

WSP

"UHA6"

July 10, 2017

CONFIDENTIAL

Upper Highway Air NPO
19 La Vigna
Plantations Estate
Hillcrest
3610

Dear Charmane

Subject: Ambient Air Quality Testing - Upper Highway

In this letter, results from recent ambient volatile organic compound (VOC) monitoring at the fenceline of the EnviroServ Shongweni landfill and at nearby community receptors are presented. The four sampling campaigns (Table 1) revealed a consistent array of VOCs across samples. This included benzene, toluene, ethylbenzene, m/p-xylene, o-xylene, styrene, tetrachloroethene (Campaigns 1 and 2) and trichloroethene (Campaigns 3 and 4). This spectrum is consistent with the results presented in the *re-energise Africa* report (Appendix G, Final Envitech Report, 17 March 2017) although it appears that styrene was not tested for in this assessment.

This letters focuses on the results of Campaign 4 as these results were corrected with field blanks and there is an upwind, downwind, and community receptor comparison. These samples were collected simultaneously at three locations (Figure 1) during southerly winds on an early winter morning (8 June 2017). Two successive samples were collected at each site directly onto Markes International Tenax tubes. Sampling commenced at 05h09 with all VOC samples collected by 06h35. Averaging periods ranged between 15 and 23 minutes. Sampling comprised the active pumping of air through Makes International sorbent tubes. Pump flow rates were controlled internally and the pumps were checked against a Bios Defender standard prior to use. The sampling methodology is in accordance with the United States Environmental Protection Agency (US EPA) TO-14a. In addition, a Tedlar bag sample was collected at the downwind site for comparison.

After sampling, the sealed tubes and Tedlar bag were transported to Skyside (Pty) Ltd in Riverhorse Valley, Durban, from which they were transferred for analysis at X-Lab Earth Science (Pty) Ltd in Randburg (SANAS Accredited Laboratory number T0775). There the samples were screened for a full spectrum of VOCs. The gas chromatography-mass spectrometry (GCMS) component of this analysis falls under X-Lab's current accreditation. While X-Lab conforms to ISO/IEC 17025 standards, the thermal desorption component of these analyses currently falls outside of the scope of X-Lab's accreditation. I am not aware of another local laboratory that is accredited for this technique.

In the upwind sample, all volatiles were below detection level except ethylbenzene (0.02 ppb in one sample), m/p-xylene (0.01 ppb in one sample) and toluene (average 0.10 ppb across the two samples). The downwind concentrations of benzene, ethylbenzene, m/p-xylene, o-xylene, toluene and styrene show the highest values across the three sites. These pollutants remained detectable at the community receptor, Plantations Estate (Figure 1), but at concentrations below those of the samples collected immediately downwind of the landfill site. These results indicate that the source of the VOC array detected is the landfill site. Of particular relevance are the benzene concentrations (downwind average of 7.43 ppb on an averaging period between 15 and 20 minutes, and community receptor average of 5.49 ppb on a 20-minute averaging period) that are significantly higher than the National Ambient Air Quality Standard (NAAQS) of 1.6 ppb (although not directly comparable since the NAAQS is based on an annual averaging period).

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Since the odour event on the morning of 9 June 2017 extended for well over an hour, and was not an exceptional odour event (i.e. we do not expect these measurements to represent worst case odour concentrations) our results bring into question the dispersion modelling outputs in the Airshed report (*Atmospheric Dispersion Simulations of Gaseous Emissions from the Shongweni Landfill Site, West of Durban*, Report 16E2M01, dated 5th of April 2017):

- The benzene concentrations measured at Plantations (the average of the two WSP samples was 5.49 ppb or 17.53 $\mu\text{g}/\text{m}^3$ on a 20-minute averaging period) are significantly higher than the maximum 98th percentile hourly average modelled by Airshed for four Plantations receptors (0.074 $\mu\text{g}/\text{m}^3$, 0.066 $\mu\text{g}/\text{m}^3$, 0.071 $\mu\text{g}/\text{m}^3$ and 0.056 $\mu\text{g}/\text{m}^3$).
- The toluene concentrations measured at Plantations (the average of the two WSO samples was 2.83 ppb or 10.68 $\mu\text{g}/\text{m}^3$ on a 20-minute averaging period) are significantly higher than the maximum 98th percentile hourly average modelled by Airshed for the four Plantations receptors (2.022 $\mu\text{g}/\text{m}^3$, 1.909 $\mu\text{g}/\text{m}^3$, 2.340 $\mu\text{g}/\text{m}^3$, 1.611 $\mu\text{g}/\text{m}^3$).
- The styrene concentrations measure at Plantations (the average of two WSP samples was 0.10 ppb or 0.42 $\mu\text{g}/\text{m}^3$ on a 20-minute averaging period) are significantly higher than the maximum 98th percentile hourly average modelled by Airshed for the four Plantations receptors (0.074 $\mu\text{g}/\text{m}^3$, 0.078 $\mu\text{g}/\text{m}^3$, 0.098 $\mu\text{g}/\text{m}^3$, 0.065 $\mu\text{g}/\text{m}^3$).
- The trichloroethene concentration measured on one tube at Plantations (5.70 ppb or 30.64 $\mu\text{g}/\text{m}^3$ on a 20-minute averaging period) is significantly higher than the maximum 98th percentile hourly average modelled by Airshed for the four Plantations receptors¹ (0.117 $\mu\text{g}/\text{m}^3$, 0.105 $\mu\text{g}/\text{m}^3$, 0.136 $\mu\text{g}/\text{m}^3$, 0.089 $\mu\text{g}/\text{m}^3$).

Our concern is that the underestimates of ambient concentrations by the Airshed simulations could be indicative of inaccurate emission inputs to Airshed's CALPUFF model. The source of this issue would be the concentration and flux data provided to Airshed by INFOTOX. This could bring into question the results for all the VOCs and other odorous compound, for which emission rates were developed from the INFOTOX dataset.

Another likely reason for the underestimate of ambient concentrations is that Airshed's modelling simulations cover only a short duration (two months, October – November 2016). In the Airshed report (page 13), the following is stated: *“Unless the health risk assessment clearly identifies acceptable health risk levels, it is recommended to extend the dispersion simulations to include the months from October 2016 up to end June 2017. This would provide the expected inversion conditions during the winter months. Nonetheless, extreme stable atmospheric conditions, such as those experienced during the winter months in the Mpumalanga Highveld may not be as prevalent in the study area, since there may be some coastal air buffering in the overlaying atmosphere.”*

We view this short simulation duration as a significant flaw in this assessment. Surface temperature inversions are a common feature of early winter mornings in the Shongweni/Hillcrest area, and of more relevance to this low-lying emission source than the upper air inversions mentioned in the quotation above. Furthermore, as documented in Diab and Preston-Whyte (1980)², low pressure systems approaching the region result in a lowering of the non-surface subsidence inversion and thus narrowing of the mixing layer. The mixing layer is shown to reach its narrowest depth just before the wind reversal associated with a squall front. From autumn into spring, the passing of cold fronts are a regular occurrence along coastal KwaZulu-Natal. The short simulation duration by Airshed likely fails to model peak pollution episodes in winter when pollutant accumulation on cool, calm nights is exacerbated by pre-frontal conditions.

The Regulations Regarding Air Dispersion Modelling, Government Notice 533 of 2014 (Government Gazette 37804) states the following: *“A minimum of 1-year on-site specific data or at least three years of appropriate off-site data must be used for Level 2 assessments. For Level 3 assessments, meteorological data from a minimum of three consecutive years is*

¹ Concentrations of Trichloroethene and Trichloroethene (TCE) # in Table 4-7 of the Airshed report were summed for each receptor.

² Diab and Preston-Whyte. 1980. *Local weather and air pollution potential: The case of Durban* in *Environmental Conservation*, 7(3): 241-244.

required. The meteorological data must be from a period no older than five years to the year of assessment. All data must be subjected to quality assurance procedures, and documented in the modelling study report". The requirements above are to ensure that all seasonal scenarios are simulated in the model run, and to ensure that simulations are not based on a single anomalous year of meteorological data. We recommend that the Airshed simulations be repeated with at least one full year of meteorological data, although a multi-year dataset would be preferable in line with the Modelling Regulations.

Our final concerns with the Airshed assessment relate to the output percentile and averaging periods. The following statement is made in the Airshed report (page 48): "*The requirement for the INFOTOX health risk assessment was to provide the 98th percentile of the hourly average concentrations and the 75th percentile of the daily average concentration.*"

These percentiles are the only outputs tabulated for the VOCs and other odorous compounds. While this might be appropriate for a health assessment, in an odour assessment, particularly where there is a known odour nuisance, the 100th percentile concentrations are relevant in the assessment of potential worst-case community exposures to odorous pollutants. Furthermore, hourly average concentrations are not sufficient for understanding odour events, which are likely to occur on shorter averaging periods. Mean hourly concentrations (the finest temporal resolution of most atmospheric dispersion models) can be converted to peak short-term concentrations (e.g. for 10-minute averages) using well-documented statistical relationships (e.g. Hinds, 1969; Smith, 1973; Belgioro et al., 2013)³.

The uncertainty associated with any dispersion model depends is a combination of the uncertainties inherent in the adopted model and the uncertainties in the model input data. There are immediate concerns with the emission inputs and the meteorological data period in the Airshed assessment. Reliance on these model outputs for any community health or odour assessment therefore is problematic. On this basis, we recommend that further measurements of the site's VOC and other odour compound emissions takes place to validate existing measurements. Emission concentration and flow rate inputs to Airshed's CALPUFF model are based on single measurements when emissions from some sources may be highly variable. Furthermore, the dispersion modelling assessment needs to be rerun with at least one full year of meteorological data that would cover a winter period, during which worst-case dispersion conditions are likely to occur. Finally, modelling outputs of VOCs and other odorous compounds should be presented at the 100th percentile as well as the 98th percentile for comparison, and hourly average concentrations should be converted to shorter averaging periods. This would allow for an assessment of community exposure to odour nuisance.

Yours faithfully,



Dr Lisa Ramsay
Air Quality Specialist

³ Hinds, W.T. 1969. *Peak-to-mean concentration ratios from ground-level sources in building wakes* in *Atmospheric Environment*, 3: 145-156.

Smith, M.E. 1973. *Recommended Guide for the Prediction of the Dispersion of Airborne Effluents*, ASME, New York.

Belgioro, V.; Naddeo, V. and Zarra, T. (eds.). 2013. *Odour Impact Assessment Handbook*, John Wiley, Chapter 5, page 135.



Table 1: Volatile organic compound (VOC) ambient monitoring results

Sample location	1 (Screening)												4a												
	Downwind			Fence line			Waterberry			MIS			Plantations			Downwind			Upwind			Plantations			
	06-Apr-17			08-May-17			14-May-17			15-May-17			09-Jun-17			09-Jun-17			09-Jun-17			09-Jun-17			
Date	No blank												Blank corrected*						Blank corrected*						
QA/QC	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	
Unit	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	ppb	µg/m ³	
1,3,5-trimethylbenzene	1.12	5.50	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzene	9.55	30.50	0.89	2.85	BDL	1.15	3.67	4.68	14.94	7.34	23.46	2.58	9.46	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	2.30	10.00	0.91	3.94	0.23	1.01	0.28	1.21	1.60	8.56	1.46	6.34	0.91	3.96	0.02	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
m/p-xylene	4.15	18.00	3.18	13.70	0.92	4.00	1.08	4.67	3.15	13.67	2.35	10.22	2.07	8.99	0.01	0.03	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
o-xylene	1.96	8.50	1.57	6.60	0.39	1.71	0.50	2.18	1.24	5.30	1.01	4.38	0.35	4.12	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Styrene	17.96	76.50	0.48	2.03	0.21	0.90	0.10	0.87	2.26	9.63	3.73	16.16	0.82	3.51	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Tetrachloroethene	142.57	567.00	0.19	1.30	0.05	0.37	0.04	0.30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Toluene	14.99	56.50	2.50	9.43	0.45	1.70	0.54	2.03	8.57	32.29	13.59	51.23	8.41	31.59	0.18	0.69	0.02	4.32	16.28	3.07	11.58	10.71	40.36	3.48	13.11
Trichloroethene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2.78	14.93	3.37	18.11	1.35	10.48	BDL	BDL	BDL	1.30	10.23	0.16	0.65	BDL	BDL	5.70	30.64

BDL -Below Detection Threshold

* If a field blank measured below the detection limit for a specific pollutant, the blank mass on the tube was assumed to be half the detection limit.

Samples shaded in grey were collected in a Tedlar bag before transfer to Tenax tubes in the laboratory. All other samples collected directly to Tenax tubes in the field.

Conversions from µg/m³ to ppb assumed a 20°C ambient temperature.



Figure 1: Sampling sites for Campaign 4, 9 June 2017