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Particulate and Dustfall Sampling Report for the Proposed Helderwyk Development

Project done on behalf of **Eco Assessments CC**

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Revision Record

Revision Date	Revision Number	Reason for Revision
April 2016	Rev 0	Comment and response

Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
AQSR	Air Quality Sensitive Receptor
ASTM	American Society for Testing and Materials
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
EA	Eco Assessments CC
km	kilometre
mm	Millimetre
m/s	Metres per second
mg/m²/day	Milligram per square metre per day
NAAQ	National Ambient Air Quality
NAAQS	National Ambient Air Quality Standard
NDCR	National Dust Control Regulation
PM_{10}	Thoracic particulate matter with an aerodynamic diameter of less than 10µm
SABS	South African Bureau of Standards
SANS	South African National Standards
SAWS	South African Weather Service
TSP	Total Suspended Particulates
µg/m³	Micrograms per cubic metre

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1 INTRODUCTION

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Purple Moss 19 (Pty) Ltd to conduct an air quality monitoring assessment for the proposed Helderwyk Development in Gauteng, South Africa. Airshed was commissioned to undertake a one-month sampling campaign for dustfall and thoracic particles (particles with an aerodynamic diameter of less than 10 µm (PM_{10})). In addition, data from two existing dustfall networks around the site operated by ERGO and ERPM were made available for inclusion in the assessment.

The main objective of this study is to determine the potential risk from ambient dust– fallout and concentrations impacting on the immediate environment and human health. The main concern is for windblown dust from the adjacent slimes storage facility on the proposed development. Ambient measurements and monitoring can serve to meet various objectives, including:

- Compliance monitoring;
- Spatial and temporal trend analysis;
- Use as input for health risk assessment;
- Source quantification and apportionment; and
- Tracking of progress made by control and management measures.

The main pollutants of concern, from an air quality perspective, associated with the site are particulates, both PM_{10} which is associated with potential health impacts and dustfall (Total Suspended Particulates (TSP)) which is of concern due to its nuisance effects. The concern is specifically for health and nuisance impacts on the proposed development within a 2 km radius from the slimes storage facility.

Sampling was done for dustfall and PM_{10}. Dustfall is measured through the collection of dust in buckets and reported on as a mass per area per time ($mg/m^2/day$) over a period of 30-days (one month). PM_{10} is sampled onto filters over 24-hours and the results reported on as a concentration per volume ($\mu g/m^3$).

The ambient air quality monitoring network erected by Airshed comprised of three single dustfall units according to the American Society for Testing and Materials (ASTM) standard method for collection and analysis of dustfall (ASTM D1739-98). PM_{10} was sampled using one gravimetric sampler i.e. 'MiniVol', which captures air particulates on a pre-weighed filter, typically exposed for 24-hours. No on-site weather station was installed to record hourly average wind speed, wind direction and temperatures; however, the South African Weather Service (SAWS) OR Tambo data was considered reflective of the local weather conditions on-site.

The Airshed monitoring network was operational during March 2016, with every third daily exchanges of the PM_{10} filters and monthly exchanges of the dust fallout units. The PM_{10} filters were sent to the Biograde Laboratory for analysis. Gravimetric analysis of the dust fallout results are undertaken at Airshed's laboratory.

The locations of the dustfall units and PM_{10} sampler erected by Airshed are shown in Figure 1. The location of the ERPM dustfall buckets is shown in Figure 2 with the location of the ERGO dustfall buckets shown in Figure 3. Coordinates for the Airshed and ERPM networks are provided in Appendix A. This report covers the results for the period October 2015 to March 2016 for the ERPM and ERGO networks and for the month of March 2016 for the Airshed network.

The following sampling sites are of interest for this study:

1. Airshed network:
    a. Dust Bucket 1
    b. Dust Bucket 2
    c. Dust Bucket 3
    d. PM_{10} Minivol sampler
2. ERPM network:
    a. Helderwyk Estate 1
    b. Helderwyk Estate 2
    c. 5L29 South
    d. 5L29 East
    e. 5L29 West
3. ERGO network:
    a. Nursery
    b. Dalpark Ext 1

1.1 Terms of Reference

The terms of reference for the study include the following tasks:

- A description of relevant legislation pertaining to dustfall and PM_{10};
- Provide input to the sampling sites;
- Identification of sensitive receptors;
- A detailed description and illustration of the sampling network and sampling methodology applied;
- Provision of sampling results and compliance evaluation with ambient standards and dust fallout limits;
- Provision of meteorological conditions (wind speed, wind direction, rainfall) for the sampling area; and
- Inclusion of all available data in a report.

Figure 1: Locations for the Airshed dustfall and PM_{10} sampling network

Figure 2: Locations for the ERPM dustfall sampling network

Figure 3: Locations for the ERGO dustfall sampling network

1.2 Assumptions and Limitations

- Dustfall measured by Airshed used an apparatus according to American Society of Testing and Materials (ASTM) D1739-98, re-approved 2004. This method is also referenced in South African National Standards (SANS) 1137-2012. The apparatus consists of a bucket approximately 150 mm diameter and 300 mm deep in which dust is collected for a period between 28 and 33 days. Solid matter larger than 2 mm in size (insects etc.) was removed by screening. The remaining solid matter is washed from the bucket, filtered and weighed. It has been shown (Kornelius & Kwata, 2010) that the latest version of the ASTM apparatus, used here, results in higher values than the methodology stipulated in the National Dust Control Regulations (NDCRs) (ASTM D1739: 1970). The results obtained are therefore conservative with respect to conformance to the NDCR.
- The dust fallout method used by ERPM and ERGO follow the older ASTM D1739: 1970 method and the results were directly compared to the NDCRs.
- PM_{10} concentrations were reported on as daily concentrations and screened against the National Ambient Air Quality Standards (NAAQS) limit for 24-hour exposure.
- Dust fallout results are limited to the period October 2015 to March 2016 with the PM_{10} concentrations limited to one-month (March 2016). These results are however deemed representative of the ambient conditions in the area.

1.3 Report Outline

The report is structured as follows:

Section 2	Legal requirements
Section 3	Background information
Section 4	Results
Section 5	Main Findings and Conclusion
Section 6	References

2 LEGAL REQUIREMENTS

2.1 National Ambient Air Quality Standards (NAAQS)

The South African Bureau of Standards (SABS) was engaged to assist the Department of Environmental Affairs (DEA, then known as the Department of Environmental Affairs and Tourism or DEAT) in the facilitation of the development of ambient air quality standards. This included the establishment of a technical committee to oversee the development of standards. Standards were determined based on international best practice.

The final revised NAAQS were published in the Government Gazette on 24 of December 2009 and included a margin of tolerance (i.e. frequency of exceedance) and implementation timelines linked to it. NAAQS for PM_{10} are listed in Table 1.

Table 1: National assessment criteria for criteria pollutants

Pollutant	Averaging Period	Limit Values	Frequency of Exceedance
		Concentration (µg/m³)	Occurrences per Year
PM_{10}	24 hour	75	4
	1 year	40	n/a

Notes:

(a) n/a – not applicable

2.2 Dust Control Regulations

South Africa has published the NDCRs in November 2013 (Government Gazette No. 36974) with the purpose to prescribe general measures for the control of dust in all areas including residential and light commercial areas. The acceptable dustfall rates as measured using the ASTM D1739:1970 or equivalent at and beyond the boundary of the premises where dust originates are given in Table 2. It is important to note that **dustfall is assessed for nuisance impact** and not inhalation health impact.

Table 2: South African National Dust Control Regulations

Restriction Area	Dustfall Rate (mg/m²-day)	Permitted Frequency of Exceedance
Residential area	D < 600	Two within a year, not sequential months
Non-residential area	600 < D < 1 200	Two within a year, not sequential months

3 BACKGROUND INFORMATION

3.1 Current Land Use and Potential Sensitive Receptors in the Area

The current slimes storage facility is located near Helderwyk Estate in the Gauteng Province of South Africa. The study area has many sensitive receptor areas (residential areas). The nearest residential areas and individual sensitive receptors (schools and hospitals) were identified as air quality sensitive receptors (AQSRs). The study area is shown in Figure 4.

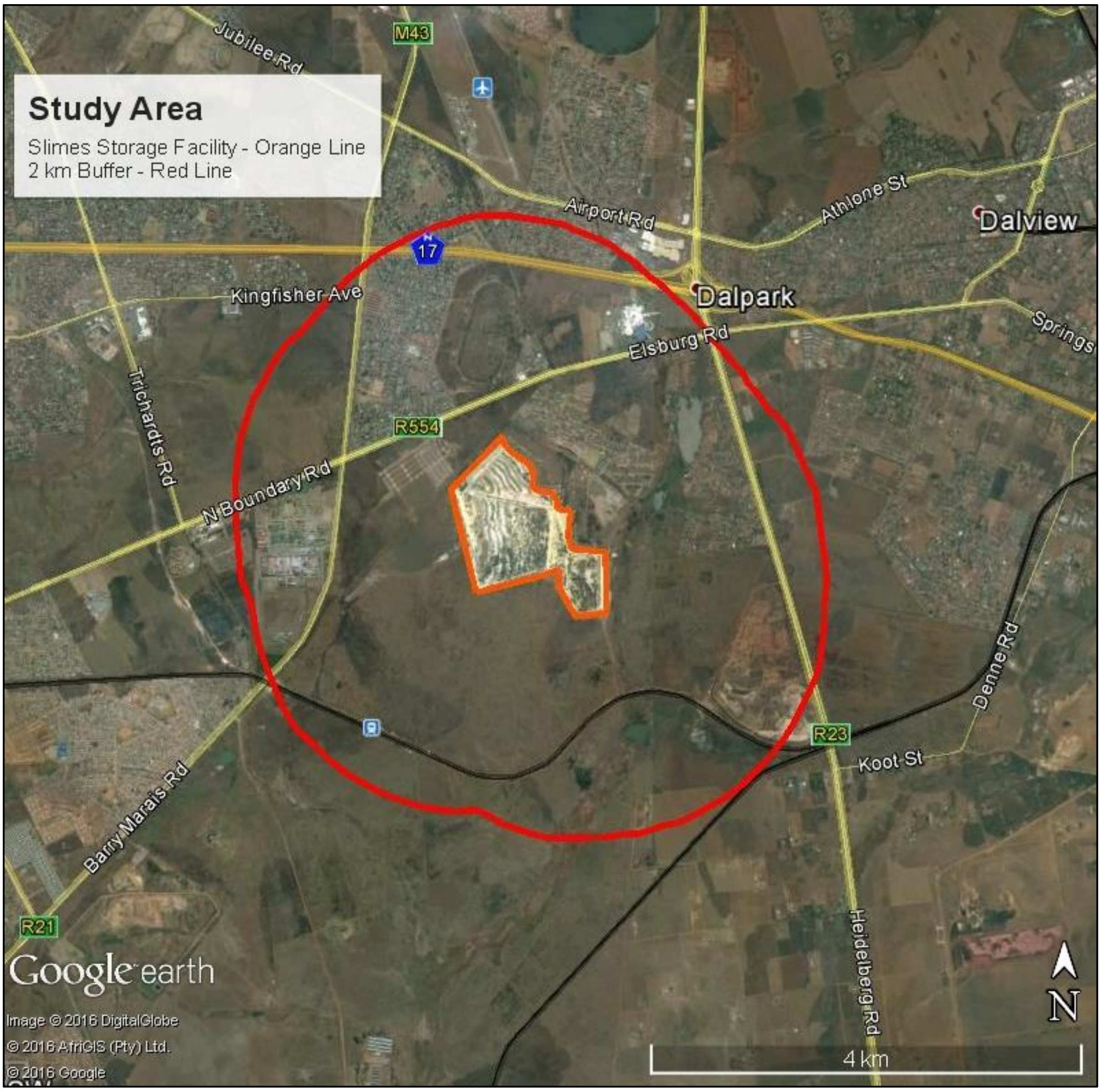

Figure 4: Study area

3.2 Atmospheric Dispersion Potential

In the assessment of the possible impacts from air pollutants on the surrounding environment and human health, a good understanding of the regional climate and local air dispersion potential of a site is essential. Meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere (Pasquill & Smith, 1983), (Godish, 1990). The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of cross-wind spreading (Shaw & Munn, 1971), (Pasquill & Smith, 1983), (Oke, 1990).

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich & Tyson, 1988). Atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area.

Meteorological data was obtained from the SAWS OR Tambo weather station which is approximately 15 km from the slimes storage facility. The meteorological analysis was retrieved from the SGS dust deposition monitoring reports (SGS, 2015), (SGS, 2016a), (SGS, 2016b), (SGS, 2016c).

3.2.1 Local wind field

Monthly wind roses are provided in Figure 5. The predominant winds during each month were as follows:

- October 2015 - north-north-easterly, northerly and north-north-westerly
- November and December 2015 – northerly, north-north-westerly and north-westerly
- January 2016 – northerly and east-north-easterly
- February 2016 - northerly and north-westerly
- March 2016 - north-westerly

October and November 2015 also tend to have higher wind speeds than other months.

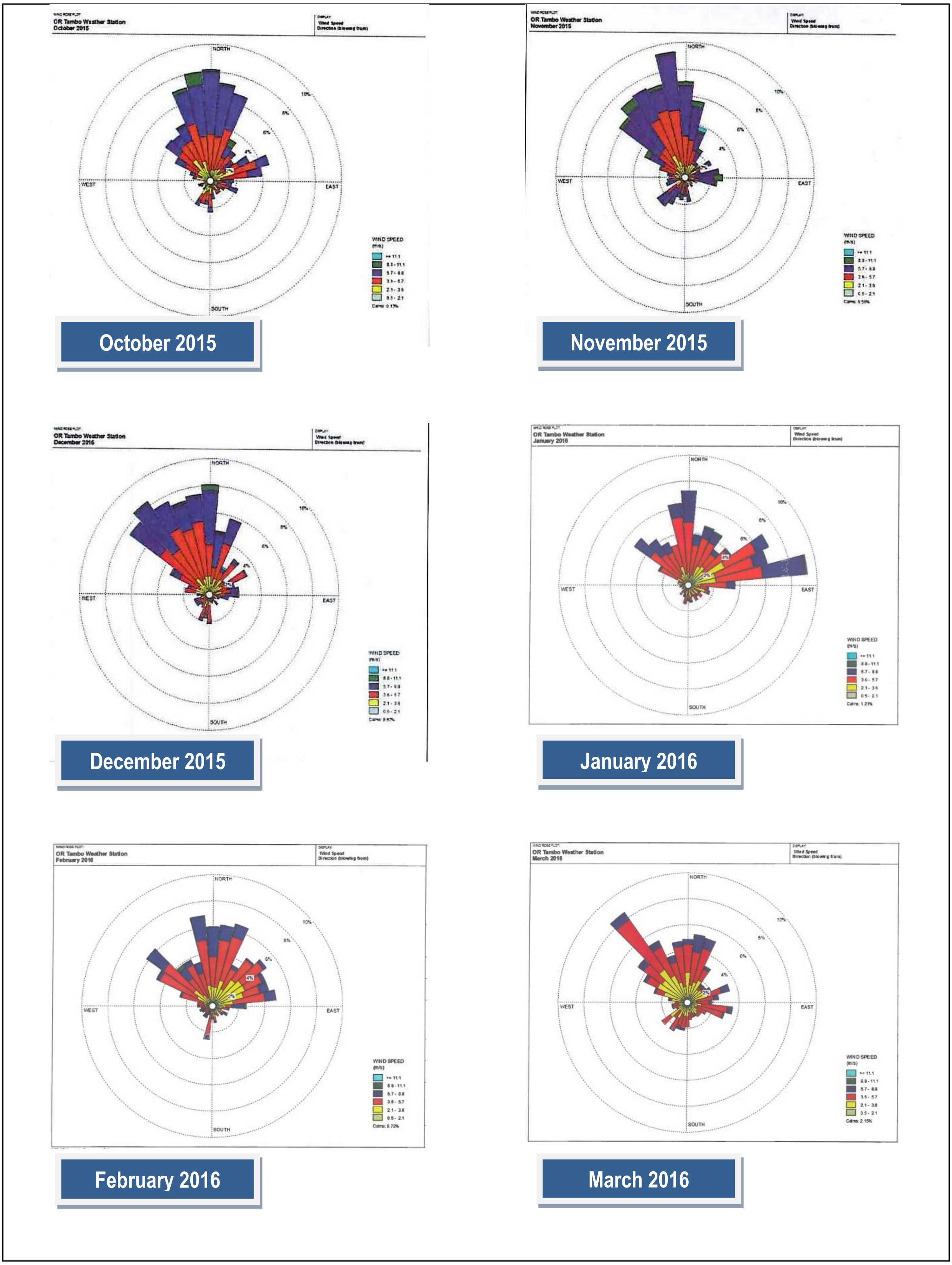

Figure 5: Monthly wind roses for the SAWS OR Tambo station (October 2015 to March 2016)

3.2.2 *Precipitation*

Precipitation represents an effective removal mechanism of atmospheric pollutants. Precipitation reduces wind erosion potential by increasing the moisture content of materials. The total rainfall for each month is:

- October 2015 – 17.6 mm
- November 2015 – 63 mm
- December 2015 – 62.4 mm
- January 2016 – 123.22 mm
- February 2016 – 65.2 mm
- March 2016 – 137 mm

The rainfall for October 2015 to March 2016 is presented in Figure 6. The month with the lowest rainfall (17.6 mm) was October 2015. The month with the greatest rainfall (137 mm) was March 2016.

Figure 6: Monthly rainfall for the SAWS OR Tambo station (October 2015 to March 2016)

4 RESULTS

4.1 Dustfall Results

4.1.1 Airshed Network

Dustfall rates for the period March 2016 are presented in Table 3 and illustrated in Figure 7. The collected deposition rates (Table 3 and Figure 7) are compared to acceptable dustfall limits provided in section 2 (Table 2). The dust fallout locations are provided in Figure 1.

Dustfall rates were low for the sampling period and well within the acceptable dustfall limit of 600 mg/m²/day (NDCR limit for residential areas). Dust Bucket 1 collected the highest dust fallout, followed by dust bucket 2. Dust bucket 3 collected the lowest dust fallout.

Table 3: Monthly dustfall deposition rate per sampling location (March 2016)

Bucket ID	Dust Deposition rates (mg/m²/day)
	March 2016
Dust Bucket 1	185
Dust Bucket 2	161
Dust Bucket 3	68

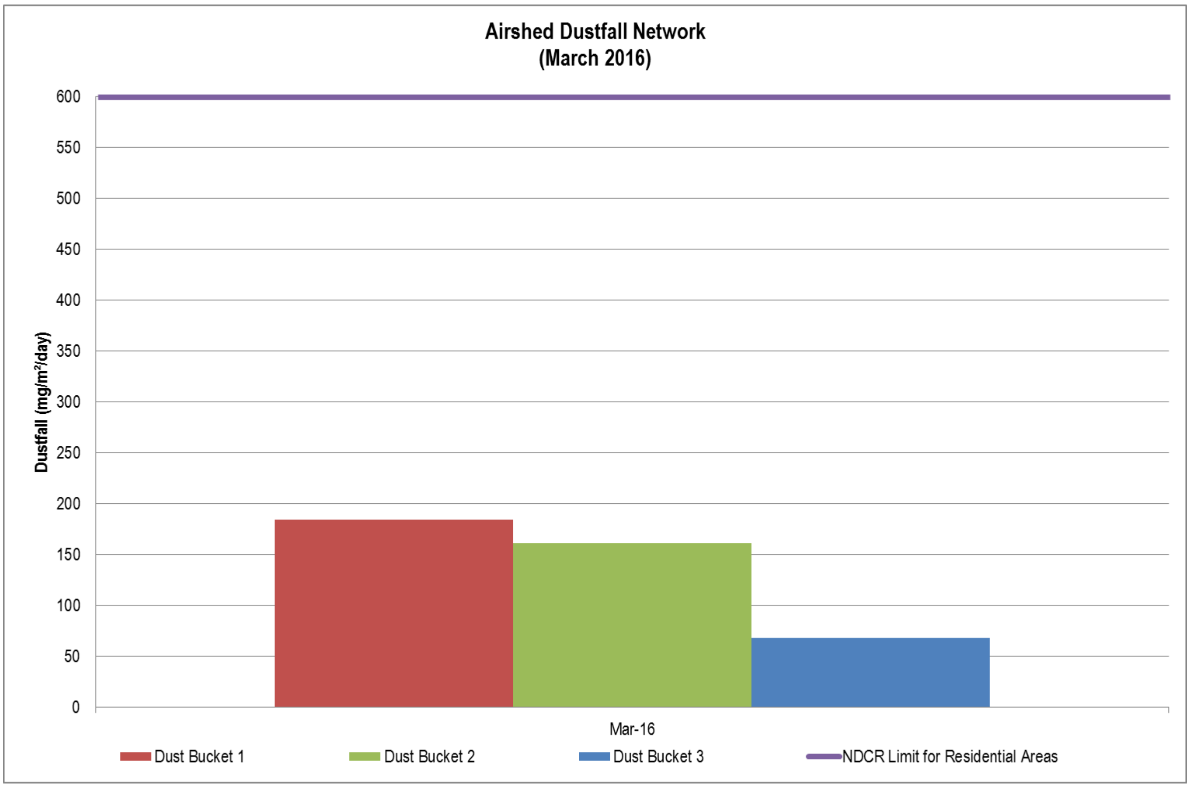

Figure 7: Monthly dustfall deposition rate per sampling location (March 2016)

4.1.2 ERPM Network

Dustfall rates for the period January 2016 to March 2016 are presented in Table 4 and illustrated in Figure 8. The collected deposition rates (Table 4 and Figure 8) are compared to acceptable dustfall limits provided in section 2 (Table 2). The dust fallout locations are provided in Figure 2.

Dustfall rates are low for the sampling period and well within the acceptable dustfall limit of 600 mg/m²/day (NDCR limit for residential areas). The site with the highest dustfall is 5L29 West (99 mg/m²/day), located downwind of the slimes storage facility during January 2016, when the east-north-easterly winds prevailed. In February 2016 5L29 South had the highest dust fallout, most likely because the northerly and north-westerly winds blowing dust over the slimes storage facility. Dust fallout rates were the lowest during March 2016 except for at 5L29 South; located downwind of the largest portion of the slimes storage facility.

Table 4: Monthly dustfall deposition rate per sampling location (January 2016 to March 2016)

Bucket ID	Dust Deposition rates (mg/m²/day)		
	January 2016	February 2016	March 2016
Helderwyk Estate 1	59	40	15
Helderwyk Estate 2	41	77	29
5L29 South	16	116	72
5L29 East	55	41	20
5L29 West	99	39	18

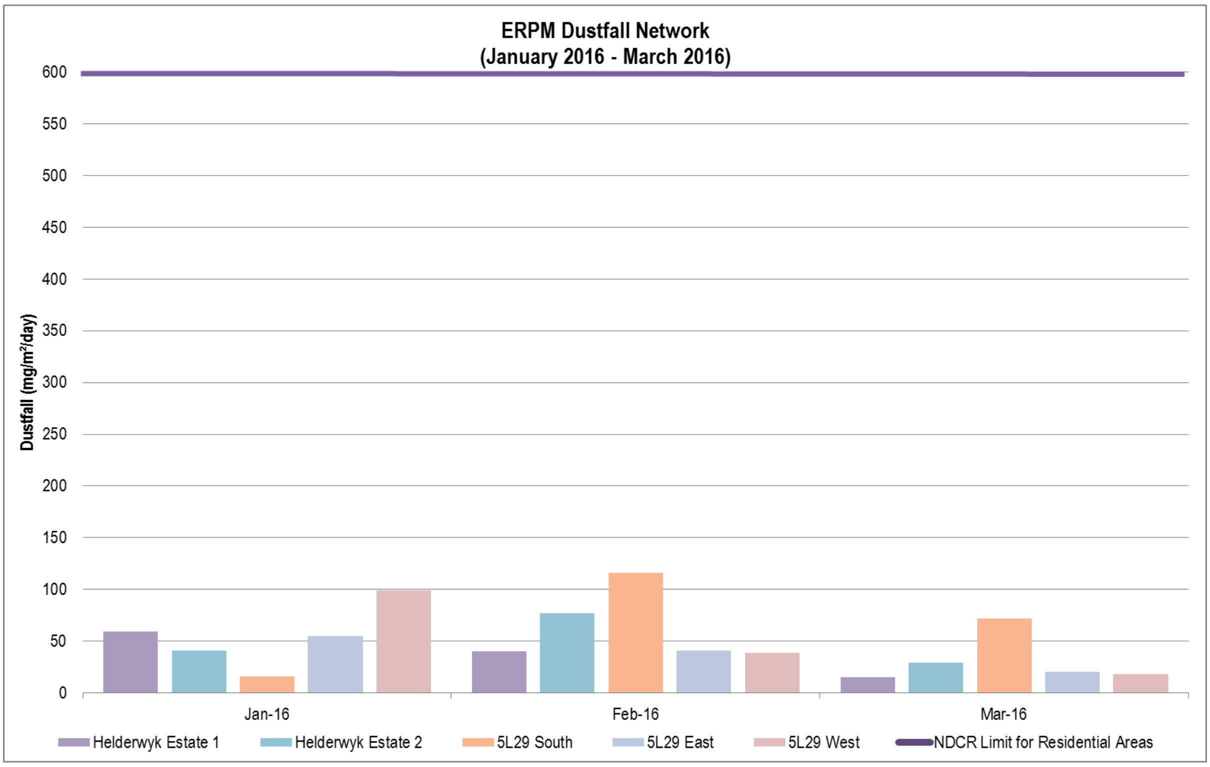

Figure 8: Monthly dustfall deposition rate per sampling location (January 2016 to March 2016)

4.1.3 ERGO Network

Dustfall rates for the period October to December 2015 are presented in Table 5 and illustrated in Figure 9. The collected deposition rates (Table 5 and Figure 9) are compared to acceptable dustfall limits provided in section 2 (Table 2). The dust fallout locations are provided in Figure 3.

Dustfall rates were low for the sampling period and well within the acceptable dustfall limit of 600 mg/m²/day (NDCR limit for residential areas). During October 2015, when the winds were from the north-north-easterly, northerly and north-north-westerly, the site with the highest dustfall was Nursery located south of the slimes storage facility. During November and December 2015, with prevailing northerly, north-north-westerly and north-westerly winds, Dalpark Ext 1 had the highest dust fallout. This was most likely from other dust sources in the region since Dalpark Ext 1 is located upwind from the slimes storage facility.

Table 5: Monthly dustfall deposition rate per sampling location (October 2015 to December 2015)

Bucket ID	Dust Deposition rates (mg/m²/day)		
	October 2015	November 2015	December 2015
Nursery	78	80	58
Dalpark Ext 1	49	84	178

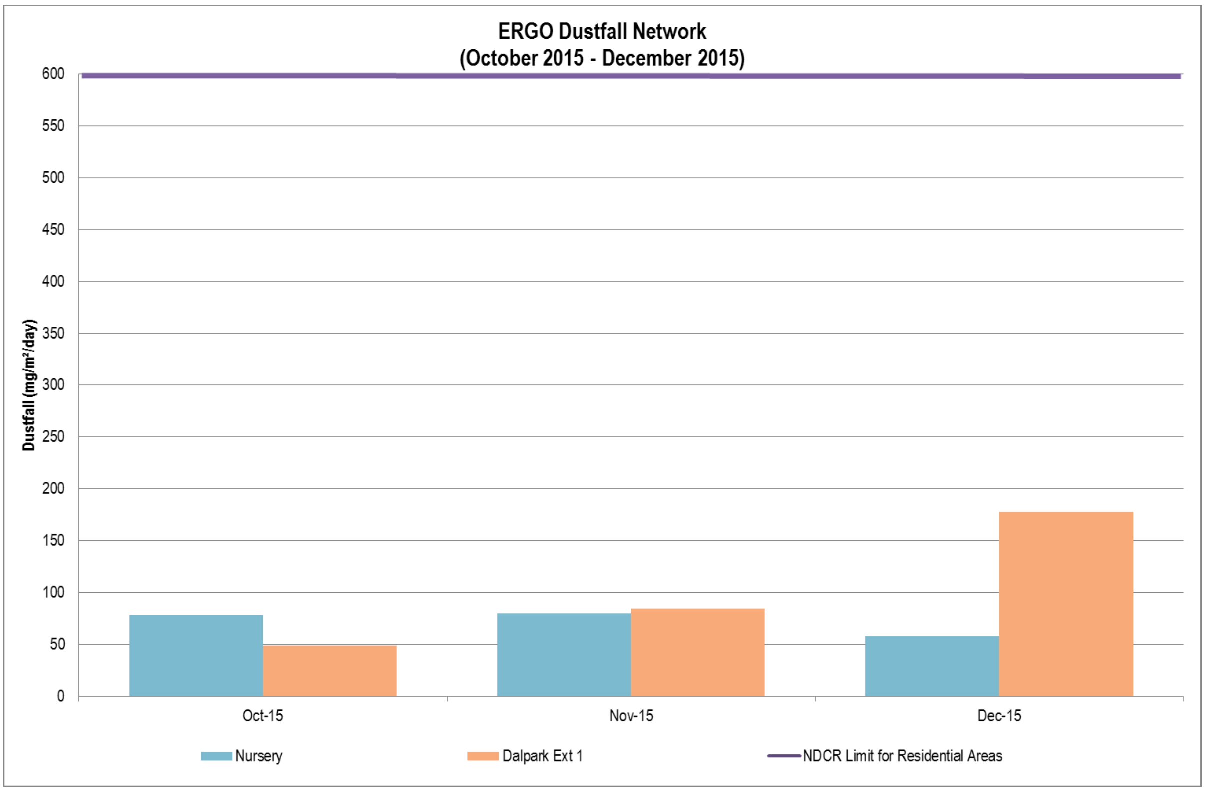

Figure 9: Monthly dustfall deposition rate per sampling location (October 2015 to December 2015)

4.2 PM_{10} Results

Daily PM_{10} results from the particulate monitors for the period 2 March to 9 March 2016 are depicted in Figure 10. Sampling was done every 3rd day, resulting in a total of 10 days of sampling over the one-month period. According to the laboratory one filter had a negative measurement which would suggest that this filter was damaged. The resulting data availability is 90%.

The PM_{10} NAAQ daily limit of 75 µg/m³ (Table 1) was not exceeded during the sampling period, equating to 0% exceedances. The highest concentration sampled (59.72 µg/m³) occurred on the 8th of March 2016. The next highest concentration sampled (51.39 µg/m³) occurred on the 23rd of March 2016.

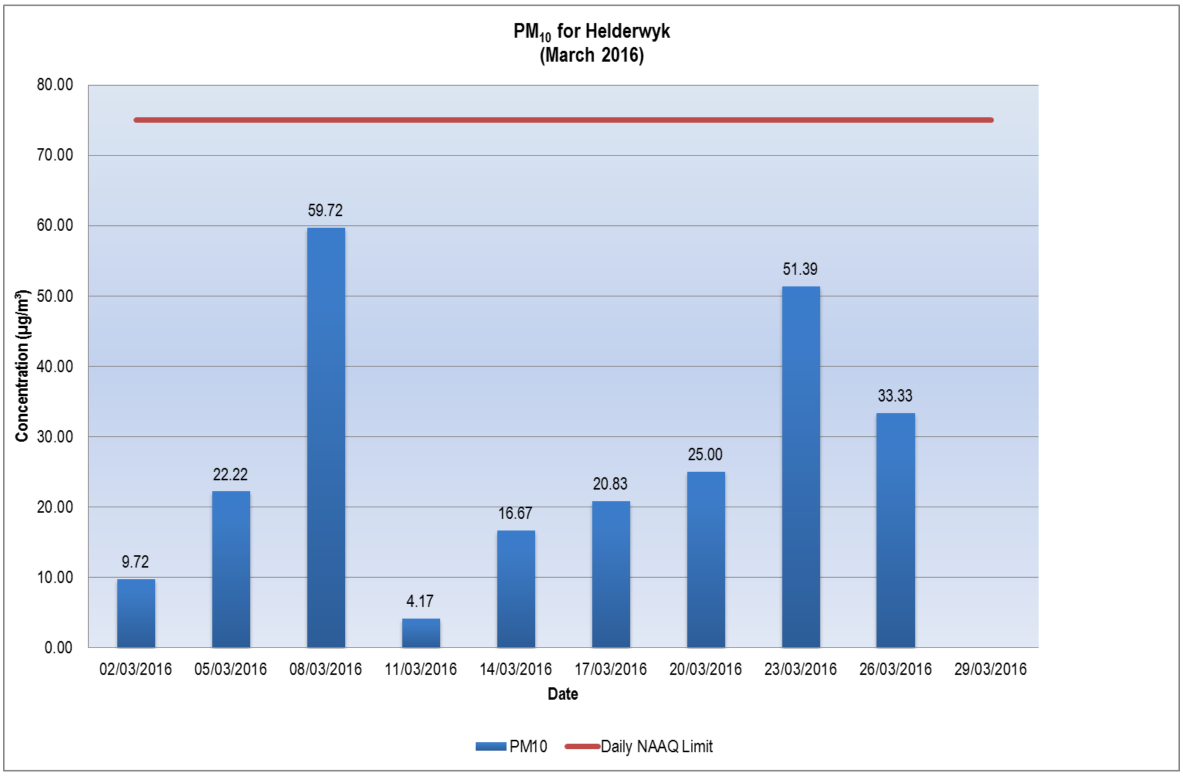

Figure 10: PM_{10} concentrations (March 2016)

5 MAIN FINDINGS AND CONCLUSION

5.1 Main findings

The prevailing wind field is from the north-east, north and north-west with infrequent winds from the south with slight variations between the months of October 2015 to March 2016. The wind speeds were similar; ranging between 2.1 and 8.8 m/s. The months of October and November 2015 had slightly higher wind speeds. The months with the lowest and highest rainfall were October 2015 (17.6 mm) and March 2016 (137 mm), respectively.

Dustfall deposition rates from the Airshed network for the month of March 2016 were low and well within the NDCR limit for residential areas. Similarly, dustfall deposition rates from the ERPM network (January to March 2016) and form the ERGO network (October to December 2015) were low and well below the NDCR limit for residential areas.

Daily PM_{10} concentrations did not exceed the daily NAAQ limit of 75 µg/m³ during the sampling period 2 March to 29 March 2016, with the highest concentration sampled of 59.72 µg/m.

5.2 Conclusion

The six months' (October 2015 to March 2016) dust fallout results in the vicinity of the slimes storage facility indicate low dust fall rates. The one month's (March 2016) PM_{10} concentrations indicate acceptable concentrations in comparison to the NAAQ limit.

The air quality results suggest low impact significance on the proposed Helderwyk development within the 2 km radius from the slimes storage facility.

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7 APPENDIX

7.1 Appendix A – Monitoring Networks

A PM_{10} and dustfall sampling network at the study area was implemented for March 2016 by Airshed. Figure 1 shows the location of the dustfall and PM_{10} monitoring network; co-ordinates are provided in Table 6. Figure 2 shows the location of the ERPM dustfall monitoring network; co-ordinates are provided in Table 7. Figure 3 shows the location of the ERGO dustfall monitoring network.

Table 6: Location of the Airshed monitoring network at the study area

ID	Latitude	Longitude
Dust Bucket 1	26°16'49.26" S	28°17'32.04" E
Dust Bucket 2	26°17'16.68" S	28°17'49.32" E
Dust Bucket 3	26°17'15.06" S	28°18'02.73" E
PM_{10}	26°17'15.60" S	28°17'50.16" E

Table 7: Location of the ERPM monitoring network at the study area

ID	Latitude	Longitude
Helderwyk Estate 1	26°15'58.00" S	28°18'15.00" E
Helderwyk Estate 2	26°16'35.90" S	28°18'42.50" E
5L29 South	26°16'47.00" S	28°18'27.10" E
5L29 East	26°17'02.20" S	28°18'42.60" E
5L29 West	26°16'18.60" S	28°17'50.90" E

7.2 Appendix B – Airshed Sampling Methodology

7.2.1 Dustfall Sampling

The dustfall network comprises of single dustfall buckets following the American Society for Testing and Materials (ASTM) standard method for collection and analysis of dustfall (ASTM D1739-98). This method employs a simple device consisting of a cylindrical container (not less than 150 mm in diameter) exposed for one calendar month (30 ± 2 days). Even though the method provides for a dry bucket, de-ionised water can be added to ensure the dust remains trapped in the bucket.

The Airshed bucket stand comprises a wind shield at the level of the rim of the bucket to provide an aerodynamic shield. The bucket holder is connected to a 2 m galvanized steel pole, which is attached to a galvanized steel base plate. This allows for a variety of placement options for the fallout samplers (Figure 11). Exposed buckets, when returned to the laboratories, are rinsed with deionised water to remove residue from the sides of the bucket, and the bucket contents filtered through a coarse (>1 mm) filter to remove insects and other course organic detritus. The sample is then filtered through a pre-weighed paper filter to remove the insoluble fraction, or dustfall. This residue and filter are dried, and gravimetrically analysed to determine the insoluble fraction (dustfall).

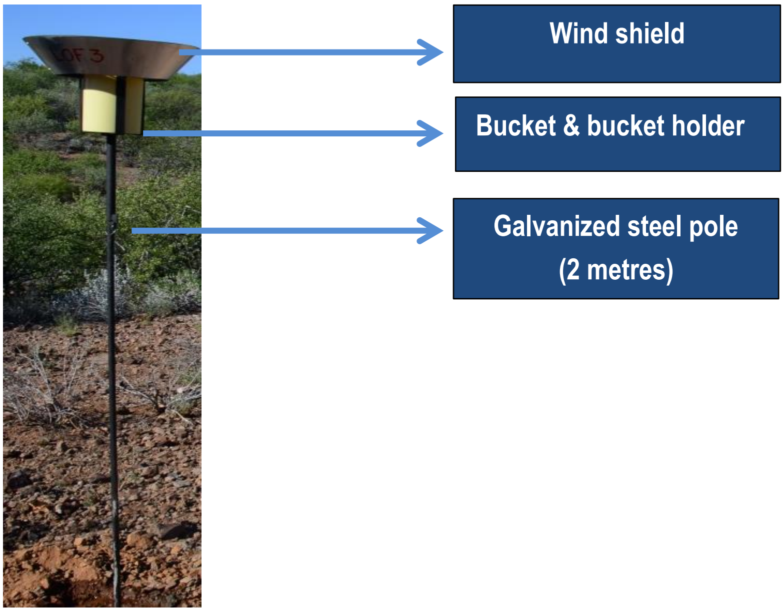

Figure 11: Example of an Airshed dustfall bucket installation

7.2.2 PM_{10} Monitoring

The PM_{10} gravimetric (*minivol)* sampler was installed similarly to the setup in Figure 12. The filters are provided and returned to the laboratory for analysis. The following methodology was followed:

- The *Minivol* sampler was programmed to draw air through a pre-weighed filter at a constant rate over a 24-hour period. The used filter is then removed and replaced with a new filter. The battery is also exchanged (each *minivol* was equipped with two batteries) and the MinVol is re-programmed for the next sampling session.
- All filter and battery exchanges and field notes are performed by an Airshed personnel.
- At each exchange, the date, location, filter number, pump run time etc. is noted in the data sheet that supplied with the sampler.
- At the end of the monitoring period, **sealed filters are sent to an accredited laboratory for gravimetric analysis**.

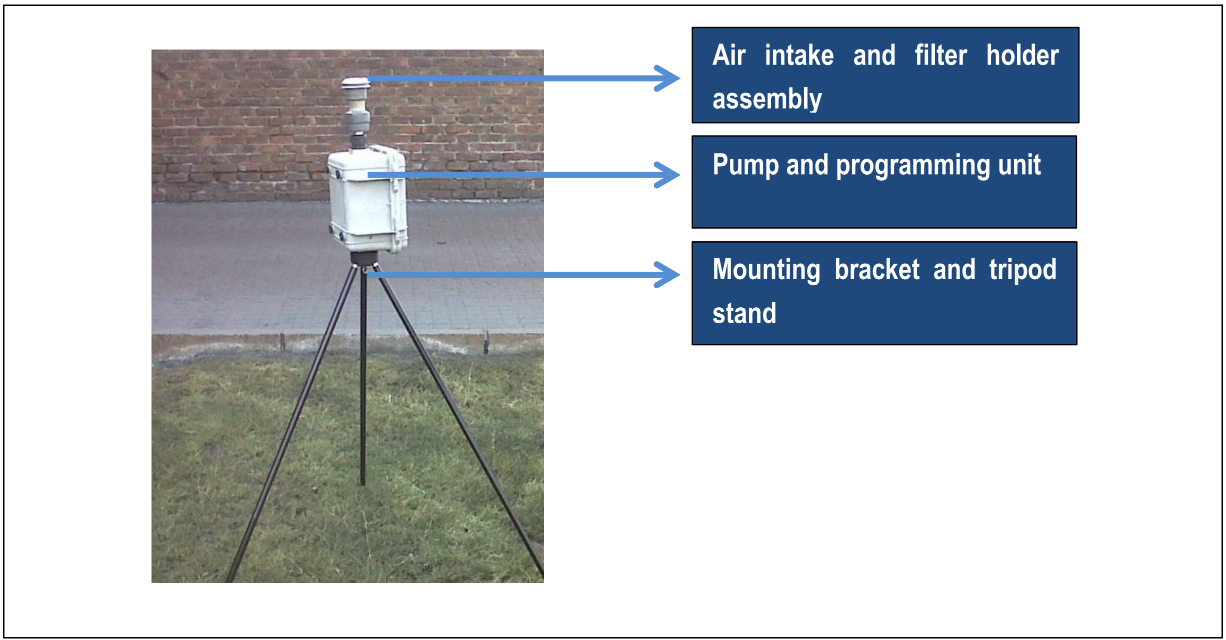

Figure 12: A *Minivol* sampler installed on a tripod stand