things) the effects of dust.

5.0 Dust Deposition Gauges

Deposited dust is dust that settles out of the air. Dust deposition rate measurements are made by means of a collection jar or gauge that catches the dust settling over a fixed surface area over a fixed period of time.

The results are reported in terms of the weight of dust collected per unit of surface area, and over a fixed period of time, and reported as $g/m^2/30$ days.

The dust deposition gauges used in the monitoring were provided by Watercare Laboratory Services Ltd. PDP installed the gauges onsite with ENZ exchanging the exposed gauges for fresh gauges approximately every 30 days.

The exposed dust deposition gauges were couriered to Watercare Laboratory Services Ltd for analysis in accordance with ISO/DIS 4222.2.

The dust deposition gauge specifications can be found in Appendix A.

[4] PM_{10} refers to airborne particulate matter that has an aerodynamic diameter of less than 10 micrometres.
[5] Ambient Air Quality Guidelines, Ministry for the Environment, 2002, p3

5.1 Dust Gauge Setup

In order to take dust deposition measurements, the deposition gauges were mounted on poles 2.0 m off the ground.

An example of the dust deposition gauge setup used is shown below in **Figure 1**.

Figure 1: A typical dust gauge installation

6.0 Dust Deposition Measurements

The primary purpose of the dust deposition monitoring was to provide an indication of baseline dust levels within ENZ's Mineral Exploration Permit. It was expected that the exploration drilling would not impact on observed dust deposition rates due to the small scale of the activity, and the drilling itself having no potential for dust generation and large distance from the dust deposition gauge locations. Field observations during this period indicated that this assumption was valid.

6.1 Deposition gauge locations

Three dust deposition gauge measurement locations were chosen across the exploration tenement in order to obtain an indication of deposited dust levels within the exploration tenement. Where possible locations were chosen in locations that would be sensitive to deposited dust e.g. houses.

The dust deposition gauge locations shown below in **Figure 2** are described in further detail below.

6.1.1 Location PD-B

PD-B was located close to a house in the northern part of the exploration tenement.

The nearest road is approximately 70 m away from the monitoring location.

6.1.2 Location PD-P

PD-P was located on Mine Road in the centre of the exploration tenement. The monitoring location was approximately 5 m from a gravel road and approximately 50 m from a house. This site was expected to give an indication of the level of deposited dust occurring due to traffic movements on Mine Road.

6.1.3 Location PD-G

PD-G was located just within the south-eastern border of the exploration tenement.

The nearest road (Puhipuhi Road) is a tar sealed road and was approximately 60 m away from the monitoring location.

6.1.4 Location PD-W

PD-W was located near the southern end of the exploration tenement.

The nearest road (Mine Road) is a gravel road and was approximately 400 m away from the monitoring location.

6.2 Deposition gauge installation and exchange

The dust deposition gauge installation and gauge exchange dates are given below in **Table 1**.

Table 1: Dust deposition gauge exchange dates (2016)

Gauge	PD-B	PD-P	PD-G	PD-W
Installation	7 March	7 March	6 April	26 September
Exchange				
1	6 April	6 April		
2	5 May	5 May	5 May	
3	14 June	14 June	14 June	
4	20 July		20 July	
5	26 September		26 September	
6	27 October		27 October	27 October
7	25 November		25 November	25 November
8	22 December		22 December	22 December

From **Table 1** the following points are noted:

- Dust deposition gauge PD-G was not installed until a month after gauges PD-B and PD-P;
- At some point between 14 June and 20 July, dust deposition gauge PD-P went missing. Due to its highly visible location adjacent to Mine Road it was decided not to replace this deposition gauge;
- The exchange of dust deposition gauges was not undertaken in August resulting in a the 26 September exchange equating to a 68 day period between exchanges; and
- A new dust deposition gauge location was identified and PD-W was installed on the 22nd of September.

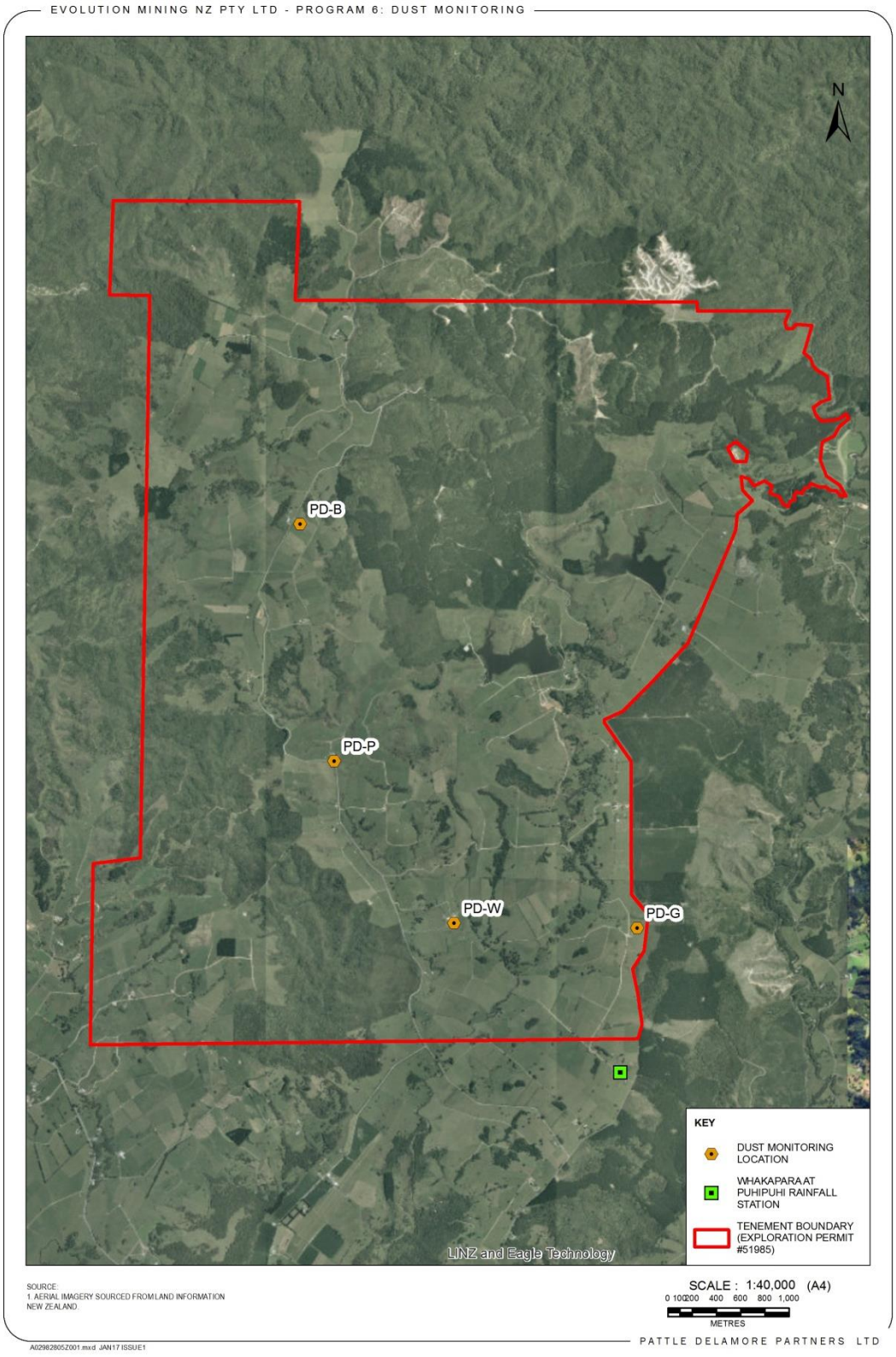

Figure 2: Dust deposition measurement locations

7.0 Monitoring results and discussion

The dust deposition monitoring results are presented below in **Table 2**.

Table 2: Dust deposition monitoring results (2016)

Gauge	PD-B	PD-P	PD-G	PD-W
	(g/m^2/30 days)	(g/m^2/30 days)	(g/m^2/30 days)	(g/m^2/30 days)
6 April	0.3	142.7[1]		
5 May	0.1	2	0.9	
14 June	0.01	0.03	0.16	
20 July	0.3		1.4	
26 September[2]	0.1[2]		0.6[2]	
27 October	0.6		0.9	0.2
25 November	0.3		0.3	1.3
22 December	0.7		0.7	0.7

Notes:

[1] This value is extremely high and indicates that the gauge was tampered with by the addition of soil or similar such material.

[2] The gauge exchange for August was not undertaken. The September dust deposition rate value give an average 30 day dust deposition rate during the 68 day exchange period between 20 July and 26 September.

It can be seen from **Table 2** that the dust deposition rate measured in gauge PD-P after the 6th April exchange date of 142.7 g/m^2/30 days is extremely high compared with the MfE trigger level of 4 g/m^2/30 days and the other values measured during the monitoring period. Gauge PD-P was located close to Mine Road and was highly visible to passing traffic. It is concluded that this gauge was tampered with by the addition of soil or similar such material at some point between its installation on the 7th of March and the gauge exchange on the 6th of April. This result is therefore excluded from the analysis.

Gauge PD-P was located adjacent to a gravel road (Mine Road) and was expected to record higher dust deposition rates than other gauge locations due to dust generated from traffic on the road. Unfortunately there was limited valid data measured at PD-P prior to the gauge going missing however the data recorded at PD-P for the 5th May gauge exchange did indicate the highest dust deposition rate recorded during the monitoring period.

The dust deposition monitoring results are also presented below in **Figure 3.**

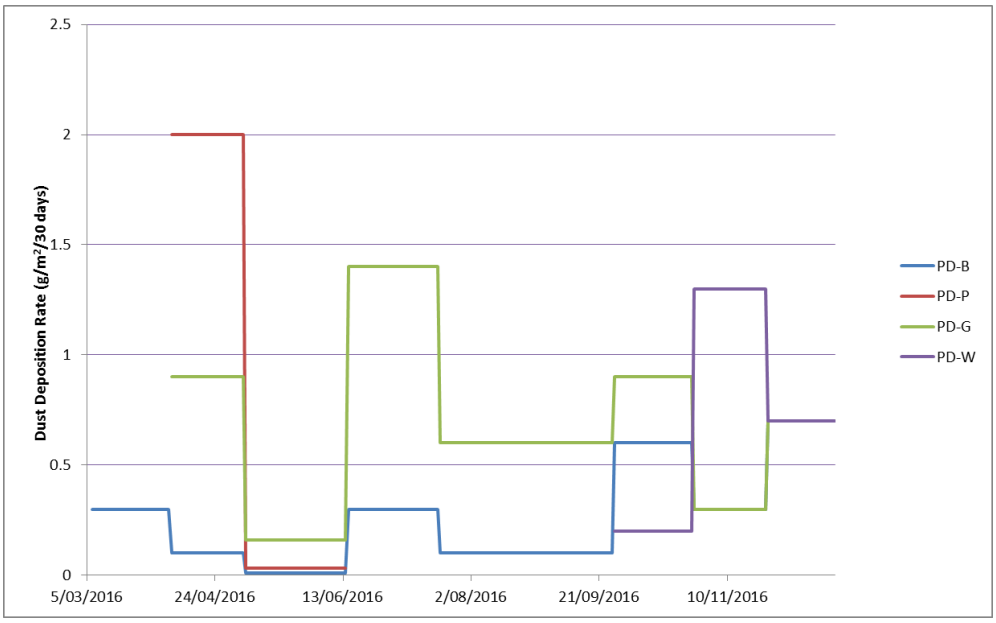

Figure 3: Dust deposition monitoring results

It can be seen from **Figure 3** that the dust deposition rates varied considerably, both in terms of location sites and with time during the 9-month monitoring period. Sites PD-G and PD-B exhibit similar trends in dust deposition rate over the monitoring period with site PD-G consistently recording higher rates despite being located close to a tar-sealed road while PD-B is located close to a gravel road. This indicates that there are different sources of dust within the exploration tenement that impact each of the monitoring sites differently.

While site PD-P exhibits a similar trend to PD-G and PD-B (i.e. decreasing when they decrease), site PD-W exhibits the opposite trend. Dust deposition rates at this site could be dominated by other variables such as localised wind or dust generating activities.

It can also be seen from **Figure 3** that the measured dust deposition rates are all below 2 g/m^2/30 days with the majority below 1 g/m^2/30 days. These results are in good agreement with the values quoted in the Good Practice Guide for Assessing and Managing Dust of general dust deposition levels measured in New Zealand being in the range 1-4 g/m^2/30 days with background concentrations usually less than 1 g/m^2/30 days[6].

Rates of dust deposition are known to be sensitive to rainfall and wind speed.

[6] Good Practice Guide for Assessing and Managing Dust, MfE, Nov 2016, p50

There are two main mechanisms for dust deposition:

- Direct settling (dry deposition); and
- Leaching in water droplets (wet deposition). Dust particles can adhere to rain droplets and fall to the ground with them.

Figure 4 shows the measured dust deposit rates plotted against rainfall (as measured by the Northland Regional Council rainfall station at Puhipuhi[7]) for the same measurement periods.

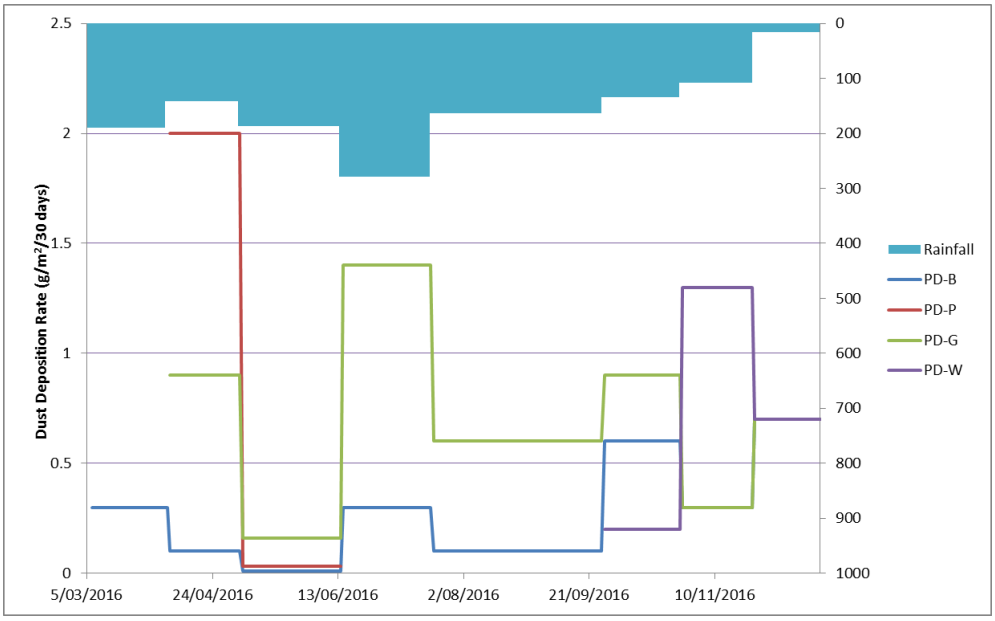

Figure 4: Dust deposition monitoring results verses rainfall

It can be seen from **Figure 4** that for the 22nd December exchange date the much reduced rainfall compared to the earlier periods did not result in large increases in dust deposition rate.

An attempt was made to correlate the measured dust deposition rates with rainfall data however the correlations were quite poor with low R^2 values obtained when attempting to fit a linear relationship.

- PD-B $R^2 = 0.306$
- PG-G $R^2 = 0.159$

Relevant wind data was not available and therefore its correlation with the measured dust deposition rates could not be assessed.

[7] http://www.nrc.govt.nz/Environment/River-and-rainfall-data/River-and-Rainfall-Data/

The MfE in their Good Practice Guide for Assessing and Managing Dust provide a recommended trigger level for deposited dust of 4 grams per m^2 per 30 days (4 g/m^2/30 days) **above** background concentration. As discussed above the measured background dust deposition rates are all below 2 g/m^2/30 days implying a trigger level for any large scale dust generating activity in the area of 6 g/m^2/30 days.

8.0 Summary and conclusion

Dust deposition rate monitoring was undertaken at four locations within and outside ENZ's Puhipuhi exploration tenement over approximately 9 months from the 7th of March until the 22nd of December 2016.

One dust deposition gauge (PD-P) was located immediately adjacent to a gravel road and the results were initially tampered with through the addition of soil and then went missing. It was replaced with gauge PD-W which was located approximately 400 m from the nearest road.

The other two gauges were located 60 to 70 m from the nearest roads.

Sites PD-G and PD-B exhibit similar trends in dust deposition rate over the monitoring period with site PD-B consistently recording higher rates. This indicates that there are different sources of dust within the exploration tenement that impact each of the monitoring sites differently.

Dust deposition rates appear to broadly correlate with rainfall in the area. Relevant wind data was not available and therefore its influence on dust deposition rates could not be assessed.

The measured dust deposition rates were all below 2 g/m^2/30 days with the majority below 1 g/m^2/30 days. These results are in good agreement with the values quoted in the Good Practice Guide for Assessing and Managing Dust of general dust deposition levels measured in New Zealand being in the range 1-4 g/m^2/30 days with background concentrations usually less than 1 g/m^2/30 days[8].

The MfE recommend a trigger level for deposited dust of 4 g/m^2/30 days **above** background concentration.

The measured background dust deposition rates are all below 2 g/m^2/30 days implying a trigger level for any large scale dust generating activity in the area of 6 g/m^2/30 days.

[8] Good Practice Guide for Assessing and Managing Dust, MfE, Nov 2016, p50

Appendix A

Dust Gauge Specification

Appendix A: Dust Gauge Specifications

The dust gauges were supplied by Watercare Air Quality and comprise of a gauge, cage and lids (see Figure 5).

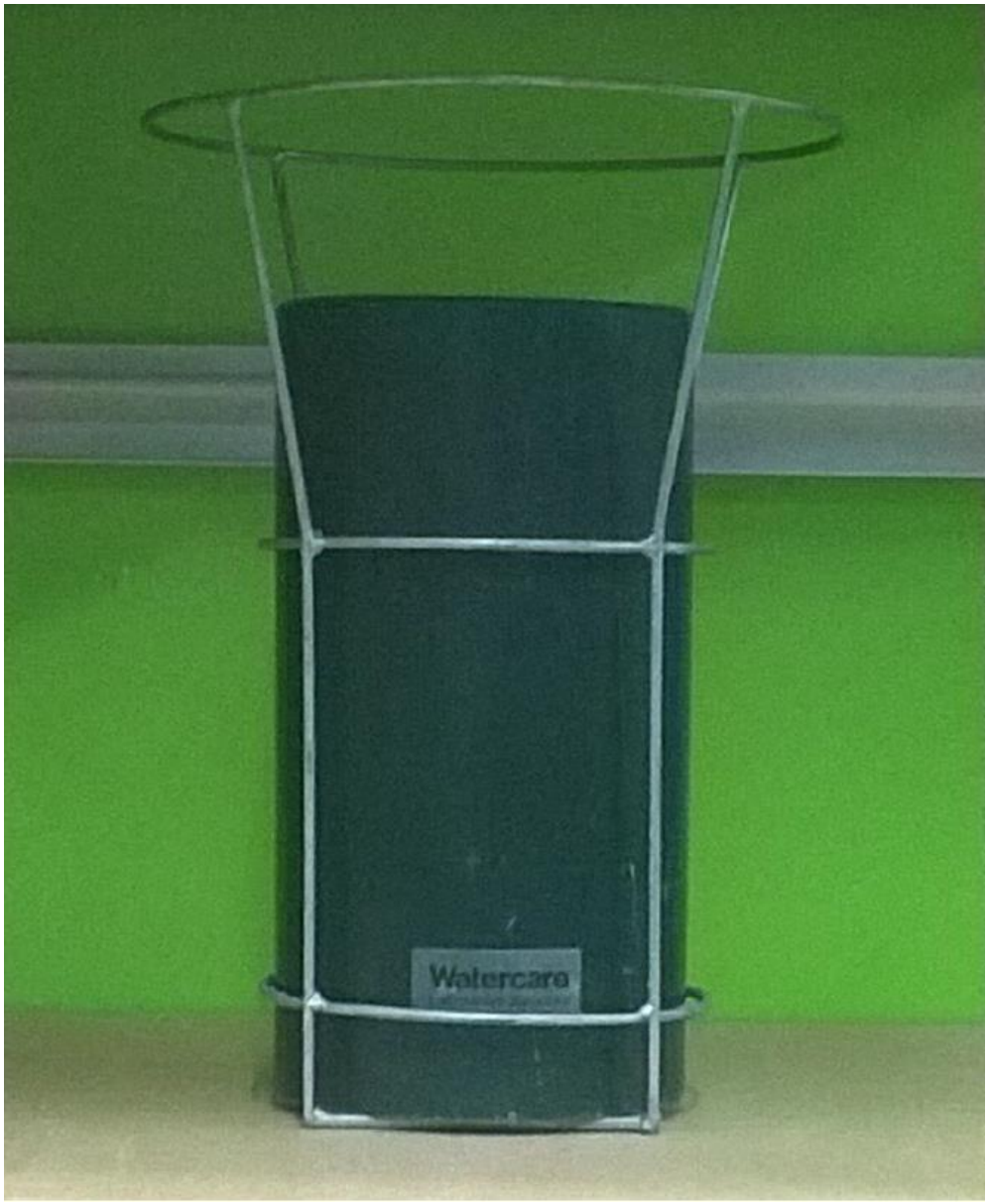

Figure 5: Dust gauge and cage

The gauge is made from a polyethylene open-topped cylinder of about 200mm diameter by 400mm high. The cylinder is commonly held in a wire frame, which also extends above the top of the gauge to serve as a bird guard. One litre of a 5% solution of fungicide (ethylene glycol monomethyl ether) is added to the gauge to prevent the growth of organisms over the monitoring period.